THE NEARSHORE ZOOPLANKTON OF LAKE MICHIGAN ADJACENT TO THE LUDINGTON PUMPED - STORAGE RESERVOIR

Thesis for the Degree of M. S.

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WALTER G. DUFFY

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ABSTRACT

THE NEARSHORE ZOOPLANKTON OF LAKE MICHIGAN ADJACENT TO THE LUDINGTON PUMPED-STORAGE RESERVOIR

By

Walter G. Duffy

Inshore zooplankton distributions and densities at six stations near Ludington, Michigan were investigated from 29 April to 31 October, 1973 and from 10 May to 4 November, 1974. Samples were collected biweekly using a pump and net method.

Distribution and abundance of major taxa (Cladocera, Cyclopoida, Calanoida, Rotifera, and copepod nauplii) in 1973 and 1974 and species in 1974 were investigated at six stations. In addition vertical distribution of species and total zooplankton at one station on three dates in 1974 are compared.

Distributions were generally comparable between the stations for both years. Total zooplankton density did not show large year to year variation, but composition of the major taxa differed between years.

Two periods of zooplankton abundance were observed during both years. Density in spring was low but soon

increased to a June maximum. A second period of abundance was recorded in August of 1973 and July of 1974. Densities in both years were low in September and showed slight increases in late fall.

Total zooplankton were found concentrated at different strata during different seasons. Certain species exibited preferences for different strata of the water column.

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Walter G. Duffy

A THESIS

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INTRODUCTION

The purpose of this research was to determine seasonal abundance and distribution of zooplankton in a nearshore area of Lake Michigan adjacent to a pumped storage reservoir. Zooplankton occupy a central location in aquatic food chains. Although the zooplankton are not directly utilized as a resource for man, they are the main trophic link between algae and fish.

The distribution of zooplankton populations is influenced by an array of chemical, physical, and biological variables. Of all the variables which affect zooplankton, temperature, food, competition, and predation are believed to have the greatest impact (Brooks and Dodson 1965; Hall, Cooper, and Werner 1970). Whether these variables act independantly, additively, or synergisticly is not clear in all cases.

Great Lakes zooplankton were viewed in past years as a stable component of the aquatic ecosystem. Damman (1966) noted gradual increases in total plankton counts from Lake Michigan over a 33 year period. Studies conducted by Wells (1960, 1970) dispelled the idea of

zooplankton stability in Lake Michigan. Wells noted dramatic changes in species composition and size of the zooplankton between 1954 and 1966. The alewife was implicated as the cause of these changes. Studies by Gannon (1972) revealed that species composition may change considerably from year to year. Studies by Roth (1973), Stewart (1974) and this study substantiate the variability of year to year zooplankton composition.

A REVIEW OF LAKE MICHIGAN ZOOPLANKTON STUDIES

Thirty one studies of Lake Michigan zooplankton have been undertaken to date. Lake Michigan zooplankton studies remain descriptive in nature. Earlier works concentrated on taxonomy, while later works emphasize distribution.

Birge (1882) described Cladocera found in the City of Chicago water supply. Forbes (1882) described zooplankton Crustacea collected near Racine, Wisconsin, and Chicago, Illinois, as well as in Grand Traverse Bay. Ward (1896) included quantitative information on plankton from vertical net hauls in Grand Traverse Bay. Marsh (1895), Jennings (1896), and Kofoid (1896) described the Copepoda, Rotifera, and Protozoa respectively of Wards examination of Grand Traverse Bay.

Eddy (1927) collected phytoplankton, Protozoa, Rotifera, and Crustacea using net tows nearshore in southern Lake Michigan. He obtained the first data on seasonal distribution. In the first offshore study, Ahlstrom (1936) added qualitative information on phytoplankton, Protozoa, and Rotifera in southern Lake Michigan.

Damman (1945) examined plankton in the City of Chicago water intake from 1926 through 1942 and again from 1943 to 1958, Damman (1960). Zooplankters were identified to genus from 1926 to 1942 and total plankton were recorded from 1943 to 1958. He conducted a similar study of plankton from the city of Milwaukee, Wisconsin water intake from 1940 through 1963 (Dammon 1966). Williams (1962, 1966) identified rotifers to genus from water intakes at Gary, Indiana, and Milwaukee, Wisconsin in 1959 through 1961 and 1961 through 1962.

The first quantitative study of Lake Michigan zooplankton vertical and seasonal distribution was conducted by Wells (1960). He used a Clarke-Bumpus sampler to sample at a station 13 km west of Grand Haven, Michigan in 1954 and another 8 km west of Frankfort, Michigan in 1955. Data on vertical distribution and seasonal abundance were obtained. Wells (1970) resampled the station 13 km west of Grand Haven in 1966 and 1968 using identical methods at the same time of year. He noted dramatic changes in species composition and size of zooplankton between 1954 and 1966. Most larger species had declined sharply, while those smaller species showed increases in abundance. Alewife abundance in 1966 was believed to be the causative agent. His data from 1968 gave evidence that the zooplankton were shifting back

toward pre-alewife (1954) compositions after the alewife die-off of 1967.

McNaught (1966) and McNaught and Hasler (1966) correlated vertical distribution and rate of movement in relation to light quality at depths for several species off Saugatuck, Michigan in 1964 and off Ludington, Michigan in 1965. Lane and McNaught (1970) mathematically analyzed McNaughts 1964 data and suggested that vertical migration is the major mechanism for seperating niches of omnivorous and herbivorous zooplankton in Lake Michigan.

Robertson (1966) reported seasonal distribution of diaptomid copepods in western Lake Michigan for 1964. Robertson and Powers (1965, 1967) analyzed zooplankton biomass measurements made during 1964 and 1966. Ayers and Huang (1967) reported biomass measurements taken in Milwaukee Harbor during 1964. Robertson (1968) employed a Hardy continuous plankton recorder in Lake Michigan in 1965 and 1966. Swain, Olson, and Odlaug (1968, 1970) towed a continuous plankton recorder along the length of Lake Michigan in July and August of 1966 and July and October 1967. Data on horizontal distribution by genera were presented. Manny and Hall (1969) presented mid-summer zooplankton data taken near Grand Haven, Michigan in 1968.

Gannon (1972) conducted the most comprehensive study of zooplankton Crustacea to date. He sampled zooplankton at stations in Milwaukee Harbor, 16 km east of Milwaukee, Wisconsin, and in Green Bay. Data on horizontal distribution of zooplankton on a transect from Milwaukee, Wisconsin to Ludington, Michigan were also presented. Seasonal distribution and abundances between these areas was compared. Alewife predation on various species was measured. Effects of eutrophication on the zooplankton community was shown via comparisons between stations.

Stemberger (1974) obtained data on seasonal abundance of rotifers in Milwaukee Harbor and adjacent Lake Michigan from July 1972 through June 1973. This study added greatly to the limited data on Great Lakes Rotifera.

Recently, several studies have focused on the effects of power generating facilities on the Lake Michigan zooplankton communities. Roth (1973) and Stewart (1974) studied the zooplankton in the vicinity of Cook Nuclear Plant, Bridgeman, Michigan in 1972 and 1973. This study of southeastern Lake Michigan continues at this time. Industrial Biotest Laboratories (1973) studied the effects of thermal effluents from power plants in southwest Lake Michigan.

DESCRIPTION OF SAMPLING AREA

The inshore sampling area of Lake Michigan was 6.4 km (4.0 mi) south of Ludington, Michigan, adjacent to the pumped-storage hydro-electric plant (Fig. 1). Station one was 4.8 km (3 mi) south of the breakwall (Table 1). Station one served as the control station because this site was considered to be unaffected by currents from the power plant. Station two was 1.6 km (1 mi) south-southeast of the southern jetty. Station three was .8 km (.5 mi) south of the breakwall. Station four was about 2.4 km (1.5 mi) west-southwest of the breakwall. Station six was 1.6 km (1 mi) north of the northern jetty. Sampling station depths and bottom sediment composition are shown in Table 1.

Deposition of bottom material at stations two and three resulted in depth changes at these stations between November 1973 and April 1974. In 1974 the depth at station two was six meters and at station three twelve meters.

Figure 1.--Map and location of sampling sites near the Consumers Power Pumped-Storage Reservoir.

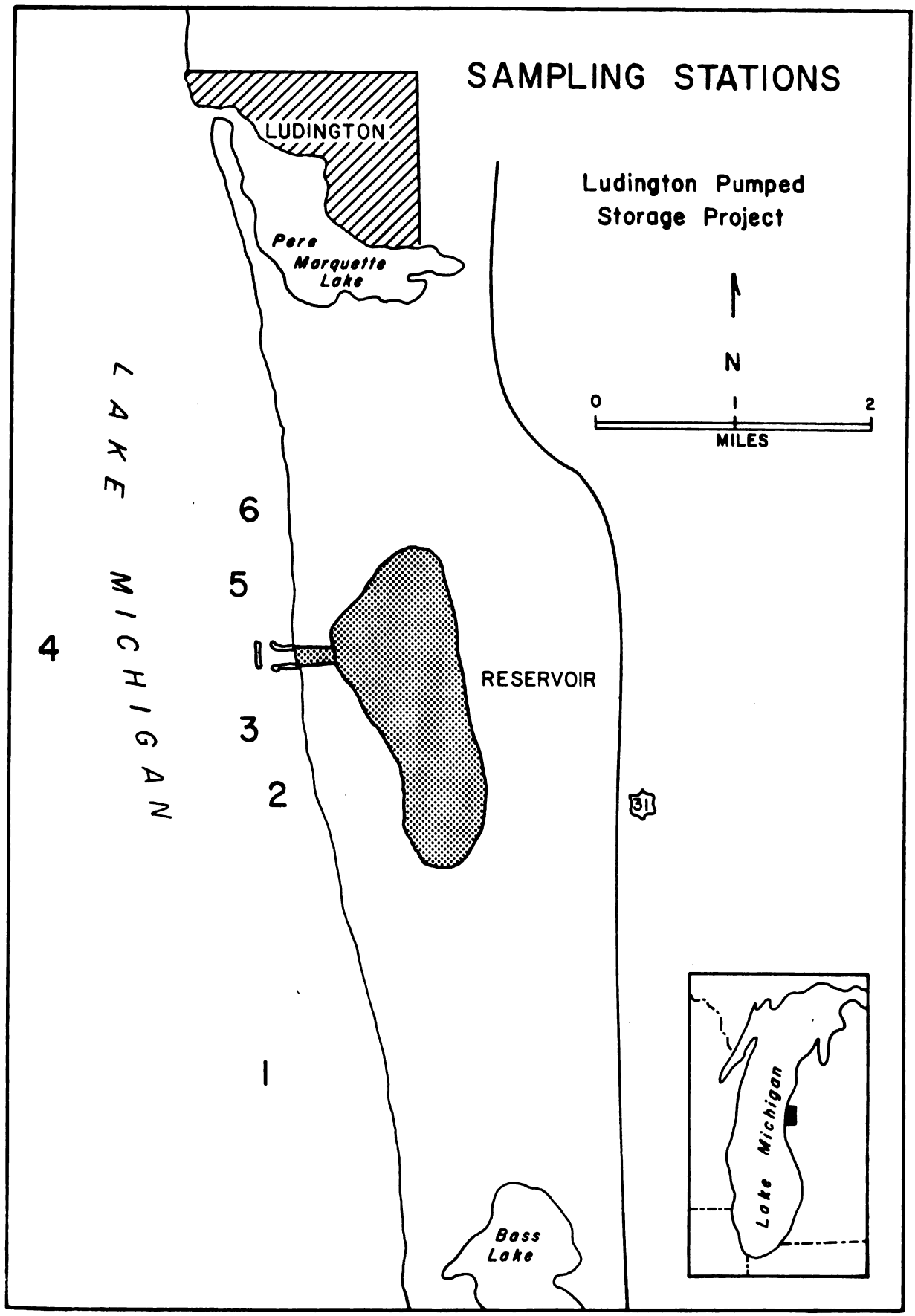

SAMPLING STATIONS
LUDINGTON
Pere Marquette Lake
Ludington Pumped Storage Project
N
0
1
2
MILES
LAKE MICHIGAN
6
5
4
RESERVOIR
3
2
1
31
Bass Lake
Lake Michigan

TABLE.1.--Location of sampling sites, their depths and bottom sediment description.

Station	N Lat.	W Long.	Depth (m)	Type
1	43° 51' 00"	86° 27' 20"	12	sand
2	43° 52' 45"	86° 26' 50"	8*	sand
3	43° 53' 5"	86° 27' 20"	14*	sand, gravel
4	43° 53' 30"	86° 29' 00"	24	silty sand and clayey silt
5	43° 54' 20"	86° 27' 35"	12	sand, gravel, rocks
6	43° 54' 50"	86° 27' 10"	6	sand, rocks

*In 1974 the depth at station two was 6 m and at station three 12 m.

Water Temperature

Water temperature measurements taken at stations of three different depths are shown in Figures 2 and 3. Unstable thermal conditions existed during both years due to vertical movements of the thermocline, station four in 1974 being an exception. These "upwellings" are common along the eastern shore and have been documented by various authors (Carr, Moffett, and Gannon 1973; Liston et. al. 1974; and Siebel and Ayers 1974). Upwellings during both years are indicated by temperature drops during June through Septemeber in Figures 2 and 3. Siebel and Ayers (1974) said, "Direct wind influenced upwelling is thought responsible for the natural daily fluctuations in excess of 12°F while a combination of factors seems a palusible explanation for the smaller ranges." The greatest upwelling occurred on 22 August, 1973. At the shallow zones, temperatures dropped from 22°C on 15 August, to 5°C on 22 August. On 27 August water temperatures were 20°C again. Another strong upwelling occurred on 17 September 1973. Examination of Figure 3 illustrates that 1974 water temperatures could be characterized as being more stable in the June to September period. At the deepest station (four) a thermocline developed in June which persisted through September.

Figure 2.--Surface and bottom water temperatures at stations one, four, and six during 1973.

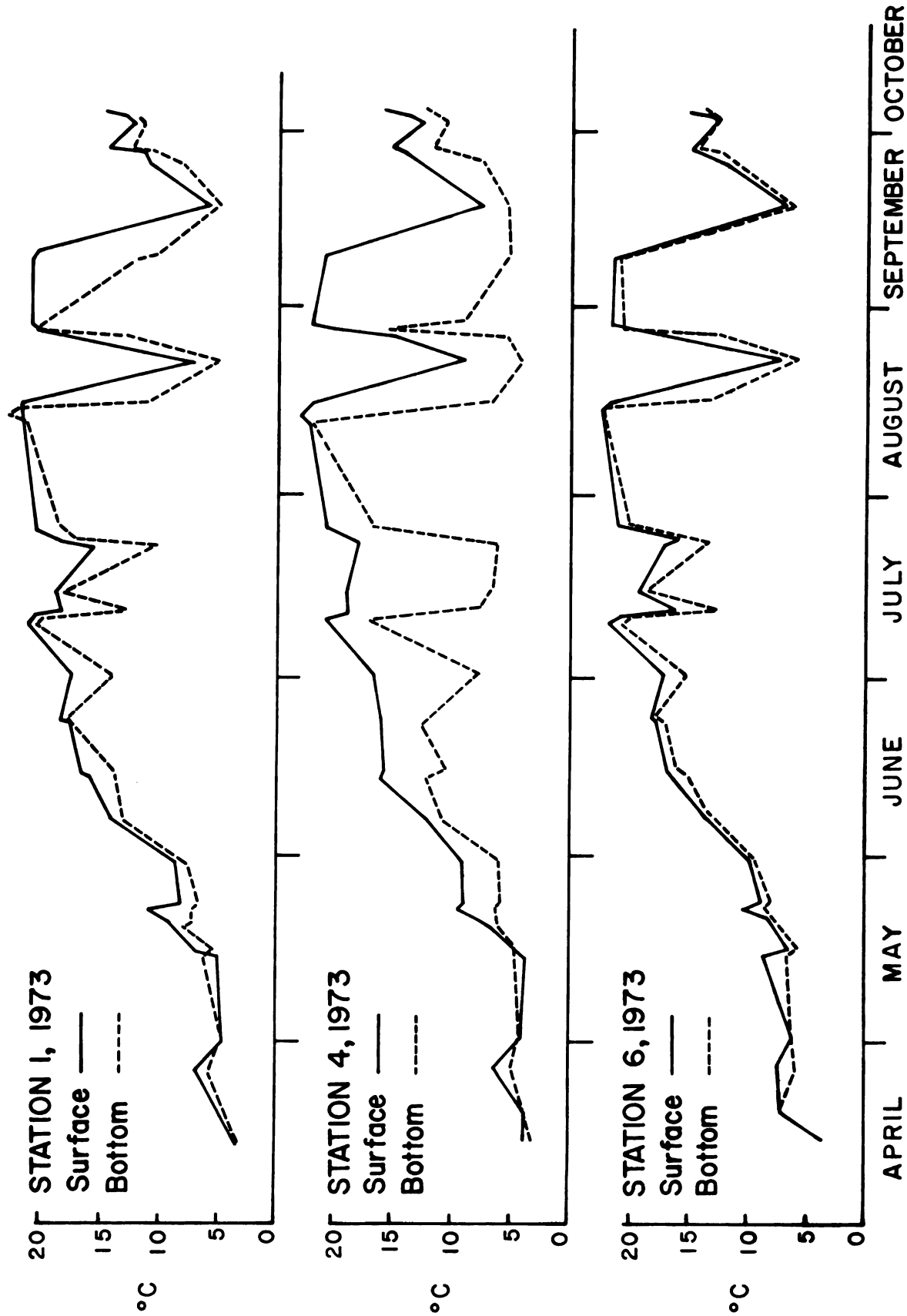
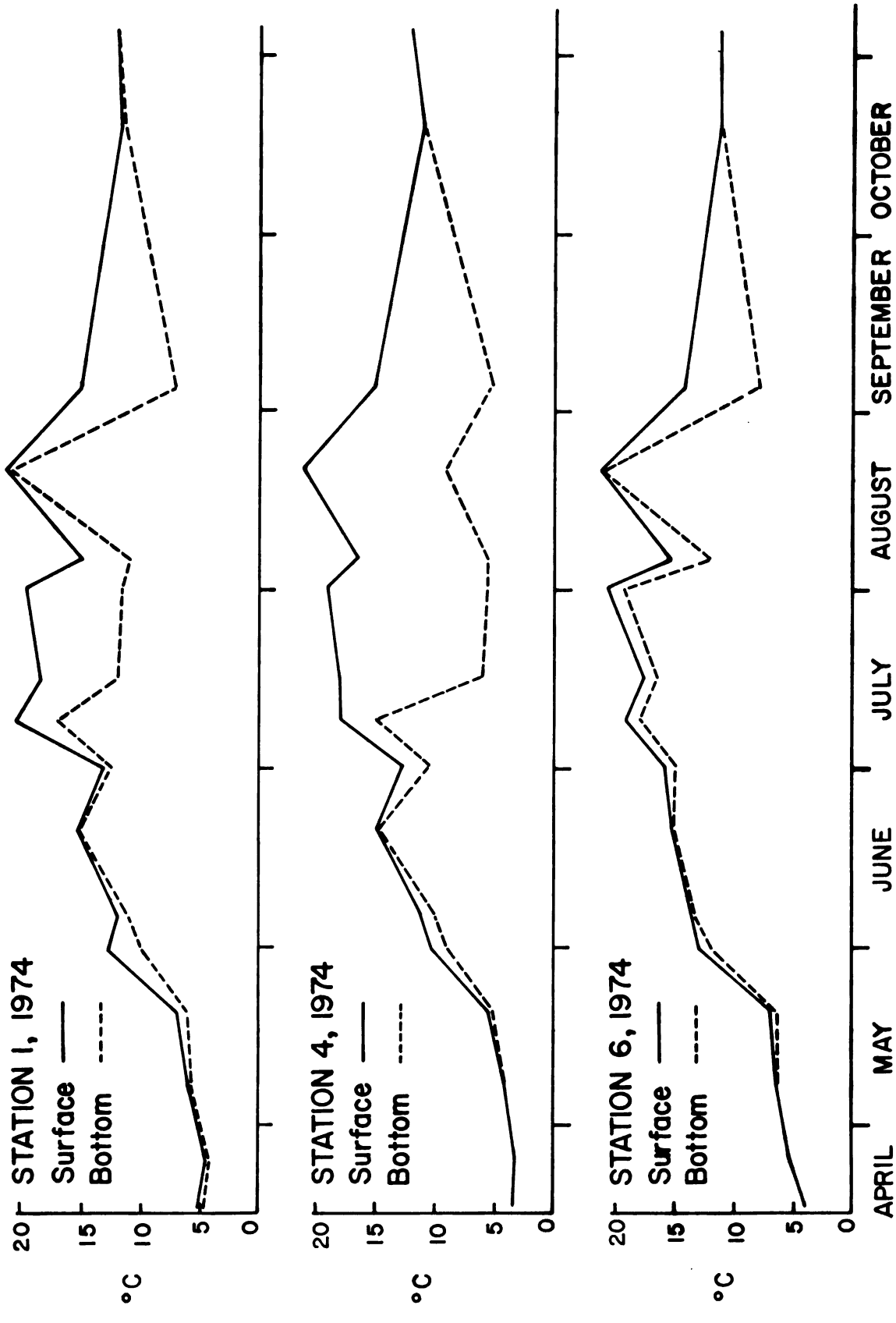

STATION 1, 1973
Surface
Bottom
STATION 4, 1973
Surface
Bottom
STATION 6, 1973
Surface
Bottom
°C
20
15
10
5
0
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER

Figure 3.--Surface and bottom water temperatures at stations one, four, and six during 1974.


STATION 1, 1974
Surface
Bottom
STATION 4, 1974
Surface
Bottom
STATION 6, 1974
Surface
Bottom
°C
20
15
10
5
0
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER

A general year by year comparison reveals that water temperatures were slightly greater in April, 1973, and attained higher maximum values (23.0°C in 1973; 21.0°C in 1974). Natural variations in warm-up time, maximum temperatures, and temperature stability existed between years. These year by year fluctuations no doubt influence primary and secondary productivity in the lake.

METHODS AND MATERIALS

Field Methods

Zooplankton samples were taken between 7:00 A.M. and noon biweekly from 29 April through 31 October, 1973 and 10 May through 4 November, 1974 using a pump and net method (Edmondson and Winberg, 1971). Adverse weather sometimes dictated changes in the sampling schedule. Duplicate samples were taken at depths of one meter, four meters, and one meter above bottom at each station. At stations two and six in 1974, only one and four meter collections were taken.

The collection technique was as follows: (1) 100 liters of water was pumped through a number 20 mesh (64u) nylon plankton net; (2) the samples were emptied into sample bottles and preserved in 10% formalin; (3) the preserved samples were allowed to settle at least one week and were then aspirated down; (4) the 10% formalin was replaced with 70% ethanol and several drops of glycerol. After the concentration process samples were approximately 50ml in size. In 1974 several ounces

of club soda were added to each sample prior to preservation in formalin to relax the animals and minimize distortion of taxonimic features, (Gannon and Gannon, 1975).

Laboratory Methods

The 1973 samples were enumerated to major groups only; i.e., copepod nauplii, Calanoida, Cyclopoida, Cladocera, and Rotifera using a counting wheel (Ward, 1955) and binocular microscope (magnification 7-60x). Each sample was mixed using a magnetic stirrer with care taken not to stir the sample faster than necessary. After the sample had mixed a sub-sample of 5 to 10ml was removed from the center of the sample using a 50ml syringe, and the organisms were enumerated.

The 1974 samples were identified to species using a binocular microscope (magnification 10-280x), a compound microscope (magnification 100-400x), and a chambered counting cell (Gannon, 1971). Each sample was drawn off. Sub-sample size was gauged so as to count 100-150 of the common species. When zooplankton were abundant and the sub-sample was small, a second sub-sample of 10ml was taken and only uncommon species were enumerated.

Taxonomy follows Brooks (1959), Chengalath et. al. (1971) Deevey and Deevey (1971), Pennak (1963), and Wilson (1959).

Statistical Methods

Estimation of zooplankton populations in the lake depend on the precision of the sampling method, random distribution of assume subsamples enumerated in the laboratory and errors of enumeration are random.

Mosely (1974) suggests that the effect of continued sampling on precision of observations can be measured by the formula $D = s/ n \bar{x}$. Where D = units of precision, s = the standard deviation, n = number of samples, and $\bar{x}$ = the mean number of organisms in n samples. He says that increasing the value of n (samples) will illustrate the effect of continued sampling on precision, assuming a good estimate of the standard deviation(s) is available.

This formula was applied to total zooplankton data collected on 3 June 1974. The test was applied in increments of sampling stations to determine the precision gained as the number of stations increased. Results imply that precision gained after 22 samples (4 stations) is slight (Table 2). Because of the labor involved in collecting and counting samples a reduction in total samples is justified. This could also free the investigator of excess labor and allow a more detailed analysis of the data.

A test for randomness of subsamples and counting errors was performed by removing 10 replicate 2 ml subsamples from one 50 ml sample. Bosmina sp., nauplii,

TABLE 2.--Precision of sampling method as number of samples increases, where $D = s/\sqrt{n}\,\bar{x}$.

Number of samples	6	12	16	22	26	32
D	0.45	0.30	0.26	0.22	0.20	0.18

Cyclops sp., and Diaptomus sp. were counted using procedures identical to thos employed in 1974. Each subsample was returned to the sample bottle following enumeration. The Chi-square (x^2) was used to test for randomness of these data (Lune, Kipling, and LeCren, 1958). The four taxa enumerated satisfied the condition of randomness (Table 3).

TABLE 3.--Counts of 4 taxa of 10 replicate subsamples.

Organism	Bosmina	Cyclops	Diaptomus	Nauplii
1	62	39	28	90
2	59	34	29	77
3	42	43	22	89
4	61	43	27	93
5	45	39	14	103
6	51	28	31	91
7	50	33	16	70
8	49	44	16	96
9	44	45	19	103
10	50	42	25	101
Mean ±(95%)	51.3±5.0	39.0±3.8	22.7±3.9	91.3±7.9
x^2	8.8	7.2	11.9	12.5

Data exhibit randomness if $X^2 < 16.92$.

When randomness of subsampling and counting procedures is satisfied, accuracy of counts can be estimated from confidence limits based on the Poisson distribution. An examination of Table 4 shows that accuracy is very low when counts are low (Table 4).

It is clear from Table 4 that a compromise between accuracy of counts and labor spent obtaining accuracy must be made.

TABLE 4.--Size of count and accuracy obtained.

Number of organisms counted	Expressed as percentage of count	Range
4	± 100%	0-8
16	± 50%	8-24
100	± 20%	80-120
400	± 10%	360-440
1,600	± 5%	1,520-1,680
10,000	± 2%	9,800-10,200
40,000	± 1%	39,600-40,400

SOURCE: Lund, Kipling, and LeCren, 1958.

Permanant sampling stations are established so that differences between these sites may be measured. One of the problems encountered by zooplankton workers is a large coefficient of variation between replicate samples at stations (Roth, 1973). This has the effect of destroying tests between stations. Variances can be reduced by logarighmic transformations (Elliot, 1972, UNESCO, 1968). These transformed data can then be treated with statistical methods designed for normally distributed populations. After transformation, data from the Ludington area did not satisfy the assumptions for analysis of variance; i.e., variances remained heterogeneous on all dates (Sokal and Rohlf, 1969).

Because of this, these data were treated by Scheffe's interval for selected contrast. Scheffe's interval is a pair-wise comparison of means and was chosen because it can be modified to get approximate answers when variances are heterogeneous (Gill, 1972). This test is relatively insensitive to type I errors.

RESULTS

Total Zooplankton, 1973

Total zooplankton densities were low (7,000 - 30,000/m^3) when sampling began on 29 April. Densities increased steadily through May and June (Fig. 2). Maximum density observed at any station (316,000/m^3) occured on 13 June, however the mean density for all stations was 134,000/m^3 (Table 5). The maximum zooplankton density for all stations combined (mean density 181,000/m^3) occurred on 30 June. Zooplankton abundance (8,000 - 53,000/m^3) declined sharply in July, this decline was followed by an increase in abundance (15,000 - 76,000/m^3) on 12 August. Densities in September were less than 10,000/m^3 at all stations, a slight increase (10,000 - 17,000/m^3) was found in October.

Total Zooplankton, 1974

The same general pattern of abundance noted in 1973 was found in 1974. The period of maximum abundance again was June. Densities recorded on 19 June ranged from 149,000/m^3 to 247,000/m^3 (Table 6). By 1 July zooplankton abundance (21,000 - 37,000/m^3) had declined

Figure 4.--Seasonal density of total zooplankton at station one in 1973 and 1974.

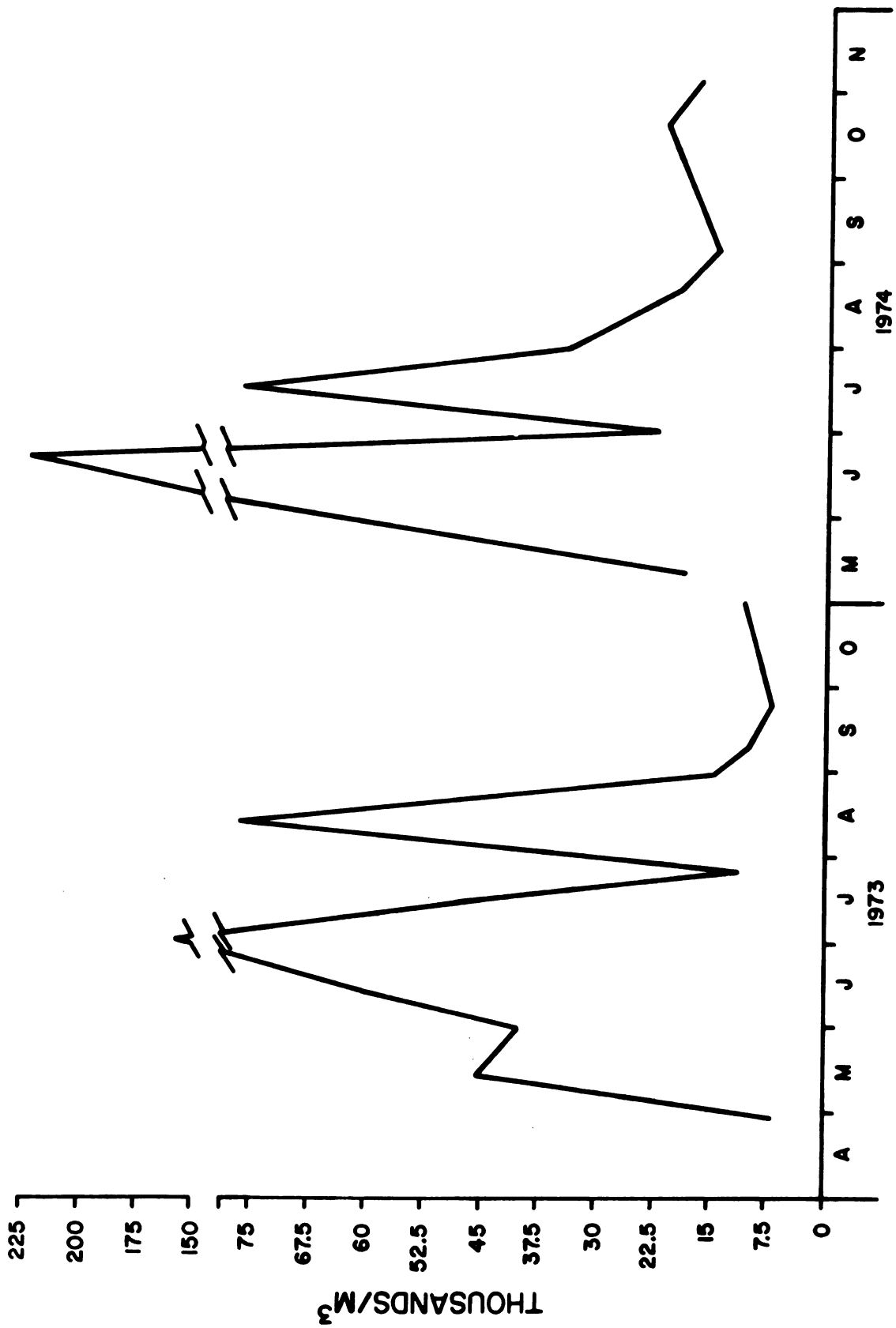

THOUSANDS/M³
225
200
175
150
75
67.5
60
52.5
45
37.5
30
22.5
15
7.5
0
A
M
J
J
A
S
O
1973
M
J
J
A
S
O
N
1974

Figure 4.--Seasonal density of total zooplankton at station one in 1973 and 1974.

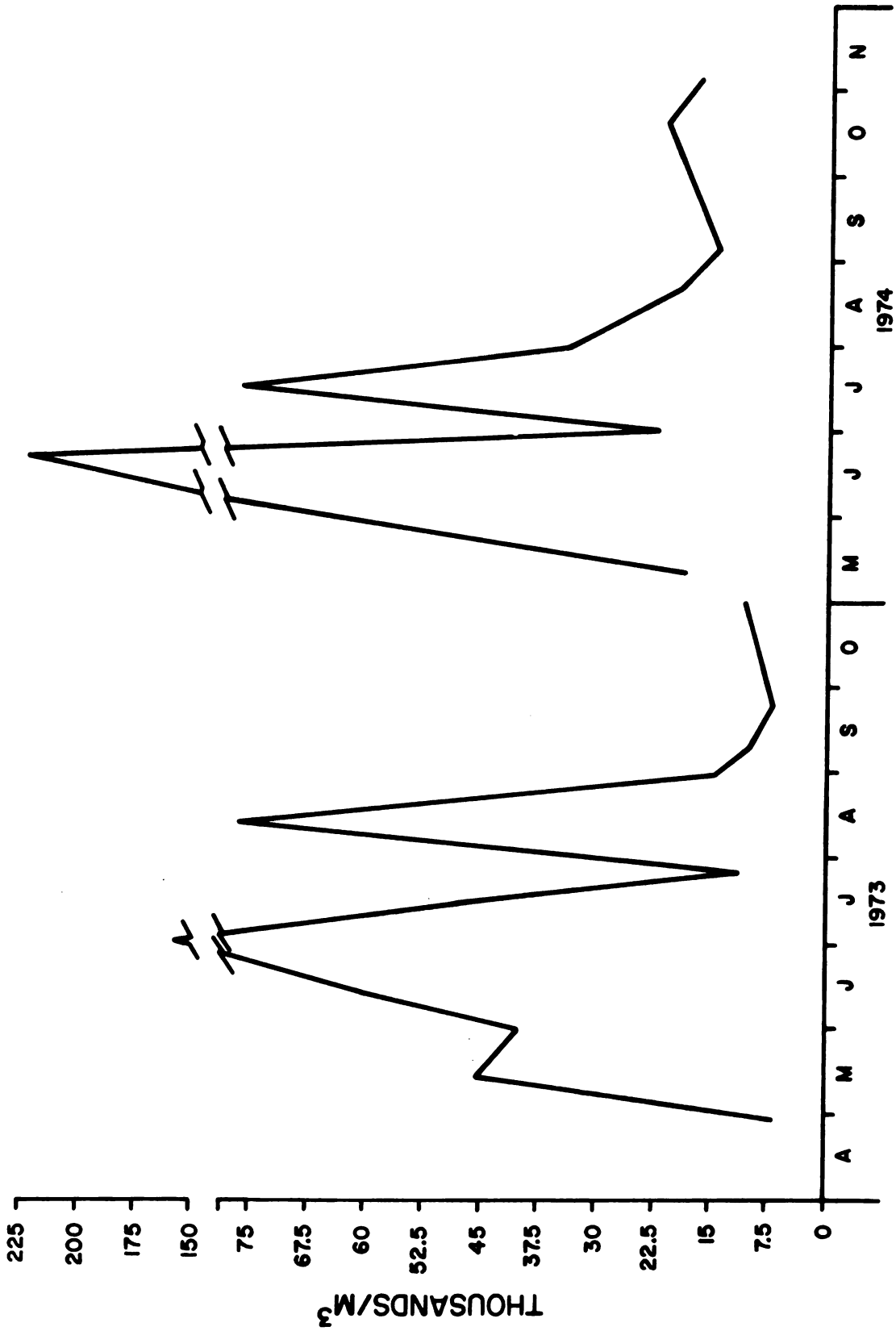

THOUSANDS/M³
225
200
175
150
75
67.5
60
52.5
45
37.5
30
22.5
15
7.5
0
A
M
J
J
A
S
O
1973
M
J
J
A
S
O
N
1974

TABLE 5.--Mean number of zooplankton/m^3 in 1973 ranked by increasing order of abundance at the sampling stations. Means underscored by a common line are not statistically different ($P < 05$).

29 April 1973

Station	1	2	3	4	5	6
Mean	6989	10446	13737	17128	21120	30893
Scheffe's						

13 May 1973

Station	4	2	6	3	1	5
Mean	15812	31244	37143	41438	45480	46344
Scheffe's						

30 May 1973

Station	2	1	3	5	4	6
Mean	32864	39852	53291	54436	59381	82414
Scheffe's						

13 June 1973

Station	2	1	4	3	6	5
Mean	21096	60615	87562	139738	180397	316234
Scheffe's						

30 June 1973

Station	4	1	3	2	5	6
Mean	122695	157539	181387	203329	211849	215214
Scheffe's						

14 July 1973

Station	6	5	3	4	1	2
Mean	21538	23754	30710	34889	47671	60216
Scheffe's						

25 July 1973

Station	6	1	2	5	3	4
Mean	8675	11329	17851	19123	25039	53874
Scheffe's						

TABLE 5.--Continued

12 August 1973

Station	6	5	4	2	3	1
Mean	15598	30251	33909	57510	60692	76057
Scheffe's						

28 August 1973

Station	4	3	6	5	1	2
Mean	7837	8302	10745	13410	14675	15061
Scheffe's						

8 September 1973

Station	4	5	2	3	6	1
Mean	3562	4958	6269	6691	7568	9294
Scheffe's						

24 September 1973

Station	2	6	3	1	5	4
Mean	3458	5395	6236	6798	7990	8182
Scheffe's						

31 October 1973

Station	3	1	2	4
Mean	10287	10967	13494	17271
Scheffe's				

TABLE 6.--Mean number of zooplankton/m^3 in 1974 ranked by increasing order of abundance at the sampling stations. Means underscored by a common line are not statistically different ($P < .05$).

10 May 1974

Station	1	3	4	2	5	6
Mean	18528	18740	20552	26960	30475	50026
Scheffe's						

3 June 1974

Station	1	2	3	6	5	4
Mean	75629	83575	102632	105129	172910	227694
Scheffe's						

19 June 1974

Station	2	6	5	1	3	4
Mean	149777	168990	210124	221932	224813	247083
Scheffe's						

1 July 1974

Station	1	6	3	2	4	5
Mean	21800	24838	25965	26574	28746	37776
Scheffe's						

15 July 1974

Station	6	4	5	3	1	2
Mean	46740	61603	89367	92429	96450	108536
Scheffe's						

1 August 1974

Station	6	2	5	4	1	3
Mean	16819	30819	32842	32969	33369	36647
Scheffe's						

20 August 1974

Station	2	1	6	3	5	4
Mean	19523	19739	20875	25330	27665	43064
Scheffe's						

4 September 1974

Station	6	3	1	5	4	2
Mean	10814	13141	14901	16733	28257	36117
Scheffe's						

TABLE 6.--Continued

13 October 1974

Station	4	6	2	3	5	1
Mean	13250	14632	19729	20196	20666	21392
Scheffe's						

4 November 1974

Station	6	5	1	3	4	2
Mean	13543	16124	17504	19653	21110	22268
Scheffe's						

sharply. As in 1973 a second period of increased abundance was noted, but occurred approximately one month earlier (15 July) than in 1973. After July zooplankton densities declined in August and remained relatively low throughout the fall.

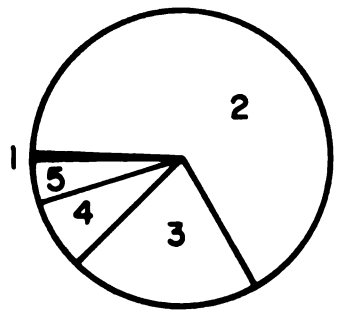
Composition of the 1973 and 1974 Zooplankton

Although total zooplankton densities were similar in 1973 and 1974 considerable difference was found in some major groups between years. Composition and seasonal abundances of the zooplankton by major groups is discussed below.

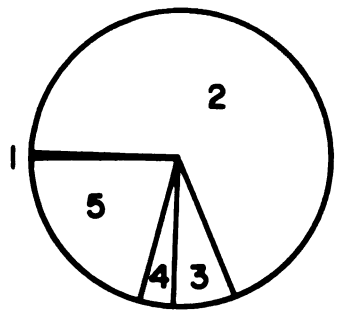
Calanoida

Calanoida comprised a minor portion of the spring and early summer zooplankton. They comprised from 1-21% (Fig. 3) of the April-June, 1973 zooplankton and 1-9% (Fig. 4) of the May-June, 1974 zooplankton. In August of both years Calanoida became important constituents of the zooplankton. They represented 12-49% of the August, 1973 zooplankton and 8-38% of the August, 1974 zooplankton. Calanoida remained prominant constituents of the fall zooplankton in both years. Numerically Calanoida were more abundant in 1973 than 1974 (Fig. 5). Maximum abundance occurred (37,000/m^3 in 1973 and 16,000/m^3 in 1974) in August of both years.

Figure 5.--Composition of the 1973 zooplankton at station one (1) Cladocera, (2) nauplii, (3) Calanoida (4) Cyclopoida, and (5) Rotifera.



29 APRIL



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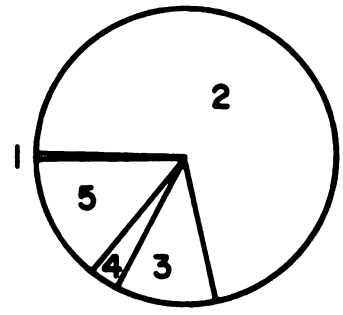

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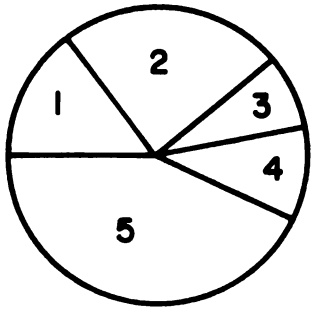
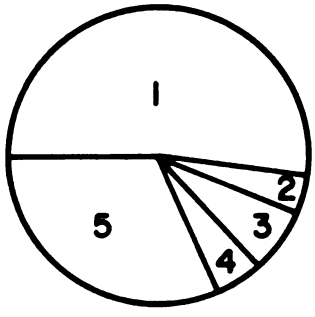
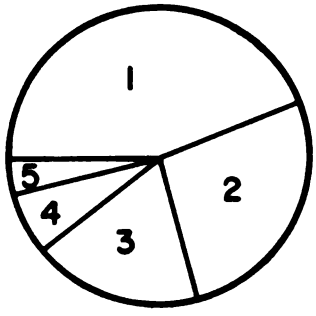


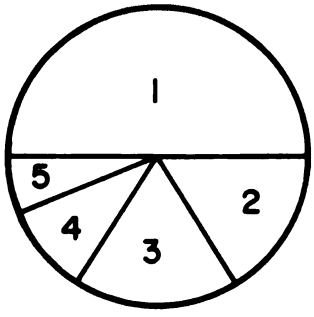
13 JUNE



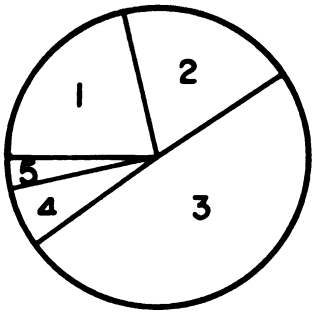
30 JUNE



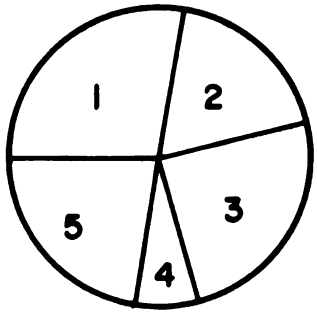
14 JULY



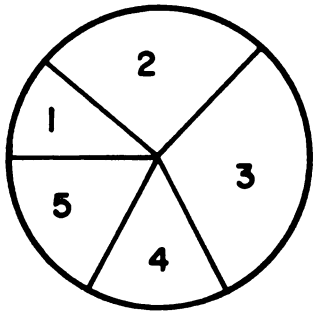
25 JULY



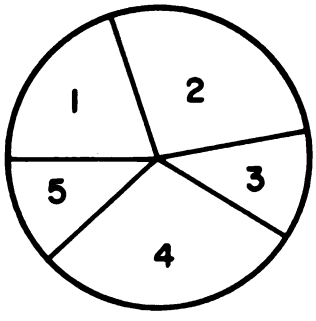
12 AUGUST



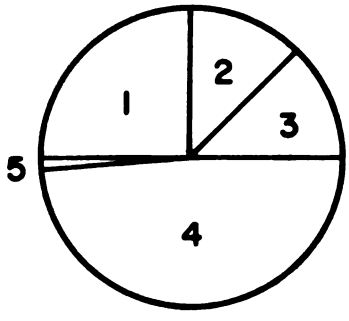
28 AUGUST



8 SEPTEMBER

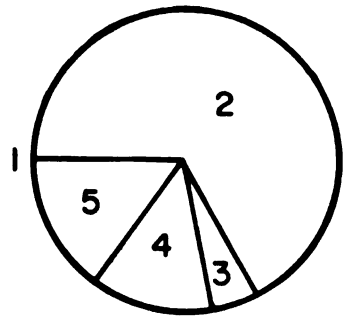


24 SEPTEMBER

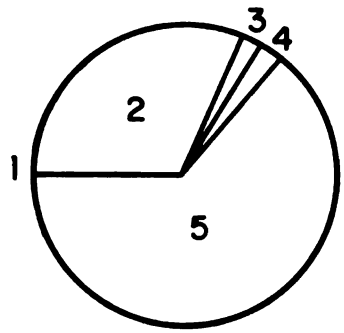


31 OCTOBER

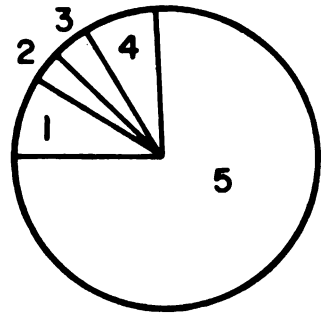
Figure 6.--Composition of the 1974 zooplankton at station one, (1) Cladocera, (2) nauplii, (3) Calanoida, (4) Cyclopoida, and (5) Rotifera.



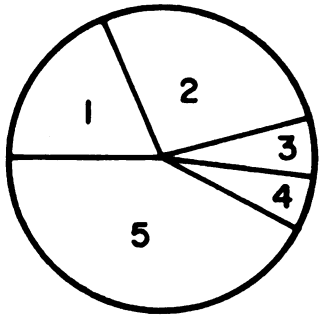
10 MAY



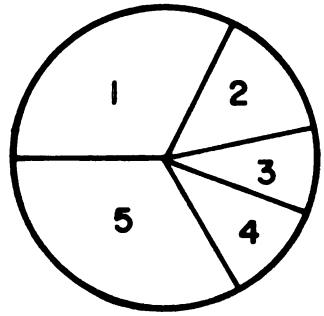
3 JUNE



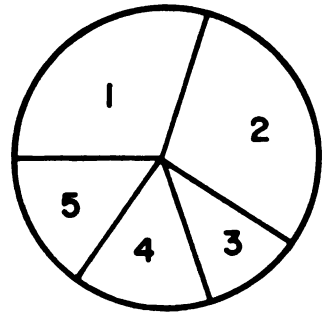
19 JUNE



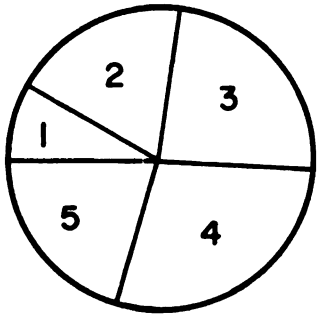
1 JULY



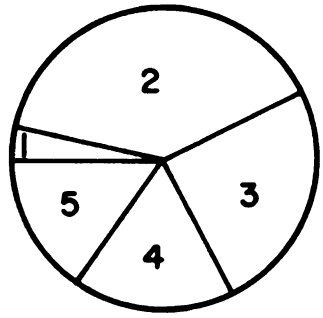
15 JULY



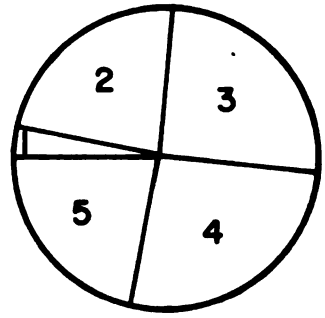
1 AUGUST



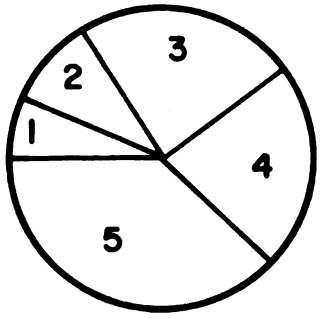
20 AUGUST



4 SEPTEMBER

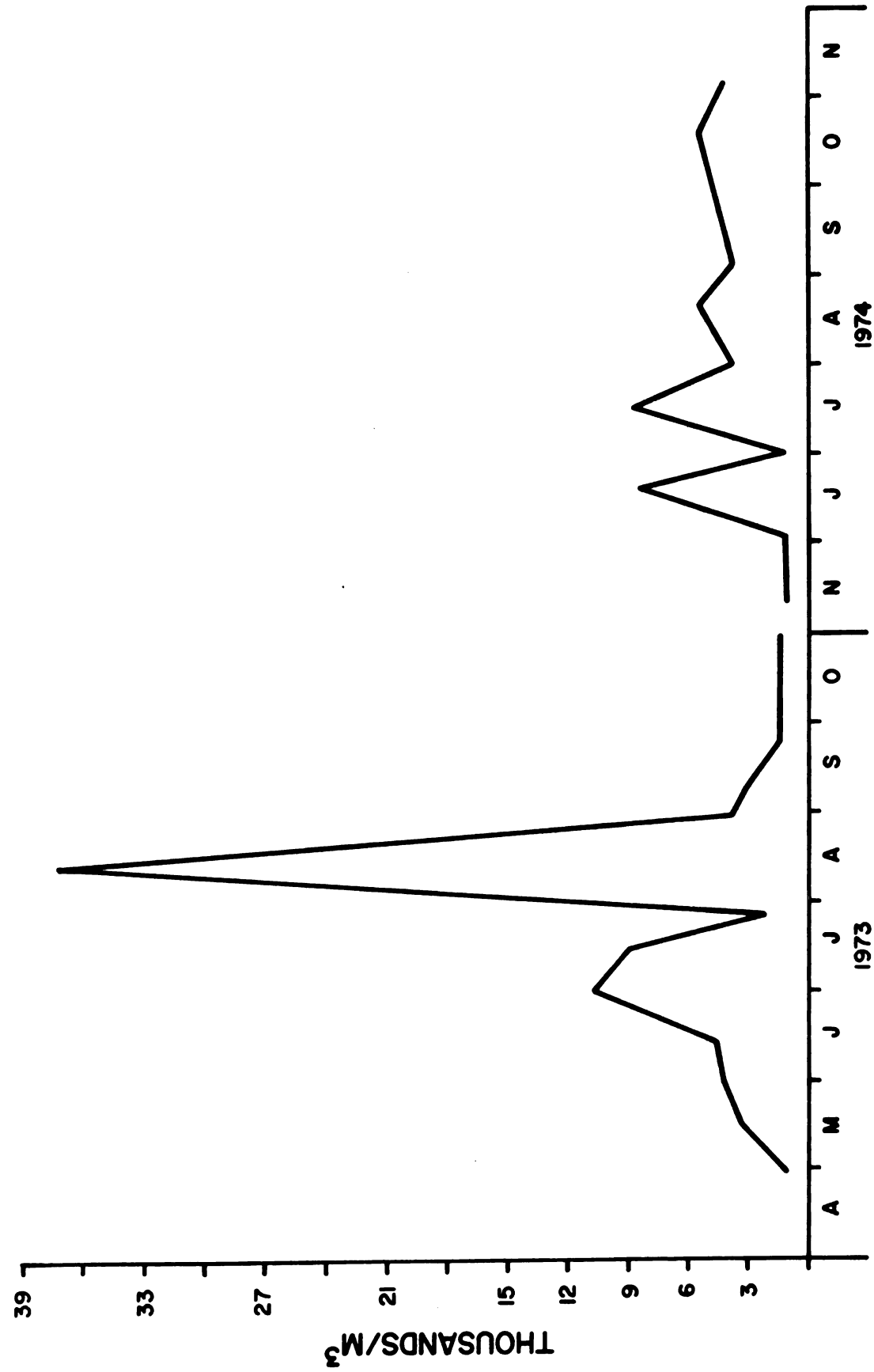


13 OCTOBER



4 NOVEMBER

Figure 7.--Seasonal density of Calanoida at staion one in 1973 and 1974.


THOUSANDS/M³
39
33
27
21
15
12
9
6
3
A
M
J
J
A
S
O
1973
N
J
J
A
S
O
N
1974

Cyclopoida

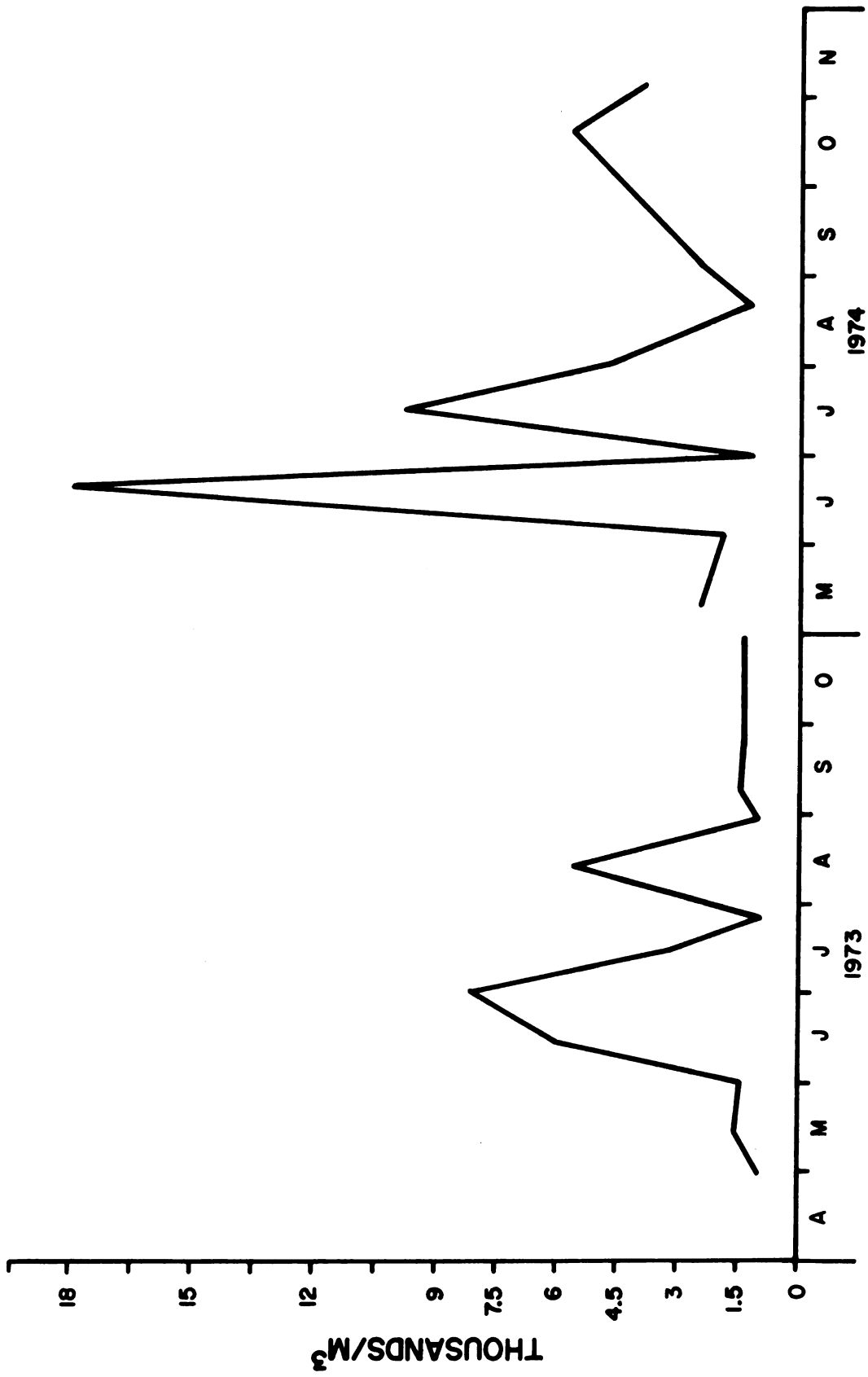
In April and May of both years Cyclopoida comprised from 1% to 13% of the zooplankton (Fig. 3 and 4). In June, the period of maximum density, they comprised 2-26% of the zooplankton. Through July and August Cyclopoida generally comprised 3-14% of the zooplankton although exceptions to this existed. Cyclopoida became prominant members of the zooplankton in September through completion of sampling in both years. In October, 1973 they clearly predominated the zooplankton, comprising 43-50% of the total. In October and November, 1974 they represented 21-31% and 13-34% of the total zooplankton respectively.

Although the percentage of the total zooplankton Cyclopoida represented was comparable between years numerical abundance was not. Maximum Cyclopoida densities in 1973 (15,000/m^3) were about one fourth those recorded in 1974 (56,000/m^3). Differences in densities were less pronounced after the June maximum abundance period (Fig. 8).

Copepod nauplii

The spring zooplankton was predominated by copepod nauplii. Copepod nauplii comprised 50-83% of the zooplankton in April and May, 1973 and 31-73% of the total in May, 1974 (Fig. 3 and 4). Maximum densities were

Figure 8.--Seasonal density of Cyclopoida at station one in 1973 and 1974.


THOUSANDS/M³
18
15
12
9
7.5
6
4.5
3
1.5
0
A
M
J
J
A
S
O
1973
M
J
J
A
S
O
N
1974

found on 30 May, 1973 (21,000-47,000/m^3) and 3 June, 1974 (12,000-78,000/m^3). After this period copepod nauplii declined both numerically (Fig. 9) and in the percentage of the zooplankton they represented (10-30%). In the period of August and September copepod nauplii comprised a larger portion of the zooplankton (17-40% in 1973 and 11-48% in 1974). This was the result of lower densities of other groups rather than an abundance of copepod nauplii. Copepod nauplii declined in October of both years.

Cladocera

In April and May of both years Cladocera were scarce and comprised less than 1% of the zooplankton at most stations. Cladocera were first recorded as abundant in mid June in both years (Figs. 3 and 4). This reflects the sudden appearance of large numbers of Bosmina longirostris which comprised over 90% of the Cladocera in June. Maximum densities (47,000-97,000/m^3) of Cladocera were found on 30 June, 1973 (Fig. 10). They comprised 36-51% of the zooplankton on this date. Densities in July, 1973 were 3,000-37,000/m^3 and still comprised 24-71% of the zooplankton. After July numbers declined, but Cladocera remained an important constituent of the zooplankton.

Figure 9.--Seasonal density of copepod nauplii at station one in 1973 and 1974.

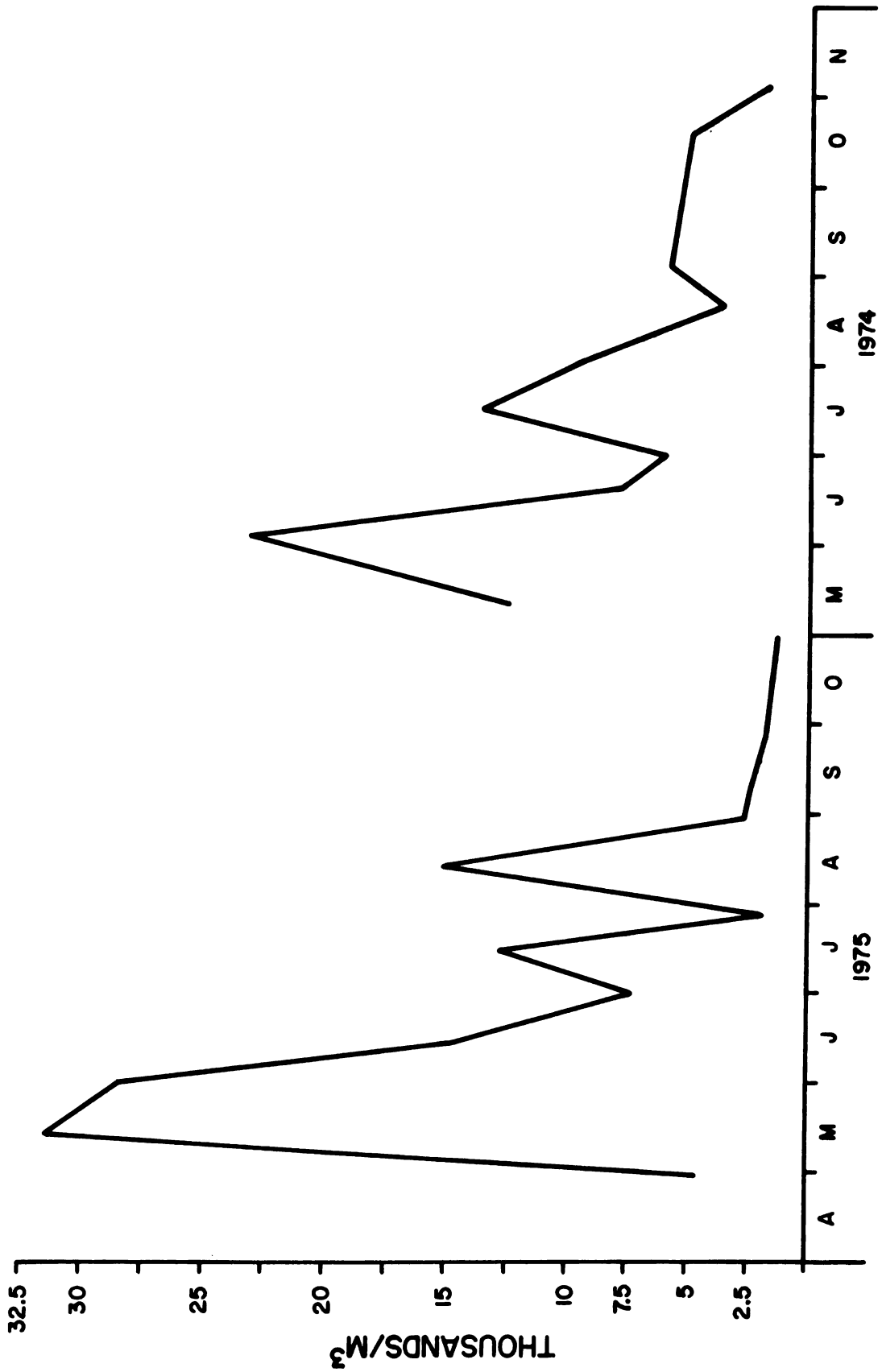
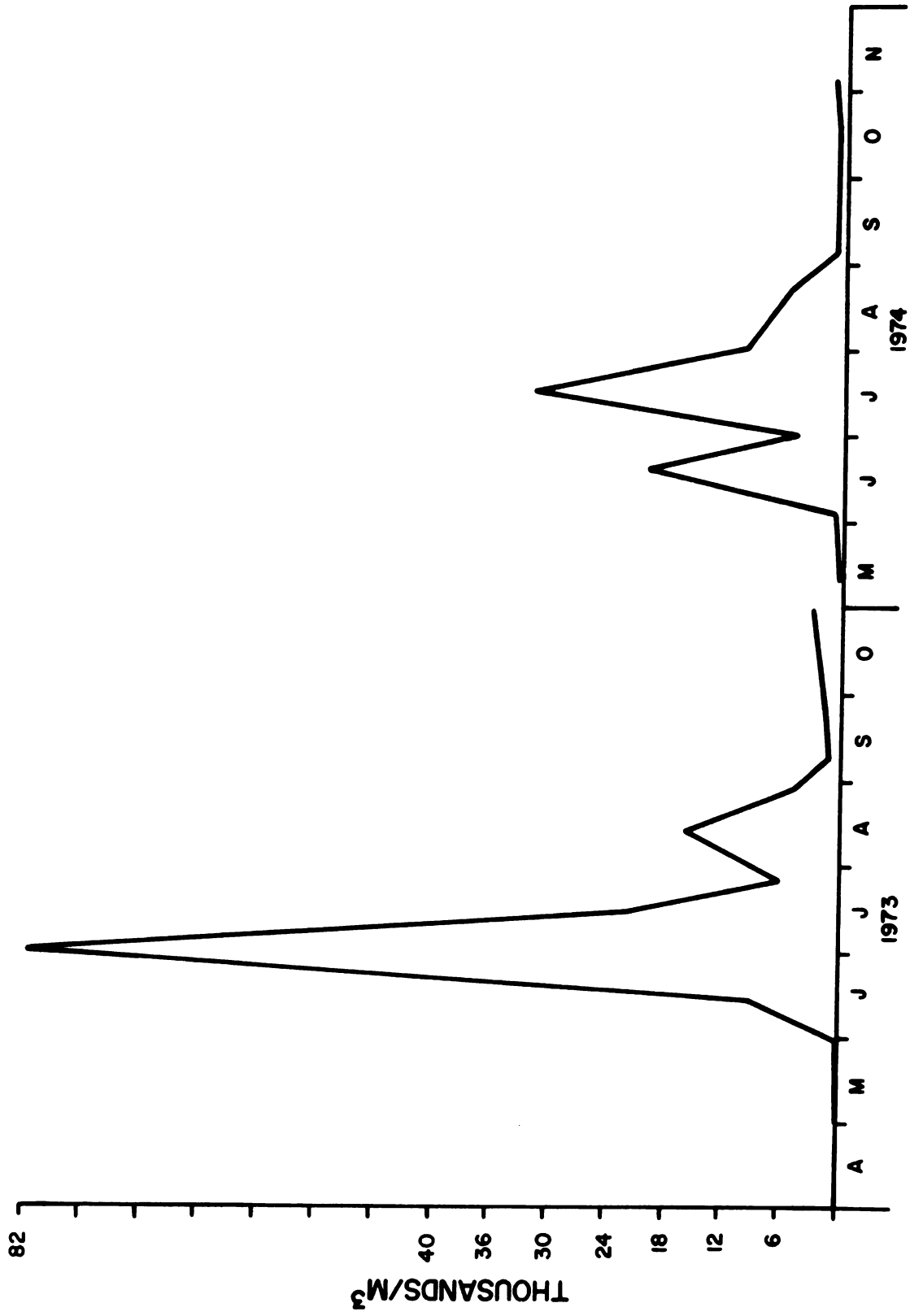

THOUSANDS/M³
32.5
30
25
20
15
10
7.5
5
2.5
A
M
J
J
A
S
O
1975
M
J
J
A
S
O
N
1974

Figure 10.--Seasonal density of Cladocera at Station one in 1973 and 1974.


THOUSANDS/M³
82
40
36
30
24
18
12
6
A
M
J
J
A
S
O
1973
M
J
J
A
S
O
N
1974

In 1974 Cladocera densities increased sharply in June, but failed to reach 1973 levels (Fig. 10). Cladocera comprised 8-24% of the zooplankton in June, 1974. Maximum densities (14,000-52,000/m^3) were found on 15 July, at this time Cladocera comprised 29-51% of the zooplankton. Cladocera comprised 10-30% of the August zooplankton and generally made up 2-10% of the total in fall samples. Numbers of Cladocera were lower in 1974 and the period of maximum abundance was two weeks later.

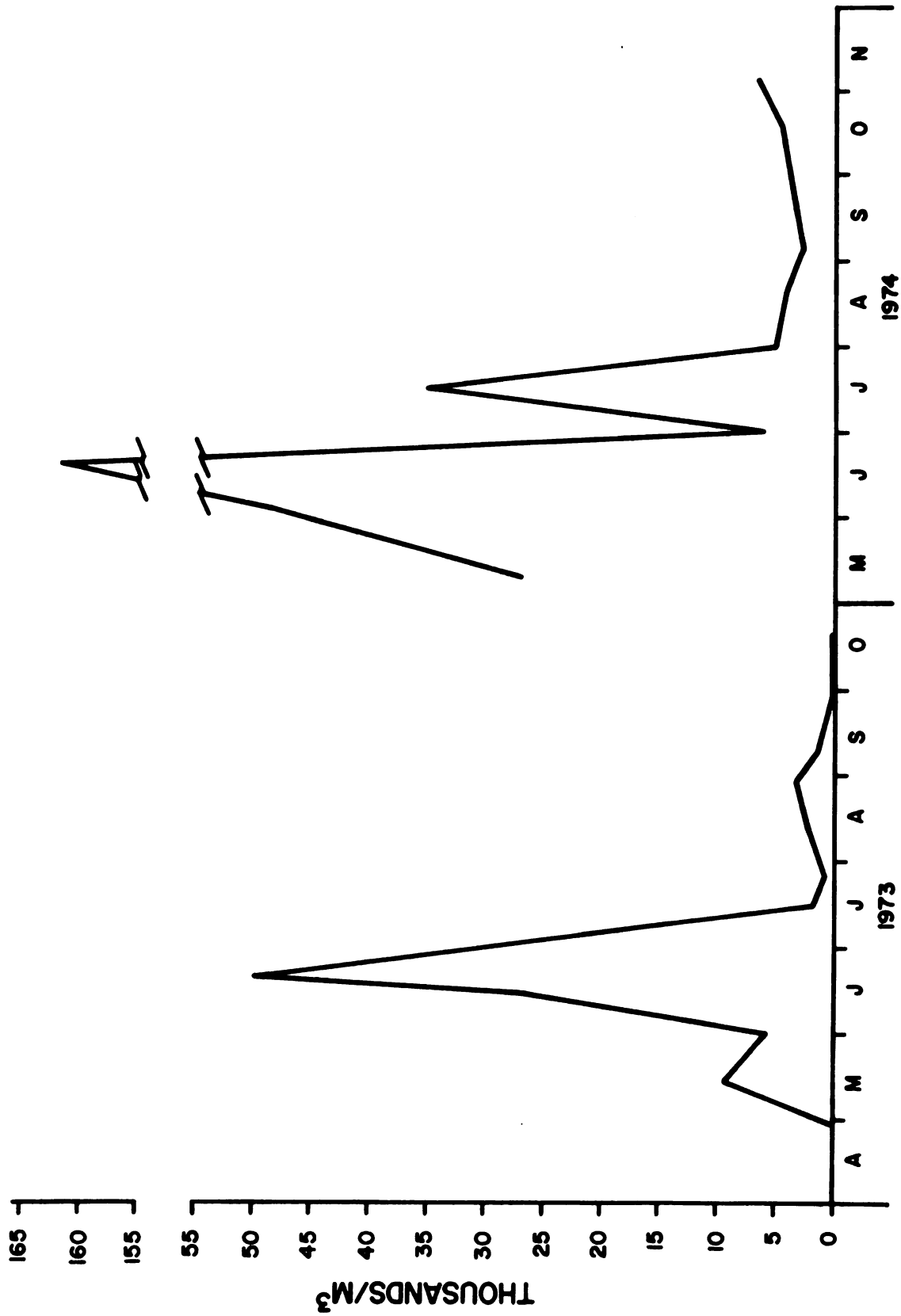
Rotifera

Rotifera were the most abundant component of the zooplankton, particularly in 1974. Considerable difference in the percentage of the zooplankton Rotifera represented was found between years.

In 1973 Rotifera densities were variable in spring (300-14,000/m^3) and comprised 7-47% (Fig. 3) of the April and May zooplankton. Maximum densities (4,000-271,000/m^3) were found on 13 June (Fig. 11) and comprised 22-85% of the zooplankton. After June Rotifera represented a relatively minor portion of the zooplankton (1-5%) until 28 August when they comprised 8-43% of the total. Rotifera densities declined after August to 100-300/m^3 by 24 September and comprised under 5% of the zooplankton.

In 1974 Rotifera were abundant when sampling began on 10 May and by 19 June maximum densities of 91,000-

Figure 11.--Seasonal density of Rotifera at station one in 1973 and 1974.


THOUSANDS/M³
0
5
10
15
20
25
30
35
40
45
50
55
155
160
165
A
M
J
J
A
S
O
1973
M
J
J
A
S
O
N
1974

161,000/m^3 were recorded. Rotifera comprised 59-72% of the zooplankton (Fig. 4) on 19 June. With the exception of 4 September Rotifera comprised between 13% and 39% of the zooplankton in the July to November, 1974 period. Densities were generally 3,000-8,000/m^3 over the entire period, no marked decrease was noted in the fall of 1974.

Seasonal Abundance and Distribution of Zooplankton Species, 1974

A total of 26 species of zooplankton Crustacea (13 Copepoda and 13 Cladocera) and 9 genera of Rotifera were collected in 1974. In addition 3 of the Rotifera were identified to species (Table 7).

Five species of cyclopoid copepods were collected --Cyclops bicuspidatus thomasi, Cyclops vernalis, Eucyclops agilis, Mesocyclops edax, and Tropocyclops prasinus mexicanus. Cyclops bicuspidatus thomasi and Tropocyclops were found on all sampling dates.

The most abundant copepod collected was C. bicuspidatus thomasi. Adults reached maximum densities (2,000-24,000/m^3) on 3 June (Fig. 12). After June adults decreased numerically through November. However, the percentage of the zooplankton they represented was greatest in July (3-17%) and they continued to represent an important portion of the zooplankton through November.

TABLE 7.--Species list of 1974 zooplankton.

Cyclopoida

Cyclops bicuspidatus thomasi S. A. Forbes
Cyclops vernalis Fischer
Eucyclops agilis (Koch)*
Mesocyclops edax (S. A. Forbes)*
Tropocyclops prasinus mexicanus Kiefer

Harpacticoida

Canthocamputs sp.

Calanoida

Diaptomus ashlandi Marsh
Diaptomus minutus Lilljeborg
Diaptomus oregonensis Lilljeborg
Diaptomus sicilis S. A. Forbes
Eurytemora affinis (Poppe)
Epischura lacustris S. A. Forbes
Limnocalanus macrurus Sars

Cladocera

Bosmina longirostris (O. F. Müller)
Eubosmina coregoni (Baird)
Daphnia retrocurva S. A. Forbes
Daphnia galeata mendotae Birge
Daphnia longiremis Sars**
Daphnia schodleri Sars**
Chydorus sphaericus (O. F. Müller)
Holopedium gibberum Zaddach
Polyphemus pediculus (Linne)
Ceriodaphnia quadrangula (O. F. Müller)
Diaphonosoma leuchtenbergianum Fischer**
Alona affinis (Leydig)
Leptodora kindtii (Focke)

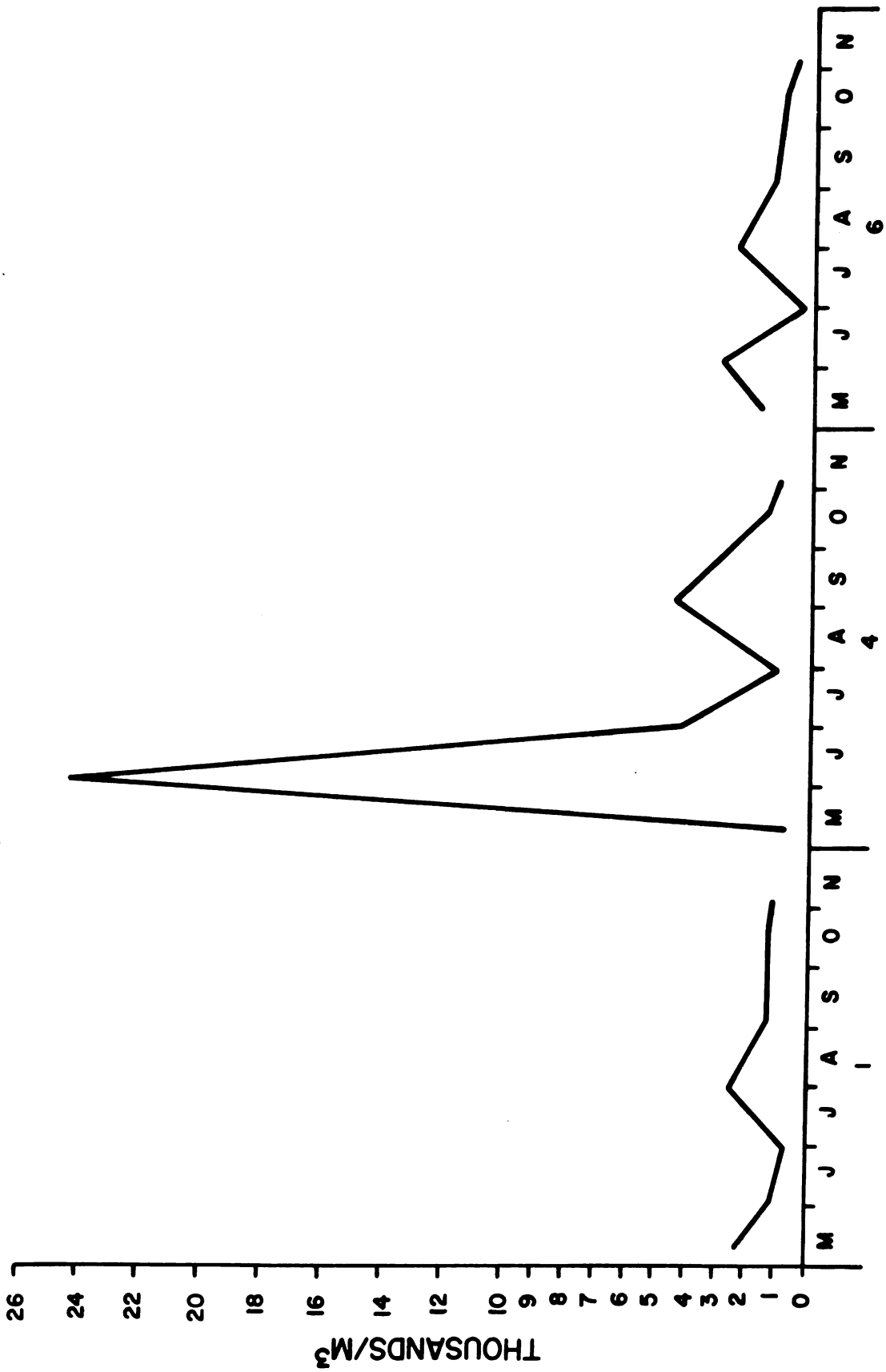
TABLE 7.--Continued.

Rotifers

Keratella cochlearis Gosse,
Keratella quadrata O. F. Muller
Kellicottia longispina (Kellicott)
Asplanchna sp.
Polyarthra sp.
Branchionus sp.
Trichotria sp.
Synchaeta sp.
Filinia sp.
Notholca sp.

*Rare species.
**Recorded as single individuals.

Figure 12.--Seasonal density of Cyclops bicuspidatus thomasi adults at stations one, four and six in 1974.


THOUSANDS/M³
26
24
22
20
18
16
14
12
10
9
8
7
6
5
4
3
2
1
0
M J J A S O N
1
M J J A S O N
4
M J J A S O N
6

Immature Cyclops sp. were not identified to species. However C. bicuspidatus thomasi comprised 99% of the adult Cyclops sp. and Cyclops vernalis was found only occasionally. Because of this it may be assumed that most Cyclops copepodids are C. bicuspidatus thomasi. Copepodids also reached maximum densities (1,000-31,000/m^3) on 3 June. Copepodids were usually more abundant than adults and were found to have the same seasonal abundance trends.

Cyclops vernalis was recorded from June through September. On all occasions it was present in low (100-300/m^3) numbers. Eucyclops agilis and Mesocyclops edax were both rare, occurring as single individuals on several dates. Tropocyclops prasinus mexicanus was found in low densities (about 100/m^3) from May through July. In August T. prasinus mexicanus was common, maximum densities being over 600/m^3. On 4 September only 2 individuals of T. prasinus mexicanus were found. In October and November it was again common.

Harpactacoid copepods of Canthocamptus sp. were collected occasionally in low numbers, less than 60/m^3. This benthic copepod was found at all depths.

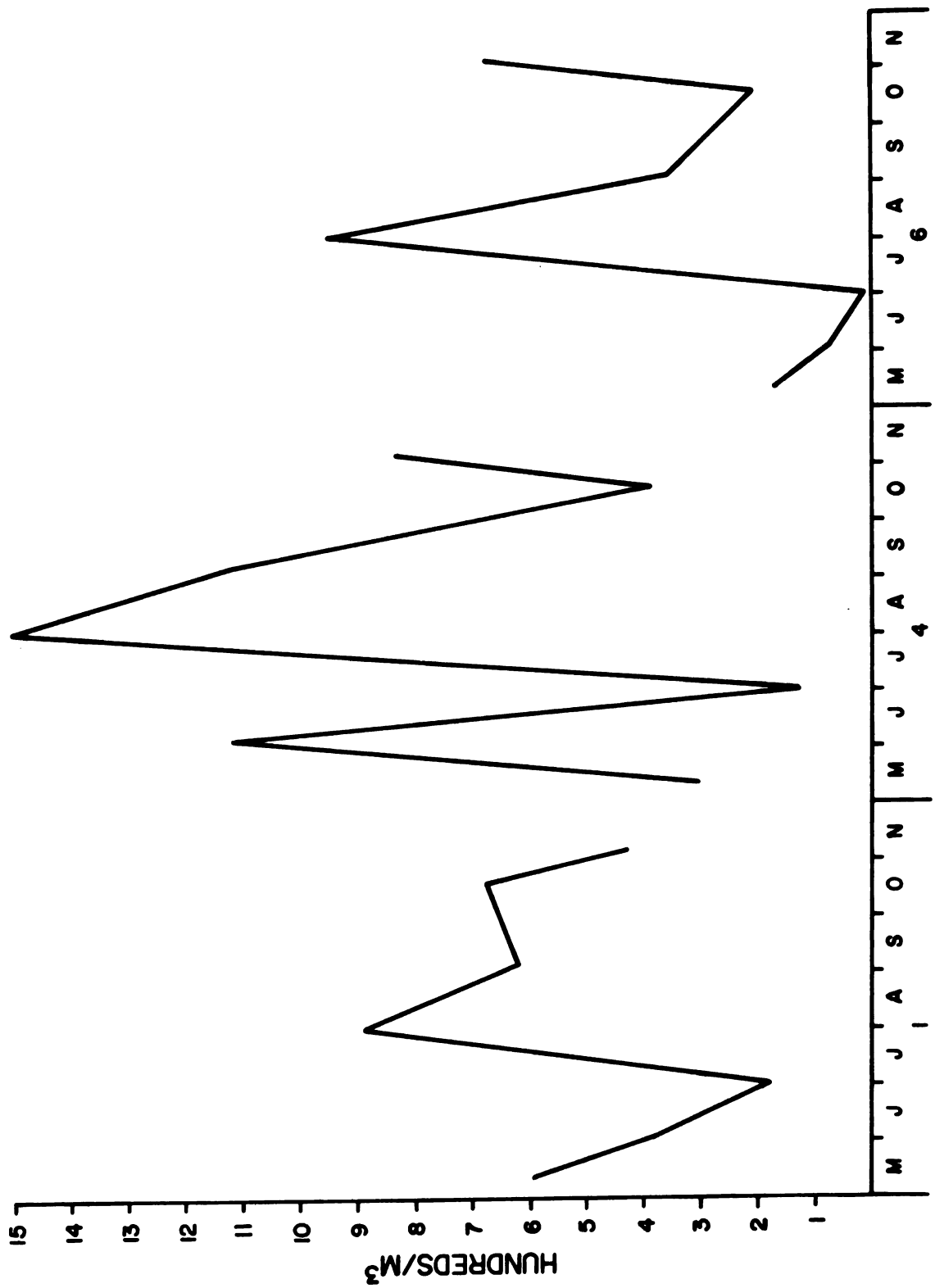
Four species of Diaptomus comprised the majority of the Calanoida. Immatures of the 4 diaptomids were not identified to species. Immature Diaptumus sp. were present in relatively low numbers (300-800/m^3) in May.

After May they became common to abundant. Maximum densities (3,000-8,000/m^3) were found in November.

Diaptomus ashlandi was common (300/m^3) in May samples, but densities were low through summer. In September D. ashlandi became common again and remained so through November. Maximum densities of D. ashlandi (300-800/m^3) were recorded in September. Diaptomus minutus became common in June and maximum densities (over 1,300/m^3) were found in August. October and November were periods of lowest densities of D. minutus. Diaptomus oregonensis was found in low numbers from May through August. It then became common in fall. Maximum abundance of D. sicilis (over 700/m^3) occurred in November. Diaptomus sp. adults were most abundant in August (Fig. 13) and increased in abundance in the fall at most stations.

Three other calanoid copepods were found. Together they usually comprised less than 1% of the zooplankton, none were recorded as abundant. Eurytemora affinis was not observed in May or September, on all other dates it was present in low numbers. Maximum densities (300/m^3) of Eurytemora were found at one station in August. Single individuals of Epischura lacustris were found in May and September. Epischura lacustris was found occasionally in October and November, densities were less than 100/m^3. Limnocalanus macrurus was found

Figure 13.--Seasonal density of Diaptomus sp. adults at stations one, four, and six in 1974.


HUNDREDS/M³
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
M J J A S O N
1
M J J A S O N
4
M J J A S O N
6

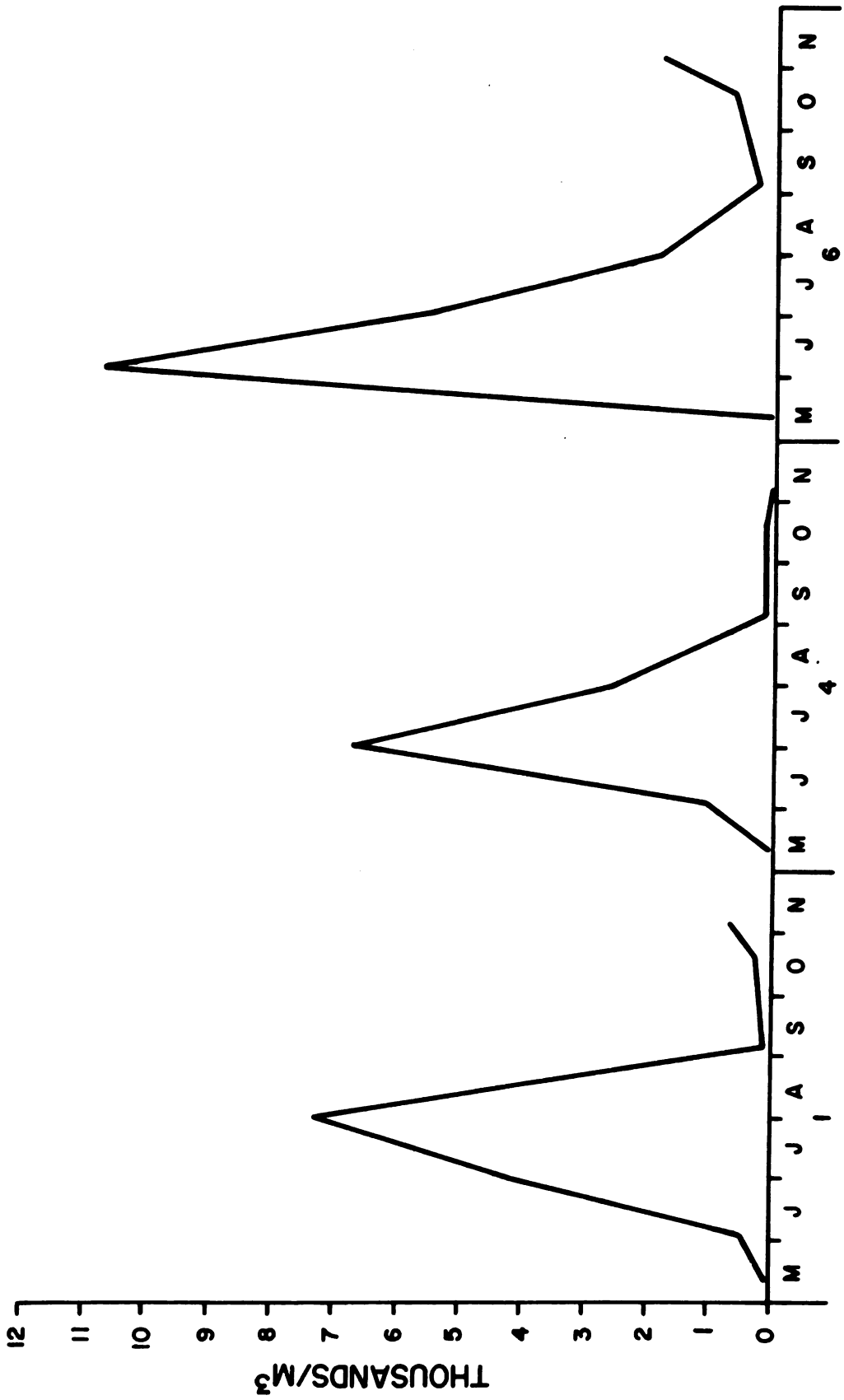
in low densities (less than 100/m^3) from May through October. No Limnocalanus were found in November.

Thirteen species of Cladocera were collected, of these Bosmina longirostris was by far the most abundant. B. longirostris appear capable of responding quickly with the onset of summer conditions. Low numbers of B. longirostris (less than 100/m^3) were found in May. By 3 June the B. longirostris population at one littoral station had reached 10,000/m^3. On 15 June B. longirostris densities were over 14,000/m^3 at all stations (Fig. 14), with maximum densities being over 30,000/m^3. B. longirostris comprised as much as 24% and 26% of the zooplankton at certain stations in July and August, though densities had declined from June. B. longirostris was present in low numbers in September samples, but common in October and November samples.

Eubosmi coregoni first appeared in July samples. It then became common in samples from August through November. However, it was never abundant and maximum densities (800/m^3) were recorded in November.

Four species of Daphnia were collected, 2 were common and 2 were collected as single individuals. The most abundant Daphnia sp. collected was D. retrocurva, which appeared in June. Maximum densities (2,500/m^3) were recorded in August. In September, densities remained high (1,000/m^3), in October, D. retrocurva was common,

Figure 14.--Seasonal density of Bosmina longirostris at stations one, four, and six in 1974.


THOUSANDS/M³
0
1
2
3
4
5
6
7
8
9
10
11
12
M J J A S O N
1
M J J A S O N
4
M J J A S O N
6

but it was not observed in November samples. Daphnia galeata mendotae was first found in August samples and was common. It remained common through November, maximum densities (200/m^3) were found in November. Daphnia longiremis was represented by a single individual found in September and Daphnia Schødleri was recorded as a single individual in October.

Chydorus sphaericus was found in low numbers on all sampling dates in the Ludington area. Findings were variable through September. In October and November Chydorus s. densities were low (less than 100/m^3), but it was recorded more commonly. No population maximum could be discerned.

Six species of Cladocera appeared in the late summer zooplankton, most were present only in July and August. Holopedium gibberum was found in very low numbers in July. Numerical maxima (over 600/m^3) was recorded in August. After August Holopedium g. was not observed in the sample. One individual of Polyphemus pediculus was found in 1 July samples, maximum densities (300-800/m^3) were found on 15 July. After this densities declined through August and P. pediculus was absent from fall samples. Ceriodaphnia quadrangula was found in samples from July through mid August. It was always present in low (less than 100/m^3) numbers and variable in occurrence between stations. Alona affinis appeared

in samppble from 1 July and 4 September. On both dates it was present in very low numbers. Diaphanosoma leuchtenbergianum was recorded as a solitary individual on 15 July. Leptodora kindtii was found at three stations on 1 August. The maximum densities being 100/m^3. A single individual was also found in July. Leptodora kindtii was not found on any other date.

Empahsis in this study was placed on total rotifer abundance, however quantitative information on three species which occurred consistently was recorded. In addition, quantitative information on seven other genera which appeared briefly or in low numbers was recorded.

Keratella cochlearis was the most abundant rotifer collected through the sampling season. A single individual was recorded in May. On 3 June the seasonal maximum (56,000/m^3) occurred. Keratella cochlearis remained an important numerical constituent of the zooplankton through November. Stemberger (personal communication) suggests that abundances of K. cochlearis which I found are probably a combination of three species, comprised mostly of K. cochlearis, but also K. crassa, and K. earlinae.

Keratella quadrata was also recorded at maximum densities on 3 June (8,000/m^3). After 3 June densities

of K. quadrata declined through the summer and were very low in the fall.

Kellicotia longispina was the only rotifer collected at all stations on each date. In May K. longispina was common, maximum densities were also found on 3 June (over 8,000/m^3).[1] Kellicottia longispina remained numerically important through August and was common thereafter.

Polyarthra sp. was recorded in greatest numbers on 3 June (14,000/m^3). It occurred through the remainder of the season in low numbers. Branchionus sp. was observed occasionally in samples from June and July, after July it was not found. Trichotria sp. first appeared in samples from 1 August. Two species were usually present, one tentatively identified as T. longicaudatus. Both Trichotria sp. were present through November and became more common in fall samples. Syncheata sp. also appeared on 1 August and was present in low numbers through November. Filinia sp. occurred in the October and November zooplankton. It was common in November samples. Notholca sp. appeared in samples

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[1]Samples from 19 June, 15 July and 20 August were enumerated to major taxa only. Maximum total rotifer abundance occurred on 19 June, thus maximum numbers of these species are probably higher than reported here.

from 3 June. It was common on this date, but was not recorded after 3 June.

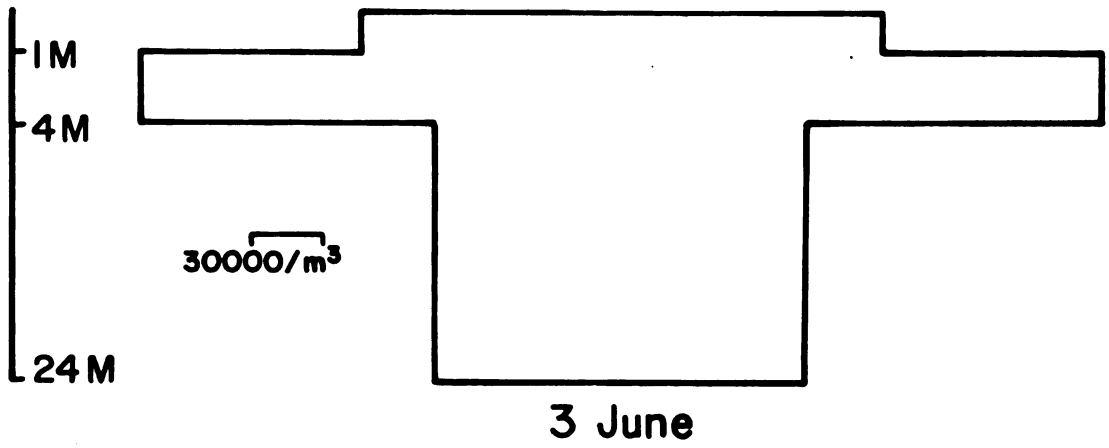
Vertical Distribution

Sampling methods allowed the examination of vertical distribution of the zooplankton. This sampling method was designed to assess the effect of plant induced turbulence on the zooplankton community. However it became apparent that (1) storm induced turbulence far exceeded that created by the plant discharge and (2) it was not possible to maintain a vessel in such turbulence. The vertical distribution of zooplankton at station four on 3 June, 1 August, and 4 November, 1974, is discussed below and presented in Figures 15 through 18.

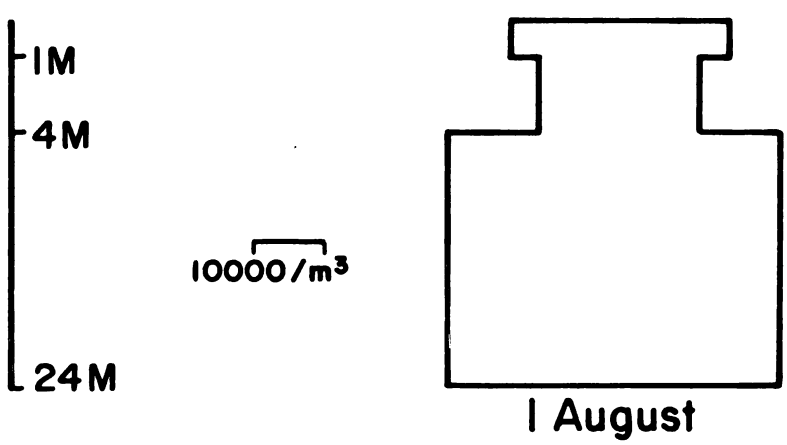
3 June 1974

Greatest densities of zooplankton were found at the 4 meter depth, over 370,000/m^3 (Fig. 15) Lowest densities were at 24 meters. Copepod nauplii, *Cyclops* sp. C_1-C_5, *Cyclops bicuspidatus*, and *Kellicottia longispina* were all found in greatest concentrations at 4 meters. *Diaptomus* sp. C_1-C_5 were four times as abundant at the 24 meter depth as at either 4 or 1 meters. Distribution of *Diaptomus oregonensis* and *D. sicilis* was contrary to that found by Wilson and Roff (1973). *Bosmina longirostris* showed a definite preference for the

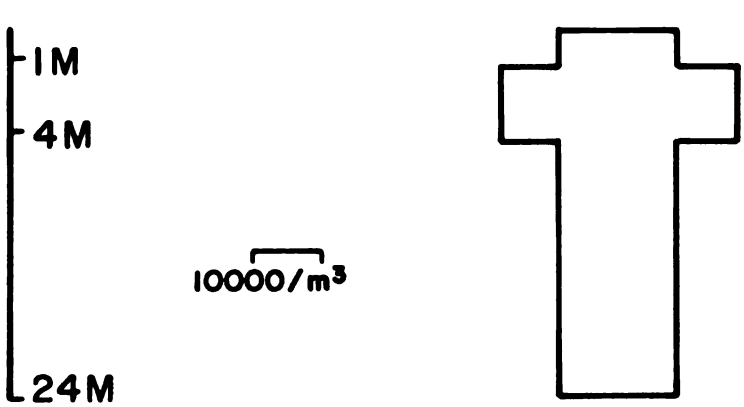
Figure 15.--Vertical distribution of total zooplankton at station four on 3 June, 1 August, and 4 November, 1974.



3 June

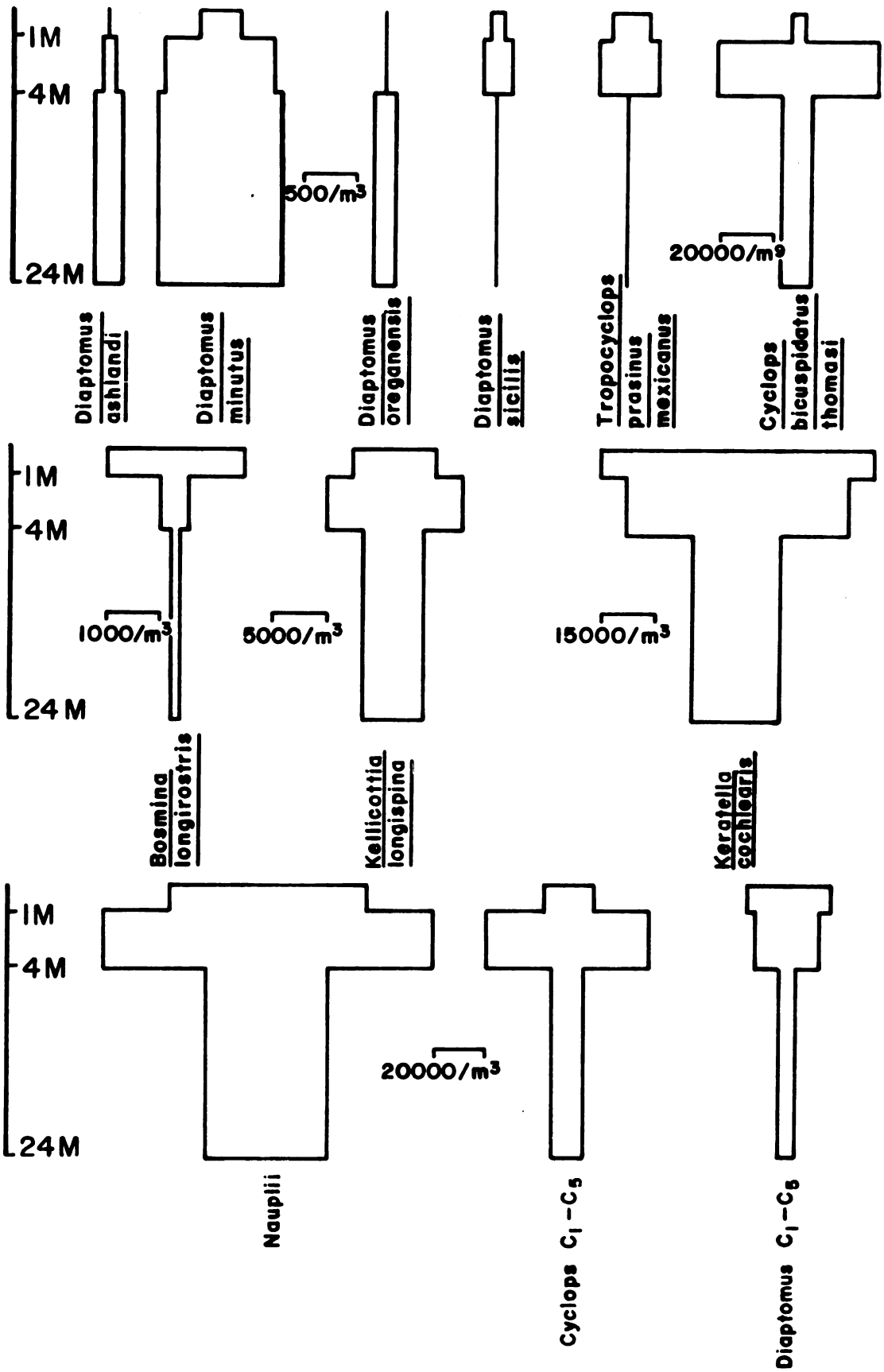


1 August



4 November

Figure 16.--Vertical distribution of zooplankton at station four on 3 June, 1974.


1M
4M
24M
500/m3
20000/m3
Diaptomus ashlandi
Diaptomus minutus
Diaptomus oregonensis
Diaptomus sicilis
Tropocyclops prasinus mexicanus
Cyclops bicuspidatus thomasi
1000/m3
5000/m3
15000/m3
Bosmina longirostris
Kellicottia longispina
Keratella cochlearis
20000/m3
Nauplii
Cyclops C1 – C5
Diaptomus C1 – C6

upper strata (Fig. 16). Temperatures on this date indicated no thermocline was present (Table 8).

TABLE 8.--Temperatures (C°) at station 4 on three dates in 1974.

Depth (m)	3 June	1 August	4 November
1	11.7	19.0	11.9
4	11.5	18.9	11.9
8	10.7	18.8	11.9
12	10.3	13.8	11.9
16	10.0	6.1	11.9
20	8.8	5.5	11.9
24	8.6	5.5	11.9

1 August 1974

Greatest densities of zooplankton, over 44,000/m^3, were found at the 24 meter depth. Lowest densities were found at the 4 meter depth. Copepod nauplii, immature diaptomids, immature Cyclops, and Kellicottia were all found most abundant at 24 meters (Fig. 17). Eurytemora affinis, Leptodora kindtii, Limnocalanus macrurus and Diaptomus sicilis were found at 1 meter and 24 meters only. This is puzzeling due to the presence of a strong thermocline (Table 8). Diaptomus minutus, Bosmina longirostris, Daphnia retrocurva, Cyclops biscuspidatus,

Tropocyclops prasinus and Keratella sp. were most abundant at the upper strata. Chydorus sphaericus, Eubosmina coregoni, Holopedium gibberum, Polyphemus pediculus and Daphnia galeata were completely absent from 24 meter samples.

4 November 1974

Maximum zooplankton abundance was found at the 4 meter depth, over 32,000/m^3. Lowest densities were found at 24 meters. Immature diaptomids, and Cyclops bicuspidatus, Diaptomus sicilis and Tropocyclops prasinus all were most abundant at the 4 meter depth (Fig. 18). Epischura lacustris, Eubosmina coregoni and Daphnia galeata were present only at 4 meters. Copepod nauplii and Keratella cochlearis were most abundant at 1 meter.

Figure 17.--Vertical distribution of zooplankton at station four on 1 August, 1974.

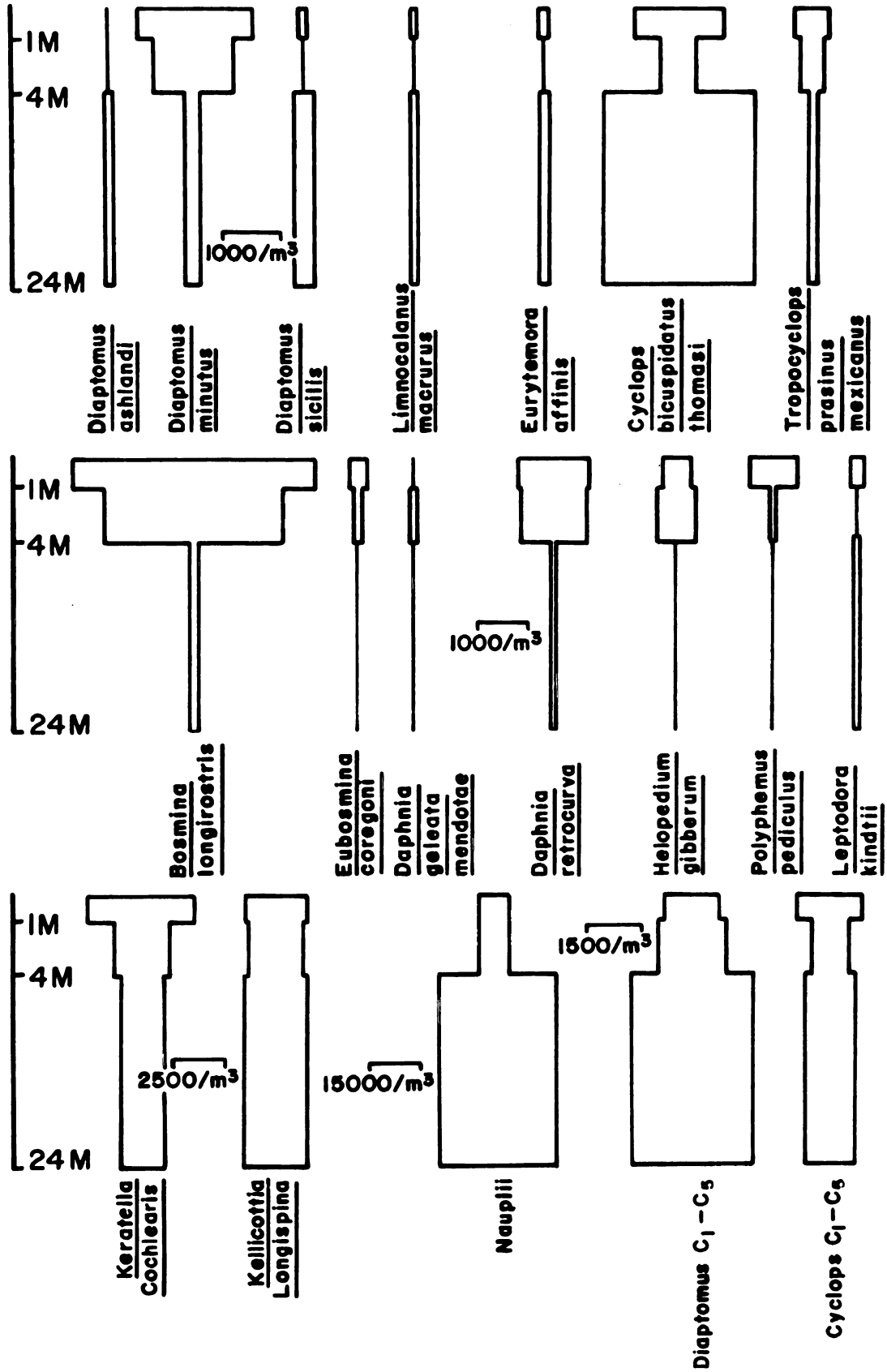
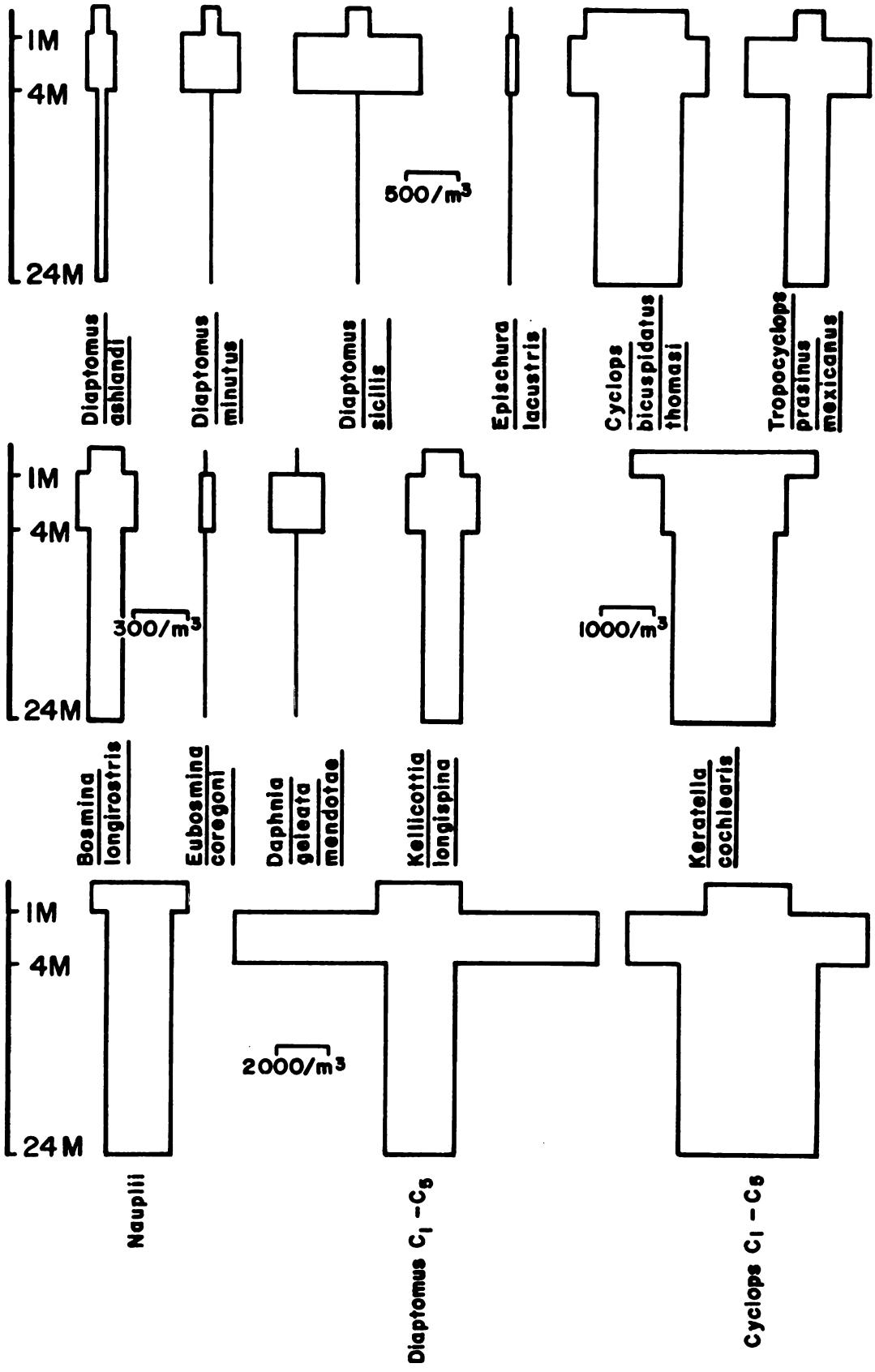

1M
4M
24M
1000/m³
Diaptomus ashlandi
Diaptomus minutus
Diaptomus sicilis
Limnocalanus macrurus
Eurytemora affinis
Cyclops bicuspidatus thomasi
Tropocyclops prasinus mexicanus
Bosmina longirostris
Eubosmina coregoni
Daphnia galeata mendotae
Daphnia retrocurva
Helopedium gibberum
Polyphemus pediculus
Leptodora kindtii
2500/m³
15000/m³
1500/m³
Keratella Cochlearis
Kellicottia Longispina
Nauplii
Diaptomus C1 – C5
Cyclops C1 – C5

Figure 18.--Vertical distribution of zooplankton at station four on 4 November, 1974.


1M
4M
24M
500/m³
Diaptomus ashlandi
Diaptomus minutus
Diaptomus sicilis
Epischura lacustris
Cyclops bicuspidatus thomasi
Tropocyclops prasinus mexicanus
1M
4M
24M
300/m³
1000/m³
Bosmina longirostris
Eubosmina coregoni
Daphnia galeata mendotae
Kellicottia longispina
Keratella cochlearis
1M
4M
24M
2000/m³
Nauplii
Diaptomus C1 - C5
Cyclops C1 - C5

DISCUSSION

Horizontal Distribution

When all six turbines are generating the maximum water flow from the reservoir into Lake Michigan is about 75,960 cfs. One of the major concerns of this investigation was whether this massive movement of water would affect zooplankton distributions in the vicinity of the power plant.

Significant differences ($P < .05$) were detected between stations on 6 of the 12 sampling dates in 1973. Depth of the sampling station appeared to be the major factor governing distribution of zooplankton. The two shallowest stations had lowest densities on 6 of the 12 dates and greatest densities on 5 dates. The deepest station (24 m) had least densities on 4 dates and greatest densities on 2 dates. Densities at stations of intermediate depth were usually between the extremes of high and low abundance.

Two groups, cyclopoid copepods and rotifers, exhibited rather consistent patterns of distribution in 1973. Cyclopoids were least abundant at the stations nearest shore on 8 sampling dates. On 2 dates there was

little difference between stations and on 2 dates there were least abundant at deeper stations. Conversly greatest densities of rotifers were most often found at the stations nearest shore. Rotifers also exhibited a north to south stratification. From April to 14 July greatest densities of rotifers occurred north of the breakwall. From August through September greatest densities occurred south of the breakwall. Calanoid copepods and Cladocera did not exhibit striking horizontal distribution patterns in 1973.

Significant differences ($P < .05$) were detected between stations on only 4 of 10 sampling dates in 1974. Again depth of the station appeared to be the major factor affecting distribution. The two nearshore stations had lowest densities of zooplankton on 6 of 10 sampling dates. These littoral stations also had highest densities on 4 of the 10 dates. On 3 dates the littoral station south of the breakwall had lowest densities, while the littoral station north of the breakwall had greatest densities. The deepest station again had greatest densities during the period of maximum zooplankton abundance.

In 1974 calanoid copepods, cyclopoid copepods, and rotifers exhibited horizontal distribution similar to that of 1973. Both calanoids and cyclopoids were found in greatest densities at 12 or 24 meter stations.

With the exception of several dates both groups were also least abundant at the stations nearest shore. Rotifers were most abundant at nearshore stations on half of the sampling dates. Although rotifers tended to be more abundant nearshore, the pattern of distribution was not as pronounced as in 1973. No horizontal distribution pattern was observed in either year for Cladocera.

Variation of Major Zooplankton Taxa Between 1973 and 1974

Differences between abundances of the major taxa existed between years. In 1973, Cladocera and Diaptomus sp. were abundant. Rotifera and copepod nauplii were abundant to moderate. Cyclops sp. was present in moderate abundance. In 1974, Cladocera and Diaptomus sp. relatively less abundant. Rotifers increased in abundance, and Cyclops sp. increased from 1973. Nauplii remained similar to 1973 abundances. Temperature, food, and predation are probably major regulators of the zooplankton community (Slobodkin 1954, Hall, Cooper, and Werner 1970, Edmondson 1957, McLaren 1963, Norden 1968), and may partially explain these differences.

The size efficiency hypothesis of Brooks and Dodson (1965) partially explains these changes. This

hypothesis suggests that superior competitive abilities are related to increased body size and these abilities help exclude smaller forms from the system. Where fish are present the larger forms are eliminated and the smaller forms flourish. This could explain lower calanoid densities in 1974, however if fish were the causative agent one would expect Cyclops sp. densities to also be depressed. Norden (1968) and Gannon (1972) found that both Cyclops sp. and calanoids were positively selected by alewife in Lake Michigan. Dodson (1974) recently tested the size-efficiency hypothesis and concluded that invertebrate predators may play an important role in governing species composition of the zooplankton. Alewife stomachs were not analyzed, consequently actual predation rates are unknown.

Frost (1974) suggests that feeding specialization may explain the observed coexistence of small and large marine copepods and postulates competitive superiority of smaller species at limiting food concentrations (in contradiction to the size-efficiency hypothesis).

Comita and Anderson (1959) found that the mean number of eggs carried by oviporous females of Diaptomus ashlandi was significantly correlated with the chlorophyll content of the water two weeks earlier. Edmondson (1957) suggests that zooplankton grazing may crop off phytoplankton faster than they are able to multiply. This

may imply that limiting food, rather than alewife predation was the causative agent in lowering calanoid abundance in 1974.

Variation in water temperatures between years is most likely the major factor contributing to observed differences in abundance of zooplankton taxa. In early May of both years temperatures were 4-6°C throughout the area. By 30 May, 1973 water temperatures had risen to 7-8°C and zooplankton densities were 30,000-80,000/m^3. During the same period (3 June) in 1974 water temperatures were 9-13°C and zooplankton densities were 80,000-220,000/m^3. After this initial warm up period 1973 water temperatures fluctuated throughout the summer. In 1974 these fluctuations were not observed. Parker and Hazelwood (1963) found that abundance of Diaptomus leptopus was negatively correlated with water temperature while Daphnia schdleri abundance was positively correlated with water temperature.

The period of maximum zooplankton abundance occurres a short time after diatomus reach maximum abundance in the Ludington area (see Liston et. al. 1974 for a discussion of diatoms from the Ludington area). Whether zooplankton crop off the diatoms or the crash in diatoms is brought about by limiting nutrients has not been determined for our data.

Species Composition

Twenty six species of zooplankton Crustacea and nine genera of rotifers were recorded in 1974. Three of the rotifers were identified to the species level.

Seven species of zooplankton Crustacea and the 3 rotifer species were present on all sampling dates. Five of the 7 Crustacea were copepods with Cyclops bicuspidatus thomasi being the most abundant. Tropocyclops prasinus mexicanus, Diaptomus minutus, D. ashlandi and D. oregonensis were also present on all dates. Two cladocera were present on all dates, Bosmina longirostris and chydorus sphaericus. Diaptomus sicilis was found in all months but July and Limnocalanus macrurus was found in all months except November.

The spring zooplankton was predominated by copepods, with nauplii being the most prominent group. Previous studies (Gannon 1972, Stewart 1974) indicate that both the offshore and inshore zooplankton is predominated by copepods in spring. Cyclops bicuspidatus thomasi and copepodids of Diaptomus sp. were also abundant. A single individual of Epischura lacustris was found in May samples. This species is normally not found until summer in Lake Michigan (Gannon 1972, Stewart 1974).

The June zooplankton was predominated by rotifers, with Keratella cochlearis being most abundant. Copepod nauplii and immature and adult Cyclops bicuspidatus

thomasis were also prominant taxa in June. The number of copepods represented was greater than in May with Cyclops vernalis, Mesocyclops edax and Eurgtemora affinis being collected. Bosmina longirostris became abundant at most stations and comprised more than 98% of the Cladocera.

Greatest species diversity (23 species on 1 August) was found in July and August. Bosmina longirostris was the predominant species and Daphnia retrocurva was abundant in August. Seven other Cladocera were also collected. Copepod nauplii and copepodids, and Cyclops bicuspidatus thomasi were abundant throughout the sampling area. Diaptomus minutus was common to abundant.

Limnocalanus macrurus was collected in both July and August. Several studies have concentrated on L. macrurus in the Great Lakes (Carter 1969; Gannon and Beeton 1971). These and other studies (Wells 1960, 1970; Patalas 1969, 1971, 1972; Robertson 1966; Davis 1969; Gannon 1972; Stewart 1974) have shown this species to be a cold water stenotherm. Stewart's data from southern Lake Michigan indicates L. macrurus occurs in low numbers in nearshore waters from April through November.

Keratella cochlearis was the second most abundant species in July and August behind Bosmina. Another rotifer, Kellicottia longispina was also abundant.

Ceriodaphnia quadrangula, Polyphemus pediculus, Holopedium gibberum, and Leptodora kindtii present only in July and August.

As in spring, copepods predominated the fall zooplankton. Copepod nauplii and copepodids of Diatomus sp. and Cyclops bicuspidatus thomasi were the most abundant zooplankton present. Cyclops bicuspidatus thomasi were abundant, while Diaptomus ashlandi, D. minutus, and D. sicilis were all common. Bosmina lingirostris remained the most abundant Cladocera species, however Eubosmina coregoni was also common to abundant. Daphnia galeata mendotae became more common than D. retrocurva, D. retrocurva was absent from November samples. Keratella cochlearis remained the most abundant rotifer, but densities were much less than in summer.

Vertical Distribution

Total zooplankton were most abundant in the upper water layers on 3 June and 4 November. Greatest densities were found at 24 meters on 1 August.

Diaptomus ashlandi, D. minutus, and D. oregonensis were found in greatest densities at 24 m on 3 June. All other species were most abundant at 1 or 4 m on both 3 June and 4 November.

On 1 August Diaptomus ashlandi was found only at 24 m, however D. minutus was most abundant at 1 m.

Diaptomus sicilis, Limnocalanus macrurus, and Eurytemora affinis were collected at 1 m and 24 m, but not at 4 m. Copepod nauplii, immatures of Diaptomus sp. and Cyclops bicuspidatus thomasi were concentrated at 24 m. All Cladocera species were most abundant at 1 or 4 m.

The presence of Limnocalanus m. and Diaptomus sicilis at 1 m on 1 August when surface temperatures were 19°C was not expected. Both species are known to inhabit colder waters (Wells 1960, Wilson and Roff 1973). However both species were present in low numbers and water currents may have transported them to the surface.

SUMMARY

Nearshore zooplankton were investigated in Lake Michigan south of Ludington, Michigan in 1973 and 1974. A pump and net method was employed in collecting samples. Seasonal distribution of major taxa in 1973, and 1974 was studied. Seasonal and vertical distribution of species also were studied in 1974.

In spring of both years the zooplankton was predominated by copepod nauplii. Cladocerans were scarce, while other taxa were common to abundant. In early summer of 1973, the fauna was predominated by rotifers, but as summer proceeded cladocerans became dominant. In 1973, cladocerans did not predominate the summer fauna, but were a prominent taxa from July through August. Rotifers predominated June, 1974 samples and remained abundant through the summer. Cyclopoid copepods were much more abundant in 1974 summer collections than in 1973 collections. Calanoids were less abundant in 1974 than 1973. In fall of 1973, rotifers decreased until they were a minor portion of the fauna. Cyclopoids increased through out fall of 1973 until they dominated October samples. Nauplii, calanoids, and cladocerans remained important

constituants of the fauna. In 1974 copepods again dominated the fall zooplankton. However, calanoids were slightly more abundant than were cyclopoids. Rotifer densities remained high through the fall in 1974.

Twenty six species of zooplankton Crustacea and nine genera of rotifers were recorded in 1974. Three rotifers were identified to species.

Seven species of zooplankton Crustacea and the three rotifer species were present on all sampling dates. Cyclops bicuspidatus thomasi was present on all dates and was the most abundant crustacean zooplankter over the entire sampling period. Tropocyclops prasinus mexicanus was found on all dates and was an important member of the fall zooplankton. Three calanoid copepods were found on all dates, Diaptomus ashlandi, D. minutus, and oregonensis. Diaptomus minutus was the most abundant calanoid collected. Two Cladocera were present on all dates, they were Bosmina longirostris and Chydorus sphaericus. Bosmina l. was a predominant summer species. Keratella cochlearis was rare in May and abundant on all other dates. Keratella quadrata was most common in summer as was Kellicottia longispina.

Comment

This study was designed and conducted to evaluate the possible effects a large pumped-storage reservoir

might have on the nearshore zooplankton communities of Lake Michigan. Because the results of this study may be utilized by future investigators, possibly studying similar problems, several suggestions are in order. I feel that future investigations of the nearshore zooplankton would benefit in taking an array of physical, chemical, and biological data to support zooplankton data.

Nutrient levels in nearshore areas probably do not correspond with those of other areas in Lake Michigan. Summer storms frequently wash clay particles into the lake at Ludington. These storms probably introduce substantial amounts of nutrients into localized areas.

Massive immagration and emigration of zooplankton undoubtedly occurrs between inshore and offshore areas and from one inshore area to another. Because quantitative information on water movements is lacking, immagration and emigration cannot be determined.

Data on seasonal abundance and distribution of zooplankton in the Ludington area appear to agree with other data from nearshore areas of Lake Michigan (Stewart 1974). It appears that in 1973 and 1974 the operation of the Ludington pumped-storage reservoir did not have an adverse affect on the zooplankton of the area. However the previously mentioned natural water movements may mask any effect which pumping and generating could have on the zooplankton communities.

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APPENDIX

Major Zooplankton Taxa, 1973

The primary data for 1973 are presented in tables 5 through 16, counts of major taxa. Included for each station are the mean number of organisms (individuals/m^3), the coefficient of variation (i.e., the standard deviation expressed as a percentage of the mean) of samples at the station, and the percent composition of the fauna.

29 April 1973 (Table 9)

Maximum zooplankton abundances occurred at the littoral (6 meter) station, exceeding 30,000/m^3. Copepod nauplii were abundant at all stations, densities at four stations being 10,000-15,000/m^3. Copepod nauplii predominated the zooplankton, comprising more than 50% of the fauna at all stations. Calanoid copepods were common at all except station six. Cyclopoid copepods were also common at each station but six. Cladocera were present in very low numbers throughout the sampling area. Rotifer abundance varied greatly between stations, ranging from over 300/m^3 to over 14,000/m^3. Total zooplankton numbers reflected this variation. Rotifers and nauplii together comprised 98.4% of the zooplankton at station six.

TABLE 9.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 29 April, 1973.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	4659	17.1	66.7	7677	5.2	73.5
Calanoid copepods	1068	20.4	15.3	881	25.8	8.4
Cyclopoid copepods	936	15.6	13.4	807	3.3	7.7
Cladocerans	9	132.2	.1	81	64.1	.8
Rotifers	317	30.6	4.5	1000	12.6	9.6
Total	6989	11.6		10446	4.2	
	Station 3			Station 4		
Copepod nauplii	10795	9.0	78.6	12778	6.5	74.6
Calanoid copepods	697	11.8	5.1	1685	13.4	9.8
Cyclopoid copepods	794	20.0	5.8	820	18.1	4.8
Cladocerans	75	64.0	.6	20	119.3	.1
Rotifers	1375	24.1	10.0	1826	12.2	10.7
Total	13737	8.8		17128	5.5	
	Station 5			Station 6		
Copepod nauplii	12556	11.1	59.5	15642	7.1	50.6
Calanoid copepods	1205	11.0	5.7	306	28.0	1.0
Cyclopoid copepods	1084	24.5	5.1	158	22.0	.5
Cladocerans	66	90.0	.3	26	107.3	.1
Rotifers	6209	30.3	29.4	14760	10.1	47.8
Total	21120	9.9		30893	8.0	

13 May 1973 (Table 10)

Total zooplankton densities recorded ranged from 31,000-46,000/m^3, with the exception of station four which had 15,000/m^3. Copepod nauplii continued to dominate the srping zooplankton, again comprising more than 50% of the zooplankton at each station. Calanoid and cyclopoid copepods were least prevelent at the deepest (24 meter) station, but abundant elsewhere. Cladocerans remained uncommon in the samples. Rotifers were a promenent taxon, and showed less variability between stations than in April.*

30 May 1973 (Table 11)

Total zooplankton densities increased from 13 May samples, however percent composition of the zooplankton was relatively unchanged. Copepod nauplii continued to be the most abundant taxon at all stations. Maximum densities of copepod nauplii for 1973 occurred at station six, over 57,000/m^3. Calanoids comprised from 10-20% of the zooplankton. Cyclopoid copepods also were abundant at all stations. Their numbers were generally half those of calanoids. Cladocera began to appear more commonly in samples and were recorded at densities of 500/m^3 for the first time. Rotifers remained abundant at all stations.

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*Predominant is defined as 45% or more of the total and prominent being 15-45% of the total.

TABLE 10.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 13 May, 1973.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	31327	13.9	68.9	19863	8.1	63.6
Calanoid copepods	3064	22.4	6.7	4611	17.6	14.8
Cyclopoid copepods	1546	22.4	3.4	2576	25.0	8.2
Cladocerans	91	138.4	.2	92	111.8	.3
Rotifers	9452	25.8	20.8	4103	11.7	13.1
Total	45480	14.8		31244	7.1	
	Station 3			Station 4		
Copepod nauplii	27327	7.6	66.0	13268	12.5	83.9
Calanoid copepods	4030	10.1	9.9	882	12.3	5.6
Cyclopoid copepods	2025	10.3	4.9	306	25.1	1.9
Cladocerans	111	94.4	.3	15	140.0	.1
Rotifers	7896	10.3	19.1	1401	9.5	8.9
Total	41438	7.1		15812	10.7	
	Station 5			Station 6		
Copepod nauplii	25761	5.7	55.6	26095	4.2	70.3
Calanoid copepods	4084	10.0	8.8	1833	11.1	4.9
Cyclopoid copepods	2074	10.9	4.5	1177	9.6	3.2
Caldocerans	97	138.9	.2	126	86.6	.3
Rotifers	14329	4.8	30.9	7912	7.0	21.3
Total	46344	5.1		37143	4.8	

TABLE 11.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 30 May, 1973

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	28296	29.1	71.0	21108	32.6	64.2
Calanoid copepods	4226	43.0	10.6	7095	53.4	21.6
Cyclopoid copepods	1411	86.1	3.5	1228	32.8	3.7
Cladocerans	220	100.4	.6	135	125.1	.4
Rotifers	5700	13.6	14.3	3295	15.7	10.0
Total	39852	24.5		32864	27.2	
	Station 3			Station 4		
Copepod nauplii	37415	22.9	70.2	42170	10.3	71.0
Calanoid copepods	7935	26.1	14.9	7549	14.0	12.7
Cyclopoid copepods	2625	23.2	4.9	5191	24.6	8.7
Cladocerans	171	98.3	.3	131	95.9	.2
Rotifers	5144	8.8	9.7	4340	7.8	7.3
Total	53291	20.3		59381	9.9	
	Station 5			Station 6		
Copepod nauplii	33795	18.6	62.1	57578	3.4	71.7
Calanoid copepods	7088	6.3	13.0	8477	4.4	10.6
Cyclopoid copepods	4865	8.6	8.9	4263	8.7	5.3
Cladocerans	512	26.1	.9	366	19.6	.5
Rotifers	8176	11.7	15.0	11730	5.2	14.6
Total	54436	7.1		82414	3.9	

13 June 1973 (Table 12)

Maximum zooplankton densities at station five exceeded densities at station two by a factor of 15. A major shift in percentage composition of the fauna was observed on this date. Numbers of copepod nauplii declined slightly, but remained abundant. Calanoid copepods remained near 30 May abundances. Cyclopoid copepods were recorded as more abundant than calanoids for the first time. Seasonal maximum of cyclopoids was recorded at station four, over 23,000/m^3. Cladocera populations increased dramatically from 30 May abundances. Cladocera were observed in densities of 8,000-22,000/m^3. Rotifers dominated the zooplankton at most stations. Seasonal maximum of rotifers was recorded at station five, over 270,000/m^3. However great variation of rotifer densities between stations existed. This variability was reflected in variability of total zooplankton densities.

30 June 1973 (Table 13)

The maximum abundance of zooplankton over all stations occurred on this date. Numbers per cubic meter were high and variation between stations moderate. Copepod nauplii and cyclopoid copepods were abundant numerically. The seasonal maximum of calanoid copepods occurred on this date. However the percentage of the

TABLE 12.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 13 June, 1973.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	14880	24.6	24.6	2738	18.2	13.0
Calanoid copepods	4721	22.4	7.8	2582	19.2	12.2
Cyclopoid copepods	5991	30.2	9.9	2419	17.1	11.5
Cladocerans	8743	43.3	14.4	8664	20.8	41.1
Rotifers	26129	58.6	43.1	4694	22.5	22.2
Total	60615	27.4		21096	17.2	
	Station 3			Station 4		
Copepod nauplii	16731	9.4	12.0	15894	25.1	18.1
Calanoid copepods	9642	8.5	6.9	7936	27.4	9.1
Cyclopoid copepods	16770	9.7	12.0	23162	41.3	26.4
Cladocerans	17535	13.5	12.5	10926	37.9	12.5
Rotifers	79060	10.8	56.6	31144	44.1	35.6
Total	139738	8.9		87562	30.5	
	Station 5			Station 6		
Copepod nauplii	7212	5.5	2.3	10056	12.4	5.6
Calanoid copepods	7033	9.0	2.2	6106	15.1	3.4
Cyclopoid copepods	7442	8.9	2.3	8211	10.7	4.5
Cladocerans	22907	12.6	7.2	18770	17.5	10.4
Rotifers	271702	26.0	85.9	137254	16.0	76.1
Total	316234	14.7		180397	13.6	

TABLE 13.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 30 June, 1973.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	7163	15.1	4.5	5169	6.9	2.5
Calanoid copepods	10612	17.0	6.7	11614	3.0	5.7
Cyclopoid copepods	8160	13.3	5.2	10727	5.3	5.3
Cladocerans	81724	13.9	51.9	97658	5.8	48.0
Rotifers	49813	35.4	31.6	78073	6.2	38.4
Total	157539	16.2		203329	4.4	
	Station 3			Station 4		
Copepod nauplii	3919	12.1	2.2	11299	17.0	9.2
Calanoid copepods	11888	6.5	6.5	21297	13.7	17.3
Cyclopoid copepods	8218	8.8	4.5	15223	9.3	12.4
Cladocerans	90616	13.3	50.0	47648	9.8	38.7
Rotifers	66805	8.5	36.8	28165	17.1	22.9
Total	181387	5.7		122695	9.5	
	Station 5			Station 6		
Copepod nauplii	4600	5.5	2.2	4050	19.6	1.9
Calanoid copepods	23268	14.5	11.0	13670	19.4	6.3
Cyclopoid copepods	12597	12.9	5.9	6725	14.1	3.1
Cladocerans	76346	20.1	36.0	94566	15.3	43.9
Rotifers	95038	21.9	44.9	96203	22.4	44.7
Total	211849	14.9		215214	17.0	

fauna they represented was low due to Cladocera and rotifer abundances. Cladocera and rotifers were the major components of the zooplankton. The seasonal maximum of cladoerans was recorded at station two, over 97,000/m^3.

14 July 1973 (Table 14)

Total zooplankton numbers declined substantially from 30 June abundances. With the exception of copepod nauplii all major taxa declined in abundance from June densities. Calanoid copepods were a prominent taxon, comprising from 14 to 43% of the zooplankton. Cyclopoid copepods were recorded in densities of 1,000-3,000/m^3, comprising 4.8-8.7% of the zooplankton. Cladocera remained the most abundant taxon even though their numbers were one-third to one-seventh those of 30 June numbers, their numbers ranged from 1,000-3,000/m^3.

25 July 1973 (Table 15)

Total zooplankton abundances reached a summer minimum on this date. This is in contrast with data by Stewart (1974) who recorded seasonal maximum of total zooplankton in southern Lake Michigan on 19 July, 1973. Densities at most stations were 10,000-20,000/m^3.

TABLE 14.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 14 July, 1973.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	12834	39.2	26.9	9115	13.1	15.1
Calanoid copepods	8847	43.0	18.6	8576	13.1	14.2
Cyclopoid copepods	3205	16.4	6.7	3830	9.9	6.4
Cladocerans	21054	9.2	44.2	37517	8.1	62.3
Rotifers	1731	5.9	3.6	1178	114.6	2.0
Total	47671	13.8		60216	5.3	
	Station 3			Station 4		
Copepod nauplii	5372	18.7	17.5	10467	18.1	30.0
Calanoid copepods	5631	17.9	18.3	9578	15.5	27.5
Cyclopoid copepods	2671	13.4	8.7	2880	18.2	8.3
Cladocerans	14461	20.8	47.1	8412	10.7	24.1
Rotifers	2575	10.3	8.4	3552	29.8	10.2
Total	30710	13.9		34889	10.4	
	Station 5			Station 6		
Copepod nauplii	4992	32.4	21.0	5285	2.7	24.5
Calanoid copepods	4574	42.8	19.3	6361	10.9	29.5
Cyclopoid copepods	1137	79.7	4.8	1360	15.1	6.3
Cladocerans	9847	24.4	41.5	6319	5.9	29.3
Rotifers	3204	87.0	13.5	3141	6.1	14.6
Total	23754	28.2		21538	8.0	

TABLE 15.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 25 July, 1973.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	1865	23.3	16.5	1682	8.5	9.4
Calanoid copepods	2032	83.3	17.9	2436	11.8	13.7
Cyclopoid copepods	815	23.0	7.2	2016	12.7	11.3
Cladocerans	5656	11.3	49.9	11256	12.4	63.1
Rotifers	667	77.7	5.9	462	26.4	2.6
Total	11329	14.6		17851	9.4	
	Station 3			Station 4		
Copepod nauplii	1186	10.9	4.7	10529	38.9	19.5
Calanoid copepods	2761	14.6	11.0	3260	27.8	6.1
Cyclopoid copepods	2721	15.8	10.9	1899	25.7	3.5
Cladocerans	17767	9.6	71.0	37923	30.7	70.4
Rotifers	605	16.4	2.4	534	21.7	1.0
Total	25039	8.7		53874	28.2	
	Station 5			Station 6		
Copepod nauplii	3905	10.1	20.4	1620	17.7	18.7
Calanoid copepods	6153	13.3	32.2	2186	12.7	25.2
Cyclopoid copepods	1338	10.2	7.0	429	24.4	5.0
Cladocerans	6622	14.5	34.6	3758	6.3	43.3
Rotifers	1105	15.5	5.8	683	27.0	7.9
Total	19123	10.6		8675	7.7	

At the deepest station densities exceeded 53,000/m^3 however, Calanoid copepods and copepod nauplii were prominent taxa at most stations. Calanoids were slightly more abundant than nauplii. Cyclopoid copepods were abundant at four stations, their densities being 1,300-2,700/m^3. Cladocera predominated the zooplankton at all but one station. Rotifers composed a minor portion of the zooplankton, being less than 700/m^3 at most stations.

12 August 1973 (Table 16)

Total zooplankton abundances ranged from over 15,000/m^3 to over 76,000/m^3. The percentage composition of the zooplankton again shifted from previous dates. Copepod nauplii and Cladocera were prominent taxa at all stations. Calanoid copepods were the most abundant taxon (26-49% of the fauna), but no taxon predominated the system. Cyclopoid copepods remained an important constituent of the summer fauna, their densities being 4,000-10,000/m^3 at all but one littoral station. Rotifer populations increased from July densities, but variability between stations was substantial.

28 August 1973 (Table 17)

After the slight increase on 12 August total zooplankton were recorded in low numbers on this date.

TABLE 16.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 12 August, 1973.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	15129	8.3	19.9	14916	7.7	25.9
Calanoid copepods	37335	17.8	49.1	17055	18.2	29.7
Cyclopoid copepods	5463	11.7	7.2	4912	8.8	8.5
Cladocerans	15820	10.8	20.8	11992	10.5	20.9
Rotifers	2310	18.5	3.0	8637	43.5	15.0
Total	76057	11.4		57510	8.4	
	Station 3			Station 4		
Copepod nauplii	19438	15.3	32.0	9888	90.7	29.2
Calanoid copepods	17546	14.6	28.9	12512	91.5	36.9
Cyclopoid copepods	10597	12.8	17.5	7305	89.7	21.5
Cladocerans	9784	16.9	16.1	3319	85.1	9.8
Rotifers	3386	9.7	5.6	886	111.7	2.6
Total	60692	11.8		33909	96.1	
	Station 5			Station 6		
Copepod nauplii	8828	6.2	29.2	6291	14.0	40.3
Calanoid copepods	8119	8.3	26.8	4144	13.8	26.6
Cyclopoid copepods	4233	16.3	14.0	779	30.3	5.0
Cladocerans	7362	11.6	24.3	3679	11.9	23.6
Rotifers	2110	16.0	7.0	706	100.7	4.5
Total	30251	7.7		15598	11.1	

TABLE 17.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 28 August, 1973.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	2673	21.0	18.2	3721	7.0	24.7
Calanoid copepods	3759	16.3	25.6	1838	11.9	12.2
Cyclopoid copepods	952	24.2	6.5	551	4.6	3.7
Cladocerans	4031	16.6	27.5	2346	10.8	3.7
Rotifers	3259	34.5	22.2	6606	11.4	43.9
Total	14675	15.5		15061	7.2	
	Station 3			Station 4		
Copepod nauplii	2515	7.6	30.3	1269	15.7	16.2
Calanoid copepods	1448	11.0	17.4	2906	28.2	37.1
Cyclopoid copepods	360	21.8	4.3	1145	80.6	14.6
Cladocerans	1339	12.5	16.1	1414	17.6	18.0
Rotifers	2639	9.3	31.8	1103	14.0	14.1
Total	8302	3.5		7837	14.9	
	Station 5			Station 6		
Copepod nauplii	2754	4.7	20.5	3068	12.5	28.6
Calanoid copepods	4982	20.2	36.8	2964	11.1	27.6
Cyclopoid copepods	1361	18.0	10.2	520	14.5	4.8
Cladocerans	2509	18.8	18.7	3276	1.7	30.5
Rotifers	1805	15.0	13.5	917	101.5	8.5
Total	13410	11.6		10745	7.3	

Total zooplankton abundances ranged from over 7,000/m^3 to over 15,000/m^3. No single taxon dominated the fauna on this date. Copepod nauplii were a major component, accounting for 7-30% of the zooplankton. However, calanoid copepods, cladocerans, and rotifers were the most abundant taxa. Cyclopoid copepods were the least common taxon. Cyclopoid copepods comprised less than 5% of the zooplankton at each station.

8 September 1973 (Table 18)

Total zooplankton abundances recorded were 5,000-10,000/m^3 with the exception of station four, where numbers were lower. Copepod nauplii, Cladocera, and rotifers all declined numerically, but remained prominent constituants of the zooplankton in percentage composition. Calanoid copepods were the most abundant taxon in samples from this date. Calanoids accounted for one-third of the zooplankton at most stations, their maximum densities were over 3,000/m^3. Cyclopoid copepods remained near 28 August abundances while the percentage of the fauna they represented increased.

24 September 1973 (Table 19)

Total zooplankton abundances exhibited little variation between stations. Densities of 8,000/m^3 or less were recorded at all stations. Copepods together

TABLE 18.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 8 September, 1973.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	2420	31.9	26.0	1757	9.9	28.0
Calanoid copepods	3029	3.3	32.6	1882	17.6	30.0
Cyclopoid copepods	1483	39.7	16.0	550	78.1	8.8
Cladocerans	1030	13.8	11.1	1011	20.6	16.1
Rotifers	1332	17.6	14.3	1070	12.5	17.1
Total	9294	15.8		6269	11.3	
	Station 3			Station 4		
Copepod nauplii	1141	4.4	17.1	1036	14.7	29.1
Calanoid copepods	1710	22.6	25.6	1117	9.4	31.4
Cyclopoid copepods	773	21.7	11.6	491	77.6	13.8
Cladocerans	836	18.2	12.5	364	73.7	10.2
Rotifers	2231	17.1	33.3	555	15.3	15.6
Total	6691	12.0		3562	12.9	
	Station 5			Station 6		
Copepod nauplii	971	16.0	19.6	2067	21.8	27.3
Calanoid copepods	1940	21.7	39.1	2466	22.2	32.6
Cyclopoid copepods	554	25.6	11.2	331	93.9	4.4
Cladocerans	786	25.0	15.9	1352	18.5	17.9
Rotifers	706	9.4	14.2	1352	22.0	17.9
Total	4958	13.7		7568	19.6	

TABLE 19--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 24 September, 1973.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	1859	8.9	27.4	1209	12.6	35.0
Calanoid copepods	1371	9.7	20.2	477	24.7	13.8
Cyclopoid copepods	1990	15.9	29.3	911	17.6	26.3
Cladocerans	1310	7.1	19.3	812	18.2	23.5
Rotifers	268	15.1	3.9	50	104.4	1.5
Total	6798	6.2		3458	10.8	
	Station 3			Station 4		
Copepod nauplii	2001	6.7	32.1	1942	35.1	23.7
Calanoid copepods	1494	14.3	24.0	3024	13.9	37.0
Cyclopoid copepods	1725	15.5	27.7	1764	18.0	21.6
Cladocerans	984	29.0	15.8	687	12.5	8.4
Rotifers	32	126.1	.5	17	141.6	.2
Total	6236	10.3		8182	14.9	
	Station 5			Station 6		
Copepod nauplii	1379	7.7	17.3	1907	15.3	35.3
Calanoid copepods	1707	14.9	21.4	1347	22.7	25.0
Cyclopoed copepods	1630	24.9	20.4	1247	20.1	23.1
Cladocerans	747	21.4	9.4	783	18.1	14.5
Rotifers	33	151.8	.4	113	162.9	2.1
Total	7990	19.1		5395	15.8	

predominated the late September zooplankton. Copepod nauplii, calanoid, and cyclopoid copepods all comprised between 20% and 30% of the zooplankton at most of the stations. Cladocera were abundant at station one, but densities of less than 1,000/m^3 were found elsewhere. Rotifer abundances were very low throughout the sampling area.

31 October 1973 (Table 20)

High winds forced discontinuation of sampling after station four on this date. Total zooplankton abundances ranged from 10,000-17,000/m^3. Copepod nauplii and calanoid copepods were abundant at all stations. Most stations exhibiting densities of 1,000-2,000/m^3 for each. Cyclopoid copepods predominated the fauna, with maximum densities being over 7,000/m^3. Cladocera were also abundant and comprised from 20% to 30% of the zooplankton. Rotifers remained at low numbers on this final sampling date of 1973.

Major Zooplankton Taxa, 1974

The primary data for 1974 are presented in tables 17 through 26, counts of major taxa and species. Included for each station are the mean number of organisms (individuals/m^3), the coefficient of variation of samples at the station, and the percent composition of the fauna.

TABLE 20.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 4 station on 31 October, 1973.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	1356	8.8	12.4	1873	7.6	13.9
Calanoid copepods	1381	16.0	12.6	2496	3.9	18.5
Cyclopoid copepods	5497	9.5	50.1	6099	4.0	45.2
Cladocerans	2729	12.7	24.9	2811	3.6	20.8
Rotifers	165	13.4	1.5	216	24.2	1.6
Total	10967	5.8		13494	1.2	
	Station 3			Station 4		
Copepod nauplii	1026	20.9	10.0	1938	11.5	11.2
Calanoid copepods	1679	21.7	16.3	1797	9.8	10.4
Cyclopoid copepods	4505	16.6	43.8	7464	10.7	43.2
Cladocerans	2719	31.1	26.4	5191	5.9	30.1
Rotifers	358	11.7	3.5	884	30.2	5.1
Total	10287	17.8		17271	6.0	

10 May 1974 (Table 21)

Total zooplankton numbers were low (18,000-26,000/m^3) at most stations. Copepod nauplii predominated the sampling area with the exception of station six. Copepod nauplii abundances ranged from over 11,000/m^3 to over 16,000/m^3 and comprised from 31% to 73% of the zooplankton. Calanoids were common, but their densities were below 1,000/m^3 at most stations. Cyclopoid copepods were abundant at all stations except the deepest station (four). Cyclopoid copepods comprised 3.8-12.9% of the zooplankton and their abundances exceeded 2,000/m^3 at most stations. Station six, a littoral station, was predominated by rotifers and had considerably greater total zooplankton densities than other stations. Rotifers were a prominent taxon at all other stations.

3 June 1974 (Table 22)

Total zooplankton densities displayed considerable variation on this date, densities ranged from over 75,000/m^3 to over 227,000/m^3. Unusually large numbers of copepod nauplii (78,000/m^3) and cyclopoid copepods (56,000/m^3) were recorded at station four. Copepods were a prominent taxa throughout the sampling area, but their densities were generally one-fourth those of station four. Cyclopoid copepod densities showed great variation between stations. However they were abundant throughout the

TABLE 21.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 10 May, 1974.

Species	1 #/m^3	1 CV	1 %	2 #/m^3	2 CV	2 %	3 #/m^3	3 CV	3 %
Copepod nauplii	12479	6.0	67.3	16484	8.8	61.1	11692	3.1	62.4
Calanoida	949	15.3	5.1	862	22.6	3.2	1131	18.3	6.0
Diaptomus C_1-C_5*	316	22.4	1.7	472	22.3	1.7	517	16.1	2.8
Diaptomus ashlandi	379	30.9	2.0	336	32.4	1.2	332	74.2	1.8
Diaptomus minutus				40	112.8	.1			
Diaptomus oregonensis	29	124.5	.2				25	122.6	.1
Diaptomus sicilis	188	70.5	1.0	14	132.2	.1	88	115.9	.5
Limnocalanus macrurus	83	164.3	.4				66	135.5	.3
Eurytemora affinis									
Epischura lacustris	20	119.1	.1						
Cyclopoida	2392	36.4	12.9	2687	6.7	10.0	2103	19.9	11.2
Cyclops C_1-C_5	92	93.1	.5	320	8.8	1.2	219	22.6	1.2
Cyclops bicuspidatus thomasi	2292	36.8	12.4	2315	7.6	8.6	1852	22.2	9.9
Cyclops vernalis									
Tropocyclops prasinus mexicanus				52	116.1	.2	33	104.5	.2
Mesocyclops edax									
Eucyclops agilis							8	133.4	.1
Harpacticoida							8	133.4	.1
Canthocamptus sp	10	133.1	.1	14	132.5	.1	28	124.2	.1
Cladocera	10	133.1	.1	14	132.5	.1	18	143.0	.1
Bosmina longirostris									
Eubosmina coregoni									
Daphnia retrocurva							10	131.6	.1
Chyderus sphaericus									
Holopedium gibberum									
Polyphemus pediculus									
Leptodora kindtii									
Alona affinis									
Rotifera	2698	8.7	14.6	6913	18.1	25.6	3786	12.4	20.2
Keratella cochlearis				13	131.0	.1			
Keratella quadrata				13	131.0	.1			
Kellicottia longispina							49	129.6	.3
TOTAL	18528	5.5		26960	8.3		18740	4.3	

*C_1-C_5 denotes immature copepods.

TABLE 21.— 10 May 1974, Continued.

Species	4 #/m^3	4 CV	4 %	5 #/m^3	5 CV	5 %	6 #/m^3	6 CV	6 %
Copepod nauplii	15066	11.7	73.3	15790	10.9	51.8	15570	.4	31.1
Calanoida copepodite	544	17.9	2.6	882	22.3	2.9	433	6.1	.9
Diaptomus C1-C5	215	13.1	1.0	564	23.7	1.8	275	3.0	.5
Diaptomus ashlandi	38	128.4	.2	48	131.3	.2	29	143.8	.1
Diaptomus minutus	72	113.4	.3	36	126.8	.1	27	107.5	.1
Diaptomus oregonensis	23	100.3	.1	73	90.8	.2	11	128.6	.1
Diaptomus sicilis	170	122.9	.8	180	18.1	.6	106	22.8	.2
Limnocalanus macrurus	18	118.0	.1						
Eurytemora affinis									
Epischura lacustris	889	24.3	4.3	2537	25.8	8.3	1887	6.7	3.8
Cyclopoida	101	18.7	.5	240	22.1	.8	210	16.3	.4
Cyclops C_1-C_5	779	26.5	3.8	2239	38.6	7.3	1654	8.4	3.3
Cyclops bicuspidatus thomasi									
Cyclops vernalis				140	121.0	.5	22	139.6	.1
Tropocyclops prasinus mexicanus									
Mesocyclops edax									
Eucyclops agilis	9	130.0	.1						
Harpacticoida									
Canthocamptus sp									
Cladocera	9	131.6	.1	119	95.4	.4	86	14.9	.2
Bosmina longirostris	9	131.6	.1	27	102.2	.1	60	80.4	.1
Eubosmina coregoni									
Daphaia geleata mendotae									
Daphnia retrocurva				92	98.3	.3	26	141.8	.1
Chyderus sphaericus									
Holopedium gibberum									
Polyphemus pediculus									
Leptodora kindtii									
Alona affinis									
Rotifera	4044	17.5	19.7	11148	15.9	36.6	32050	8.2	64.1
Keratella cochlearis									
Keratella quadrata							241	72.8	.5
Kellicottia longispina	90	109.4	.4	147	97.2	.5	625	16.7	1.2
TOTAL	20552	11.7		30475	12.5		50026	5.2	

TABLE 22.—Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 3 June, 1974.

	#/m³	1 CV	%	#/m³	2 CV	%	#/m³	3 CV	%
Copepod nauplii	23217	8.5	30.7	20304	12.2	24.3	16414	5.2	16.0
Calanoida	1194	21.8	1.6	934	24.0	1.1	3941	7.9	3.8
Diaptomus C_1-C_5	814	22.8	1.1	814	26.0	1.0	3509	9.3	3.4
Diaptomus ashlandi				14	131.9	.1	41	154.5	.1
Diaptomus minutus	282	25.6	.4				284	73.4	.3
Diaptomus oregonensis	63	112.2	.1	51	152.0	.1	37	127.9	.1
Diaptomus sicilis	27	123.3	.1				35	152.6	.1
Limnocalanus macrurus	9	131.3	.1	26	141.8	.1			
Eurytemora affinis				30	144.1	.1	35	127.5	.1
Epischura lacustris									
Cyclopoida	2046	10.6	2.7	4004	27.8	4.8	17238	4.2	16.8
Cyclops C_1-C_5	493	22.2	.6	1996	55.5	2.4	8329	9.4	8.1
Cyclops bicuspidatus thomasi	1134	79.4	1.5	1983	19.8	2.4	8856	7.1	8.6
Cyclops vernalis	302	150.7	.4				36	152.6	.1
Tropocyclops prasinus m	10	132.8	.1	26	141.9	.1	18	142.5	.1
Mesocyclops edax									
Eucyclops agilis									
Harpacticoida									
Canthocamptus sp									
Cladocera	498	75.8	.7	3782	18.2	4.5	2460	10.1	2.4
Bosmina longirostris	488	75.6	.6	3782	18.2	4.5	2352	9.2	2.3
Eubosmina coregoni									
Daphnia geleata mendotae									
Daphnia retrocurva	10	132.8	.1						
Chyderus sphaericus							108	122.6	.1
Holopedium gibberum									
Polyphemus pediculus									
Leptodora kindtii									
Alona affinis									
Rotifera	48677	9.5	64.4	54553	6.7	65.3	62578	4.3	61.0
Keratella cochlearis	26362	16.5	34.7	33223	7.6	39.7	27495	3.5	26.8
Keratella quadrata	1348	82.1	1.8	1448	9.4	1.7	4552	16.8	4.4
Kellicottia longispina	905	78.6	1.2	2253	21.7	2.7	2902	11.4	2.8
TOTAL	75629	7.6		83575	7.8		102632	2.9	

TABLE 22.—3 June 1974, Continued.

Species	#/m^3	4 CV	%	#/m^3	5 CV	%	#/m^3	6 CV	%
Copepod nauplii	78793	10.0	34.6	41275	11.2	23.9	12565	6.9	11.9
Calanoida	6881	16.7	3.0	3725	8.4	2.1	657	16.8	.6
Diaptomus C_1-C5	5682	18.6	2.5	3388	166.2	2.0	587	19.1	.6
Diaptomus ashlandi	132	120.5	.1	36	127.5	.1			
Diaptomus minutus	861	14.7	.4	226	15.1	.1	70	119.7	.1
Diaptomus oregonensis	75	162.9	.1	19	143.8	.1			
Diaptomus sicilis	131	120.1	.1						
Limnocalanus macrurus				17	143.8	.1			
Eurytemora affinis				17	143.8	.1			
Epischura lacustris									
Cyclopoida	56231	17.0	24.7	22810	5.5	13.2	5570	11.4	5.3
Cyclops C_1-C5	31363	14.6	13.8	12269	5.7	7.1	2551	13.6	2.4
Cyclops bicuspidatus thomasi	24354	25.1	10.7	10119	8.0	5.8	2991	11.4	2.8
Cyclops vernalis	202	146.8	.1	17	143.8	.1			
Tropocyclops prasinus mexicanus	331	104.2	.1	55	110.9	.1			
Mesocyclops edax							29	143.6	.1
Eucyclops agilis									
Harpacticoida									
Canthocamptus sp									
Cladocera	1081	87.3	.5	2781	9.8	1.6	10771	13.7	10.2
Bosmina longirostris	1081	87.3	.5	2706	9.3	1.5	10743	13.6	10.1
Bubosmina coregoni									
Daphnia geleata mendotae									
Daphnia retrocurva							28	144.5	.1
Chydorus sphaericus				75	114.5	.1			
Holopedium gibberum									
Polyphemus pediculus									
Leptodora kindtii									
Alona affinis									
Rotifera	84708	7.9	37.2	102300	5.8	59.2	75568	11.8	71.9
Keratella cochlearis	56335	12.6	24.7	42350	11.4	24.5	46048	16.5	43.8
Keratella quadrata	3902	11.4	1.7	8453	14.8	4.9	3630	17.7	3.4
Kellicottia longispina	8653	8.4	3.8	7010	9.5	4.0	4013	11.1	3.8
TOTAL	227694	8.6		172910	17.5		105129	10.5	

sampling area. Calanoid copepods were abundant at all but the two littoral stations. However, calanoids comprised a minor percentage of the fauna (see Fig. 5). Cladocera had become abundant at most stations, maximum densities of Cladocera (over 10,000/m^3) were obtained from a littoral station. Rotifers dominated the fauna at all stations except four. Maximum rotifer abundances were obtained at station five, over 100,000/m^3.

19 June 1974 (Table 23)

Total zooplankton abundance exceeded 200,000/m^3 at all but the two littoral stations. Little variation between stations was observed. Peak abundances of total zooplankton were recorded on this date. Copepod nauplii were abundant at all stations (over 6,000-25,000/m^3), but did not comprise a significant percentage of the fauna. Calanoid copepods were the least abundant taxon in 19 June samples and comprised a minor percentage of the zooplankton. Cladocera were prominent at half of the stations, as were cyclopoid copepods. Rotifers dominated the zooplankton, comprising more than 59% of the fauna at all stations. At half of the stations rotifer densities obtained were over 161,000/m^3.

TABLE 2 3.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 19 June, 1974.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	7743	21.3	3.5	6375	13.2	4.3
Calanoid copepods	8304	21.6	3.7	1011	30.7	.7
Cyclopoid copepods	18003	6.5	8.1	14139	19.4	9.4
Cladocerans	19090	12.2	8.6	36864	20.3	24.6
Rotifers	161860	6.3	72.9	91388	14.5	61.0
Total	221932	3.0		149777	13.9	
	Station 3			Station 4		
Copepod nauplii	6837	13.4	3.0	13943	15.2	5.6
Calanoid copepods	3594	19.2	1.6	11699	34.4	4.7
Cyclopoid copepods	37268	14.0	16.6	37638	20.9	15.2
Cladocerans	26360	32.8	11.7	22708	3.9	9.2
Rotifers	161217	16.4	71.7	161093	5.2	65.2
Total	224813	14.6		247083	7.8	
	Station 5			Station 6		
Copepod nauplii	11322	15.2	5.6	25396	2.5	15.0
Calanoid copepods	2553	25.7	1.2	1018	8.7	.6
Cyclopoid copepods	25153	10.6	12.0	15535	9.2	9.2
Cladocerans	30880	129.6	14.7	25977	11.9	15.4
	140216	145.7	66.7	101064	5.8	59.8
	210124	146.5		168990	5.6	

1 July 1974 (Table 24)

Total zooplankton abundances (21,000-37,000/m^3) declined sharply from the previous sampling date. Copepod nauplii remained abundant at all stations and were a prominent taxon at most stations. Calanoid copepods were abundant in samples from all but the littoral stations, as on previous sampling dates. Calanoids continued to comprise aminor percentage of the total composition. Cyclopoid copepods exhibited the same pattern of distribution as did calanoids on this date, being abundant at all but the littoral stations. Maximum cyclopoid densities recorded were over 6,000/m^3. Cladocera declined in numerical abundance throughout the sampling area, but represented a larger portion of the percentage composition. Maximum cladoceran densities exceeded 9,000/m^3. Rotifers dominated the fauna at all stations except four. Maximum rotifer abundances were obtained at station five over 17,000/m^3.

15 July 1974 (Table 25)

Total zooplankton numbers increased from 1 July abundances, maximum densities recorded at station two were over 108,000/m^3. Copepod nauplii were a prominant taxon throughout the sampling area. Cyclopoid and calandoid copepods both occurred in abundance at all

TABLE 24.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 1 July, 1974.

Species	1 #/m^3	1 CV	1 %	2 #/m^3	2 CV	2 %	3 #/m^3	3 CV	3 %
Copepod nauplii	6069	37.1	27.8	6925	5.1	26.1	6679	87.7	25.7
Calanoida	1264	63.6	5.8	460	24.3	1.7	928	77.9	3.6
Diaptomus C_1-C_5	1081	18.3	4.8	418	23.5	1.6	908	77.8	3.5
Diaptomus ashlandi							10	130.3	.1
Diaptomus minutus	167	18.5	.7	42	113.2	.1			
Diaptomus oregonensis	17	117.3	.1						
Diaptomus sicilis									
Limnocalanus macrurus							10	130.3	.1
Eurytemora affinis	9	131.6	.1						
Epischura lacustris									
Cyclopoida	1196	80.6	5.4	615	9.9	2.3	1327	88.1	5.1
Cyclops C_1-C_5	464	78.2	2.1	320	28.7	1.2	669	80.6	2.6
Cyclops bicuspidatus thomasi	722	36.6	3.2	281	31.6	1.1	649	79.8	2.5
Cyclops vernalis							9	129.3	.1
Tropocyclops prasinus mexicanus	9	131.9	.1						
Mesocyclops edax				14	132.5	.1			
Eucyclops agilis									
Harpacticoida									
Canthocamptus sp									
Cladocera	4144	42.8	19.0	2209	6.6	8.3	4947	86.6	19.0
Bosmina longirostris	4127	4.2	18.5	2209	6.6	8.3	4912	86.6	18.9
Bobosmina coregoni							13	134.6	.1
Daphnia geleata mendotae									
Daphnia retrocurva	9	131.0	.1				23	118.6	.1
Chyderus sphericus									
Holopedium gibberum									
Polyphemus pediculus									
Leptodora kindtii	9	131.3	.1						
Alona affinis	9	131.9	.1						
Rotifera	9127	35.7	41.8	16365	7.8	61.6	12084	90.5	46.5
Keratella cochlearis	8549	8.1	38.3	13393	8.3	50.4	8958	90.1	34.5
Keratella quadrata	19	143.3	.1	131	126.5	.5	96	137.8	.4
Kellicottia longispina	559	24.4	2.5	2841	31.8	10.5	706	76.3	2.7
TOTAL	21800	3.3		26574	5.4		25965	94.1	

TABLE 24.--1 July 1974, Continued.

Species	4 #/m³	4 CV	4 %	5 #/m³	5 CV	5 %	6 #/m³	6 CV	6 %
Copepod nauplii	3650	29.6	12.8	5731	5.0	15.2	5275	9.5	21.2
Calanoida	2334	29.5	8.2	1233	8.1	3.3	417	17.1	1.7
Diaptomus C_1-C_5	2199	28.8	7.7	1114	10.2	2.9	395	16.3	1.6
Diaptomus ashlandi	78	114.5	.3	54	110.5	.1	11	128.6	.1
Diaptomus minutus	40	129.1	.1	28	124.2	.1			
Diaptomus oregonensis	9	131.3	.1	19	118.5	.1			
Diaptomus sicilis									
Limnocalanus macrurus									
Eurytemora affinis	9	131.3	.1	18	118.0	.1	11	128.6	.1
Epischura lacustris									
Cyclopoida	6215	20.3	21.8	3946	9.5	10.4	502	25.7	2.0
Cyclops C_1-C_5	1957	20.2	6.9	1566	5.4	4.1	247	29.4	1.0
Cyclops bicuspidatus thomasi	4192	28.8	14.7	2325	14.9	6.1	241	29.3	.9
Cyclops vernalis				19	118.4	.1			
Tropocyclops prasinus mexicanus	64	111.9	.2	27	123.5	.1	15	133.1	.1
Mesocyclops edax									
Eucyclops agilis				9	132.5	.1			
Harpacticoida	63	132.8	.2						
Canthocamptus sp	63	132.8	.2						
Cladocera	8306	16.5	29.2	9322	9.5	24.7	5562	9.2	22.4
Bosmina longirostris	6724	16.9	23.6	9294	9.5	24.6	5508	9.4	22.2
Bubsomina coregoni									
Daphnia geleata mendotae									
Daphnia retrocurva	52	132.4	.2				55	108.1	.2
Chydorus sphaericus	43	131.3	.1						
Holopedium gibberum	9	131.3	.1	19	119.0	.1			
Polyphemus pediculus				9	132.5	.1			
Leptodora kindtii									
Alona affinis	47	131.1	.2						
Rotifera	7908	22.9	27.8	17543	9.3	46.4	13083	10.6	52.7
Keratella cochlearis	5760	44.0	20.2	15182	9.4	40.2	11736	10.4	47.2
Keratella quadrata	55	110.6	.2	74	114.0	.2	26	142.2	.1
Kellicottia longispina	1511	25.6	5.3	1862	11.3	4.9	766	22.3	3.1
TOTAL	28476	8.8		37776	5.4		24838	4.4	

TABLE 25.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 15 July, 1974.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	13502	5.3	14.0	19084	11.6	17.6
Calanoid copepods	8648	11.0	9.0	1491	10.9	1.4
Cyclopoid copepods	9882	6.9	10.2	3645	6.4	3.4
Cladocerans	31712	6.4	32.9	52096	8.5	48.0
Rotifers	32702	6.2	33.9	32220	5.1	29.7
Total	96450	4.5		108536	6.9	
	Station 3			Station 4		
Copepod nauplii	13288	10.1	14.4	20733	12.6	33.7
Calanoid copepods	4903	14.6	5.3	7110	9.9	11.5
Cyclopoid copepods	4491	11.2	4.9	5623	20.9	9.1
Cladocerans	42113	7.8	45.6	18453	9.3	29.9
Rotifers	28452	8.2	30.8	15237	15.5	24.7
Total	92429	4.9		61603	9.3	
	Station 5			Station 6		
Copepod nauplii	16734	9.7	18.7	9653	13.9	20.6
Calanoid copepods	5122	24.0	5.7	1731	26.7	3.7
Cyclopoid copepods	6322	18.4	7.1	2416	7.3	5.2
Cladocerans	46378	6.5	51.9	14369	15.2	30.7
Rotifers	15261	12.2	17.1	18571	15.6	39.7
Total	89367	24.1		46740	12.9	

stations. Cyclopoid copepods being slightly more abundant than calanoids. Cladocerans were the most abundant taxon at most stations, comprising 29-51% of the zooplankton. Maximum cladoceran densities exceeded 52,000/m^3. Rotifers were a prominent component of the zooplankton at all stations. Abundance of rotifers ranged from over 15,000/m^3 to over 32,000/m^3.

1 August 1974 (Table 26)

Total zooplankton numbers exceeded 30,000/m^3 at all stations except station six, where abundances were half those of other stations. Copepod nauplii comprised from 11% to 48% of the zooplankton between stations, their maximum abundance (16,000/m^3) occurring at station four. Calanoid copepods were an important component of the zooplankton, comprising 7% to 12% of the zooplankton. Cyclopoid densities were generally 3,000-4,000/m^3, however their maximum densities exceeded 13,000/m^3. Cladocera were a prominent taxon, comprising from 10% to 33% of the fauna, their maximum abundances (10,000/m^3) occurring at station two. Rotifers ranged from 5,000-8,000/m^3 between stations, comprising from 15% to 32% of the fauna.

20 August 1974 (Table 27)

Total zooplankton abundance ranged from 19,000 27,000/m^3 with the exception of station four where

TABLE 26.—Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 1 August, 1974.

Species	#/m³	1 CV	%	#/m³	2 CV	%	#/m³	3 CV	%
Copepod nauplii	9849	17.9	29.5	6898	10.2	22.4	9377	14.0	25.6
Calanoida	3692	13.3	11.1	2523	9.4	8.2	4689	14.2	12.8
Diaptomus C_1-C_5	2782	18.4	8.3	2000	11.4	6.5	3614	16.4	9.9
Diaptomus ashlandi	165	98.0	.5	27	142.5	.1	86	137.9	.2
Diaptomus minutus	645	76.9	1.9	408	4.8	1.3	859	10.8	2.3
Diaptomus oregonensis	20	144.3	.1	49	151.5	.2	17	141.9	.1
Diaptomus sicilis	60	159.9	.2	13	131.6	.1	114	168.4	.3
Limnocalanus macrurus	20	144.3	.1						
Eurytemora affinis				26	142.2	.1			
Epicschura lacustris									
Cyclopoida	4880	18.8	14.6	2915	10.6	9.5	8648	11.8	23.6
Cyclops C_1-C_5	1595	83.2	4.8	955	14.8	3.1	1609	12.2	4.4
Cyclops bicuspidatus thomasi	2510	19.9	7.5	1523	11.4	4.9	6497	13.0	17.7
Cyclops vernalis	147	171.6	.4				141	144.2	.4
Tropocyclops prasinus mexicanus	628	18.0	1.9	436	10.8	1.4	213	70.9	.6
Mesocyclops edax							17	144.9	.1
Eucyclops agilis									
Harpacticoida	40	154.3	.1						
Canthocamptus sp	40	154.3	.1						
Cladocera	9941	6.5	29.8	10231	11.8	33.2	6791	10.0	18.5
Bosmina longirostris	7303	10.8	21.9	8139	12.9	26.4	3628	17.3	9.9
Bubosmina coregoni	175	123.5	.5	258	134.4	.8	198	69.7	.5
Daphnia geleata mendotae	179	69.0	.5				19	143.6	.1
Daphnia retrocurva	1488	22.1	4.5	1430	20.5	4.6	2536	25.3	6.9
Chydoris sphaericus	124	95.3	.4	51	120.8	.2			
Holopedium gibberum	634	110.1	1.9	78	81.9	.2	139	96.6	.4
Polyphemus pediculus				77	70.6	.2	252	101.4	.7
Leptodora kindtii							18	142.5	.1
Aloma affinis									
Rotifera	5007	9.4	15.0	8253	8.3	26.8	7143	4.7	19.5
Keratella cochlearis	3872	9.9	11.6	6043	8.4	19.6	6048	5.5	16.5
Keratella quadrata	42	155.0	.1	535	18.4	1.7	70	136.4	.2
Kellicottia longispina	599	78.7	1.8	948	2.6	3.1	427	14.8	1.2
TOTAL	33369	8.0		30819	7.7		36647	8.2	

TABLE 26.—1 August, 1974, Continued.

Species	4 #/m³	4 CV	4 %	5 #/m³	5 CV	5 %	6 #/m³	6 CV	6 %
Copepod nauplii	16107	15.8	48.8	3808	17.9	11.6	2572	4.2	15.3
Calanoida	3945	7.6	12.0	4613	27.4	14.0	1344	4.7	8.0
Diaptomus C_1-C_5	2376	15.1	7.2	3362	26.4	10.2	1194	6.7	7.1
Diaptomus ashlandi	51	157.1	.1	284	126.7	.9			
Diaptomus minutus	1316	80.7	4.0	330	104.5	1.0	125	126.4	.7
Diaptomus oregonensis				319	152.7	1.0			
Diaptomus sicilis	102	117.6	.3	18	142.5	.1			
Limnocalanus macrurus	34	126.8	.1	33	151.8	.1			
Eurytemora affinis	67	137.5	.2	301	128.1	.9	25	141.3	.2
Epischura lacustris									
Cyclopoida	3167	12.1	9.6	13220	27.3	40.2	4046	10.0	24.1
Cyclops C_1-C_5	1899	14.0	5.8	9190	33.7	27.7	1216	8.7	7.2
Cyclops bicuspidatus thomasi	914	19.6	2.8	3697	38.4	11.3	2507	12.2	14.9
Cyclops vernalis	17	141.6	.1	33	151.8	.1			
Tropocyclops prasinus mexicanus	335	74.0	1.0	346	130.0	1.0	324	21.4	1.9
Mesocyclops edax				33	151.8	.1			
Eucyclops agilis									
Harpacticoida									
Canthocamptus sp									
Cladocera	4386	42.8	13.3	3560	10.3	10.8	3418	17.1	20.3
Bosmina longirostris	2585	41.9	7.8	1913	9.7	5.8	1828	13.7	10.9
Bubosmina coregoni	134	96.2	.4				177	90.0	1.0
Daphnia geleata mendotae	134	96.2	.4						
Daphnia retrocurva	16	141.3	.1	33	141.3	.1			
Chydoris sphaericus	862	79.9	2.6	1083	80.3	3.3	1213	107.4	7.2
Holopedium gibberum	17	103.9	.1	17	113.4	.1			
Polyphemus pediculus	355	104.8	1.1	70	75.5	.2	75	120.3	.4
Leptodora kindtii	3336	98.3	1.0	234	101.1	.7	100	123.6	.6
Aloma affinis	100	137.5	.3	17	142.5	.1			
Rotifera									
Keratella cochlearis									
Keratella quadrata									
Kellicottia longispina									
TOTAL									

TABLE 27.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 20 August, 1974.

	#/m^3	CV	%	#/m^3	CV	%
	Station 1			Station 2		
Copepod nauplii	3687	85.6	18.7	4948	6.4	25.3
Calanoid copepods	5335	87.5	27.0	4007	9.2	20.5
Cyclopoid copepods	1116	79.2	5.6	631	3.5	3.2
Cladocerains	5655	87.7	28.6	5107	5.8	26.2
Rotifers	3932	86.0	19.9	4831	9.7	24.7
Total	19739	93.6		19523	5.8	
	Station 3			Station 4		
Copepod nauplii	4702	10.9	18.6	12539	7.0	29.1
Calanoid copepods	4749	12.5	18.7	16584	7.3	38.5
Cyclopoid copepods	1200	10.6	4.7	2962	26.2	6.9
Cladocerains	7207	15.4	28.4	5141	13.9	11.9
Rotifers	7471	12.9	29.5	5874	8.5	13.6
Total	25330	8.6		43064	7.9	
	Station 5			Station 6		
Copepod nauplii	9033	8.1	32.6	7905	6.2	37.9
Calanoid copepods	7844	21.0	28.3	5066	18.9	24.3
Cyclopoid copepods	1226	8.5	4.4	981	18.4	4.7
Cladocerains	5487	14.3	19.8	3391	7.5	16.2
Rotifers	4083	7.0	14.8	3231	20.3	15.7
Total	27665	7.2		20875	9.5	

densities of 43,000/m^3 were recorded. Calanoid copepods increased in abundance from 1 August levels and were a prominent taxon throughout the sampling area. Maximum densities (over 16,000/m^3) of calanoids were recorded at the deepest station, over 16,000/m^3. Cyclopoid copepods were prevelent at all but the littoral stations. However cyclopoids were a minor component of the total percentage. Cladocera also were a prominent taxon, their densities exceeding 5,000/m^3 at all stations except six. Rotifers occurred only slightly less abundant than did cladocerans. No single taxon dominated the fauna on this date, nauplii, calanoids, Cladocera, and rotifers were all abundant.

4 September 1974 (Table 28)

Maximum densities of total zooplankton were recorded at station two (over 36,000/m^3) while densities at most stations were 10,000-16,000/m^3. Copepod nauplii were the most abundant taxon in samples from this date, comprising more than 36% of the zooplankton at all stations except six. Calanoid copepods were second in abundance to anuplii, comprising more than 20% of the fauna at all stations. Maximum calanoid densities (8,200/m^3) were recorded at station two. Cyclopoid copepods also were an important constituant of the fauna, their maximum densities being over 5,000/m^3. Cladocerans

TABLE 28.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 4 September, 1974.

Species	#/m^3	1 CV	%	#/m^3	2 CV	%	#/m^3	3 CV	%
Copepod nauplii	5859	22.0	39.3	15515	15.3	43.0	4787	11.1	36.4
Calanoida	3690	28.7	28.7	8217	8.1	22.7	2952	13.9	22.5
Diaptomus C1-C5	3075	27.1	20.6	6977	13.9	19.3	2574	14.6	19.5
Diaptomus ashlandi	291	105.7	1.9	407	96.0	1.1	224	71.5	1.7
Diaptomus minutus	184	99.2	1.2	317	93.7	.9			
Diaptomus oregonensis	146	121.0	1.0	411	96.1	1.1	137	96.4	1.0
Diaptomus sicilis	8	130.3	.1	106	162.1	.3	17	141.6	.1
Limnocalanus macrurus									
Eurytemora affinis									
Epischura lacustris									
Cyclopoida	2517	26.8	16.9	5701	13.1	15.8	1433	18.6	10.9
Cyclops C1-C5	1245	27.3	8.4	2809	12.6	7.8	587	76.3	4.5
Cyclops bicuspidatus thomasi	1256	33.3	8.4	2892	14.9	8.0	829	22.2	6.3
Cyclops vernalis	8	129.3	.1						
Tropocyclops prasinus mexicanus	8	130.3					17	142.2	.1
Mesocyclops edax									
Eucyclops agilis									
Harpacticoida									
Canthocamptus sp									
Cladocera	548	20.2	3.7	2224	17.2	6.2	903	25.7	6.9
Bosmina longirostris	87	65.3	.6	694	79.5	1.9	220	100.7	1.7
Eubosmina coregoni	56	88.1	.4	233	110.2	.6	87	115.9	.7
Diaphnia geleata mendotae	79	91.7	.5	133	93.9	.4	70	135.6	.6
Daphnia retrocurva	307	73.6	2.1	1087	31.4	3.0	425	20.4	3.2
Chydorus sphaericus				52	128.9	.1	84	138.4	.6
Holopedium gibberum									
Polyphemus pediculus									
Leptodora kindtii									
Alona affinis							17	144.6	.1
Rotifera	2287	24.3	15.3	4460	8.5	12.3	3066	13.1	23.3
Keratella cochlearis	948	20.8	6.4	1293	75.3	3.6	928	78.5	7.1
Keratella quadrata	133	96.8	.9	537	32.4	1.5	445	21.4	3.4
Kellicottia longispina	283	31.2	1.9	787	9.1	2.2	773	20.9	5.9
TOTAL	14901	20.7		36117	17.8		13141	10.8	

TABLE 28.—4 September 1974, Continued.

Species	4 #/m³	CV	%	5 #/m³	CV	%	6 #/m³	CV	%
Copepod nauplii	13100	16.7	46.4	7250	19.9	43.3	2426	3.1	22.4
Calanoida	5754	27.5	20.4	4175	28.1	24.9	2507	37.0	23.2
Diaptomus C1-C5	3431	25.6	12.1	3693	27.3	22.1	2150	107.8	19.9
Diaptomus ashlandi	830	111.1	2.9	294	73.9	1.8	326	94.2	3.0
Diaptomus minutus	83	138.4	.3	17	142.2	.1			
Diaptomus oregonensis	201	146.6	.7	84	137.6	.5	31	144.8	.3
Diaptomus sicilis	35	127.2	.1	35	152.3	.5			
Limnocalanus macrurus	18	142.7	.1	52	158.0	.3			
Eurytemora affinis									
Epischura lacustris	17	141.6	.1						
Cyclopoida	5792	22.1	20.5	1529	25.9	9.1	1787	31.3	16.5
Cyclops C1-C5	1557	23.3	5.5	844	21.2	5.0	597	38.3	5.5
Cyclops bicuspidatus thomasi	4401	24.3	15.6	685	109.8	4.1	1190	35.2	11.0
Cyclops vernalis									
Tropocyclops prasinus mexicanus									
Mesocyclops edax									
Eucyclops agilis									
Harpacticoida									
Canthocamptus sp									
Cladocera	874	26.0	3.1	949	113.0	5.7	449	96.3	4.1
Bosmina longirostris	107	140.1	.4	315	104.0	1.9	280	92.8	2.6
Eubosmina coregoni	54	132.6	.2	68	89.8	.4	26	136.8	.1
Daphnia galeata mendotae	122	95.3	.4	69	161.9	.4			
Daphnia retrocurva	557	25.7	2.0	479	158.7	2.9	143	127.4	1.3
Chydorus sphaericus	18	93.1	.1	17	143.2	.1			
Holopedium gibberum									
Polyphemus pediculus									
Leptodora kindtii									
Alona affinis									
Rotifera	2738	7.7	9.7	2831	15.0	16.9	3646	16.1	33.7
Keratella cochlearis	980	14.2	3.5	1145	30.6	6.8	545	6.5	5.0
Keratella quadrata	173	98.3	.6	35	152.3	.2	52	129.8	.5
Kellicottia longispina	768	80.1	2.7	707	20.6	4.2	253	18.1	2.3
TOTAL	28257	16.2		16733	18.8		10814	12.8	

declined numerically and in the percentage of the zooplankton they comprised. Cladocerans were recorded as abundant at only one station. Rotifers again were an important part of the fauna numerically and in percentage of the total composition. Their densities ranged from 2,000-4,000/m^3.

18 October 1974 (Table 29)

Total zooplankton densities exhibited little variation between stations and the total zooplankton was dominated by immature and adult copepods. Copepod nauplii, calanoid, and cycloppoid copepods comprised between 60% and 75% of the zooplankton at all stations. Maximum densities of anuplii (4,900/m^3), calanoids (5,400/m^3), and cyclopoids (5,600/m^3) were recorded at station one. Densities of Cladocera exhibited great variability (252-1,845/m^3) between stations. Rotifers comprised from 18% to 32% of the fauna and remained abundant throughout the sampling area.

4 November 1974 (Table 30)

Zooplankton abundance was approximately the same as those of 18 October. Though abundant, copepod nauplii declined from October densities. Nauplii comprised from 5% to 9% of the fauna. Meximum densities of calanoid copepods (over 8,000/m^3) were recorded at station three,

TABLE 29.—Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 18 October, 1974.

Species	1 #/m^3	1 CV	1 %	2 #/m^3	2 CV	2 %	3 #/m^3	3 CV	3 %
Copepod nauplii	4972	16.0	23.2	3354	10.3	17.0	3708	10.8	18.4
Calanoida	5437	12.8	25.4	4253	7.6	21.6	4902	12.0	24.3
Diaptomus C_1-C_5	4702	12.9	22.0	3894	19.1	19.7	4461	12.2	22.1
Diaptomus ashlandi	289	73.1	1.3	104	99.5	.5	246	22.5	1.2
Diaptomus minutus	179	146.5	.8	26	121.6	.1			
Diaptomus oregonensis	47	130.9	.2	102	109.4	.5	49	131.4	.2
Diaptomus sicilis	166	170.4	.8	128	86.9	.5	96	116.9	.5
Limnocalanus macrurus							17	141.6	.1
Eurytemora affinis	55	133.0	.2				17	141.6	.1
Epischura lacustris							17	141.6	.1
Cyclopoida	5696	15.0	26.6	4294	11.9	21.8	5033	9.5	24.9
Cyclops C_1-C_5	3300	17.5	17.8	2706	17.5	13.7	2793	8.3	13.8
Cyclops bicuspidatus thomasi	1318	20.3	6.2	1254	28.2	6.4	1484	11.0	7.3
Cyclops vernalis									
Tropocyclops prasinus mexicanus	385	131.4	1.8	335	95.7	1.7	740	23.4	3.7
Mesocyclops edax	19	143.6	.1						
Eucyclops agilis							16	141.0	.1
Harpacticoida	16	140.6	.1						
Canthocamptus sp	16	140.6	.1						
Cladocera	561	23.5	2.6	1845	17.3	9.3	1541	14.2	7.6
Bosmina longirostris	234	125.3	1.1	1132	27.0	5.7	904	13.4	4.5
Eubosmina coregoni	69	113.3	.3	156	167.2	.8	96	115.4	.5
Daphnia geleata mendotae	119	94.8	.6	172	129.4	.9	166	97.9	.8
Daphnia retrocurva	111	140.4	.5	428	96.4	2.2	358	74.5	1.8
Chydorus sphaericus							16	140.6	.1
Holopedium gibberum									
Polyphemus pediculus	16	140.6	.1						
Leptodora kindtii									
Alona affinis									
Rotifera	4575	10.5	21.4	5983	15.7	30.3	5012	7.6	24.8
Keratella cochlearis	1659	11.2	7.8	1748	106.1	8.9	893	10.9	4.4
Keratella quadrata	69	136.2	.3	52	152.3	.3	67	149.6	.3
Kellicottia longispina	411	74.2	1.9	356	94.5	1.8	264	71.6	1.3
TOTAL	21392	11.4		19729	7.1		20196	6.3	

TABLE 29.—Continued.

Species	4 #/m³	4 CV	4 %	5 #/m³	5 CV	5 %	6 #/m³	6 CV	6 %
Copepod nauplii	2336	82.2	17.6	3115	6.6	15.1	2030	3.9	13.9
Calanoida	4002	22.8	30.2	4883	5.9	23.6	3636	14.7	24.8
Diaptomus C_1-C_5	3613	25.0	27.3	4510	6.3	21.8	3431	17.6	23.4
Diaptomus ashlandi	281	73.2	2.1	203	70.7	1.0	51	141.9	.3
Diaptomus minutus									
Diaptomus oregonensis	75	113.9	.6	137	96.4	.7	52	116.1	.3
Diaptomus sicilis	33	151.8	.2				103	84.9	.7
Limnocalanus macrurus									
Eurytemora affinis									
Epischura lacustris				33	151.7	.2			
Cyclopoida	4160	9.5	31.4	5586	8.3	27.0	3326	6.0	22.7
Cyclops C_1-C_5	2594	10.7	19.6	3706	11.6	17.9	2213	6.4	15.1
Cyclops bicuspidatus thomasi	1368	13.3	10.3	1354	6.6	6.5	884	15.3	6.0
Cyclops vernalis									
Tropocyclops prasinus mexicanus	197	99.8	1.5	526	14.8	2.5	230	91.2	1.6
Mesocyclops edax									
Eucyclops agilis									
Harpacticoida									
Canthocamptus sp									
Cladocera	252	32.7	1.9	1652	10.7	8.0	938	8.6	6.4
Bosmina longirostris	111	142.1	.8	896	7.9	4.3	685	7.4	4.7
Eubosmina coregoni	25	147.8	.2	135	67.4	.6	76	81.8	.5
Daphnia geleata mendotae	98	116.6	.7	185	12.6	.9	51	115.7	.2
Daphnia retrocurva	17	141.6	.1	370	73.4	1.8	102	84.6	.7
Chydorus sphaericus				33	126.4	.2			
Holopedium gibberum									
Polyphemus pediculus									
Leptodora kindtii									
Alona affinis									
Rotifera	2501	20.0	18.9	5414	4.7	26.2	4702	12.0	32.1
Keratella cochlearis	1029	19.5	7.8	1633	10.8	7.9	909	18.9	6.2
Keratella quadrata	35	152.3	.3						
Kellicottia longispina	287	128.4	2.2	977	12.6	4.7	451	96.9	3.1
TOTAL	13250	9.5		20666	4.2		14632	8.1	

TABLE 30.--Mean abundance, coefficient of variation, and percentage composition for zooplankton collected at 6 stations on 4 November, 1974.

Species	1 #/m^3	1 CV	1 %	2 #/m^3	2 CV	2 %	3 #/m^3	3 CV	3 %
Copepod nauplii	1727	15.4	9.9	1721	15.1	7.7	1172	81.0	6.0
Calanoida	4136	19.3	23.9	6026	16.0	27.1	8192	15.3	41.7
Diaptomus C_1-C_5	3642	18.9	20.8	5673	16.3	25.5	7085	15.3	36.0
Diaptomus ashlandi	165	98.3	.9	77	157.7	.3	85	138.7	.4
Diaptomus minutus	49	157.2	.3	26	141.9	.1	31	150.6	.2
Diaptomus oregonensis	65	134.4	.4	144	87.8	.6	217	176.5	1.1
Diaptomus sicilis	251	101.9	1.4	108	162.4	.5	742	26.8	3.8
Limnocalanus macrurus									
Eurytemora affinis							17	141.6	.1
Epischura lacustris	141	38.5	.1				33	126.6	.2
Cyclopoida	3839	17.6	21.9	3016	16.7	13.5	3158	19.9	16.1
Cyclops C_1-C_5	2523	16.2	14.4	2027	11.7	9.1	2971	21.1	15.1
Cyclops bicuspidatus thomasi	1131	31.8	6.5	909	101.6	4.1	987	26.6	5.0
Cyclops vernalis									
Tropocyclops prasinus mexicanus	188	70.4	1.1	80	121.1	.4	204	70.3	1.0
Mesocyclops edax									
Eucyclops agilis	14	138.5	.1						
Harpacticoida									
Canthocamptus sp									
Cladocera	1075	24.5	6.1	2769	13.1	12.4	2844	16.4	14.5
Bosmina longirostris	657	109.4	3.7	1342	12.3	8.3	2392	17.8	12.2
Eubosmina coregoni	287	102.7	1.6	800	21.8	3.6	260	71.2	1.3
Daphnia geleata mendotae	148	97.3	.8	104	124.0	.5	175	69.9	.9
Daphnia retrocurva									
Chydorus sphaericus				24	140.6	.1	17	142.2	.1
Holopedium gibberum									
Polyphemus pediculus									
Leptodora kindtii									
Alona affinis									
Rotifera	6678	14.0	38.1	8737	12.7	39.2	4287	9.3	21.8
Keratella cochlearis	4898	15.4	28.0	6387	14.7	28.7	2952	243.4	15.0
Keratella quadrata	28	149.3	.2						
Kellicottia longispina	338	104.1	1.9	510	19.9	2.3	284	102.6	1.4
TOTAL	17504	14.6		22268	12.2		19653	12.2	

TABLE 30.—4 November 1974, Continued.

Species	4 #/m^3	4 CV	4 %	5 #/m^3	5 CV	5 %	6 #/m^3	6 CV	6 %
Copepod nauplii	2882	5.3	13.6	1489	6.3	9.2	1007	25.7	7.4
Calanoida	7362	24.4	34.9	3836	13.0	23.8	3637	19.6	26.9
Diaptomus C_1-C_5	6509	23.7	30.8	3260	17.5	20.2	2960	20.5	21.9
Diaptomus ashlandi	135	67.0	.6	49	131.4	.3			
Diaptomus minutus							50	151.8	.4
Diaptomus oregonensis	239	101.3	1.1	62	111.9	.4	126	86.5	.9
Diaptomus sicilis	461	106.8	2.2	421	25.5	2.6	501	16.0	3.7
Limnocalanus macrurus									
Eurytemora affinis				34	152.0	.2			
Epischura lacustris				11	135.6	.1			
Cyclopoida	7367	11.3	34.9	2532	9.8	15.7	2191	20.3	16.2
Cyclops C_1-C_5	5793	12.0	27.4	1949	9.1	12.1	1563	24.7	11.5
Cyclops bicuspidatus thomasi	973	15.0	4.6	343	72.8	2.1	528	25.7	3.9
Cyclops vernalis									
Tropocyclops prasinus mexicanus	601	26.3	2.8	240	18.8	1.5	100	84.5	.7
Mesocyclops edax									
Eucyclops agilis									
Harpacticoida									
Canthocamptus sp									
Cladocera	356	23.5	1.7	2678	7.7	16.6	2871	24.3	21.2
Bosmina longirostris	237	18.6	1.1	1730	9.2	10.7	1838	25.8	13.6
Eubosmina coregoni	17	141.6	.1	699	8.0	4.3	856	22.1	6.3
Daphnia geleata mendotae	103	140.8	.5	233	17.3	1.4	177	130.4	1.3
Daphnia retrocurva									
Chydorus sphaericus				16	141.0	.1			
Holopedium gibberum									
Polyphemus pediculus									
Leptodora kindtii									
Alona affinis									
Rotifera	3143	10.5	14.9	5589	8.4	34.7	3837	18.7	28.3
Keratella cochlearis	2469	11.9	11.7	4009	8.7	24.7	3081	20.9	22.7
Keratella quadrata	65	161.1	.3						
Kellicottia longispina	302	102.1	1.4	453	11.5	2.8	200	131.7	1.5
TOTAL	21110	9.1		16124	6.3		13543	17.4	

maximum densities of cyclopoid copepods (over 7,000/m^3) were recorded at station four. Both of these copepod groups comprised a major portion of the zooplankton. Rotifers also were a prominent taxon in the November samples, comprising from 14% to 39% of the fauna. Maximum densities (over 8,000/m^3) occurred at station two.