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Title: POPULATION DYNAMICS OF SELECTED ZOOPLANKTON IN THREE OLIGOTROPHIC OREGON LAKES

Abstract approved: Redacted for privacy
John R. Donaldson

Selected zooplankton from three oligotrophic lakes in Oregon were studied to determine whether or not their instantaneous birth rates and densities could be used in lake classification. The species of zooplankton studied in their respective lakes were *Daphnia pulex* in Crater Lake, *Daphnia longispina* in Odell Lake, and *Daphnia longispina* and *Diaphanosoma brachyurum* in Woahink Lake. Instantaneous birth rates, densities and other population parameters were estimated for these species. The species studied in Odell and Woahink Lakes were also collected to determine the relationship between diel vertical distribution of these species and the temperature and phytoplankton primary production occurring in the lakes.

Woahink Lake *Daphnia* had the highest instantaneous birth rates for *Daphnia* sp. of the three lakes. However, Woahink Lake *Daphnia* carried fewer eggs and were less dense than *Daphnia* in Odell Lake on

every sampling date. Crater Lake Daphnia were usually less dense and had lower instantaneous birth rates than was observed for the Woahink Lake Daphnia.

Because of changes in the density of zooplankters from one year to the next, as occurred with Daphnia in Crater Lake, and the lack of correlation between phytoplankton primary production and density, as occurred for Daphnia and Diaphanosoma in Woahink Lake, application of these population dynamics to lake systematics were nullified. The finite birth rate also lacked the expected correlation with phytoplankton primary production for all the selected species in the study lakes.

The lack of correlation may be due to interactions between the total species of zooplankton present in the lakes. If instantaneous birth rate and density were calculated for all the species in each lake it might be possible to use them for lake classification. However, the time expended in analysis would be prohibitive.

The diel vertical distribution of Daphnia in Odell Lake showed a typical migration to the surface at night and a return to deeper water during daylight hours. In Woahink Lake, however, Daphnia and Diaphanosoma were found to migrate only when the lake reached temperatures near 15°C or greater. The phytoplankton primary production occurring during the periods when migration did not take place, was equal to or greater than that occurring during some of the periods when vertical migration did occur. These observations may or may not have significance since the density of these two species did not show correlation with primary production.

Population Dynamics of Selected Zooplankton in Three Oligotrophic Oregon Lakes

by

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Special appreciation is given to my wife, Layne, who has displayed much patience and understanding during the course of this study. Without her assistance and sacrifices this study would not have been possible.

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POPULATION DYNAMICS OF SELECTED ZOOPLANKTON IN THREE OLIGOTROPHIC OREGON LAKES

INTRODUCTION

Much interest has been shown in the literature concerning the dynamics of zooplankton populations in lakes. Until recent years the main emphasis in the study of zooplankton populations was to enumerate species present and estimate their abundance in units of either weight or numbers per unit volume. Edmondson (1968) discusses a means of obtaining more information about the dynamics of zooplankton populations by enumeration of the zooplankters and their eggs. By following this procedure it is possible to determine the birth and death rates of a population. The egg ratios of zooplankton populations have been shown to directly reflect the nutritive quality of aquatic ecosystems (Slobodkin, 1954; Hall, 1964). Death rates may be indicative of the natural death rate and predation occurring in the population as was shown by Wright (1965).

Birth rates and densities of zooplankton populations may be of some use in the classification of lakes on the basis of biotic production. Since the egg ratios and food supply of zooplankton populations are related it follows that a productivity ranking using the peak summer instantaneous birth rate in conjunction with the number of zooplankters present might be possible.

One of the measurements needed for the calculation of the birth rate estimates is the thermal history of the zooplankters. Zooplankton may experience a large daily temperature change if they undergo diel vertical migration. McLaren (1963) has suggested that this migration is mainly controlled by light, but may also be partially affected by temperature and/or food supply of the migrating zooplankters. This migration may have adaptive value because higher temperatures increase the rate of maturation of the eggs; and lower temperatures increase the number of eggs carried by a female (McLaren, 1963). This increase in egg development time and increase in number of eggs per female would allow a more rapid response to increased food supply. Vertical migration may also serve as a method of dispersion. By passing through different water currents in the lake, zooplankters may be spread laterally in the lake. The dispersion would allow a more complete utilization of the lake's food resources.

Zooplankton were collected in Crater, Odell and Woahink Lakes to determine the feasibility of using zooplankton instantaneous birth rates and densities in the classification of lakes. The vertical distribution of zooplankton in relation to temperature and phytoplankton primary production in Odell and Woahink lakes was also observed.

Only the most abundant species were observed in each lake. For Crater Lake this included <u>Daphnia pulex</u> and <u>Bosmina longispina</u>

(Hoffman, 1969). The species studied in Odell Lake were *Daphnia longispina* and *Cyclops bicuspidatus thomasi* (Chapman and Fortune, 1963). In Woahink Lake *Daphnia longispina*, *Diaphanosoma brachyurum*, *Cyclops bicuspidatus thomasi*, *Diaptomus franciscanus*, and *Epischura nevadensis* (Chapman and Fortune, 1963) were studied. Also present but not in sufficient numbers to warrant counting were: *Bosmina* sp. in Odell Lake and *Bosmina* sp. and *Polyphemus pediculus* in Woahink Lake.

STUDY AREAS

Sampling was conducted on Crater, Odell and Woahink Lakes[1] which are all considered oligotrophic (Nelson, 1961; Averett, 1966; Griffiths and Yoeman, 1938). Although classed similarly on a production basis these lakes manifest unique origins, elevations and geographic location which brings them under the influence of diverse climatic conditions. They also exhibit a great diversity in their morphometric and physical features (Table 1).

Crater Lake (Figures 1 and 2) is located in Oregon's southern Cascade Mountains in a caldera formed by the collapse of Mount Mazama (Baldwin, 1959). The lake is deep and undergoes only weak thermal stratification during the summer months. It is fed almost entirely by direct precipitation and has no surface outlet.

Odell Lake (Figures 3 and 4) is located in Oregon's central Cascade Mountains in a basin formed by glaciation that was dammed by lateral and terminal moraines (Russell, 1905). It is relatively deep and shows moderate thermal stability during the summer months. The lake is fed by numerous streams which enter the lake on all sides. There is a single surface outlet on the east end of the lake.

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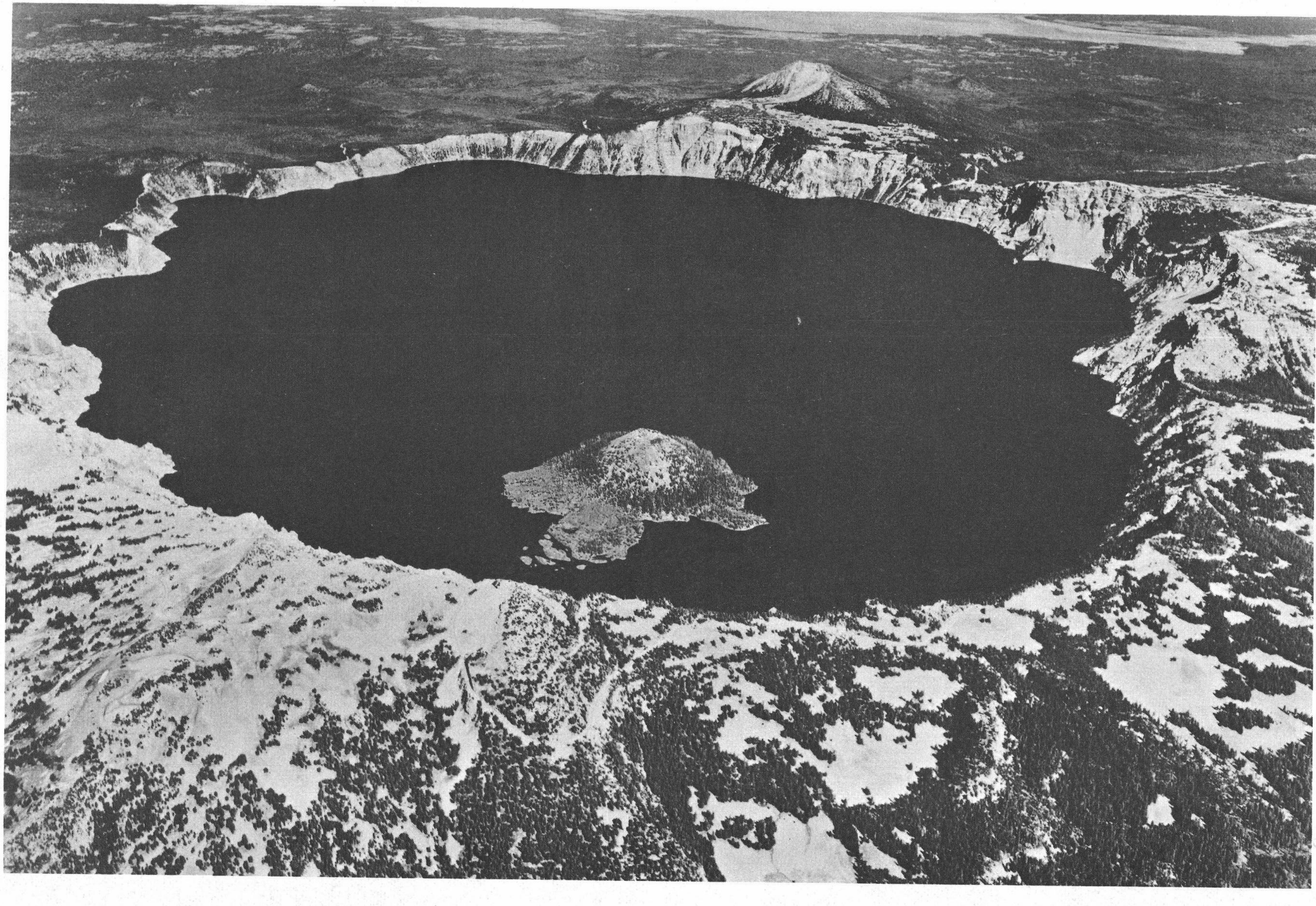
[1] For a more complete description of these lakes than will be given here refer to D. W. Larson, Ph.D. Thesis, Oregon State University, 1970.

Table 1. Selected physical and morphometric features of three oligotrophic lakes.

	Crater	Odell	Woahink
Area	48 km^2	14.4 km^2	3.2 km^2
Volume	16 km^3	0.59 km^3	0.033 km^3
Maximum depth	589 m	86 m	21 m
Mean depth	325 m	41 m	10.5 m
Shoreline length	31 km	21.5 km	22.3 km
Shoreline development	1.27	1.59	3.50
Elevation	1882 m	1459 m	11.6 m
Source	Byrne, J. V. (1965)	Oregon State Game Commission map number 1274 (Scale 1":1135')	McGie, A. and R. Breuser (1962)

Figure 1. Aerial view of Crater Lake, Oregon (Delano Photographics).



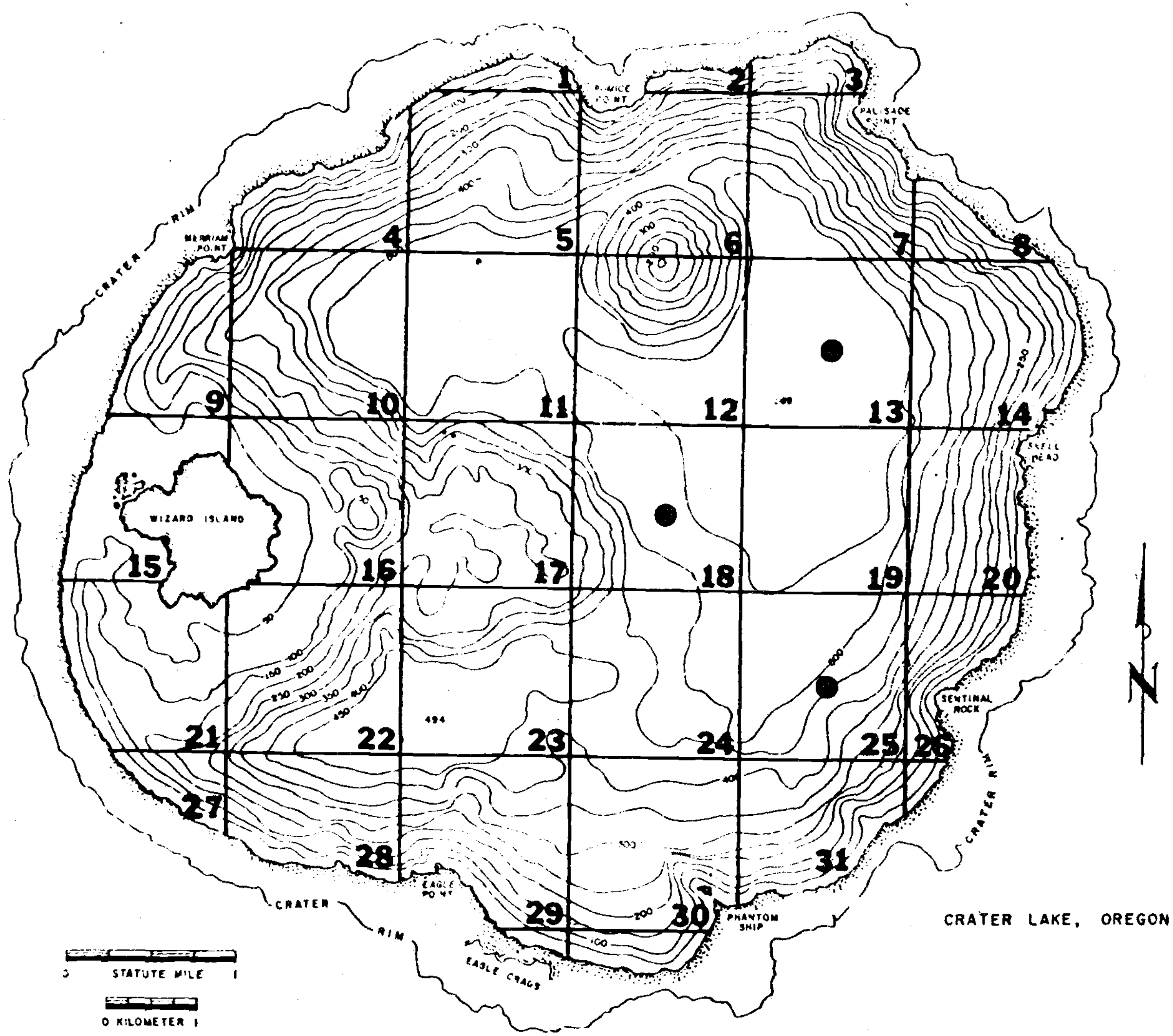
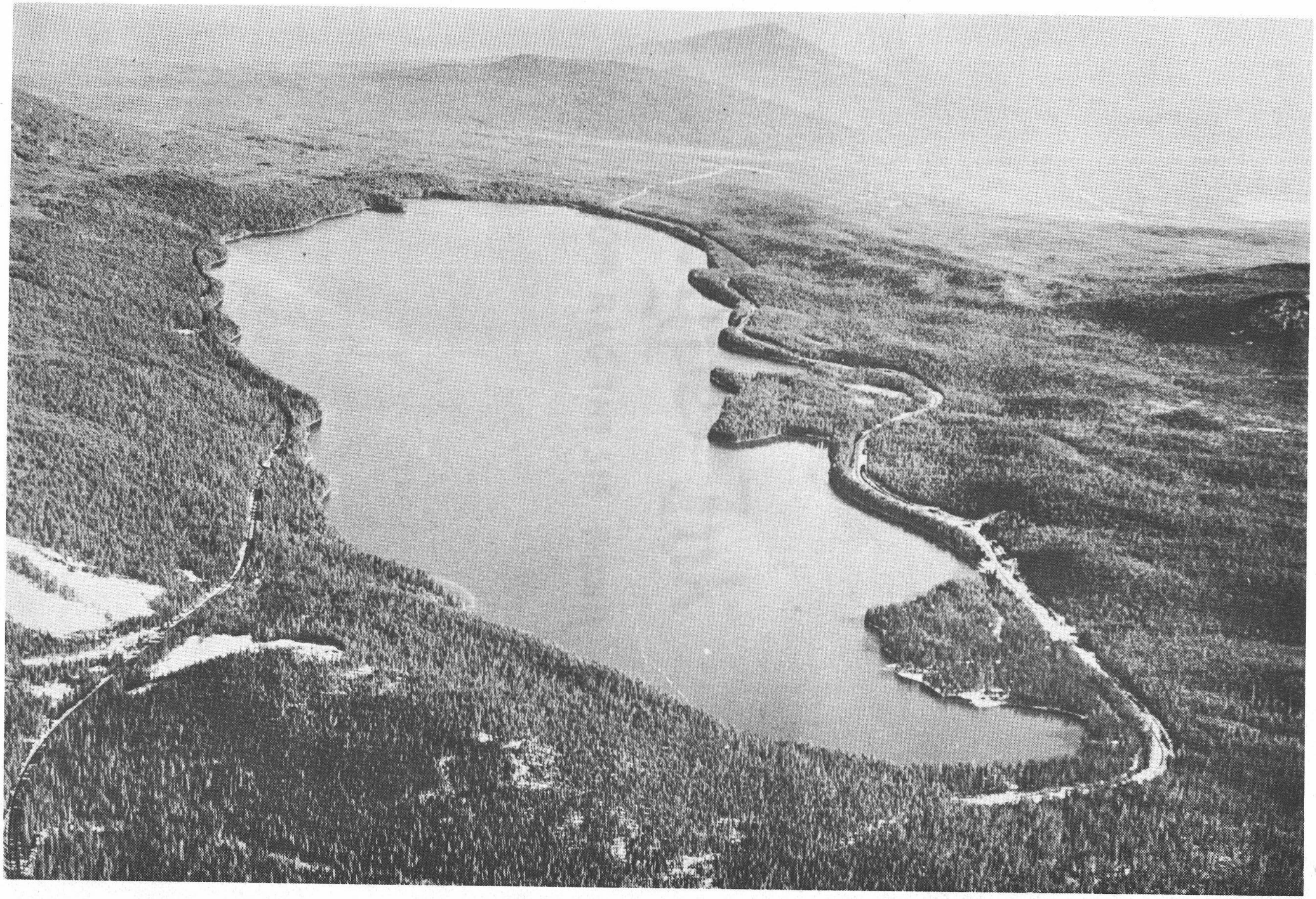


Figure 2. Bathymetric map of Crater Lake, Oregon (with depth in meters).

Figure 3. Aerial view of Odell Lake, Oregon as viewed from the west.



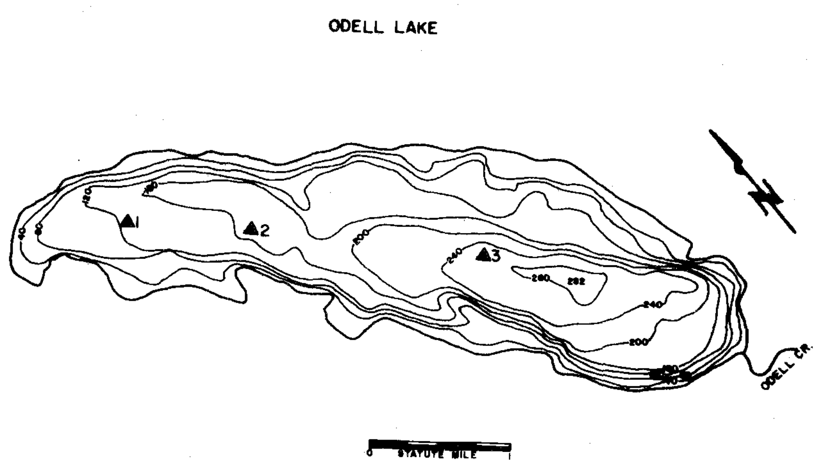


Figure 4. Bathymetric map of Odell Lake, Oregon, showing sampling station locations. Contours, in meters, based on Oregon State Game Commission map no. 1274.

Woahink Lake (Figures 5 and 6) is located on the south central Oregon coast in what was a small river basin which gradually filled with water following sand dune encroachment across its mouth (Baldwin, 1959). It is a small, shallow lake which forms a metalimnion from April or May through August or September. The lake receives water from several small streams around its margin and has a single surface outlet on the southern end.

Figure 5. Aerial view of Woahink Lake, Oregon as viewed from the southwest (Delano Photographics).

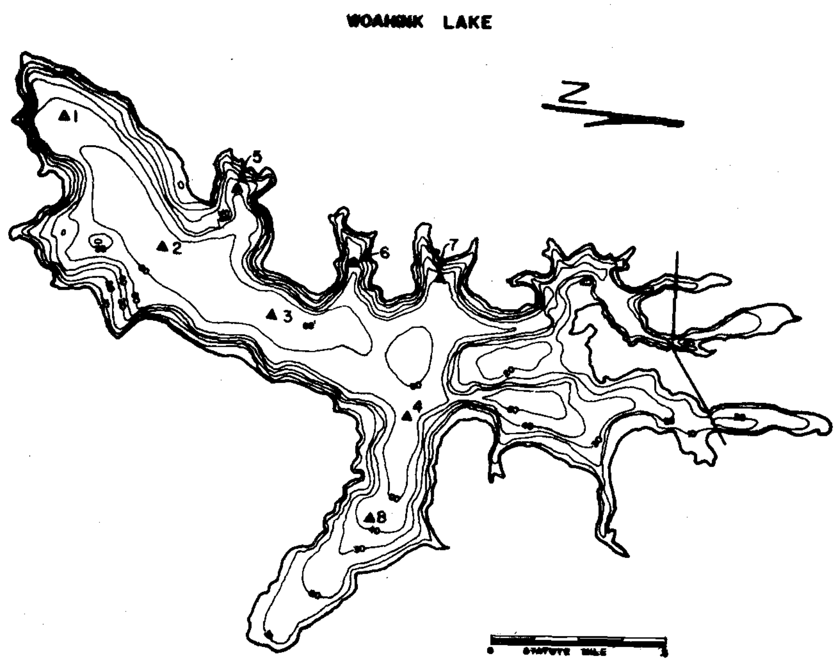


Figure 6. Bathymetric map of Woahink Lake, Oregon, showing sampling station location (1, 2, 3, 4). Contours, in meters, based on Oregon State Game Commission map no. CL-61-6.

METHODS

Plankton Collection

Sampling occurred during the period June, 1968 to September, 1969 (Table 2). Each of the three study lakes was sampled approximately once every three weeks during the summer months. Sampling was continued on a monthly basis during the winter of 1968-69 at Woahink Lake because of its accessability throughout this period. However, two of these monthly sampling periods, January and March 1969, were missed due to hazardous travel conditions.

Zooplankton collections were made by vertical and horizontal net tows in Odell and Woahink Lakes with vertical tows only being made in Crater Lake. Hoffman (1969) studied the vertical distribution of zooplankton in Crater Lake.

Vertical net tows were made with a no. 6 or no. 20 mesh standard tow net or with a no. 20 closing net (Figure 7). These nets were on a 0.5 m diameter net ring which was equipped with a T.S.K. flowmeter, mounted in the aperture to measure the volume of water strained by the net. Only a few of the 1968 Crater Lake tows did not use a flowmeter. The vertical tows in Crater Lake were all 100 m in length. The vertical tows in Odell Lake varied from 28 m to 40 m during the sampling period for 1968, depending on the depth of the lake at the respective stations, but was standardized to 30 m during the 1969 sampling

Table 2. Sampling dates for the study lakes showing number of samples collected and sampling gear used.

Crater Lake		Odell Lake		Woahink Lake	
Date	Samples per Station	Date	Samples per Station	Date	Samples per Station
6/15/68[c]	1	6/17/68[a]	2	7/17/68[a]	2
7/4/68[c]	1	7/9/68[a]	2	8/6/68[a]	2
7/25/68[b]	1	7/30/68[a]	2	9/3/68[b]	2
8/8/68[b]	1	8/13/68[a]	2	9/19/68[b]	2
8/28/68[b]	2	9/5/68[b]	2	10/14/68[b]	2
7/17/69[a]	4	9/25/68[b]	2	11/13/68[a, d]	4
8/31/69[a]	2	10/18/68[b]	2	12/9/68[a]	4
		7/10/69[a, d]	4	2/23/69[a]	4
		7/24/69[a, d]	4	4/13/69[a, d]	2
		8/8/69[a, d]	4	5/25/69[a, d]	4
		9/24/69[d]	-	6/13/69[a, d]	4
				7/1/69[a, d]	4
				8/1/69[a, d]	4

[a]No. 6 mesh 0.5 m diameter standard tow net

[b]No. 20 mesh 0.5 m diameter standard tow net

[c]No. 20 mesh 0.5 m diameter closing net

[d]Horizontal tows using the Miller samplers were made on these dates.

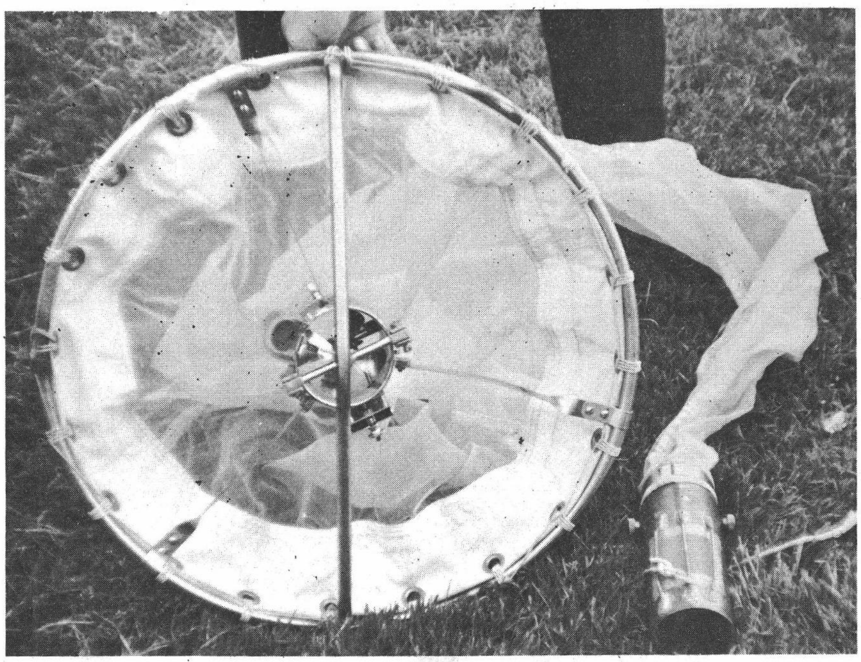


Figure 7. A standard tow net 0.5 m diameter, with number 6 mesh nylon net equipped with a T.S.K. flowmeter.

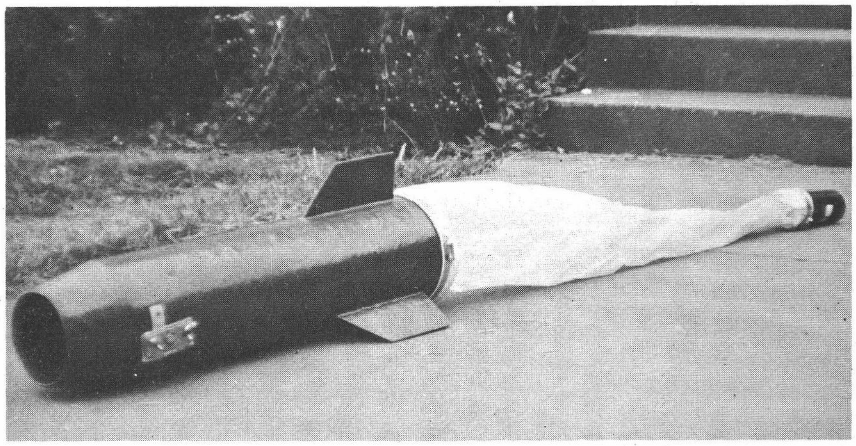


Figure 8. A Miller sampler with number 12 mesh nylon net (0.199 mm aperture).

period. Vertical tows in Woahink Lake varied from 15 m to 18 m depending on the depth of the lake at the respective stations but was standardized to 16 m in November, 1968. All of the vertical tows in Woahink Lake were taken at night. The vertical tows in the other study lakes were collected during the daylight hours.

The number of samples taken per station varied over the course of the study. The 1968 Crater Lake samples were collected by Hoffman (1969). These samples were collected at several stations in the lake (Figure 2) with one or two samples per station being taken. The samples in 1969 were collected at three of his stations with two or four tows per station. The samples in Odell Lake were collected at three stations (Figure 4). Two samples were collected per station during 1968 in Odell Lake, however, the number was increased to four per station in 1969. In Woahink Lake two samples were collected at each of four stations (Figure 6) on the Lake from July, 1968 through October, 1968 and April, 1969. Beginning November, 1968 the sample number was increased to four per station.

Since the vertical tows in Crater and Odell Lakes were made during the day it was necessary to estimate the degree of net avoidance. Ricker (1938) found that cladocera were able to avoid nets towed during daylight hours. To evaluate the possible avoidance, tows were taken at night and compared with tows taken during the normal daily sampling schedule of these two lakes on July 17, 1969 and on

July 24, 1969 respectively.

Another factor to be considered as a possible variable in sampling was the efficiency of the nets used. On July 21, 22, and 25, 1968, a series of vertical tows were taken with the no. 6 and the no. 20 standard tow nets, and the no. 20 closing net in Crater Lake. Vertical tows with only the 0.5 m diameter net ring with the flowmeter mounted in the aperture constituted the 100 percent efficient tows.

Horizontal net tows were made with Miller plankton samplers (Miller, 1961) (Figure 8). These are high speed non-clogging samplers which are towed horizontally at a given depth. Four of these samplers were mounted and used at the same time. Each sampler was equipped with a no. 12 mesh net. These samplers were used in Odell and Woahink Lakes in conjunction with the vertical tows in these lakes. In Odell Lake samples were spaced every four meters from 0 to 28 m and collected every six hours over a 24 hour period. The samples in Woahink Lake were spaced every two meters from 0 to 14 meters. These samples were also collected every six hours over a 24 hour period. The horizontal tows in Woahink Lake were five minutes in duration while those in Odell Lake were of two minute duration.

The sampling depths were maintained with the use of two 15 pound lead weights connected to the end of the sampling cable and by varying the speed of the boat until the cable came to 70° from the vertical. The samplers were attached to the cable at predetermined intervals, depending on the depth to be sampled. The sampler spacing on the cable, and amount of cable needed to attain proper depths were calculated from the formula:

$$\text{cable length} = \frac{\text{vertical depth}}{\cos 70^{\circ}}$$

The samplers were attached to the cable one at a time and lowered into the water until they were all attached. When all the samplers were attached the required length of cable was let out to bring the samplers to the proper depths. The boat was kept moving slowly ahead throughout the operation to maintain the proper towing angle and prevent the nets from fouling.

The volume of water passing through the nets was calculated from estimates made by holding a T. S. K. flowmeter in the water along side the boat as the horizontal tows were taken on August 8, 1969 in Odell Lake. The calculations made from these tows will assume 100 percent efficiency of the samplers as Miller (1961) found might be the case.

The horizontal samplers had no closing devices which meant that all the time they were moving through the water they were collecting zooplankton. In order to obtain an indication of the extent of contamination it was necessary to make contamination tows. These tows were made by putting the samplers out and bringing the cable to the proper angle then immediately retrieving them, thus simulating the added collection made by the samplers under normal use. This procedure was repeated promptly after each series of the regular horizontal tows on July 24 and 25, 1969 in Odell Lake and July 1 and 2, 1969 in Woahink Lake.

Plankton Counting

The plankton collected were preserved in approximately a four percent formalin solution. The samples were then brought back to Corvallis and stored until they were counted.

Each sample was readied for counting by putting it in a beaker of known weight and bringing it to a specific volume by weight for a given sample. A one milliliter aliquot was removed after mixing had taken place and before any of the organisms had time to settle or concentrate. The aliquot removed was then placed in a plastic counting chamber of dimension 69 x 32 x 4 mm with a grid etched on the bottom of the chamber. Monofilament fishing line was glued to the etchings running across the chamber to decrease the possibility of zooplankters moving from one column to the next while the chamber was being moved in the process of counting (Alevras, 1970). The ridges formed by the line also decreased the number of zooplankters that would lie on the line between two columns and thus diminished the number of choices that had to be made as to which column a zooplankter should be counted in.

The aliquot was placed in the counting chamber and counted in its entirety. When it had been counted the aliquot was returned to the sample and the procedure was repeated one more time. After the second aliquot was counted the entire sample was returned to the sample bottle.

These counts included the eggs of the species of interest which were *Daphnia* sp. in all the lakes and *Diaphanosoma* in Woahink Lake. The egg counts included the young of the two species that had not fallen out of the carapace of the adult and those young zooplankters that appeared to have fallen from the carapace as the sample was preserved.

Daphnia eggs were distinguished from other zooplankter eggs by their oval shape and yellow to greenish color. *Diaphanosoma* eggs were distinguished from *Daphnia* eggs in Woahink Lake by their more elongate form and their somewhat more granular appearance. The juveniles of *Daphnia* that were counted as eggs were distinguished from *Diaphanosoma* by their less blunt head, their caudal carapace spine, and by their shorter and smaller diameter antennae.

Supporting Limnological Measurements

Limnological measurements included in this study are temperature at depth and estimates of phytoplankton primary production using the *in situ* ^{14}C method of light and dark bottles. For a full description of the methods used in obtaining these measurements refer to D. W. Larson, Ph. D. thesis, Oregon State University.

Estimation of Population Parameters

The population parameters to be estimated are density in numbers per cubic meter, intrinsic rate of increase, instantaneous birth rate, finite birth rate, and death rate. Of these estimates only the numbers per cubic meter and intrinsic rate of increase will be estimated for each species counted. The other estimates will be computed only for the species of interest described in the previous section.

The density estimate will be obtained for each species by taking the counts made on each sample and multiplying them by the respective dilution used for each count. These numbers will then be averaged and divided by the number of flowmeter revolutions recorded for the sample multiplied by the number of cubic meters for each revolution. The formula used was:

$$\frac{\dfrac{(\text{Count } 1)(\text{dilution}) + (\text{Count } 2)(\text{dilution})}{2}}{(\text{number of flowmeter revolutions})(\text{number of cubic meters per revolution})}$$

The intrinsic rate of increase (r) is calculated from two measures of population abundance (N) from consecutive time periods (t). The formula as given by Edmondson (1968) is:

$$r = \frac{\ln N_{t_2} - \ln N_{t_1}}{t_2 - t_1}$$

The instantaneous birth rate (b) was calculated by the formula given by Edmondson (1968) which was:

$$b = \frac{\ln (1+E)}{D}.$$

Where E was the number of eggs per female or in this case the number of eggs per zooplankter counted, including sub-adults and males. The duration of egg development was denoted by D. Hall (1964) found that the duration of egg development was influenced mostly by water temperature. Since zooplankton may undergo vertical migration and thus change the temperature of their environment it was necessary to calculate an average temperature for this egg duration time.

The average temperature was determined from the horizontal tows. For those sampling periods when no horizontal tows were made the average temperature was determined by using the vertical distribution from other horizontal tow periods where similar temperature and primary production profiles occurred. The average temperature was obtained by multiplying the number of zooplankton per cubic meter by the number of eggs per cubic meter at their respective depths. These numbers were then added together and the percent of each depth found and multiplied by the temperature at that depth. The temperature-percent numbers were totaled for each tow series thus arriving at an average temperature for that series of samples. The formula used for these calculations was:

$$\text{Average temperature} = \sum_{i=1}^{4}\left[\sum_{i=1}^{8}\left(\frac{(\text{number of zooplankters/m}^3 \text{ at } z_i)\,(\text{number of eggs/m}^3 \text{ at } z_i)}{\sum_{i=1}^{8}(\text{number of zooplankters/m}^3 \text{ at } z_i)\,(\text{number of eggs/m}^3 \text{ at } z_i)}\right)\text{temp. at } z_i\right]$$

The finite birth rate (B) was obtained from the formula given by Edmondson (1968) where $B = E/D$. Death rate (d) was obtained by the formula $d = r - b$ (Edmondson, 1968).

Statistical Analyses

There were two types of statistical analyses used for the data obtained from the vertical tows in each lake. The first was a two-way classification using the natural logarithm of the number of zooplankters per cubic meter increased by one. These data were classified by stations and dates. This analysis was used for each species and the eggs of the species of interest.

The second analysis used was simple linear regression. The natural logarithms of the number of the species of interest per cubic meter were related to the carbon uptake in milligrams per square meter per hour. This analysis was also used to relate the finite birth rate (B) to the natural logarithm of the carbon uptake in milligrams per square meter per hour.

There was no statistical analysis used for the horizontal tow data.

RESULTS

Population Abundance

The dominant zooplankton species of Crater Lake, Daphnia and Bosmina, in 1968 and 1969 exhibited peak abundance in late August. The peaks followed rather closely the primary production curves obtained for the lake (Figure 9). There was a good correlation between Daphnia abundance and primary production (Figure 10). During 1968 Bosmina was the dominant species. In 1969 Daphnia was more abundant than in 1968 and was the dominant species (Figure 11). The low numbers of Bosmina in 1969 may be partially explained by the change in mesh size of the nets used in 1968 and 1969. The larger mesh used in 1969 may have allowed the smaller Bosmina to pass through the net.

In Odell Lake the zooplankton species, Daphnia and Cyclops were dominant. Daphnia exhibited a strong relationship to the primary production values obtained for the lake with an r value of 0.7818 (Figure 10, 12, and 13). Daphnia in Odell Lake peaked in August, 1968 and 1969. The peak in 1968 lagged only slightly behind the peak value for primary production. Cyclops did not exhibit this relationship to primary production. This species was more abundant in September and October, 1968 and declined in numbers from July through August in both years (Figure 12). The higher values for Cyclops during September and October may have been partly due to the change from a

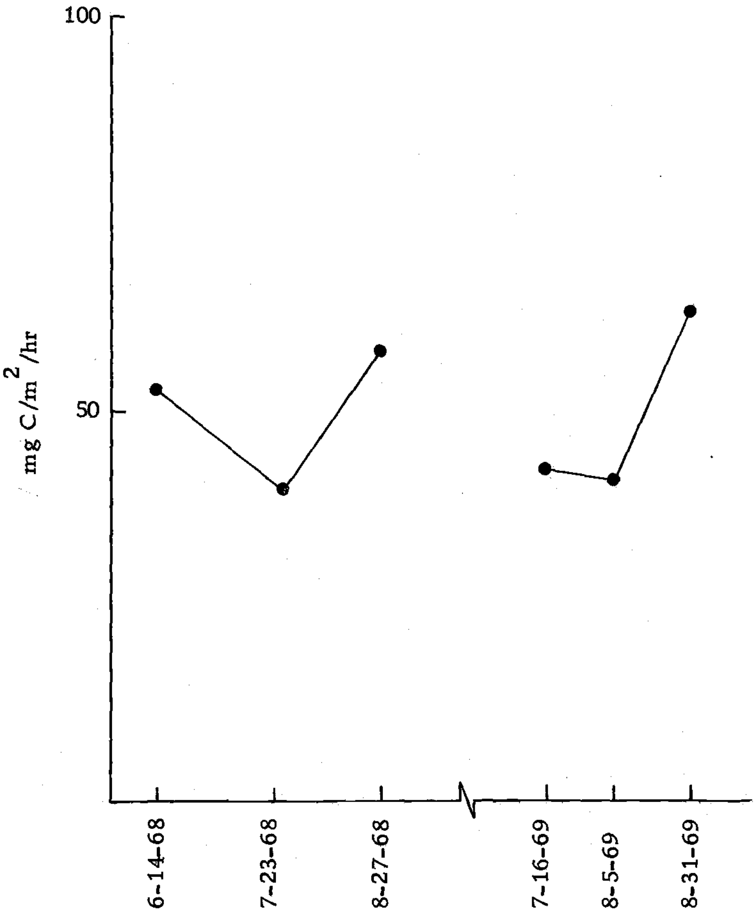


Figure 9. Primary production occurring at station 13 in Crater Lake during 1968 and 1969 (Larson, 1970).

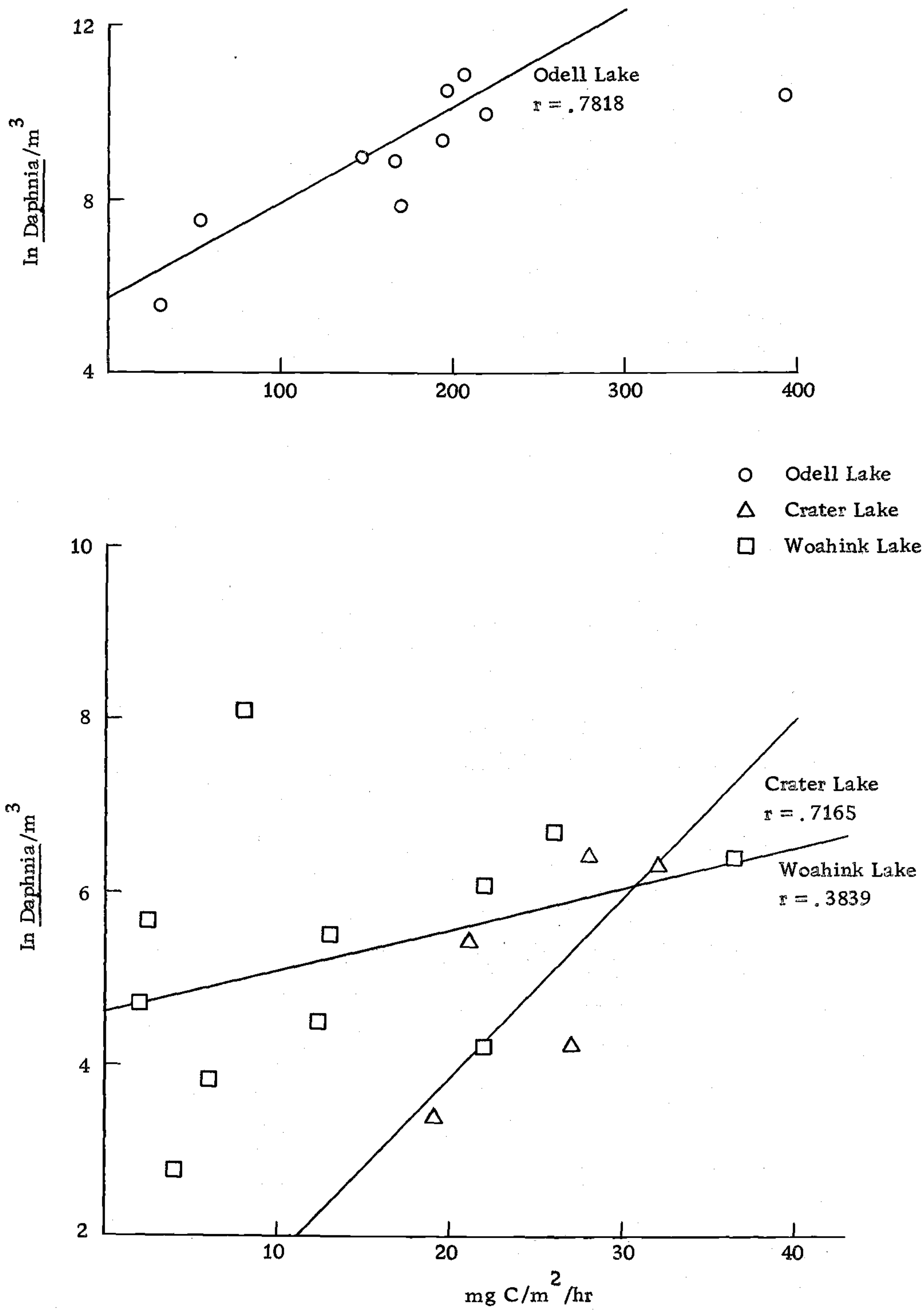


Figure 10. Simple linear regression of ln Daphnia/m^3 and primary production taken from the same station in Crater, Odell and Woahink Lakes during 1968 and 1969.

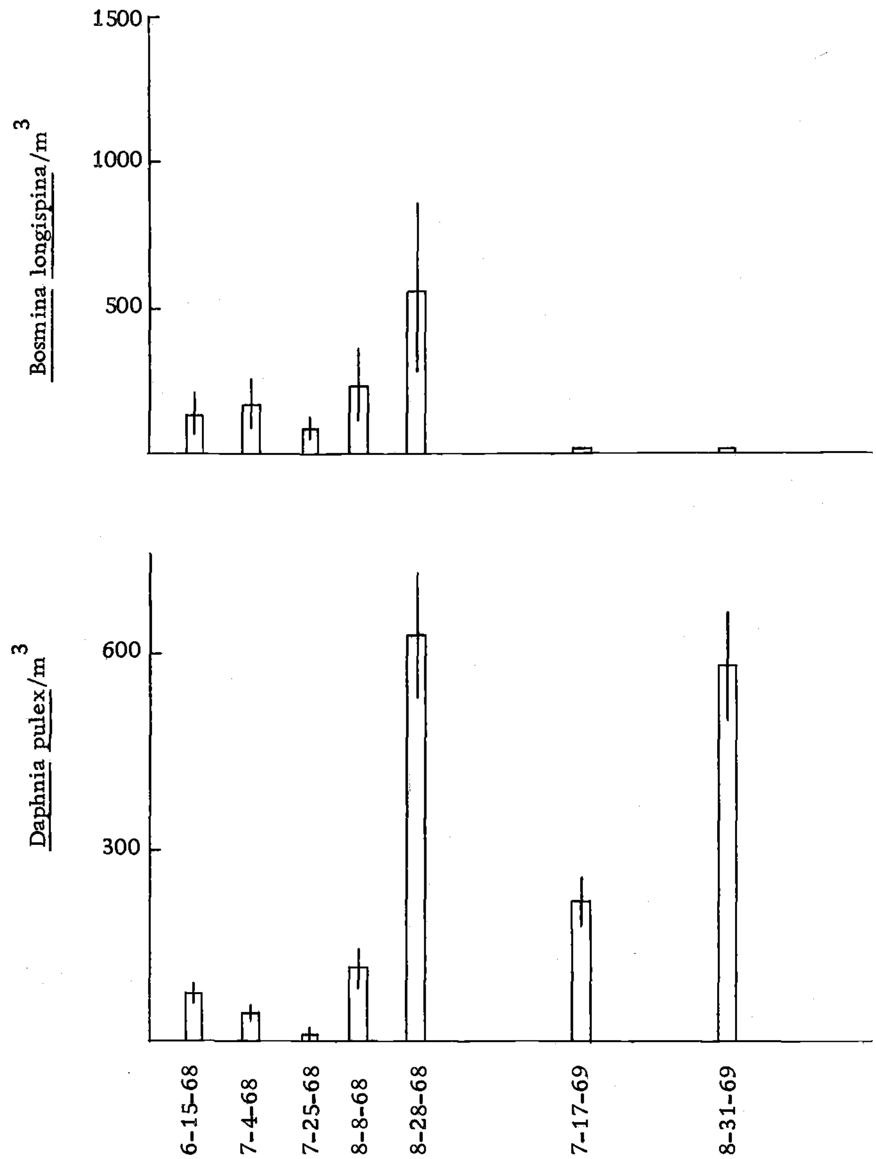


Figure 11. Changes in density of Daphnia pulex and Bosmina longispina at station 13 in Crater Lake during 1968 and 1969.

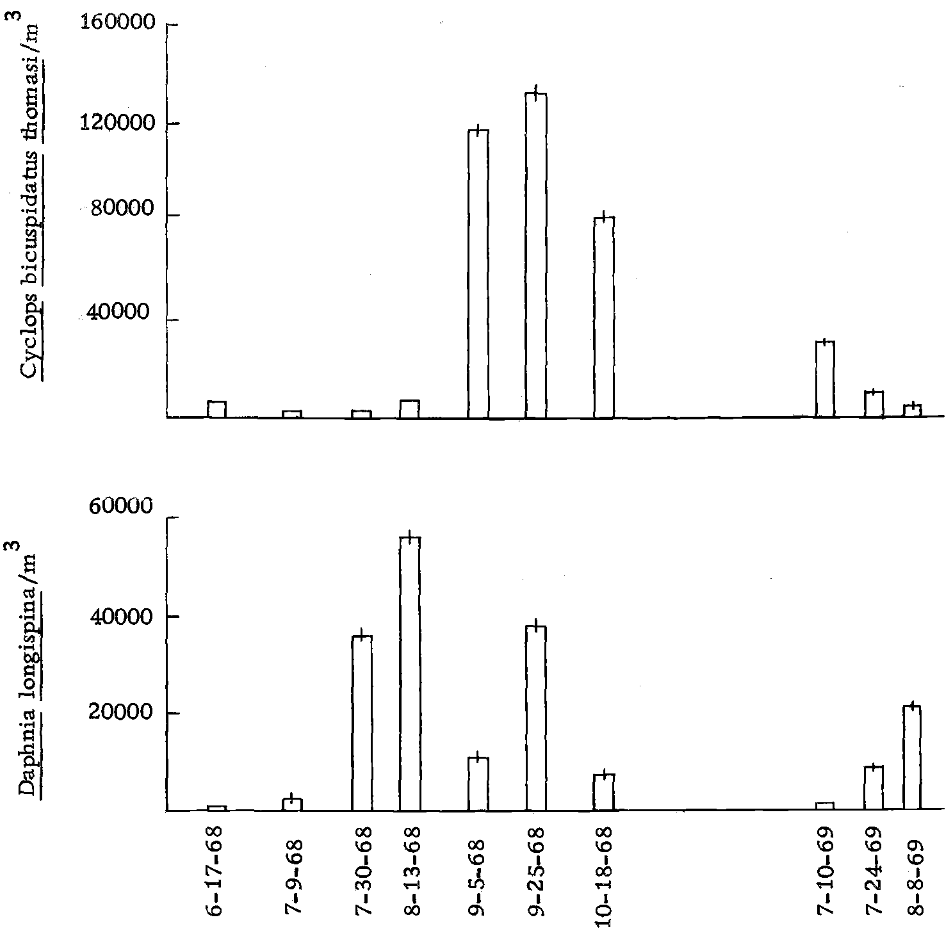


Figure 12. Changes in density of Daphnia longispina and Cyclops bicuspidatus thomasi at station 1 in Odell Lake during 1968 and 1969.

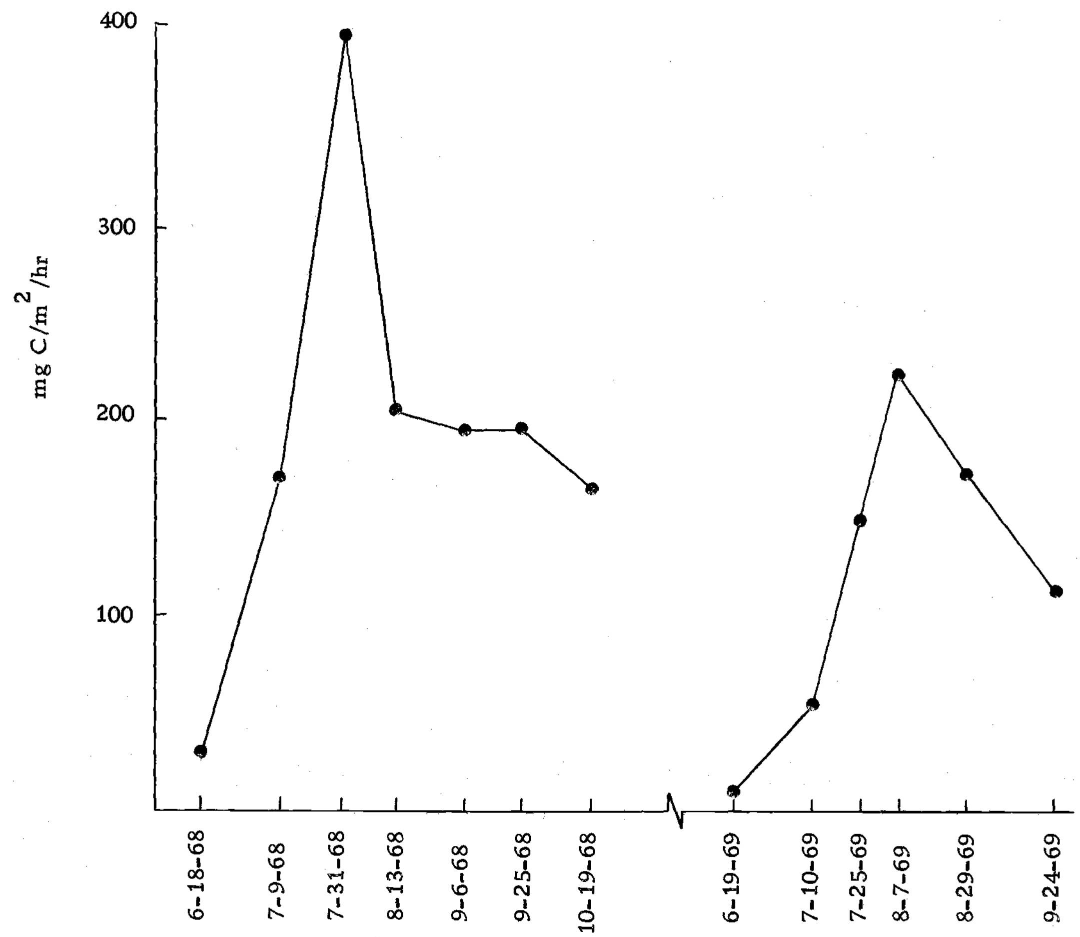


Figure 13. Primary production occurring at station 1 in Odell Lake during 1968 and 1969 (Larson, 1970).

no. 6 to a no. 20 mesh net which allowed fewer of them to pass through the net. The Cyclops in this lake seemed to be controlled primarily by temperature and secondly by primary production since they were most abundant when the lake was cooler yet had substantial primary production occurring.

Woahink Lake Daphnia, unlike the Daphnia in the other two study lakes, seem to exhibit no distinct pattern of abundance in relation to primary production. Daphnia in this lake had its highest peak in October, 1968 (Figure 14) at which time the primary production value obtained was one of the lowest (Figure 15). This species in general increased during the late summer and early fall and remained in low numbers the rest of the year. The correlation coefficient for the relation between Daphnia and primary production was only 0.3839 (Figure 10).

The abundance of Diaphanosoma was not obviously related to the primary production in Woahink Lake with an r of 0.3065 (Figure 16). Diaphanosoma had peaks of abundance in August and October, 1968 and a lower peak in June, 1969. The highest abundance over the course of the study occurred in August, 1969 (Figure 14).

Cyclops in Woahink Lake exhibited abundance curves similar to those previously mentioned for this species in Odell Lake and was probably controlled mostly by temperature during the summer months and primary production during the winter months. The peaks of

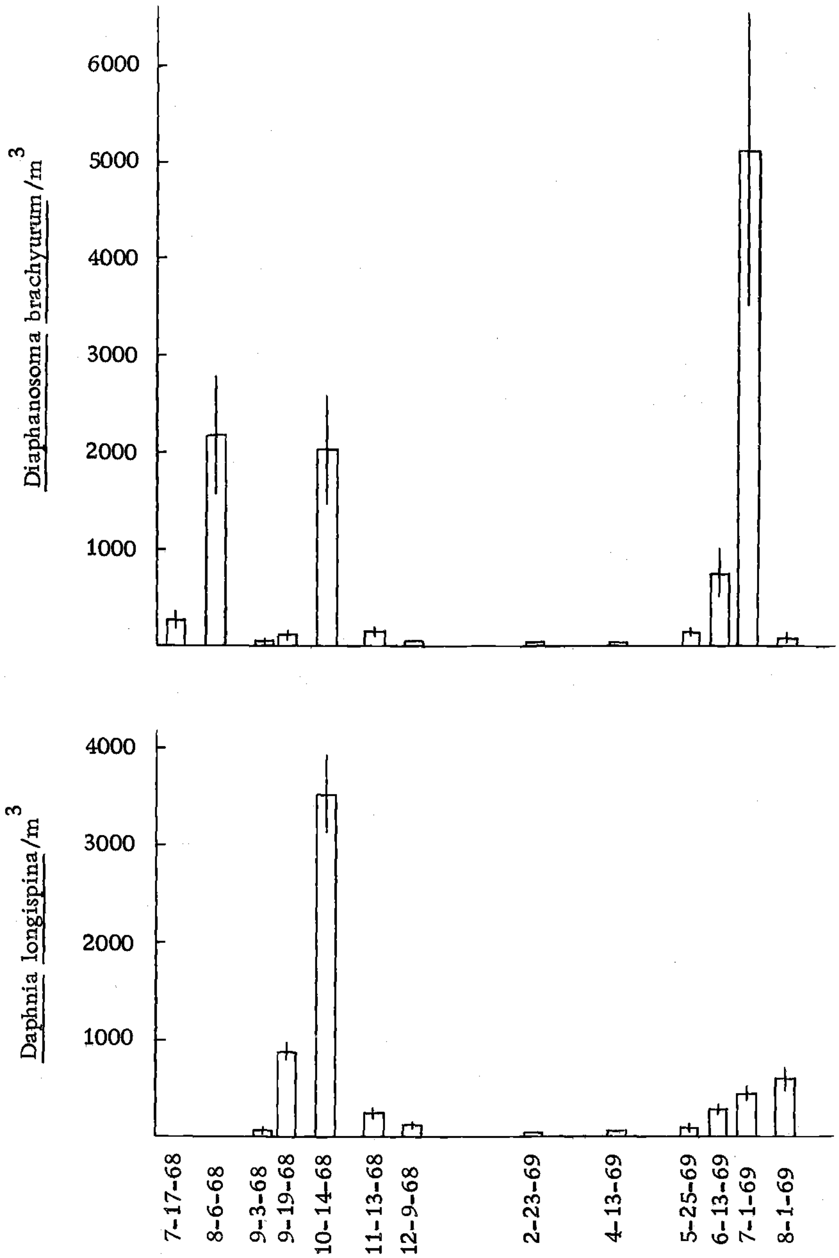


Figure 14. Changes in density of Daphnia longispina and Diaphanosoma brachyurum at station 3 in Woahink Lake during 1968 and 1969.

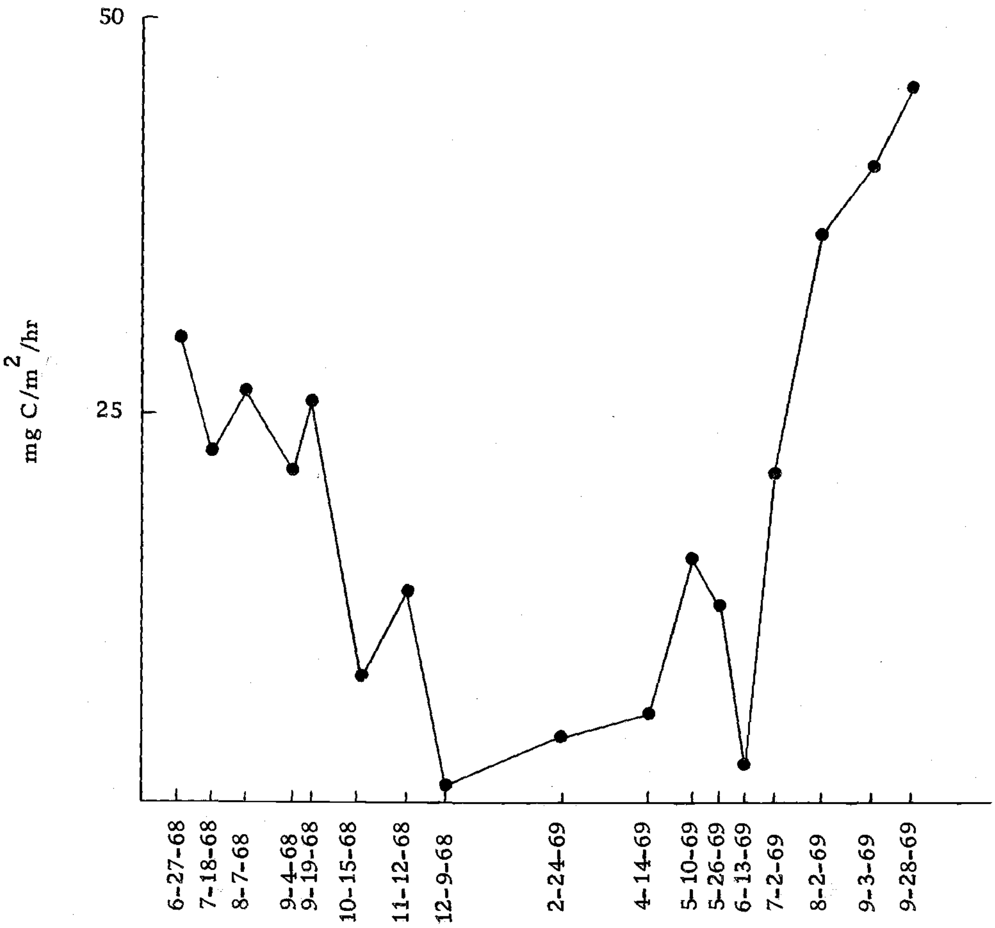


Figure 15. Primary production occurring at station 3 in Woahink Lake during 1968 and 1969 (Larson, 1970).

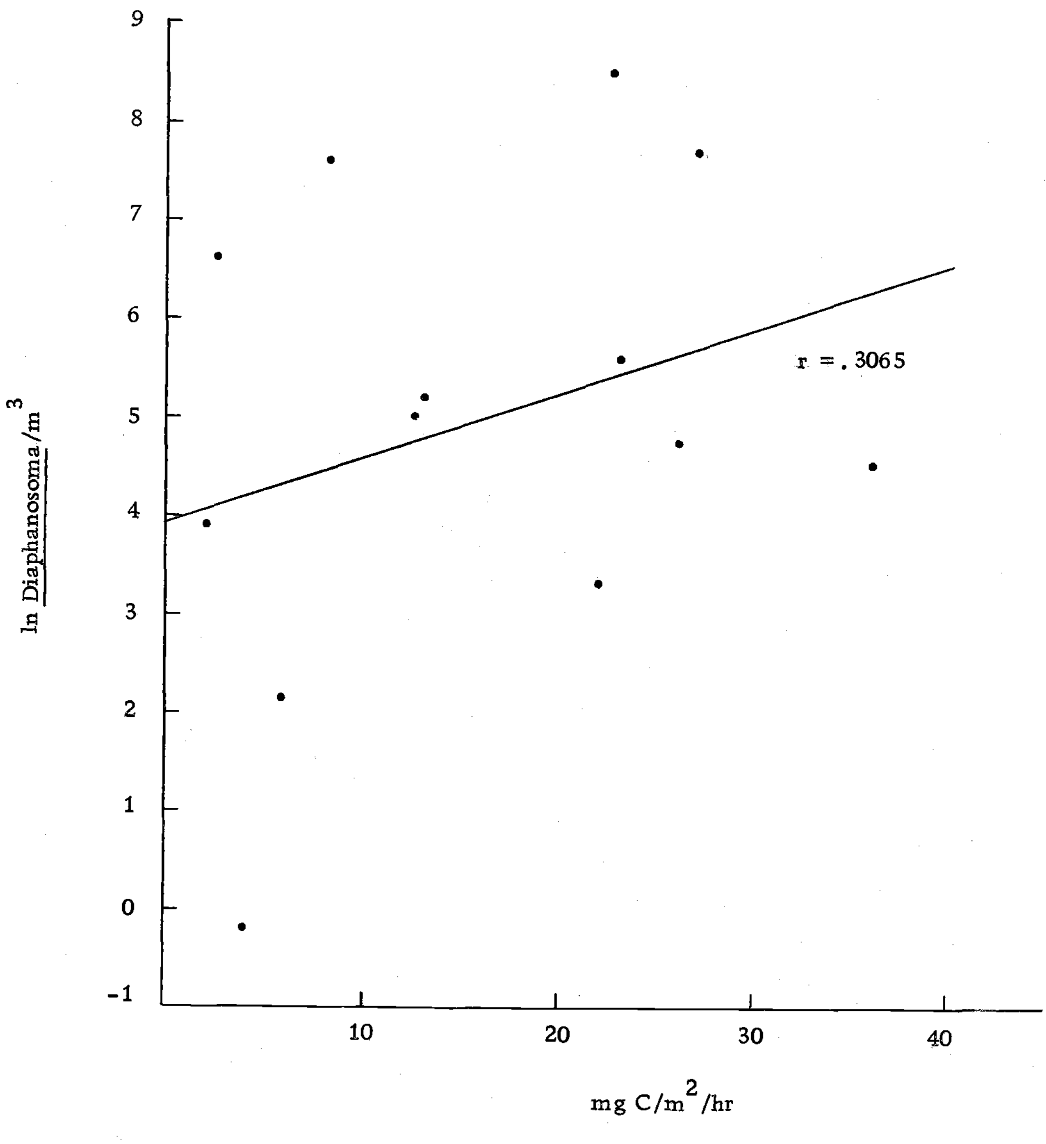


Figure 16. Simple linear regression of ln *Diaphanosoma*/m^3 and primary production at station 3 in Woahink Lake during 1968 and 1969.

abundance for this species occurred in early September through October in 1968 and in August, 1969.

Diaptomus was probably the most abundant species most times of the year in Woahink Lake. This species was in least abundance during November and December, 1968 and exhibited peaks during early September, 1968 and mid-April and early June, 1969 (Figure 17).

Epischura was the least abundant of the zooplankters counted in Woahink Lake. It was never very abundant having only one small peak in December, 1968.

Zooplankton Catchability and Net Efficiency

The nets that were used for the vertical tows varied over the course of the study. The nets used were no. 20 mesh 0.5 m diameter closing net, no. 20 mesh and no. 6 mesh 0.5 m diameter standard tow nets. The collecting ability of these nets is quite different as discussed by Ricker (1938), who says that a no. 6 mesh net will capture all larger species such as Daphnia sp. and their early instars but is less able to capture the smaller species such as the copepods. This may be a reason for increased numbers of these smaller species in the net tows when the no. 20 mesh net was used. He also states that the ability of a no. 20 mesh net to strain water and capture zooplankton varies greatly with time. A new no. 20 mesh net is more efficient than one that has been in use for a time but as the net becomes

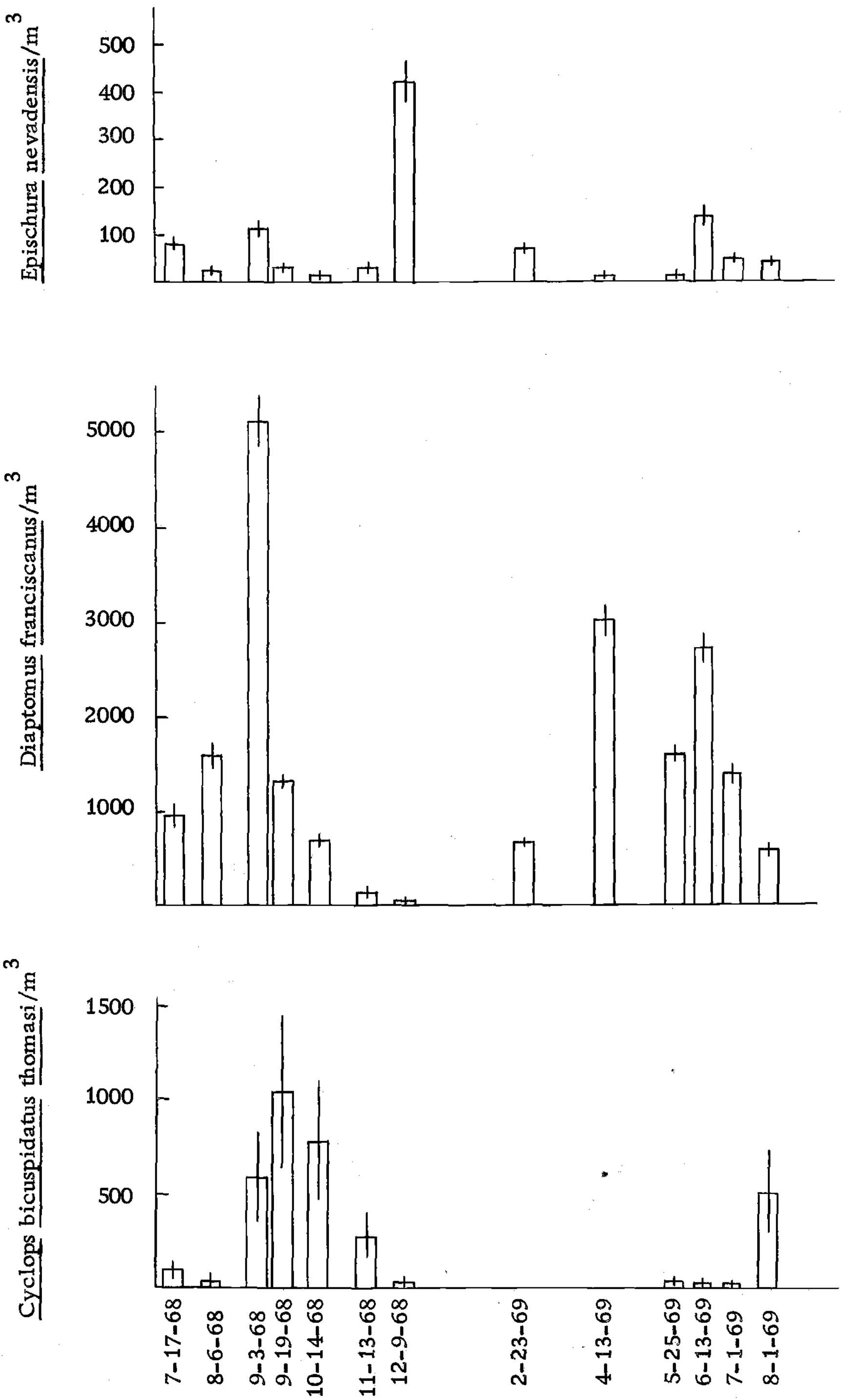


Figure 17. Changes in density of Cyclops bicuspidatus thomasi, Diaptomus franciscanus and Epischura nevadensis at station 3 in Woahink Lake during 1968 and 1969.

older it increases in efficiency again (Ricker, 1938). The mean zooplankton density of the efficiency tows (Table 3) which show the no. 20 mesh closing net capturing more zooplankton per cubic meter than the newer no. 20 mesh standard tow net but straining less water than either of the standard tow nets. The no. 20 mesh closing net also captured more of both species of zooplankton per cubic meter than the no. 6 mesh standard tow net which may have been due to the zooplankters passing through the no. 6 mesh net. A more plausible explanation would be that the closing net is in the period of less efficiency as discussed by Ricker and clogged after it passed through the area of zooplankton abundance thus indicating a higher abundance.

The efficiency of these nets was calculated from the amount of water sampled and not from the number of animals collected. The density of zooplankters collected appears to be very nearly the same in these efficiency tows even though the amount of water sampled was different.

The vertical zooplankton tows made in Crater and Odell Lakes indicated a difference in the catchability of zooplankton between day and night. In Crater Lake at stations 13 and 18 Daphnia showed a twofold increase at night. However, at station 25 the night tow indicated less Daphnia at night than during the day (Table 4). The night collections at all stations in Odell Lake indicated that Daphnia were more abundant than the day tows indicated (Table 4).

Table 3. Net efficiency tows collected in Crater Lake using 0.5 m diameter nets.

Date	Mesh No.	Flowmeter reading	Number of zooplankters/m^3 Daphnia pulex	Bosmina longispina	Daphnia pulex eggs
7/21/68	20[a]	199	122.60	131.02	11.08
	20[a]	-	85.82	164.18	3.73
	20[a]	-	156.72	302.24	16.87
	20[a]	196	73.27	253.45	11.26
	20[a]	196	50.75	326.58	3.75
Mean		197	97.83	235.49	9.33
Net efficiency		34.31%			
7/21/68	6	552	83.91	195.79	13.32
	6	550	70.86	213.90	10.70
	6	552	77.94	151.20	18.01
	6	548	75.85	208.00	18.14
Mean		550.5	77.14	192.22	15.04
Net efficiency		95.87%			
7/21/68	no net	571			
	no net	577			
	no net	575			
	no net	574			
Mean		574.2			
7/25/68	20	448	14.77	95.19	0.82
	20	457	79.54	68.98	5.68
	20	453	144.00	208.36	25.74
Mean		452.7	79.44	124.18	10.75
Net efficiency		80.85%			

[a] Number 20 closing net

Table 4. Analysis of night and day tows made on Crater and Odell Lakes.

Lake	Date	Station	Average of Day Tows (number/m^3)			Average of Night Tows (number/m^3)		
			Daphnia	Bosmina	Daphnia eggs	Daphnia	Bosmina	Daphnia eggs
Crater	7/17/69	13	233.37	3.78	88.71	500.31	2.12	274.61
		18	170.06	5.39	257.31	300.20	3.16	255.35
		25	742.89	3.99	333.62	596.19	3.17	354.27
t value			.6223	1.0921	1.0912			
			Daphnia	Cyclops	Daphnia eggs	Daphnia	Cyclops	Daphnia eggs
Odell	7/24/69	1	9127.99	10418.72	17627.29	12623.36	8983.17	21398.51
		2	7320.78	5735.08	6749.20	9794.32	7346.98	7527.82
		3	6365.28	3146.32	8293.31	10633.70	4259.02	6487.08
t value			4.8368**	.2914	.3130			

** 99% Confidence

Statistical Analyses

The vertical tow data were analyzed with a simple Chi square test to see if they were from a poisson probability distribution. The data did not show a poisson distribution for the total number of zooplankters in a sample, the number of each species in a sample, the number of each species per cubic meter or for the number of each species per sample for the night tows. These values would be expected to be in a poisson distribution but are not because the variation due to the distribution is, in these larger numbers, small in comparison to other variables such as net differences and clustering of zooplankton.

The vertical tow data were also analyzed by a two-way classification for each species and for the eggs of the species of interest in each lake. The analysis was done on the natural logarithm of the number per cubic meter increased by one (Pierce, 1970). These analyses showed that there were always a significant difference in these numbers over time as is to be expected. However, an unexpected feature was that the date x station interaction was almost always significant, indicating that the stations on a lake for a species did not vary the same with time. The corrected "F" values as seen in Tables 5, 6, and 7 are the mean square of the date or station factors divided by the mean square of the date x station interaction. Of all the species only

Table 5. Analysis of variance by two-way classification of numbers of zooplankton/m^3 in Crater Lake.

Source	Degrees of Freedom	Sum of Squares	Mean Square	F	Corrected F
<u>Daphnia pulex</u>					
Date	6	27.3889	4.5648	32.0665	5.1347**
Station	2	1.2802	0.6401	4.4964	0.7200
Date X Station	12	10.6681	0.8890	6.2450**	
Error	15	2.1353	0.1424		
Total	35	41.4726			
<u>Bosmina longispina</u>					
Date	6	138.1168	23.0195	55.6765**	
Station	2	1.8451	0.9225	2.2313	
Date X Station	12	8.1042	0.6753	1.6334	
Error	15	6.2017	0.4134		
Total	35	154.2678			
<u>Daphnia pulex</u> eggs					
Date	6	50.6025	8.4337	66.3639	9.0120**
Station	2	2.8031	1.4015	11.0285	1.4976
Date X Station	12	11.2299	0.9358	7.3639**	
Error	15	1.9063	0.1271		
Total	35	66.5417			

** 99% Confidence

Table 6. Analysis of variance by two-way classification of numbers of zooplankton/m^3 in Odell Lake.

Source	Degrees of Freedom	Sum of Squares	Mean Square	F	Corrected F
<u>Daphnia longispina</u>					
Date	9	167.2550	18.5839	835.8572	57.3070**
Station	2	0.6031	0.3016	13.5639	0.9299
Date X Station	18	5.8372	0.3243	14.5856**	
Error	48	1.0672	0.0222		
Total	77	174.7625			
<u>Cyclops bicuspidatus thomasi</u>					
Date	9	165.3086	18.3676	1159.6403	840.2703**
Station	2	5.0051	2.5025	157.9976	11.4484**
Date X Station	18	3.9347	0.2186	13.8008**	
Error	48	0.7603	0.0158		
Total	77	175.0086			
<u>Daphnia longispina</u> eggs					
Date	9	76.9816	8.5535	125.9616	9.1856**
Station	2	0.4831	0.2415	3.5570	0.2593
Date X Station	18	16.7613	0.9312	13.7129**	
Error	48	3.2595	0.0679		
Total	77	97.4855			

** 99% Confidence

Table 7. Analysis of variance by two-way classification of numbers of zooplankton/m^3 in Woahink Lake.

Source	Degrees of Freedom	Sum of Squares	Mean Square	F	Corrected F
Daphnia longispina					
Date	12	614.0164	51.1680	485.5068	60.5574**
Station	3	0.6212	0.2071	1.9646	0.2450
Date X Station	36	30.4183	0.8450	9.0173**	
Error	108	11.3822	0.1054		
Total	159	656.4381			
Diaphanosoma brachyurum					
Date	12	808.5677	67.3806	271.8083	104.3169**
Station	3	2.3238	0.7746	3.1247	1.1992
Date X Station	36	23.2535	0.6459	2.6056**	
Error	108	26.7730	0.2479		
Total	159	860.9180			
Cyclops bicuspidatus thomasi					
Date	12	902.8730	75.2394	229.2593**	
Station	3	10.4984	3.4995	10.6631**	
Date X Station	36	6.6840	0.1857	0.5657	
Error	108	42.3358	0.3282		
Total	159	962.3913			
Diaptomus franciscanus					
Date	12	274.7496	22.8958	510.1839	45.5846**
Station	3	0.7403	0.2468	5.4987	0.4913
Date X Station	36	18.0817	0.5023	11.1920**	
Error	108	4.8468	0.0449		
Total	159	298.4183			

Table 7. (Continued).

Source	Degrees of Freedom	Sum of Squares	Mean Square	F	Corrected F
Epischura nevadensis					
Date	12	176.2146	14.6845	140.6851	8.8666**
Station	3	2.4374	0.8125	7.7839	0.4906
Date X Station	36	59.6219	1.6561	15.8669**	
Error	108	11.3773	0.1044		
Total	159	249.6512			
Daphnia longispina eggs					
Date	12	750.1492	62.5124	286.3234	30.1812**
Station	3	3.9402	1.3134	6.0157	0.6341
Date X Station	36	74.5647	2.0712	9.4868**	
Error	108	27.5093	0.2183		
Total	159	856.1634			
Diaphanosoma brachyurum eggs					
Date	12	1012.0525	84.3377	229.3901	69.5965**
Station	3	2.9014	0.9671	2.6305	0.7980
Date X Station	36	43.6248	1.2118	3.2960**	
Error	108	48.1635	0.3677		
Total	159	1106.7422			

** 99% Confidence

Bosmina in Crater Lake and Cyclops in Woahink Lake did not show the typical significance in the date x station interaction (Tables 5 and 7).

The only species found to have a significant difference between stations was Cyclops in Odell and Woahink Lakes (Tables 6 and 7). This indicates that this species may have a more patchy distribution than any of the other species in the study lakes.

The second analysis used was simple linear regression between the natural logarithm of the numbers per cubic meter of the species of interest at station 13 in Crater Lake, station 1 in Odell Lake and station 3 in Woahink Lake in relation to milligrams carbon taken up per square meter per hour. The analyses were run only at these stations since these were the stations where the primary production values were obtained and since the previous analysis showed a difference between stations over time. The results of these analyses showed that there was a correlation between Daphnia and primary production in Crater Lake with a correlation coefficient of 0.7165 (Figure 10). There was also a correlation in Odell Lake between Daphnia and primary production with a correlation coefficient of 0.7818 (Figure 10). However, Daphnia and Diaphanosoma in Woahink Lake showed very low or no correlation with primary production having correlation coefficients of 0.3839 and 0.3065 respectively (Figures 10 and 16). The overall correlation of Daphnia sp. and primary production in the study lakes was quite high with a correlation coefficient of 0.8270 (Figure 10). The graph of all these points and regression lines for Daphnia seem to represent a curveilinear relationship for all the lakes rather than a simple linear relationship.

There were other simple linear regression tests made for the finite birth rate (B) of Daphnia and Diaphanosoma in relation to the natural logarithm of milligrams carbon taken up per square meter per hour. The results of these analyses will be shown in a later section.

Vertical Distribution

The vertical distribution of the zooplankton in Odell and Woahink Lakes were studied beginning July, 1969 through September, 1969 in Odell Lake and November, 1968 through August, 1969 in Woahink Lake. It was found that the samples collected by the Miller samplers always yielded larger numbers per cubic meter than those observed with the 0.5 m diameter net. This larger estimate is accounted for through the greater efficiency of the Miller samplers and the contamination of the samples collected with these samplers. The density estimates from the Miller sampler collections were very close to the values of those obtained by the 0.5 meter net when corrected for contamination from tows taken on the same dates. It was also noted that some of the peaks of abundance of zooplankters in the lower portion of their vertical distribution were very much reduced or deleted when corrected by the contamination tows. The contamination tows in Odell Lake showed, in fact, that most of the time on July 24 and 25, 1969 that Daphnia in Odell Lake were very seldom below 20 meters (Table 8) which agrees with the findings of Lewis (1970).

In Woahink Lake Daphnia were, according to the contamination tows, usually found above 14 meters on July 1 or 2, 1969 (Table 9). Diaphanosoma on the other hand was found throughout the water column sampled (Table 9).

Daphnia in Odell Lake was found to undergo a diel migration on all dates on which sampling for vertical migration occurred (Figures 18, 19, 20, and 21). The egg ratios on the sampling dates July 10 and 11 and again on July 24 and 25 were larger than during the other two sampling periods and showed a significant increase at the surface at night. The egg ratios observed during the last two sampling periods showed little or no change with depth over the 24 hour sampling period.

Cyclops in Odell Lake showed diel vertical migration during all sampling periods. However, the migration seemed to be less pronounced after the first sampling period.

Daphnia in Woahink Lake showed little or no diel migration during the November and April sampling periods even though primary production was fairly high during November (Figures 22 and 23). However,

Table 8. Percent contamination for each species for each depth of each series of eight samples collected on July 24 and 25, 1969 in Odell Lake.

Date	Time	Depth (m)	Daphnia longispina	Cyclops bicuspidatus thomasi	Daphnia longispina eggs
7/24/69	13:05	0	6.7	12.3	20.0
	13:05	4	24.9	31.7	37.1
	13:05	8	26.2	29.8	15.6
	13:05	12	53.9	52.6	29.1
	12:50	16	97.9	47.7	46.2
	12:50	20	100	52.9	100
	12:50	24	69.7	67.4	25.6
	12:50	28	70.0	99.7	32.7
7/24/69	18:55	0	13.6	54.8	8.2
	18:55	4	23.6	97.3	23.3
	18:55	8	30.1	36.5	66.2
	18:55	12	67.6	62.3	36.5
	18:40	16	97.9	89.9	75.3
	18:40	20	100	70.1	100
	18:40	24	100	51.1	100
	18:40	28	100	86.8	100
7/25/69	01:40	0	28.1	68.7	18.0
	01:40	4	22.7	16.8	29.3
	01:40	8	16.6	26.5	80.0
	01:40	12	100	37.7	100
	01:20	16	79.1	49.5	39.8
	01:20	20	28.1	48.2	40.7
	01:20	24	50.8	15.6	38.9
	01:20	28	37.0	24.9	21.1
7/25/69	07:35	0	23.9	20.0	15.2
	07:35	4	15.5	40.5	9.9
	07:35	8	19.4	27.5	38.7
	07:35	12	88.2	10.2	46.2
	07:20	16	65.3	24.3	25.3
	07:20	20	87.3	37.5	72.3
	07:20	24	100	58.5	100
	07:20	28	100	60.1	100

Table 9. Percent contamination for each species for each depth of each series of eight samples collected on July 1 and 2, 1969 in Woahink Lake.

Date	Time	Depth (m)	*Daphnia longispina*	*Diaphanosoma brachyurum*	*Cyclops bicuspidatus thomasi*	*Diaptomus franciscanus*	*Epischura nevadensis*	*Daphnia longispina* eggs	*Diaphanosoma brachyurum* eggs
7/1/69	14:12	0	57.6	31.8	15.5	62.2	100	100	100
	14:12	2	19.2	8.9	9.5	66.6	33.3	5.2	4.3
	14:12	4	9.5	13.6	4.7	6.5	22.2	8.7	9.9
	14:12	6	62.9	39.9	20.0	25.3	16.6	46.4	13.3
	14:05	8	11.7	19.4	19.0	8.2	100	24.0	7.9
	14:05	10	33.9	15.5	28.5	14.5	100	17.9	7.9
	14:05	12	44.3	33.1	50.0	13.3	100	29.4	13.1
	14:05	14	99.0	39.6	100	100	100	75.0	22.2
7/1/69	18:44	0	13.5	8.1	3.0	27.2	3.1	4.7	33.3
	18:44	2	19.0	8.5	23.2	7.7	17.3	13.6	15.4
	18:44	4	0.6	13.2	26.6	12.0	44.4	7.7	11.5
	18:44	6	47.6	26.0	33.3	16.0	100	86.6	29.0
	18:35	8	26.4	34.1	16.6	10.0	100	33.3	3.9
	18:35	10	20.0	28.6	33.3	24.1	100	6.6	11.3
	18:35	12	73.3	36.0	66.6	23.8	100	44.4	15.9
	18:35	14	100	65.4	100	36.8	100	100	28.2
7/2/69	00:14	0	4.1	3.4	5.3	7.7	7.2	0.9	6.6
	00:14	2	10.1	9.6	5.5	8.6	8.2	5.3	9.2
	00:14	4	24.6	17.9	5.0	28.5	6.3	28.5	18.1
	00:14	6	83.1	98.0	30.7	0.9	100	27.6	100
	00:05	8	61.5	37.0	82.0	7.5	100	100	49.5
	00:05	10	100	100	70.0	22.5	100	100	100
	00:05	12	100	90.4	100	22.9	100	100	81.6
	00:05	14	100	100	100	36.6	100	100	100

Table 9. (Continued)

Date	Time	Depth (m)	Daphnia longispina	Diaphanosoma brachyurum	Cyclops bicuspidatus thomasi	Diaptomus franciscanus	Epischura nevadensis	Daphnia longispina eggs	Diaphanosoma brachyurum eggs
7/2/69	07:05	0	11.1	4.5	4.4	31.5	5.0	4.6	9.1
	07:05	2	23.2	9.1	15.5	15.0	2.7	16.1	11.9
	07:05	4	14.8	13.0	16.6	1.4	13.8	13.3	18.6
	07:05	6	28.5	31.0	14.3	9.8	71.4	85.7	27.3
	06:55	8	26.3	10.8	35.7	10.1	100	64.2	4.1
	06:55	10	48.4	4.4	53.3	17.3	100	100	26.6
	06:55	12	92.1	6.0	66.6	22.8	100	11.1	50.9
	06:55	14	100	74.1	66.6	46.5	33.3	100	59.7

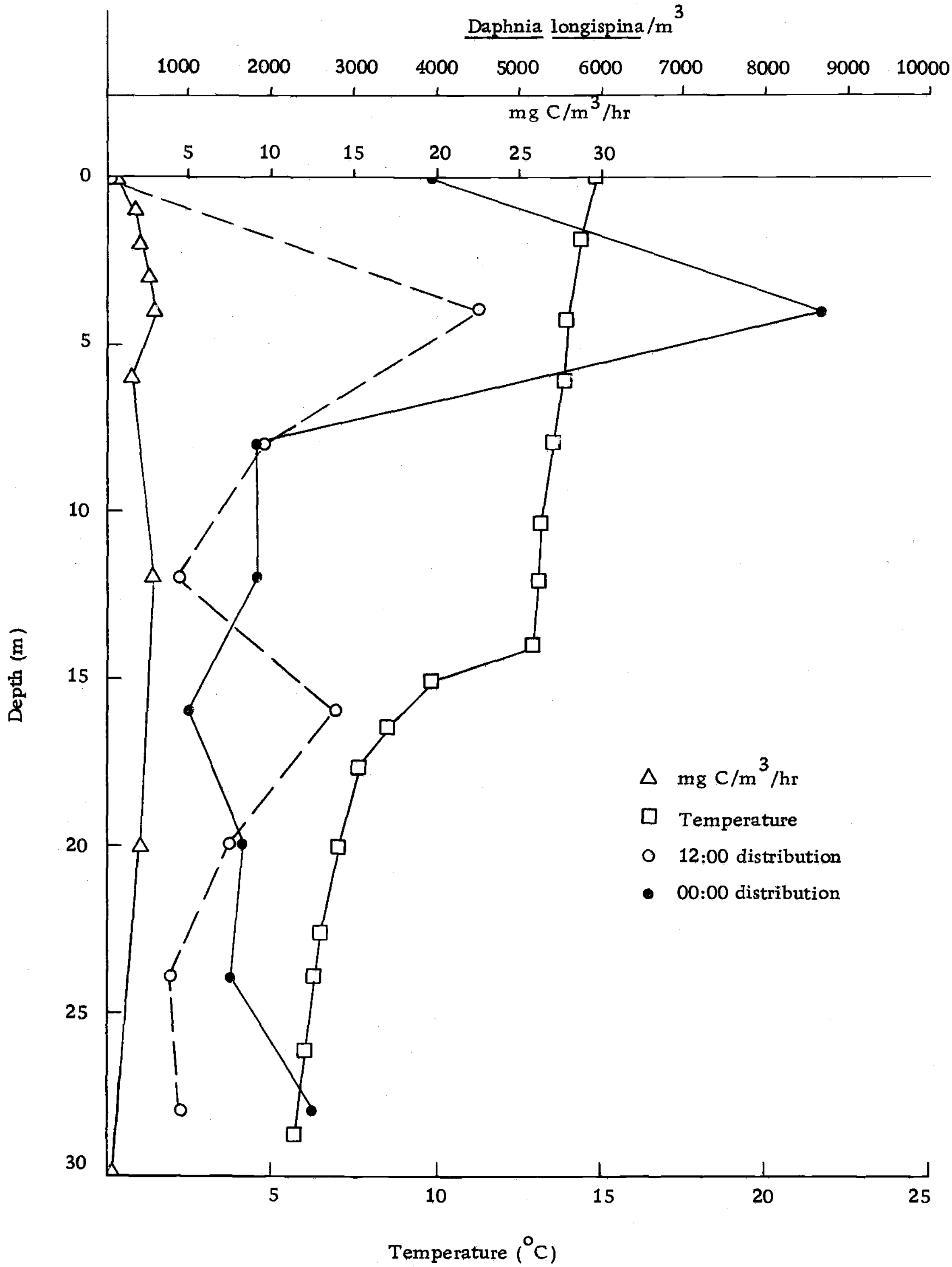


Figure 18. Vertical distribution of Daphnia in Odell Lake on July 10, 1969 with primary production and temperature profiles shown.

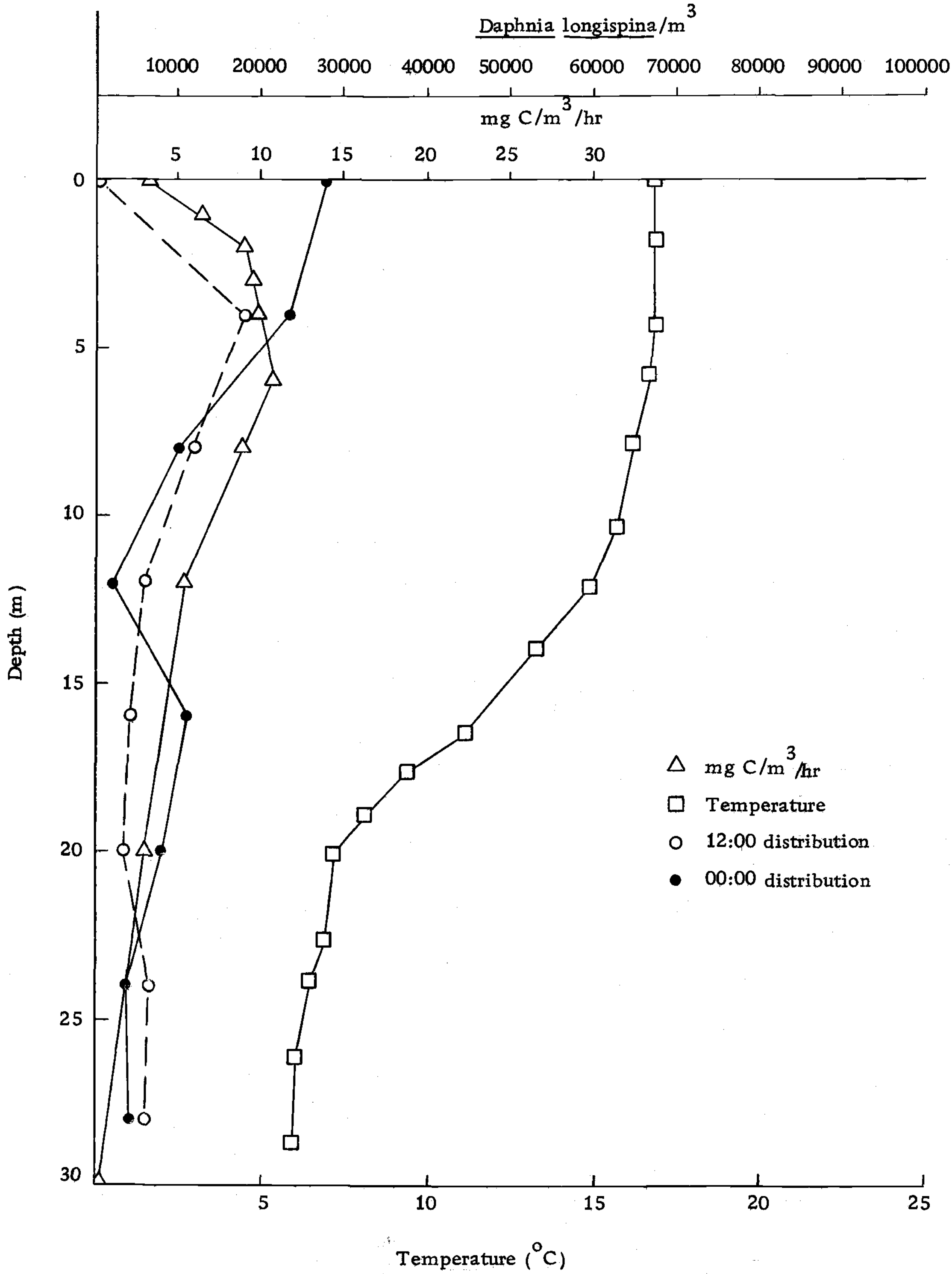


Figure 19. Vertical distribution of Daphnia in Odell Lake on July 25, 1969 with primary production and temperature profiles shown.

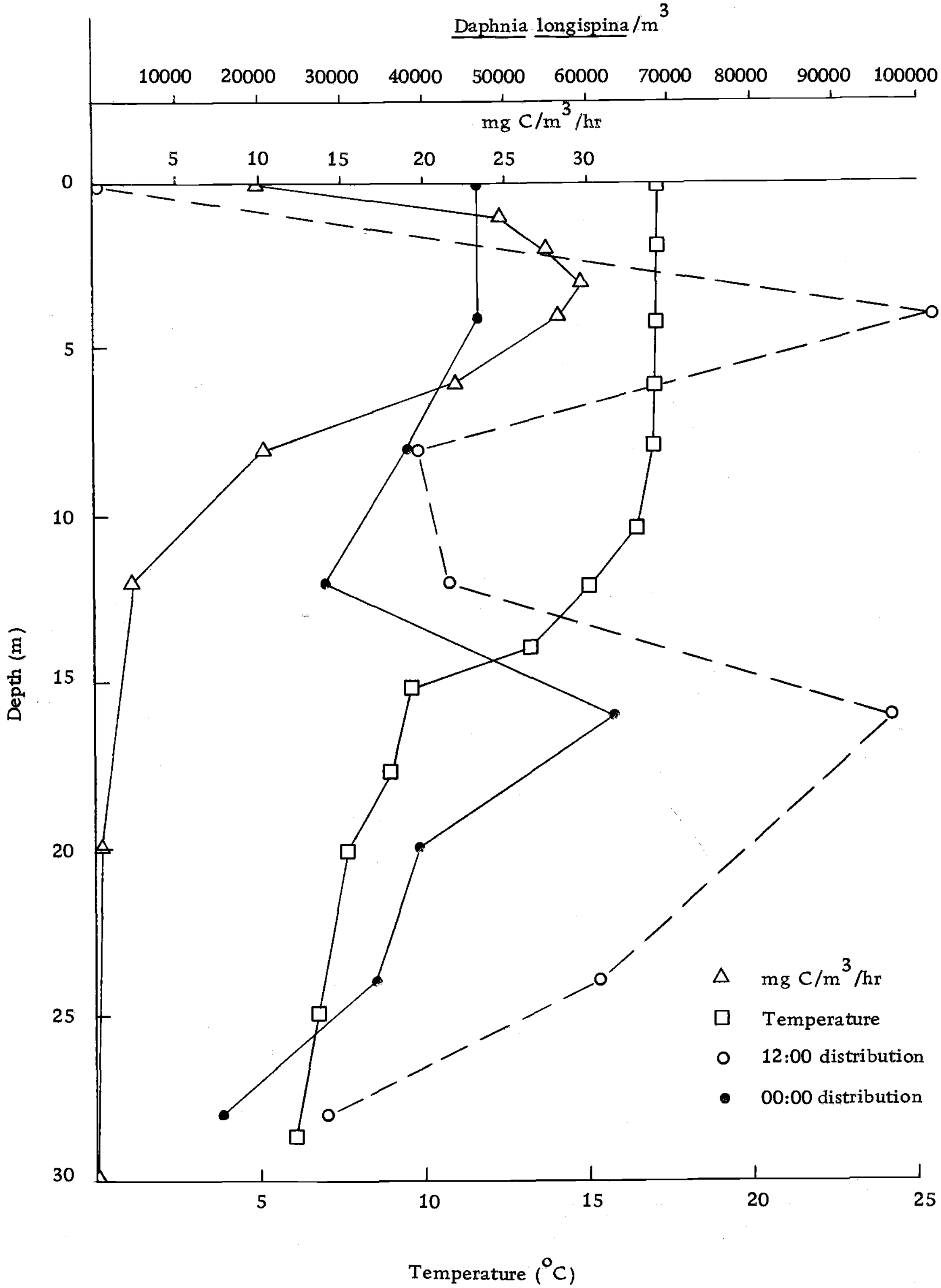


Figure 20. Vertical distribution of Daphnia in Odell Lake on August 7, 1969 with primary production and temperature profiles shown.

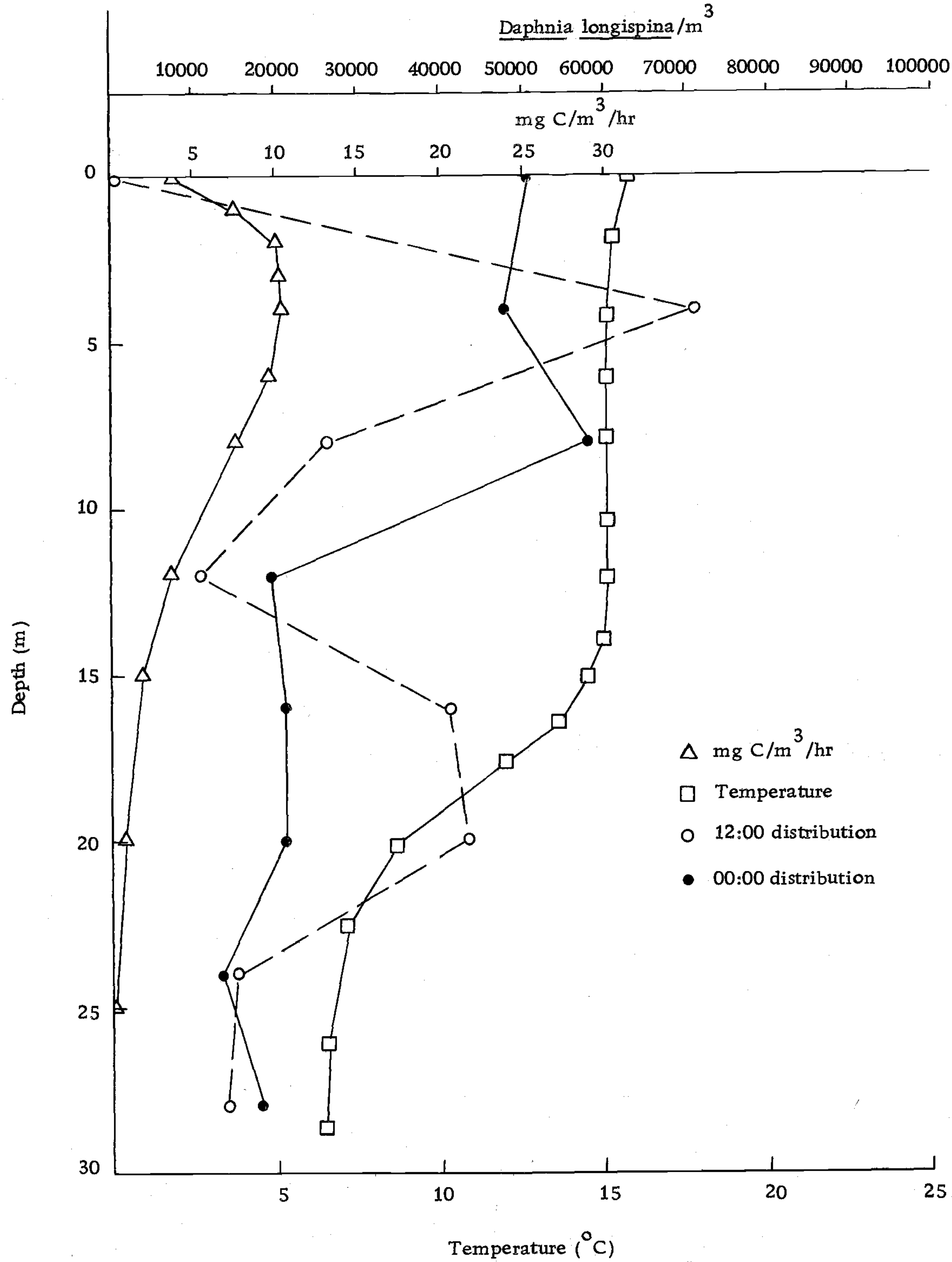


Figure 21. Vertical distribution of Daphnia in Odell Lake on September 24, 1969 with primary production and temperature profiles shown.

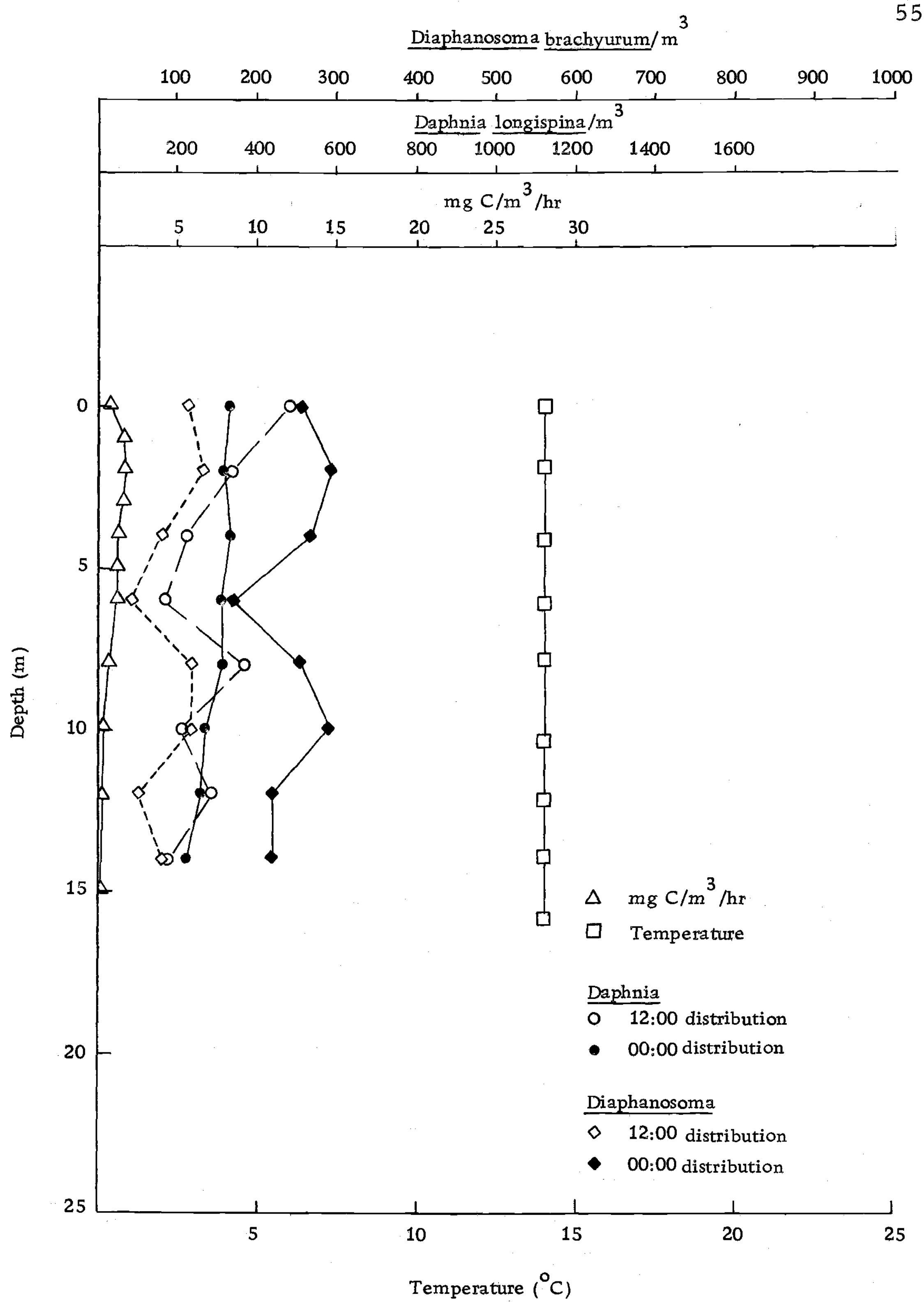


Figure 22. Vertical distribution of Daphnia and Diaphanosoma in Woahink Lake on November 13, 1968 with primary production and temperature profiles shown.

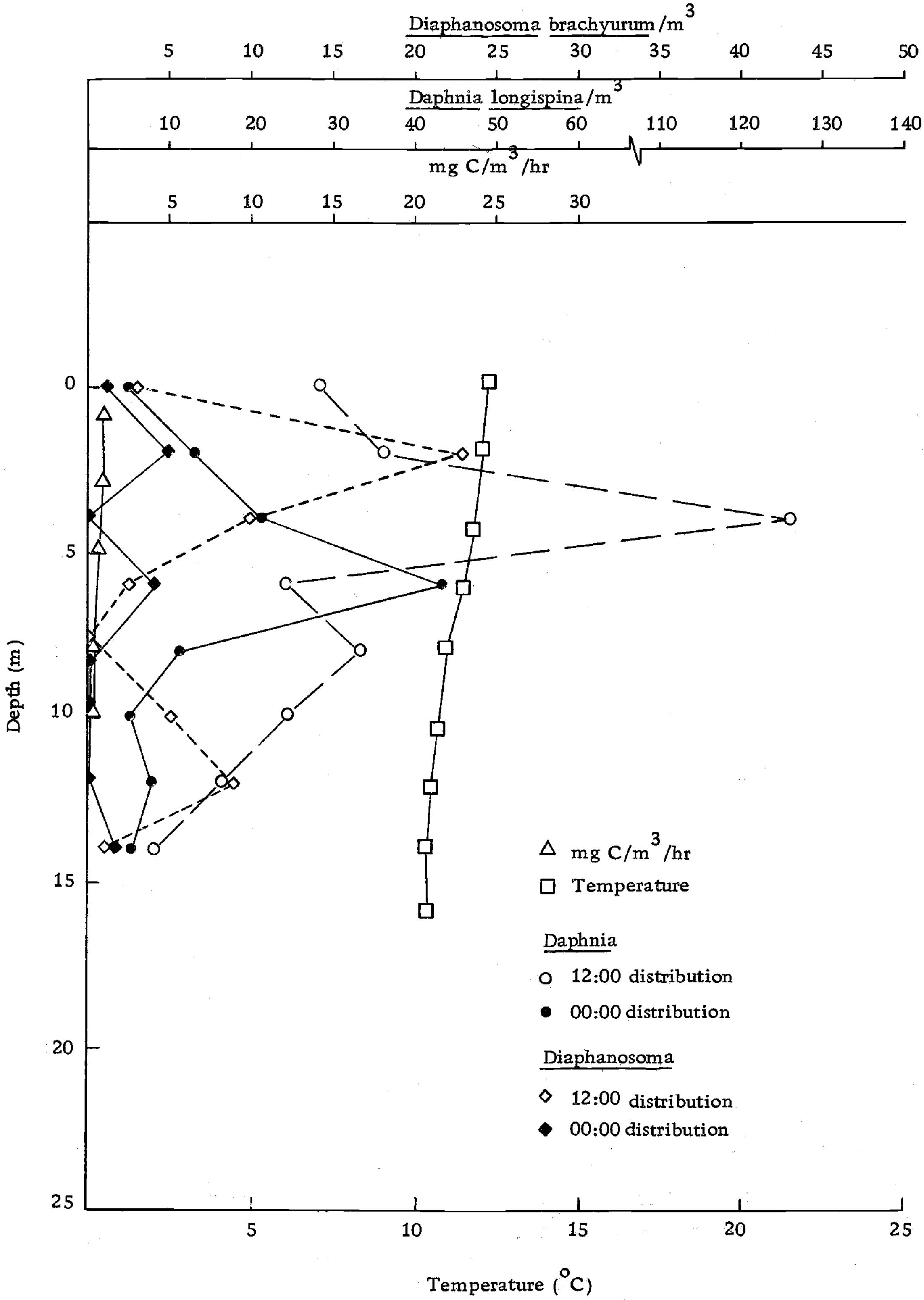


Figure 23. Vertical distribution of Daphnia and Diaphanosoma in Woahink Lake on April 14, 1969 with primary production and temperature profiles shown.

during these two sampling periods the temperature in the water column was low and nearly orthograde. During the other four sampling periods Daphnia showed a definite diel migration with various amounts of primary production occurring and with high temperatures or definite thermal stratification in the water column (Figures 24, 25, 26 and 27).

The Daphnia egg ratios were not as high in Woahink Lake as they were in Odell Lake as was also noted in the vertical tows. The vertical distribution of egg ratios from one sampling time to the next, did not change during the first three sampling periods. However, during the last three sampling periods the egg ratios did show an increase in the surface water at night.

Diaphanosoma in Woahink Lake underwent vertical migration during the same sampling periods as Daphnia and showed similar reduction in migration during November and April (Figures 22, 23, 24, 25, 26, and 27). Diaphanosoma did not have as pronounced a migration in the August sampling period as it had exhibited in the previous three sampling periods. Diaphanosoma egg ratios increased at the surface at night during the June and July sampling periods. The egg ratios during the remainder of sampling periods showed no change with depth over a 24 hour period.

Cyclops in Woahink Lake exhibited a diel vertical migration during the November and April sampling periods. During the

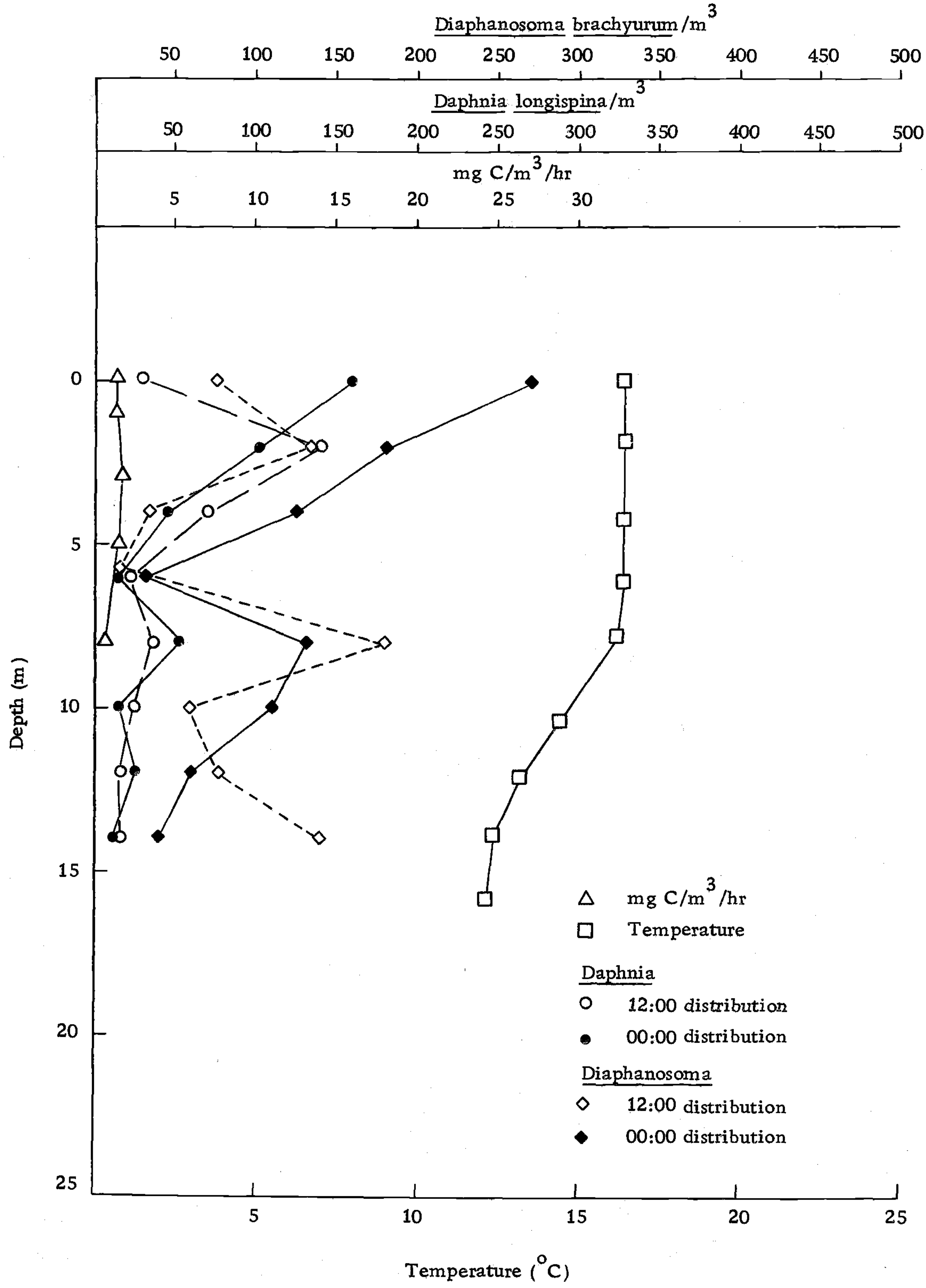


Figure 24. Vertical distribution of Daphnia and Diaphanosoma in Woahink Lake on May 26, 1969 with primary production and temperature profiles shown.

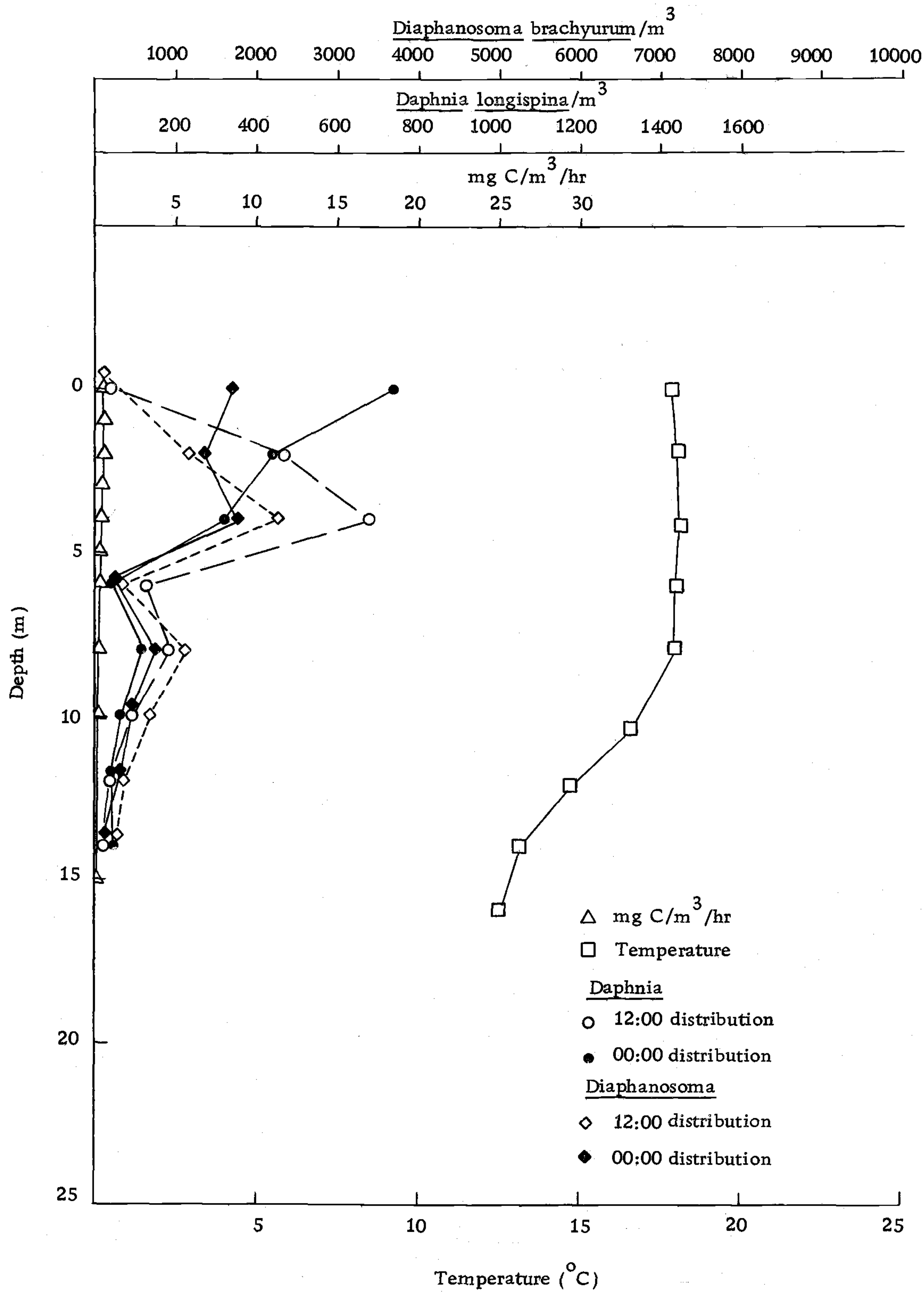


Figure 25. Vertical distribution of Daphnia and Diaphanosoma in Woahink Lake on June 13, 1969 with primary production and temperature profiles shown.

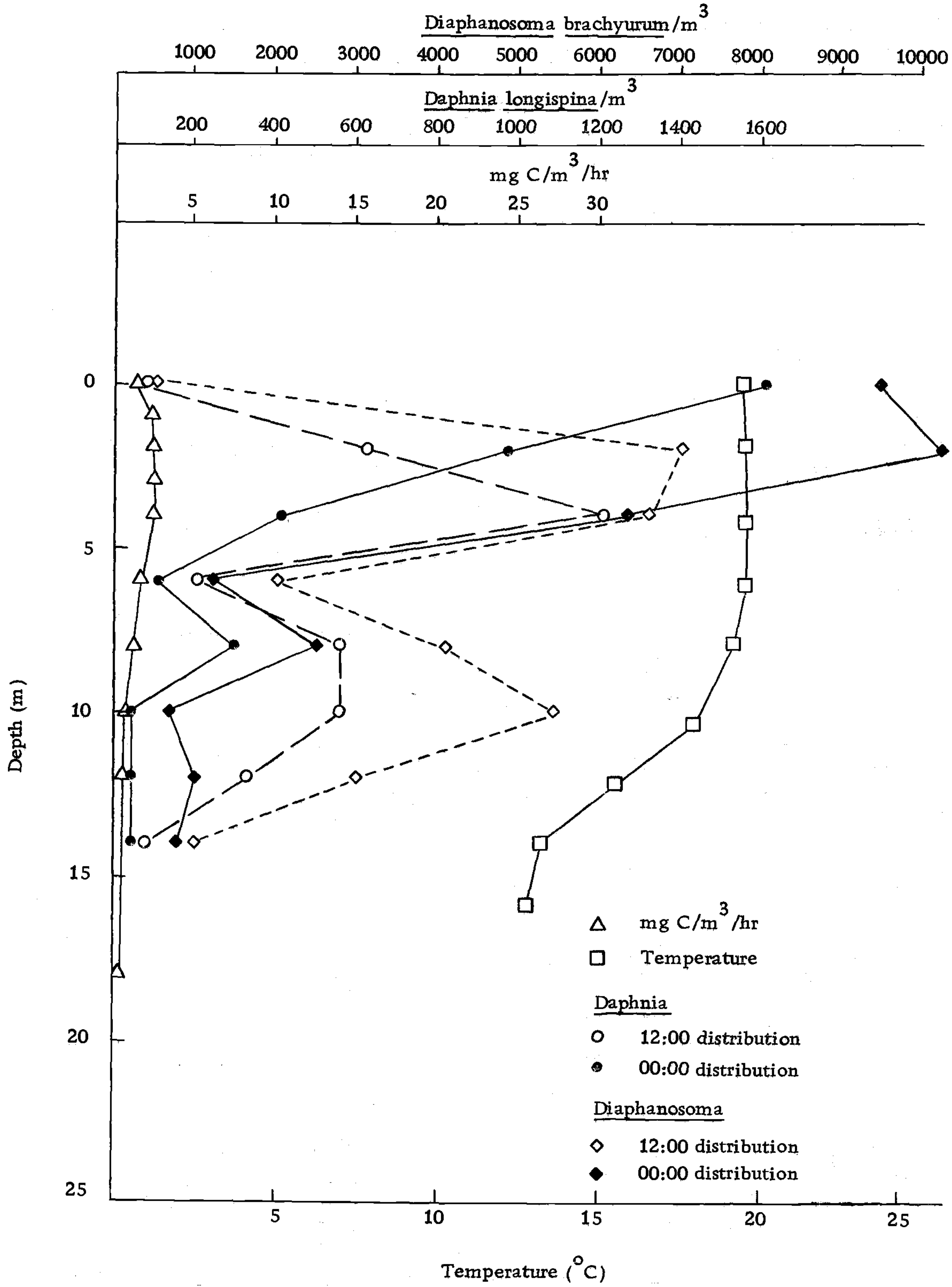


Figure 26. Vertical distribution of Daphnia and Diaphanosoma in Woahink Lake on July 2, 1969 with primary production and temperature profiles shown.

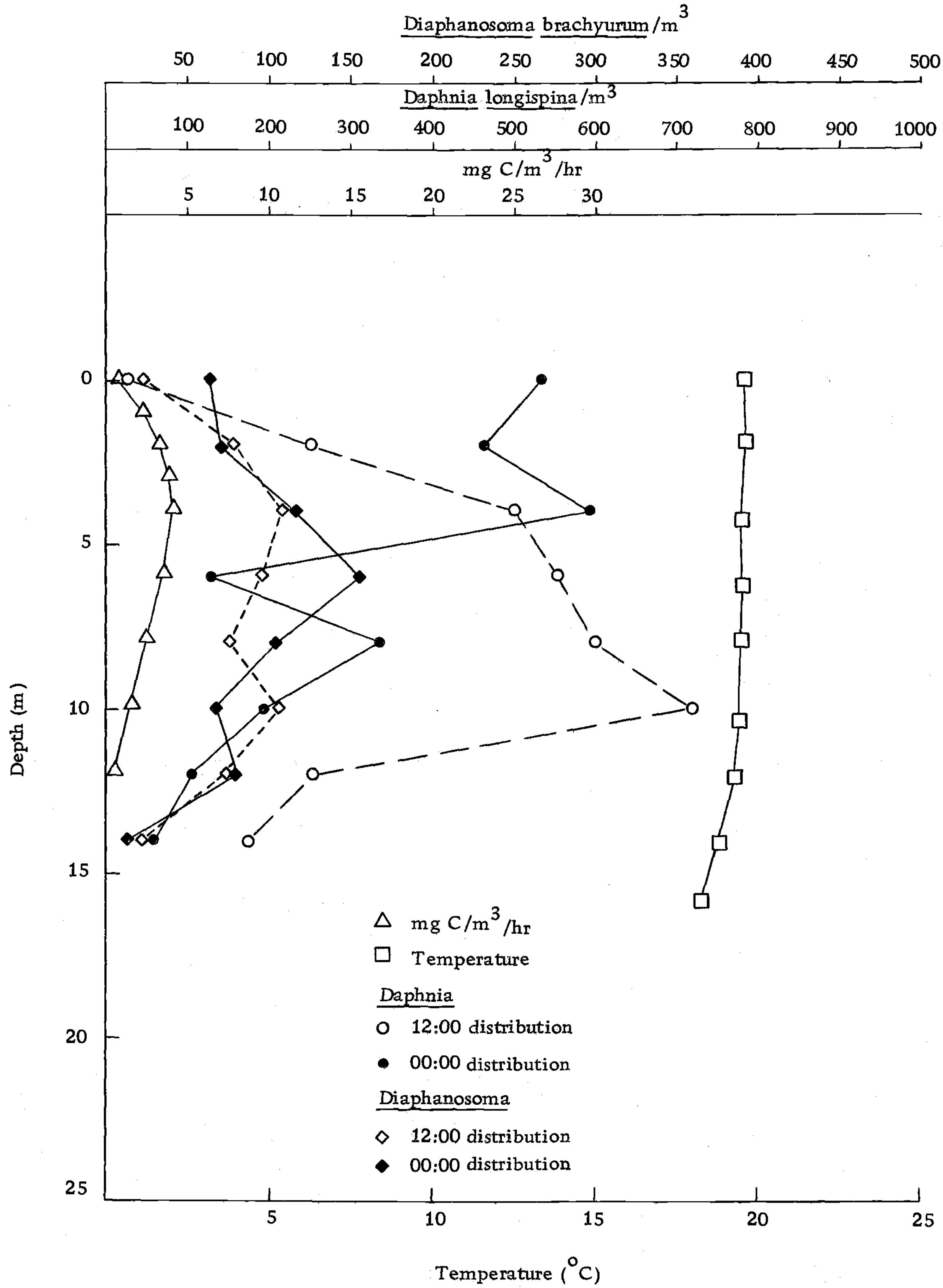


Figure 27. Vertical distribution of Daphnia and Diaphanosoma in Woahink Lake on August 2, 1969 with primary production and temperature profiles shown.

remainder of sampling periods there was little or no vertical migration.

Diaptomus in Woahink Lake did not migrate vertically during the November sampling period. However, diel vertical migration of Diaptomus was quite evident during the remainder of the sampling periods.

Diel vertical migration of Epischura in Woahink Lake was not evidenced in the November and April sampling periods. However, diel vertical migration did take place during the remainder of the sampling periods.

Estimates of Population Rate Functions

The intrinsic rate of increase (r) of any population indicates only the magnitude and direction of population change. These estimates are limited in their value as true population parameters in that they require associated assumptions of a stable age distribution which is maintained by constant reproduction. In a zooplankton population both of these assumptions may be invalid if the sampling dates are rather far apart as was the case in this study. The values for these rates may be seen in Tables 10, 11, 12, 13, 14, 15, 16, 17, and 18 and Figures 28, 29, 30 and 31.

The instantaneous birth rate (b) is a rate function which was

Table 10. Population data for Daphnia pulex in Crater Lake, 1968 and 1969.

Date	Station	Daphnia pulex/m^3	Average Temper- ture °C	E	D	B	b	t_2-t_1	r	d
6/15/68	13	76.52	4.93[a]	.34	18.3	.0186	.0158			
								19	-.0163	.0304
7/4/68	13	55.99	5.22[b]	.23	17.0	.0135	.0124			
								21	-.0638	.0719
7/25/68	13	14.77	5.52[a]	.06	16.0	.0038	.0038			
								14	.1557	-.1428
8/8/68	13	130.72	5.95[c]	.39	14.9	.0262	.0221			
								20	.0785	-.0556
8/28/68	13	624.71	6.39[a]	.39	13.95	.0278	.0237			
7/17/69	13	233.37	5.03[a]	.39	17.6	.0222	.0188			
								45	.0200	-.0037
8/31/69	13	572.11	6.91[a]	.20	13.0	.0154	.0138			
6/15/68	18	104.51	4.93[a]	.32	18.3	.0175	.0154			
								19	.0011	.0110
7/4/68	18	106.38	5.22[b]	.16	17.0	.0094	.0088			
								21	-.0138	.0204
7/25/68	18	79.54	5.52[a]	.07	16.0	.0438	.0044			
								14	.0671	-.0559
8/8/68	18	203.43	5.95[c]	.31	14.9	.0208	.0181			
								20	.0565	-.0364
8/28/68	18	635.60	6.39[a]	.37	13.95	.0265	.0222			
7/14/69	18	170.06	5.03[a]	1.55	17.6	.0881	.0534			
								45	.0529	-.0189
8/31/69	18	1849.21	6.91[a]	.21	13.0	.0162	.0146			

Table 10. (Continued)

Date	Station	Daphnia pulex/m^3	Average Temperature ^oC	E	D	B	b	t_2-t_1	r	d
6/15/68	25	48.52	4.93[a]	.08	18.3	.0044	.0044			
								19	.0300	-.0231
7/4/68	25	85.85	5.22[b]	.17	17.0	.0100	.0094			
								21	.0248	-.0148
7/25/68	25	144.00	5.52[a]	.18	16.0	.0113	.0106			
								14	-.0271	.0441
8/8/68	25	98.04	5.95[c]	.42	14.9	.0282	.0235			
								20	.0915	-.0690
8/28/68	25	614.24	6.39[a]	.35	13.95	.0251	.0215			
7/17/69	25	742.89	5.03[a]	.45	17.6	.0256	.0210			
								45	-.0184	.0346
8/31/69	25	322.23	6.91[a]	.16	13.0	.0123	.0115			

[a] Average temperature was determined for adult Daphnia pulex by using horizontal tow data obtained by Hoffman (1969).

[b] Obtained by averaging the temperatures obtained for 6/15/68 and 7/25/68.

[c] Obtained by averaging the temperatures obtained for 7/25/68 and 8/28/68.

Table 11. Population data for Bosmina longispina in Crater Lake, 1968 and 1969.

Date	Bosmina longispina/m^3	t_2-t_1	r
6/15/68	90.20		
		19	.0411
7/4/68	196.58		
		21	-.0219
7/25/68	124.18		
		14	.0364
8/8/68	205.88		
		20	.0800
8/28/68	1017.85		
7/17/69	4.39		
		45	.0344
8/31/69	20.72		

Table 12. Population data for Daphnia longispina in Odell Lake, 1968 and 1969.

Date	Station	Daphnia longispina/m^3	Average Temperature °C	E	D	B	b	t_2-t_1	r	d
6/17/68	1	241.10	12.06	.83	6.9	.1203	.0870			
								22	.1127	-.0077
7/9/68	1	2886.34	13.47	1.12	6.1	.1836	.1230			
								21	.1210	-.0400
7/30/68	1	36598.39	13.39	.27	6.15	.0439	.0390			
								14	.0307	-.0008
8/13/68	1	56274.51	16.25	.10	4.8	.0208	.0208			
								23	-.0674	.0935
9/5/68	1	11962.89	14.31	.20	5.7	.0351	.0315			
								20	.0580	-.0379
9/25/68	1	38051.47	12.27	.06	6.85	.0088	.0088			
								23	-.0687	.0827
10/18/68	1	7837.37	10.07	.19	8.8	.0216	.0193			
7/10/69	1	1643.21	11.14	2.57	7.7	.3338	.1649			
								14	.1229	.0534
7/24/69	1	9127.99	14.16	1.93	5.75	.3357	.1878			
								15	.0580	.0794
8/8/69	1	21702.04	14.93	.60	5.4	.1111	.0870			
6/17/68	2	674.66	12.06	1.25	6.9	.1812	.1174			
								22	.0514	.0671
7/9/68	2	2085.45	13.47	1.07	6.1	.1754	.1197			
								21	.1395	-.0748
7/30/68	2	39018.95	13.39	.06	6.15	.0098	.0098			
								14	.0243	-.0121
8/13/68	2	54787.28	16.25	.07	4.8	.0146	.0146			
								23	-.0300	.0522

Table 12. (Continued)

Date	Station	*Daphnia longispina*/m^3	Average Temperature ^oC	E	D	B	b	t_2-t_1	r	d
9/5/68	2	27335.39	14.31	.18	5.7	.0316	.0298			
								20	-.0045	.0228
9/25/68	2	25052.52	12.27	.08	6.85	.0117	.0069			
								23	-.0435	.0543
10/18/68	2	9191.18	10.07	.14	8.8	.0159	.0148			
7/10/69	2	2028.06	11.14	1.45	7.7	.1883	.1169			
								14	.0921	.0228
7/24/69	2	7320.78	14.16	.92	5.75	.1600	.1130			
								15	.1127	-.0183
8/8/69	2	39651.21	14.93	.50	5.4	.0926	.0759			
6/17/68	3	366.83	12.06	1.27	6.9	.1841	.1188			
								22	.0923	.0286
7/9/68	3	2778.12	13.47	1.12	6.1	.1836	.1230			
								21	.1243	-.0539
7/30/68	3	37850.94	13.39	.12	6.15	.0195	.0179			
								14	.0207	-.0086
8/13/68	3	50484.72	16.25	.03	4.8	.0063	.0063			
								23	-.0087	.0487
9/5/68	3	41462.30	14.31	.52	5.7	.0912	.0737			
								20	-.0525	.0954
9/25/68	3	14529.07	12.27	.07	6.85	.0102	.0121			
								23	-.0148	.0441
10/18/68	3	10291.42	10.07	.51	8.8	.0580	.0466			
7/10/69	3	1813.26	11.14	1.36	7.7	.1766	.1117			
								14	.0900	.0389
7/24/69	3	6365.28	14.16	1.31	5.75	.2278	.1461			
								15	.1527	-.0537
8/8/69	3	62927.92	14.93	.32	5.4	.0593	.0519			

Table 13. Population data for _Cyclops bicuspidatus thomasi_ in Odell Lake, 1968 and 1969.

Date	_Cyclops bicuspidatus thomasi_/m^3	t_2-t_1	r
6/17/68	7896.61		
		22	.0786
7/9/68	1392.22		
		21	.0181
7/30/68	2044.01		
		14	.0507
8/13/68	4166.60		
		23	.1448
9/5/69	116328.86		
		20	-.0005
9/25/68	117411.96		
		23	-.0104
10/18/68	91641.73		
7/10/69	20319.97		
		14	-.0821
7/24/69	6433.37		
		15	-.0200
8/8/69	4762.68		

Table 14. Population data for Daphnia longispina in Woahink Lake, 1968 and 1969.

Date	Station	Daphnia longispina/m^3	Average Temper-ature °C	E	D	B	b	t_2-t_1	r	d
9/3/68	1	146.14	20.04	.55	3.4	.1618	.1294			
								16	.0981	.0166
9/19/68	1	232.43	19.18	.43	3.6	.1194	.1000			
								25	.1044	.0056
10/14/68	1	3156.60	17.48	.66	4.25	.1553	.1200			
								29	-.0769	.1619
11/13/68	1	341.52	13.99	.34	5.8	.0586	.0500			
								26	-.0292	.0688
12/9/68	1	159.49	10.96	.26	7.85	.0331	.0293			
								76	-.0113	.0381
2/23/69	1	67.07	6.55	.39	13.6	.0287	.0243			
								49	-.0453	.0574
4/13/69	1	7.35	11.81	0	7.1	0	0			
								42	.0262	.0025
5/25/69	1	21.90	16.39	.31	4.7	.0660	.0574			
								19	.1311	-.0387
6/13/69	1	265.25	17.96	.67	4.1	.1634	.1275			
								18	.0194	.1326
7/1/69	1	374.29	19.34	.65	3.6	.1806	.1389			
								31	-.1335	.2798
8/1/69	1	386.01	19.47	.76	3.45	.2203	.1652			
9/3/68	2	136.66	20.04	.91	3.4	.2676	.1912			
								16	.0700	.0978
9/19/68	2	418.63	19.18	.69	3.6	.1917	.1444			
								25	.0848	.0262
10/14/68	2	3502.08	17.48	.39	4.25	.0918	.0776			
								29	-.0696	.1454

Table 14. (Continued).

Date	Station	Daphnia longispina/m^3	Average Temperature °C	E	D	B	b	t_2-t_1	r	d
11/13/68	2	464.29	13.99	.53	5.8	.0914	.0741			
								26	-.0346	.0914
12/9/68	2	189.02	10.96	.36	7.85	.0459	.0395			
								76	-.0214	.0504
2/23/69	2	36.79	6.55	.47	13.6	.0346	.0287			
								49	-.0112	.0474
4/13/69	2	21.38	11.81	.36	7.1	.0507	.0437			
								42	.0102	.0638
5/25/69	2	32.90	16.39	.64	4.7	.1362	.1043			
								19	.0753	.0585
6/13/69	2	136.79	17.96	.96	4.1	.2341	.1634			
								18	.0750	.0582
7/1/69	2	529.51	19.34	.64	3.6	.1778	.1361			
								31	-.0229	.1698
8/1/69	2	258.98	19.47	.57	3.45	.1652	.1304			
9/3/68	3	72.82	20.04	1.31	3.4	.3853	.2471			
								16	.1544	.0205
9/19/68	3	860.37	19.18	.45	3.6	.1500	.1028			
								25	.0560	.0248
10/14/68	3	3492.65	17.48	.29	4.25	.0682	.0588			
								29	-.0921	.1525
11/13/68	3	242.41	13.99	.43	5.8	.0741	.0621			
								26	-.0292	.0825
12/9/68	3	113.10	10.96	.42	7.85	.0535	.0446			
								76	-.0257	.0539
2/23/69	3	16.10	6.55	.17	13.6	.0125	.0118			
								49	.0214	.0302

Table 14. (Continued)

Date	Station	Daphnia longispina/m^3	Average Temperature °C	E	D	B	b	t_2-t_1	r	d
4/13/69	3	45.87	11.81	.92	7.1	.1296	.0915			
								42	.0164	.0804
5/25/69	3	91.39	16.39	.61	4.7	.1296	.1021			
								19	.0600	.0642
6/13/69	3	288.07	17.96	.83	4.1	.2024	.1463			
								18	.0244	.0948
7/1/69	3	444.69	19.34	.51	3.6	.1417	.1139			
								31	.0097	.1257
8/1/69	3	600.33	19.47	.53	3.45	.1536	.1246			
9/3/68	4	132.35	20.04	.89	3.4	.2618	.1882			
								16	.1181	.0288
9/19/68	4	881.74	19.18	.46	3.6	.1278	.1056			
								25	.0592	.0246
10/14/68	4	3481.62	17.48	.26	4.25	.0612	.0541			
								29	-.0914	.1546
11/13/68	4	246.47	13.99	.52	5.8	.0897	.0724			
								26	-.0096	.0757
12/9/68	4	192.27	10.96	.60	7.85	.0764	.0599			
								76	-.0389	.0802
2/23/69	4	10.02	6.55	.36	13.6	.0265	.0228			
								49	.0500	-.0041
4/13/69	4	115.01	11.81	.63	7.1	.0887	.0690			
								42	-.0093	.1055
5/25/69	4	78.39	16.39	.79	4.7	.1681	.1234			
								19	.0526	.0761
6/13/69	4	211.96	17.96	.74	4.1	.1805	.1341			
								18	-.0026	.0778

Table 14. (Continued)

Date	Station	*Daphnia longispina*/m^3	Average Temperature °C	E	D	B	b	t_2-t_1	r	d
7/1/69	4	476.03	19.34	.74	3.6	.2056	.1528	31	.0450	.1160
8/1/69	4	441.71	19.47	.38	3.45	.1101	.0928			

Table 15. Population data for Diaphanosoma brachyurum in Woahink Lake, 1968 and 1969.

Date	Station	Diaphanosoma brachyurum/m^3	Average Temperature °C	E	D	B	b	t_2-t_1	r	d
7/17/68	1	240.74	20.59	.10	3.25	.0308	.0308			
								22	.0936	-.0235
8/6/68	1	1878.02	20.64	.42	3.2	.1313	.1094			
								31	-.1277	.2353
9/3/68	1	35.85	20.04	.43	3.4	.1265	.1059			
								16	.0363	.0875
9/19/68	1	64.01	19.19	.67	3.6	.1861	.1417			
								25	.1616	-.0590
10/14/68	1	3656.53	17.49	.31	4.25	.0706	.0635			
								29	-.0824	.1245
11/13/68	1	335.01	13.99	.13	5.8	.0224	.0207			
								26	-.0658	.0870
12/9/68	1	60.11	10.99	.18	7.85	.0229	.0217			
								76	-.0284	.0392
2/23/69	1	6.95	6.56	0	13.6	0	0			
								49	-.0298	.0791
4/13/69	1	1.69	11.90	1.00	7.0	.1429	.0986			
								42	.0898	-.0178
5/25/69	1	73.07	16.14	.24	4.85	.0495	.0454			
								19	.1268	-.0529
6/13/69	1	815.39	17.84	.52	4.1	.1268	.1024			
								18	.0711	.0015
7/1/69	1	2935.82	19.12	.42	3.65	.1151	.0959			
								31	-.1213	.1971
8/1/69	1	68.36	19.44	.19	3.45	.0551	.0493			
7/17/68	2	307.96	20.59	.08	3.25	.0246	.0246			
								22	.0741	.0038

Table 15 (Continued)

Date	Station	*Diaphanosoma brachyurum*/m^3	Average Temperature °C	E	D	B	b	t_2-t_1	r	d
8/6/68	2	1574.91	20.64	.52	3.2	.1625	.1313			
								31	-.1606	.2262
9/3/68	2	10.76	20.04	0	3.4	0	0			
								16	.0981	-.0148
9/19/68	2	51.96	19.19	.73	3.6	.2028	.1667			
								25	.1500	-.0443
10/14/68	2	2216.86	17.49	.21	4.25	.0494	.0447			
								29	-.0690	.1025
11/13/68	2	298.30	13.99	.14	5.8	.0241	.0224			
								26	-.0958	.1229
12/9/68	2	24.77	10.99	.29	7.85	.0369	.0318			
								76	-.0287	.0446
2/23/69	2	2.80	6.56	0	13.6	0	0			
								49	.0163	-.0163
4/13/69	2	3.72	11.90	0	7.0	0	0			
								42	.0652	-.0333
5/25/69	2	57.23	16.14	.37	4.85	.0763	.0639			
								19	.1237	-.0467
6/13/69	2	600.99	17.84	.45	4.1	.1098	.0902			
								18	.1150	-.0463
7/1/69	2	4750.73	19.12	.33	3.65	.0904	.0795			
								31	-.1503	.2244
8/1/69	2	45.05	19.44	.22	3.45	.0638	.0580			
7/17/68	3	280.41	20.59	.08	3.25	.0246	.0246			
								22	.0927	-.0133
8/6/68	3	2158.75	20.64	.53	3.2	.1656	.1343			
								31	-.1400	.2571

Table 15 (Continued).

Date	Station	*Diaphanosoma brachyurum*/m^3	Average Temperature ^{o}C	E	D	B	b	t_2-t_1	r	d
9/3/68	3	28.14	20.04	.40	3.4	.1176	.1000			
								16	.0881	.0035
9/19/68	3	115.46	19.19	.35	3.6	.0972	.0833			
								25	.1144	-.0504
10/14/68	3	2015.93	17.49	.21	4.25	.0494	.0447			
								29	-.0834	.1161
11/13/68	3	178.81	13.99	.13	5.8	.0224	.0207			
								26	-.0492	.0742
12/9/68	3	50.11	10.99	.26	7.85	.0331	.0293			
								76	-.0541	.0687
2/23/69	3	.82	6.56	0	13.6	0	0			
								49	.0486	-.0486
4/13/69	3	8.1	11.90	0	7.0	0	0			
								42	.0679	-.0329
5/25/69	3	152.32	16.14	.41	4.85	.0845	.0701			
								19	.0842	.0069
6/13/69	3	761.27	17.84	.58	4.1	.1415	.1122			
								18	.1056	-.0277
7/1/69	3	5070.55	19.12	.24	3.65	.0658	.0602			
								31	-.1281	.2320
8/1/69	3	95.17	19.44	.39	3.45	.1130	.0957			
7/17/68	4	339.22	20.59	.09	3.25	.0277	.0277			
								22	.0636	.0174
8/6/68	4	1379.50	20.64	.54	3.2	.1688	.1343			
								31	-.1200	.1871
9/3/68	4	33.61	20.04	0	3.4	0	0			
								16	.0775	-.0428
9/19/68	4	115.46	19.19	.29	3.6	.0806	.0694			
								25	.1180	-.0692

Table 15. (Continued).

Date	Station	*Diaphanosoma brachyurum*/m^3	Average Temperature °C	E	D	B	b	t_2-t_1	r	d
10/14/68	4	2200.37	17.49	.13	4.25	.0306	.0282			
								29	-.1003	.1221
11/13/68	4	120.04	13.99	.09	5.8	.0155	.0155			
								26	-.0592	.0828
12/9/68	4	25.91	10.99	.30	7.85	.0382	.0318			
								76	$-\infty$	$+\infty$
2/23/69	4	0	6.56	0	13.6	0	0			
								49	$+\infty$	$+\infty$
4/13/69	4	5.59	11.90	0	7.0	0	0			
								42	.0705	-.0285
5/25/69	4	107.80	16.14	.47	4.85	.0969	.0841			
								19	.1147	-.0251
6/13/69	4	956.84	17.84	.48	4.1	.1171	.0951			
								18	.0878	-.0016
7/1/69	4	4630.06	19.12	.32	3.65	.0877	.0767			
								31	-.1226	.2180
8/1/69	4	103.82	19.44	.39	3.45	.1130	.0957			

Table 16. Population data for <u>Cyclops bicuspidatus thomasi</u> in Woahink Lake, 1968 and 1969.

Date	<u>Cyclops bicuspidatus thomasi</u>/m^3	t_2-t_1	r
7/17/68	131.57		
		22	-.0591
8/6/68	35.90		
		31	.0955
9/3/68	695.66		
		16	.0100
9/19/68	814.35		
		25	-.0116
10/14/68	610.09		
		29	-.0372
11/13/68	206.97		
		26	-.0442
12/9/68	65.47		
		76	- ∞
2/23/69	0		
		49	+ ∞
4/13/69	1.75		
		42	.0731
5/25/69	37.99		
		19	-.0142
6/13/69	28.87		
		18	-.0833
7/1/69	481.27		
		31	.1394
8/1/69	6.41		

Table 17. Population data for Diaptomus franciscanus in Woahink Lanke, 1968 and 1969.

Date	Diaptomus franciscanus/m^3	t_2-t_1	r
7/17/68	972.86		
		22	.0114
8/6/68	1250.84		
		31	.0394
9/3/68	4234.79		
		16	-.0869
9/19/68	1058.51		
		25	.0024
10/14/69	1122.68		
		29	-.0734
11/13/68	133.60		
		26	.0573
12/9/68	53.89		
		76	.0053
2/23/69	876.22		
		49	-.1067
4/13/69	2184.27		
		42	.1476
5/25/69	2323.74		
		19	-.0063
6/13/69	2612.57		
		18	-.0288
7/1/69	414.86		
		31	-.0426
8/1/69	1550.88		

Table 18. Population data for Epischura nevadensis in Woahink Lake, 1968 and 1969.

Date	*Epischura nevadensis*/m^3	t_2-t_1	r
7/17/68	116.49	22	-.0564
8/6/68	33.85	31	.0597
9/3/68	164.28	16	-.1131
9/19/68	26.79	25	-.0040
10/14/68	29.64	29	-.0303
11/13/68	71.23	26	.0665
12/9/68	401.65	76	-.0172
2/23/69	108.36	49	-.0402
4/13/69	15.21	42	-.0005
5/25/69	14.90	19	.1258
6/13/69	162.42	18	.0838
7/1/69	50.95	31	.0113
8/1/69	35.91		

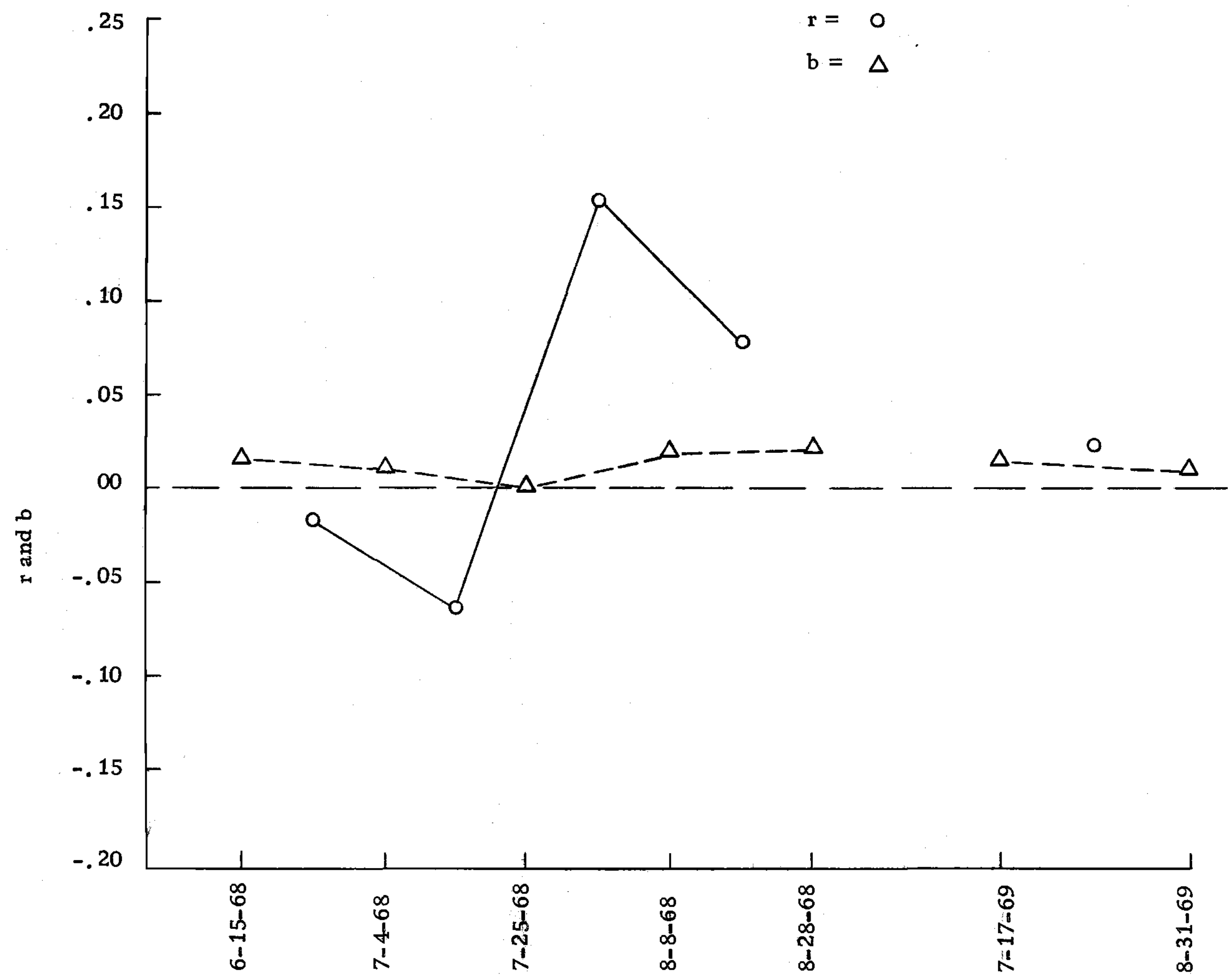


Figure 28. Average rates of population change (r) and instantaneous birth rates (b) of *Daphnia pulex* at station 13 in Crater Lake, 1968 and 1969.

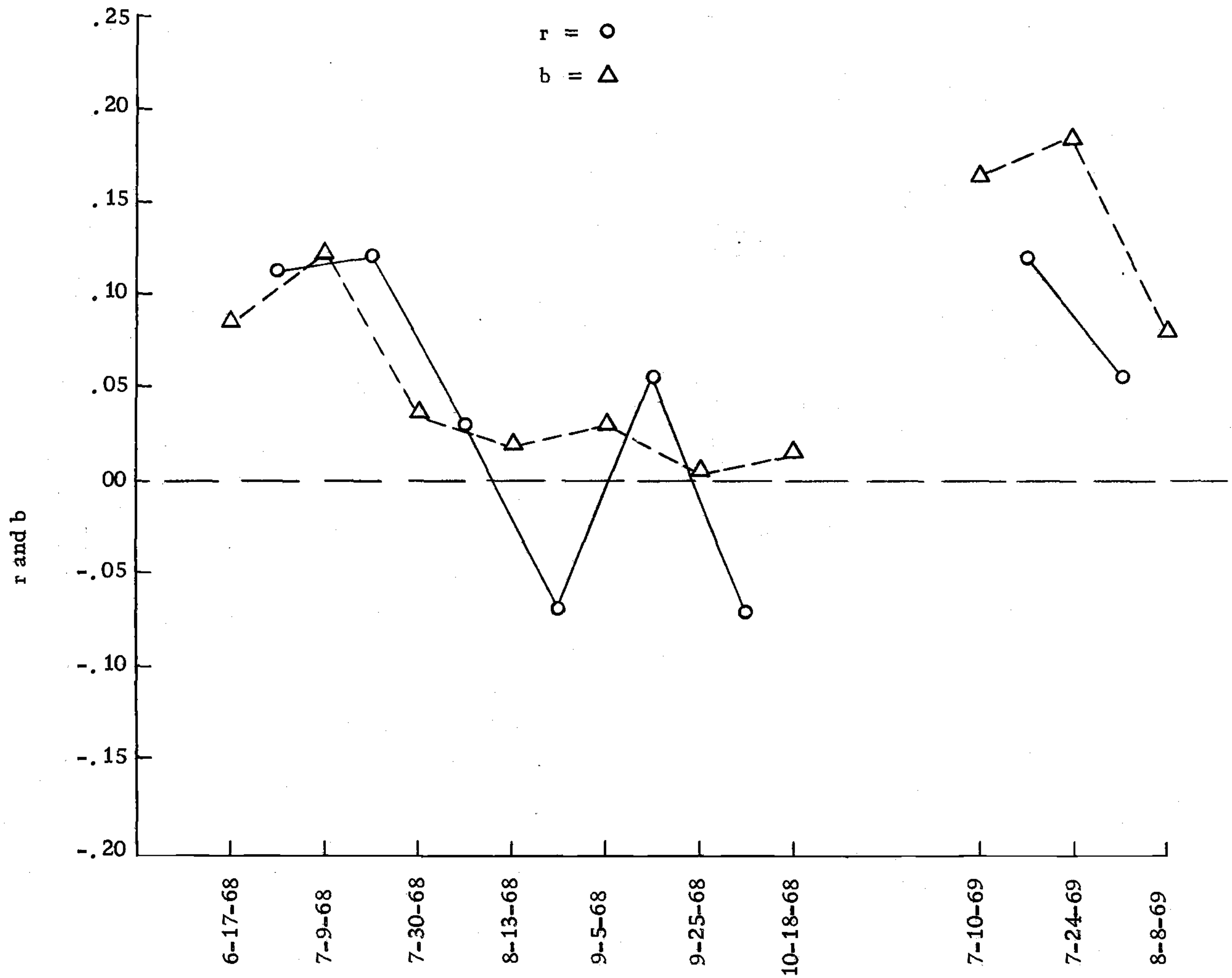


Figure 29. Average rates of population change (r) and instantaneous birth rates (b) of Daphnia longispina at station 1 in Odell Lake, 1968 and 1969.

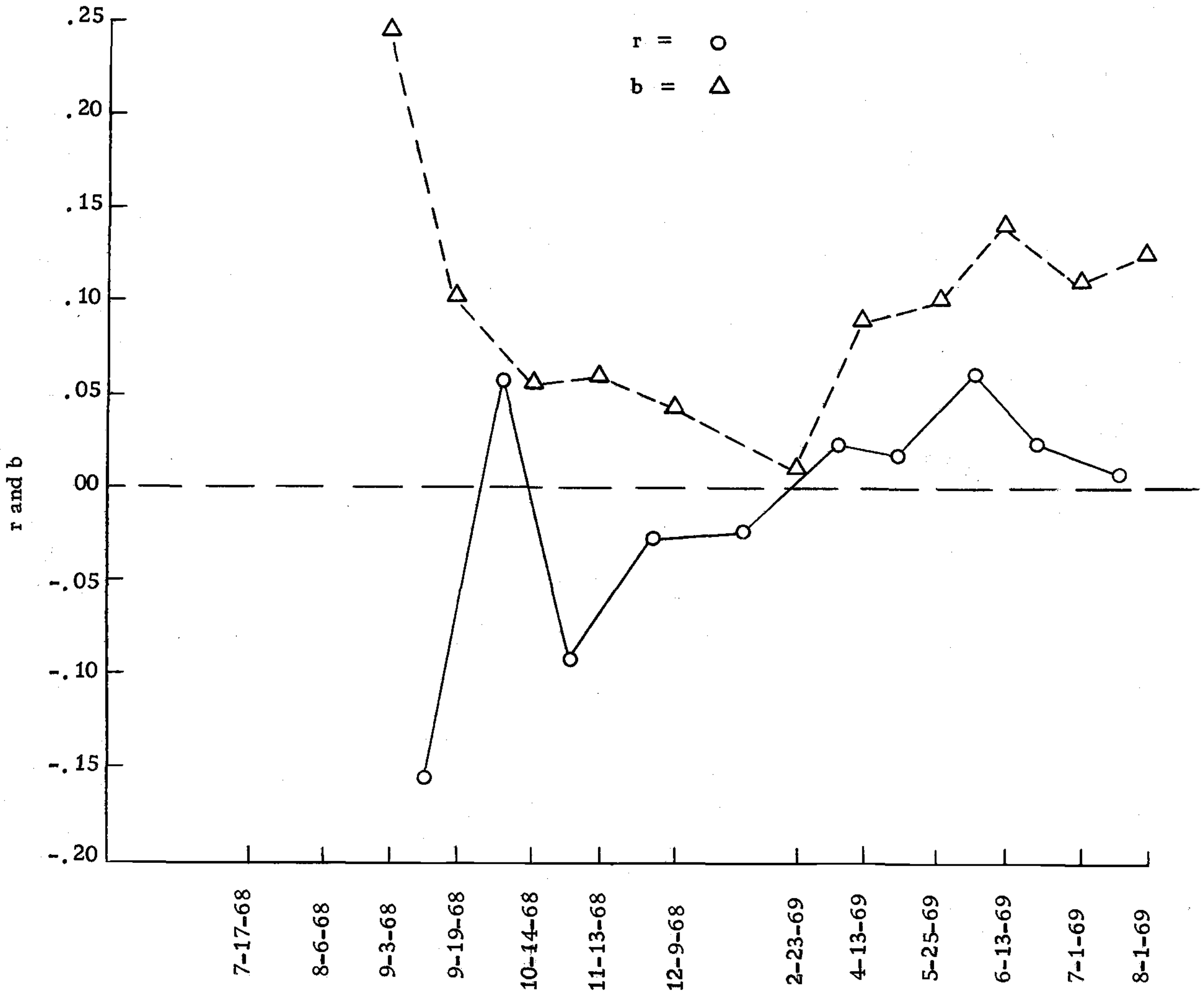


Figure 30. Average rates of population change (r) and instantaneous birth rates (b) of Daphnia longispina at station 3 in Woahink Lake, 1968 and 1969.

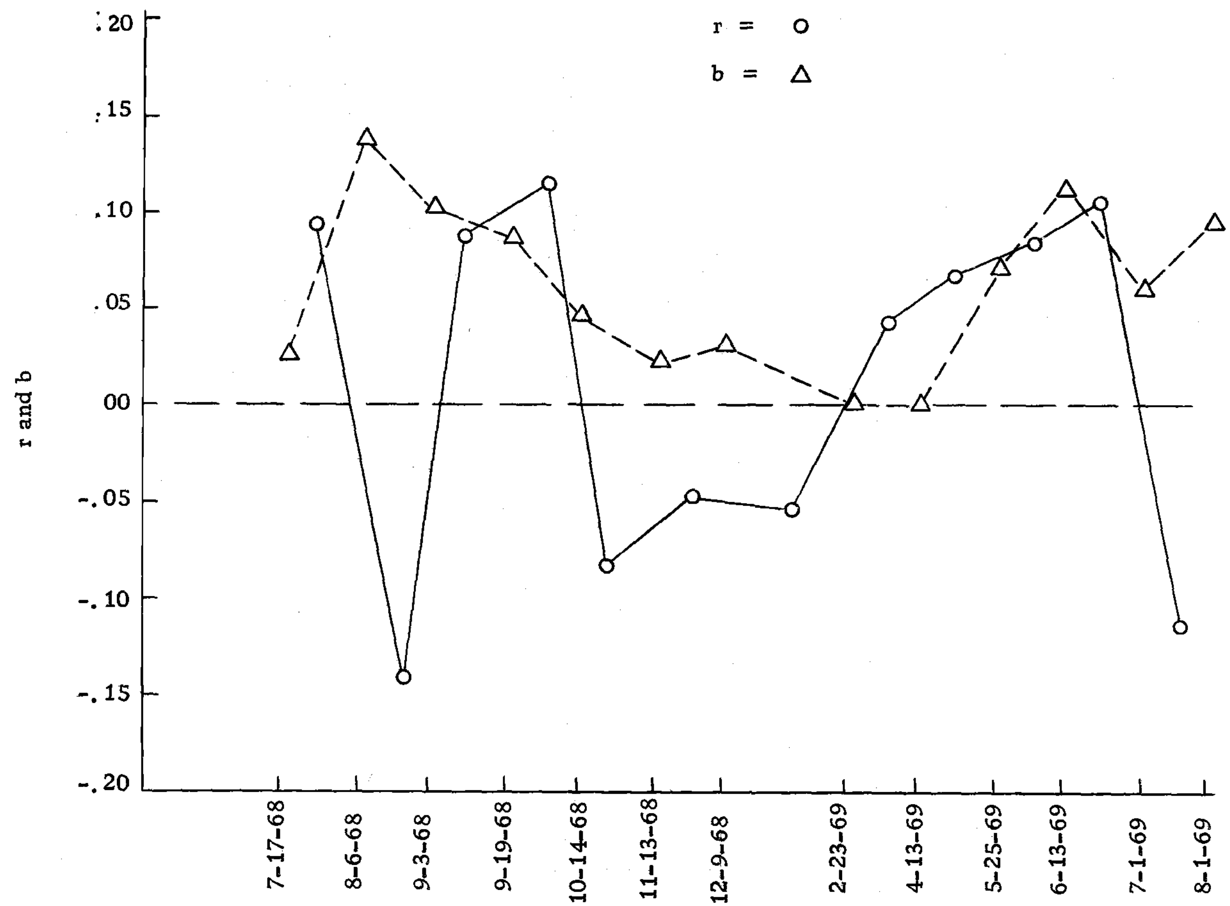


Figure 31. Average rates of population change (r) and instantaneous birth rates (b) of Diaphanosoma brachyurum at station 3 in Woahink Lake, 1968 and 1969.

calculated only for the species of interest in each lake. In Crater Lake, Daphnia had peak b values in early and late August 1968 (Table 10) (Figure 28). The late August population abundance and birth rate were larger than occurred in early August.

Odell Lake Daphnia had a peak instantaneous birth rate during July, 1968 which was followed by a marked increase in numbers (Table 12) (Figure 29). During the two sampling dates in July, 1969 there were also peak instantaneous birth rate values which were both followed by population increases.

Daphnia in Woahink Lake showed peaks in their instantaneous birth rate during September and October, 1968 and June, July and August, 1969 (Table 14, Figure 30). Each of these periods of high reproduction were followed by population increases except after the October sampling period. There was a marked increase of numbers from September to October, 1968.

Daphnia in each of the three lakes showed continuous reproduction when the animals were present. However, Diaphanosoma in Woahink Lake did not exhibit this characteristic. Diaphanosoma were not reproducing during February, 1969 (Table 15, Figure 31). The periods of peak reproduction were August through September, 1968 and June, 1969. Only the August, 1968 peak birth rate was not followed by a population increase.

The egg development times for Daphnia in all three lakes and

Diaphanosoma in Woahink Lake were assumed to be the same as the development times found by Alevras (1970) for *Daphnia pulex* in East and Paulina Lakes, Oregon. The values he found were close to those found by Hall (1964) for *Daphnia galeata mendotae*. Alevras also had similar values for *Daphnia pulex* and other copepod species in his study lakes. This information indicates that the egg development time may be very similar for most species of zooplankton.

The finite birth rate (B) of *Daphnia* and *Diaphanosoma* were examined in relation to the natural logarithm of milligrams carbon taken up per square meter per hour by simple linear correlation. The results of these analyses (Figures 32 and 33) showed that there was no significant correlation between the finite birth rates of *Daphnia* and primary production in any lake or of finite birth rates of *Diaphanosoma* and primary production in Woahink Lake.

The death rates (d) of the species of interest are shown in Tables 10, 12, 14, and 15. These rates are estimates determined from two other estimates and sometimes show negative values. Since a negative death rate is impossible their only use in this study may be to indicate population trends.

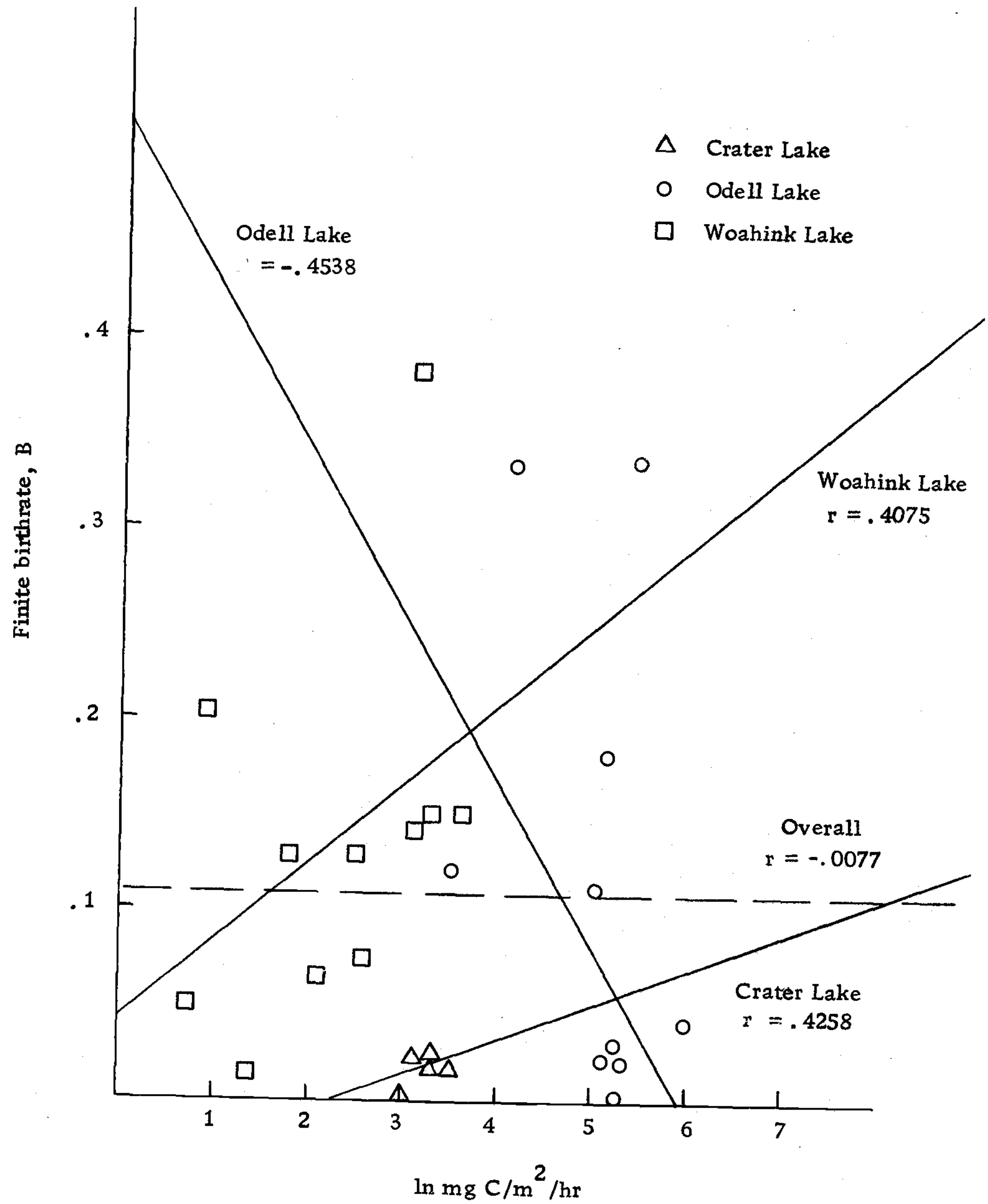


Figure 32. Simple linear regression of finite birth rate (B) for Daphnia sp. and ln mg C/m^2/hr taken from the same station in the respective study lakes.

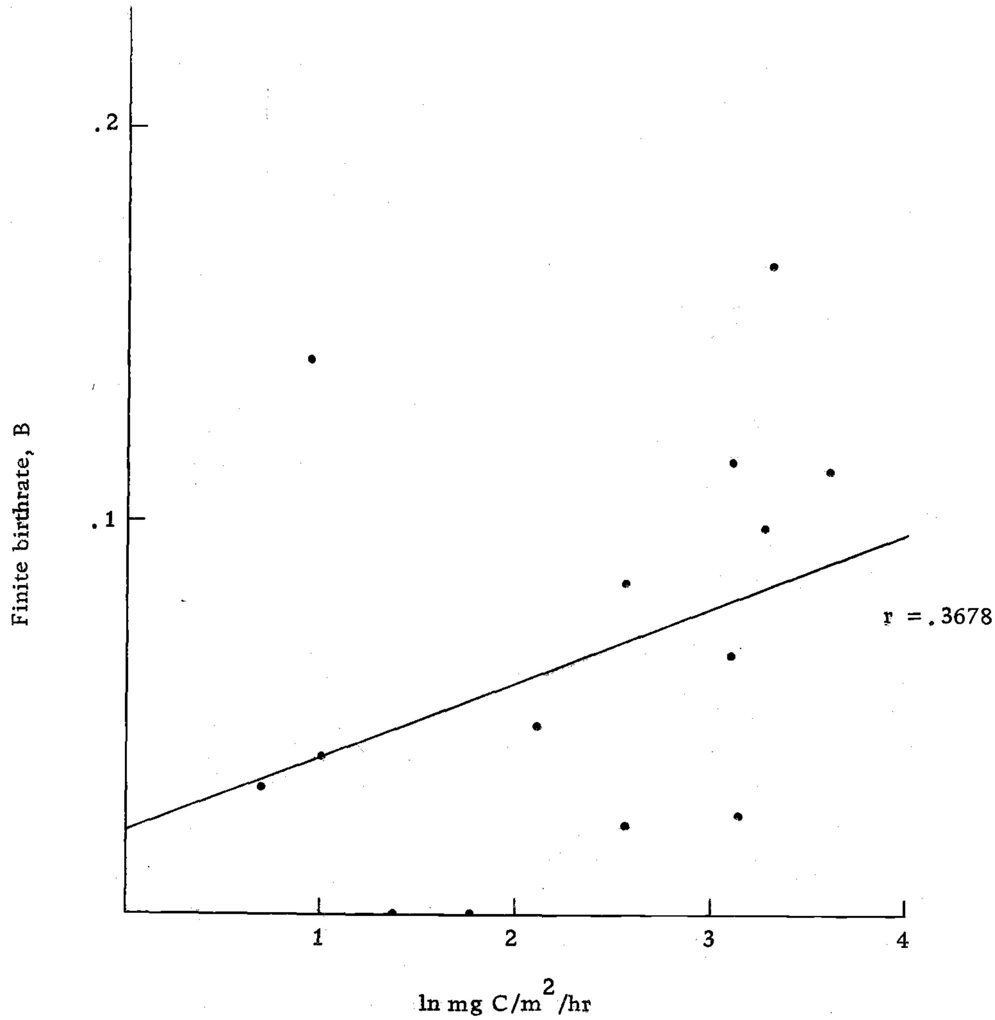


Figure 33. Simple linear regression of finite birth rate (B) for Diaphanosoma and ln mg C/m^2/hr in Woahink Lake station 3.

DISCUSSION

Alevras (1970) pointed out that population rate functions are only a measure of how fast a population is changing. He goes on to say that since these rate functions do not take into account the actual values of population abundance they can not by themselves be used to characterize an aquatic habitat as far as production is concerned. Since these population rate functions are not useful by themselves to classify a lake it may be possible to use the rate function b in conjunction with the numbers of zooplankton per cubic meter.

It was noted in this study that birth rate could not be used to indicate the productivity of a lake. The peak birth rate in Odell Lake was 0.1878, whereas in Woahink Lake it was 0.2471. This difference in the birth rates is not manifest in the zooplankton abundance of the two lakes, *Daphnia* in Odell Lake, at their peak in August, 1968, outnumbered *Daphnia* in Woahink Lake, at their peak in October, 1968 by about 53,000 zooplankters per cubic meter. Odell Lake *Daphnia* always outnumbered Woahink Lake *Daphnia* at all other sampling periods. The differences in birth rate are brought about by different temperatures of the two lakes. The egg ratio of *Daphnia* in Odell Lake was usually larger than that of Woahink Lake *Daphnia*.

The abundance of zooplankters is usually low when the birth rates are high, and the abundance is usually high when the birth rates are low. Multiplying the peak birth rate value times the number of animals at peak abundance would probably yield the best value by which to classify a lake. These numbers would, however, be quite questionable due to the large changes in population numbers from one year to the next. These fluctuations could be brought about by any number of factors such as competition with other zooplankton species, predation or other environmental changes. There are other problems which arise in trying to find the peak abundance and peak birth rate which make their use in lake classification questionable. Because of limited summer sampling, as occurred on Crater Lake for Daphnia, peak abundance may occur at times other than the sampling period (Figure 11). Another problem, such as occurred on Woahink Lake, might be the presence of numerous species of zooplankton which would make the use of a single species to classify a lake very questionable. To determine the unknown interspecific relationships it would be necessary to carry out complete analyses on all the species.

A further problem of using zooplankton as a means of lake classification is the large amounts of time and effort required to collect and analyze the samples. Zooplankton populations are very dynamic and necessitate frequent sampling. The time spent in collection and analysis of these samples would negate any benefit this method might have over other methods of lake classification.

The lack of correlation between finite birth rates (B) and primary production (Figures 32 and 33) also makes this method of lake classification of doubtful value. According to Hall (1964) the egg ratio (E) of Daphnia galeata mendotae is regulated mostly by its food supply. Egg ratios are directly related to the finite birth rates so it would seem that there would be a correlation between the finite birth rate and primary production. This lack of correlation may in part be brought about by not distinguishing between adults and juveniles in the species of interest. This lack of differentiation may cause large underestimates of the egg ratios when the population has been increasing rapidly and there are large numbers of juveniles present in the population.

Still another problem that arises from using the peak abundance of zooplankters in lake classification is that these numbers may be regulated most by factors other than their food supply. The lack of correlation between Daphnia and Diaphanosoma with primary production in Woahink Lake indicates that such regulation may occur. Daphnia in Crater Lake and Daphnia in Odell Lake were both correlated with primary production using the same techniques as those employed in Woahink Lake.

The instantaneous birth rate (b) though not useful for lake classification is of value, along with the death rate (d), as an indicator of the rate of change of a population and its use in the food chain of a lake. As pointed out by Edmondson (1968) birth and death rate functions are a much more sensitive indicator of zooplankton population dynamics than is population abundance alone. A zooplankton population may be reproducing rapidly but because of heavy predation its abundance may not vary. Without observing either the birth rate or the death rate when rapid reproduction and heavy predation is occurring an investigator would erroneously assume that the population is static and not contributing much in the way of food to predator species present.

The birth and death rates of the species of interest in the three study lakes did not indicate that they are involved in a situation as has been described above. These lakes all contain a species of fish which is primarily plankton feeding. Woahink Lake contains a fresh-water shrimp that feeds primarily on zooplankton. It is abundant in early and mid summer. High birth and death rates occurred simultaneously only once in any of the study lakes (Tables 10, 12, 14, and 15) indicating that these populations were affected more by environmental changes or competition with other zooplankters than by predation.

The horizontal tows which allowed the calculation of average temperatures for use in calculating birth rates were also used to observe the diel vertical migration of the zooplankton in Odell and Woahink Lakes. McLaren (1963) says that vertical distribution may be controlled by many factors. The most important factor is light. He also mentions that vertical distribution may be secondarily controlled by food supply and temperature. The food supply only is important if there was not enough food in the upper water column to sustain the zooplankton during migrations.

The results of the horizontal tows in Odell Lake were such that nothing could be said about Daphnia in that lake other than it migrated on every occasion. The horizontal tow results in Woahink Lake showed that Daphnia and Diaphanosoma migrated to the surface at night and back to their former day time depth over a 24 hour period during times of increased temperature and thermal stratification in the lake. When the lake was not thermally stratified and had low temperatures these species did not migrate. Primary production during the times of migration was quite variable and at times less than or about equal to the primary production occurring when no migration took place. These observations indicate that in Woahink Lake, at least, temperature is more important in causing Daphnia and Diaphanosoma to migrate than is primary production. However, as discussed earlier primary production in this lake does not correlate with the abundance of these species so this pattern of temperature and migration may not be true in other lakes such as Odell Lake or Crater Lake where abundance appears to be dependent on food supply.

The use of zooplankton as a tool for lake classification on the basis of biotic production leaves much to be desired. The method is seriously limited by the time required for sample analysis and by a lack of understanding of zooplankton population relationships within a lake.

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Appendix Table 1a. Vertical tows collected from June, 1968 through September 1969 in the three study lakes with the 0.5 m net. Crater Lake.

Date	Station	Revolutions	Daphnia pulex/m^3	Bosmina longispina/m^3	Daphnia longispina eggs/m^3
6-15-68	13	197[1]	76.52	147.43	26.13
	18	197[1]	104.51	76.52	33.59
	25	197[1]	48.52	46.66	3.73
7- 4-68	13	197[1]	55.99	171.69	13.06
	18	197[1]	106.38	246.34	16.80
	25	197[1]	85.85	171.69	14.93
7-25-68	13	448	14.77	95.19	0.82
	18	453	79.54	68.98	5.68
	25	457	144.00	208.36	25.74
8- 8-68	13	450[2]	130.72	233.66	50.65
	18	450[2]	203.43	160.95	63.73
	25	450[2]	98.04	223.04	40.85
8-28-68	13	372	545.54	542.58	254.98
	13	351	703.87	590.75	229.39
	18	352	554.60	485.67	159.80
	18	354	716.60	2395.94	305.33
	25	340	600.13	1106.19	184.90
	25	330	628.34	985.86	243.98
7-17-69	13	522	234.53	2.82	83.11
	13	521	201.11	6.35	76.21
	13	288	354.88	3.83	125.10
	13	517	142.93	2.13	70.40
	18	524	71.56	0.70	141.02
	18	266	226.67	5.53	328.95
	18	529	97.99	4.86	141.08
	18	211	284.01	10.45	418.18
	25	526	581.53	6.99	240.44
	25	535	531.89	2.06	259.76
	25	434	742.07	2.54	365.95
	25	252	1116.07	4.38	468.31
8-31-69	13	488	515.31	6.03	79.86
	13	470	628.91	0	154.88
	18	489	1714.18	18.04	366.90
	18	418	1984.24	28.15	422.18
	25	510	304.21	40.37	49.02
	25	510	340.25	31.72	51.90

[1] Average of 7-21-68 closing net tows.

[2] Average of 7-25-68 and 8-27-68 net tows.

Appendix Table 1b. Vertical tows collected from June, 1968 through September, 1969 in the three study lakes with the 0.5 m net. Odell Lake.

Date	Station	Revolutions	Daphnia longispina/m^3	Cyclops bicuspidatus thomasi/m^3	Daphnia longispina eggs/m^3
6-17-68	1	162	246.91	5599.13	181.55
	1	155	235.29	6929.79	220.11
	2	168	787.82	11668.42	1207.98
	2	165	561.50	9590.02	472.37
	3	200	308.82	5757.35	522.06
	3	180	424.84	7834.97	392.16
7- 9-68	1	154	3084.42	2167.69	3733.77
	1	157	2688.27	1789.06	2716.37
	2	174	2332.66	1521.30	2510.14
	2	180	1838.24	1683.01	1944.44
	3	239	2615.06	596.85	2811.96
	3	205	2941.18	595.41	3407.46
7-30-68	1	147	34593.84	3151.26	10294.12
	1	140	38602.94	2647.06	9485.29
	2	196	34611.34	1575.63	2783.61
	2	183	43426.55	2418.84	1912.57
	3	212	27143.45	1116.81	2816.32
	3	152	48558.44	1354.49	6569.27
8-13-68	1	135	59901.96	6666.67	6568.63
	1	135	52647.06	6568.63	5196.08
	2	150	55235.29	4147.06	4058.82
	2	142	54339.27	2609.78	3262.22
	3	142	53686.83	2609.78	1957.33
	3	138	47282.61	2397.70	1150.90
9- 6-68	1	68	11678.20	113862.46	1946.37
	1	67	12247.59	120895.52	2765.58
	2	66	30681.82	129344.92	4411.76
	2	80	23988.97	105551.47	5294.13
9- 5-68	3	70	40084.03	117037.82	20420.17
	3	76	42840.56	111280.96	22813.47
9-25-68	1	80	38713.24	125073.53	2977.94
	1	80	37389.71	139466.91	1654.41
	2	98	26200.48	144372.75	1215.49
	2	98	23904.56	128031.21	2701.08
	3	132	12834.22	78509.36	1002.67
	3	124	16223.91	89018.03	1067.36
10-18-68	1	85	6851.21	78788.93	1868.51
	1	78	8823.53	83823.53	1131.22
10-19-68	2	96	7352.94	88143.38	1654.41
	2	100	11029.41	94941.18	970.59
	3	94	12672.09	110669.59	7603.25
	3	116	7910.75	93483.77	3194.73

Continued on next page

Appendix Table 1b continued.

Date	Station	Revolutions	Daphnia longispina/m^3	Cyclops bicuspidatus thomasi/m^3	Daphnia longispina eggs/m^3
7-10-69	1	152	1789.86	30427.63	3821.59
	1	164	1389.89	29949.78	3676.47
	1	222	1622.95	34081.88	4173.29
	1	162	1770.15	32588.96	5174.29
	2	259	1760.16	14393.60	2555.08
	2	158	1675.35	15636.63	2885.33
	2	162	2768.70	15477.49	3540.31
	2	158	1908.04	15450.48	2745.72
	3	152	1838.24	12529.02	1983.36
	3	152	1838.24	13448.14	2128.48
	3	145	1774.85	14858.01	3752.54
	3	151	1801.71	14998.05	2045.19
7-24-69	1	143	8278.49	11415.06	16454.13
	1	148	9638.31	9141.49	18680.45
	1	143	8895.52	11157.96	17122.58
	1	141	9699.62	9960.37	18251.98
	2	150	6813.73	5098.04	6764.71
	2	148	7352.94	5862.48	7501.99
	2	147	7252.90	5852.34	6602.64
	2	144	7863.56	6127.45	6127.45
	3	160	5698.53	3768.38	7398.90
	3	149	6711.41	3306.36	8438.61
	3	158	6282.58	2978.41	9447.13
	3	151	6768.60	2532.14	7888.59
8- 8-69	1	167	18060.94	5794.29	10848.89
	1	140	26397.06	7132.35	16176.47
	1	154	21256.68	5080.21	11697.86
	1	163	21093.47	5873.33	13009.74
	2	140	43823.53	4411.76	20661.76
	2	149	37504.93	4263.72	20529.02
	2	163	32767.95	4041.86	13496.93
	2	143	44508.43	4607.16	25668.45
	3	158	54532.76	4942.29	18010.05
	3	148	65192.77	4024.24	20568.36
	3	150	65117.65	3088.24	22500.00
	3	153	66868.51	3892.73	18598.62

Table 1c. Vertical tows collected from June, 1968 through September, 1969 in the three study lakes with the 0.5 m net. Woahink Lake.

Date	Station	Revolutions	Daphnia longispina/m^3	Diaphanosoma brachyurum/m^3	Cyclops bicuspidatus thomasi/m^3	Diaptomus franciscanus/m^3	Epischura nevadensis/m^3	Daphnia longispina eggs/m^3	Diaphanosoma brachyurum eggs/m^3
7-17-68	1	87	0	256.93	112.41	943.20	165.65	0	23.66
	1	93	0	224.54	164.45	910.82	167.62	0	22.14
	2	85	0	297.58	114.19	1134.95	124.57	0	13.84
	2	85	0	318.34	79.58	1020.76	124.57	0	34.60
	3	90	0	323.53	114.38	947.71	91.50	0	32.68
	3	88	0	237.30	96.93	939.17	76.87	0	13.37
	4	91	0	294.12	161.60	827.41	106.66	0	32.32
	4	75	0	384.71	149.02	1058.82	74.51	0	27.45
8- 6-68	1	60	0	1828.43	24.51	1088.24	44.12	0	705.88
	1	65	0	1927.60	40.72	882.35	36.20	0	859.73
	2	69	0	1419.44	46.89	1470.59	29.84	0	750.21
	2	60	0	1730.39	29.41	1598.04	29.41	0	877.45
	3	78	0	1964.56	30.17	1470.59	18.85	0	935.14
	3	72	0	2352.94	49.02	1617.65	24.51	0	1348.04
	4	71	0	1429.16	53.85	952.78	24.86	0	687.66
	4	70	0	1329.83	12.61	926.47	63.03	0	800.42
9- 3-68	1	40	154.21	44.12	650.74	3242.65	176.47	66.18	11.03
	1	48	137.87	27.57	533.09	3593.75	156.25	91.91	18.38
	2	35	176.47	0	1184.87	6542.02	352.94	163.87	0
	2	41	96.84	21.52	710.19	5100.43	118.36	86.08	0
	3	40	55.15	11.03	386.03	4720.59	99.26	88.24	0
	3	39	90.50	45.25	757.92	5328.05	135.75	101.81	22.62
9- 4-68	4	35	88.24	37.82	504.20	2483.19	113.45	100.84	0
	4	30	176.47	29.41	833.24	2867.65	161.76	132.35	0
9-19-68	1	50	255.88	97.66	652.94	864.71	0	132.35	70.59
	1	57	208.98	30.96	665.63	928.79	0	69.66	15.48
	2	45	343.14	68.63	725.49	754.90	19.61	264.71	49.02

Continued on next page

Appendix Table 1c continued.

Date	Station	Revolutions	Daphnia longispina/m³	Diaphanosoma brachyurum/m³	Cyclops bicuspidatus thomasi/m³	Diaptomus franciscanus/m³	Epischura nevadensis/m³	Daphnia longispina eggs/m³	Diaphanosoma brachyurum eggs/m³
9-19-68	2	50	494.12	35.29	926.47	741.18	17.65	317.65	26.47
	3	49	864.35	153.06	909.36	1332.53	27.01	378.15	54.02
	3	51	856.40	77.85	1115.92	1280.28	34.60	389.27	25.95
	4	53	815.76	116.54	849.06	1340.18	58.27	382.91	33.30
	4	54	947.71	114.38	669.93	1225.49	57.19	424.84	32.68
10-14-68	1	44	3823.53	4010.70	374.33	1082.89	40.11	2740.64	1390.37
	1	57	2489.68	3302.37	387.00	799.79	51.60	1457.69	941.69
	2	56	3742.12	2468.49	459.56	1234.24	26.26	1575.63	525.21
	2	55	3262.03	1965.24	521.39	1069.52	26.74	1122.99	401.07
	3	60	3210.78	2156.86	796.57	919.12	12.25	870.10	453.43
	3	60	3774.51	1875.00	735.29	575.98	24.51	1151.96	404.41
	4	56	2757.35	1930.15	827.21	1667.54	26.26	722.16	288.87
	4	50	4205.88	2470.59	779.41	1632.35	29.41	1058.82	294.12
11-13-68	1	88	344.25	250.67	140.37	63.50	56.82	90.24	43.45
	1	60	426.47	446.08	220.59	112.75	58.82	151.96	58.82
	1	78	305.43	290.35	165.91	71.64	52.79	105.58	37.71
	1	70	289.92	352.94	151.26	88.24	58.82	117.65	33.61
	2	82	398.13	240.32	147.06	68.15	28.69	279.77	39.45
	2	70	483.19	268.91	138.66	71.43	29.41	189.08	46.22
	2	57	567.60	376.68	139.32	144.48	36.12	309.60	30.96
	2	67	408.25	307.29	184.37	79.02	35.12	188.76	48.29
	3	72	281.86	257.35	236.93	171.57	32.68	106.21	40.85
	3	73	205.48	187.35	247.78	132.96	30.22	60.44	42.30
	3	74	226.55	149.05	286.17	184.82	41.73	95.39	11.92
	3	69	255.75	121.48	274.94	159.85	31.97	159.85	0
	4	73	265.91	139.00	235.70	247.78	205.48	102.74	6.04
	4	73	247.78	96.70	314.26	181.31	139.00	145.04	18.13

Continued on next page

Appendix Table 1c continued.

Date	Station	Revolutions	Daphnia longispina/m^3	Diaphanosoma brachyurum/m^3	Cyclops bicuspidatus thomasi/m^3	Diaptomus franciscanus/m^3	Epischura nevadensis/m^3	Daphnia longispina eggs/m^3	Diaphanosoma brachyurum eggs/m^3
11-13-68	4	75	311.76	147.06	164.71	188.24	158.82	170.59	17.65
	4	77	160.43	97.40	263.56	171.89	143.24	97.40	0
12- 9-68	1	82	143.47	39.45	100.43	25.11	304.88	35.87	7.17
	1	78	154.60	98.04	26.40	26.40	275.26	56.56	7.54
	1	60	200.98	53.92	78.43	39.22	426.47	29.41	4.90
	1	72	138.89	49.02	81.70	57.19	302.29	36.76	24.51
	2	88	163.77	16.71	16.71	16.71	180.48	56.82	3.34
	2	49	198.08	24.01	102.04	24.01	258.10	66.03	0
	2	61	168.76	28.93	67.50	24.11	216.97	81.97	9.64
	2	60	225.49	29.41	34.31	29.41	289.22	68.63	14.71
	3	65	126.70	99.55	27.15	27.15	479.64	54.30	36.20
	3	60	93.14	34.31	53.92	102.94	485.29	29.41	0
	3	63	112.04	28.01	28.01	18.67	368.81	65.36	9.34
	3	61	120.54	38.57	38.57	19.29	361.62	38.57	4.82
	4	60	220.59	34.31	98.04	102.94	612.75	132.35	14.71
	4	75	219.61	15.69	66.67	82.35	513.73	141.18	3.92
	4	65	135.75	31.67	126.70	113.12	696.83	63.35	9.05
	4	57	193.15	21.95	100.97	153.64	654.08	122.91	4.39
2-23-69	1	58	101.42	15.21	0	1409.74	258.62	30.43	0
	1	70	33.61	0	0	1079.83	201.68	8.40	0
	1	70	63.03	12.61	0	1147.06	201.68	12.61	0
	1	67	70.24	0	0	1150.13	210.71	52.68	0
	2	74	39.75	0	0	814.79	63.59	3.97	0
	2	78	30.17	3.77	0	614.03	52.79	37.71	0
	2	70	54.62	4.20	0	760.50	58.82	21.01	0
	2	91	22.62	3.23	0	481.58	35.55	6.46	0
	3	90	19.61	3.27	0	830.07	81.70	6.54	0
	3	68	4.33	0	0	657.44	69.20	0	0

Continued on next page

Appendix Table 1c continued.

Date	Station	Revolutions	Daphnia longispina/m³	Diaphanosoma brachyurum/m³	Cyclops bicuspidatus thomasi/m³	Diaptomus franciscanus/m³	Epischura nevadensis/m³	Daphnia longispina eggs/m³	Diaphanosoma brachyurum eggs/m³
2-23-69	3	88	20.05	0	0	568.18	60.16	0	0
	3	72	20.42	0	0	812.91	85.78	4.08	0
2-24-69	4	77	11.46	0	0	920.55	87.85	0	0
	4	74	3.97	0	0	1017.49	103.34	0	0
	4	88	16.71	0	0	738.64	66.84	6.68	0
	4	74	7.95	0	0	989.67	95.39	7.95	0
4-13-69	1	78	11.31	0	0	1361.24	22.62	0	3.77
	1	87	3.38	3.38	6.76	1169.71	16.90	0	0
	2	68	12.98	0	0	2560.55	12.98	8.65	0
	2	79	29.78	7.45	0	2110.95	14.89	7.45	0
	3	86	51.30	10.26	0	2705.20	13.68	44.46	0
	3	80	40.44	7.35	0	3308.82	18.38	40.44	0
	4	78	131.98	7.54	0	2115.38	11.31	45.25	0
	4	81	98.04	3.63	7.26	2142.34	10.89	98.04	0
5-25-69	1	63	49.02	35.01	56.02	4993.00	28.01	14.01	14.01
	1	58	15.21	121.70	38.03	4814.91	30.43	0	45.64
	1	70	12.61	44.12	56.72	3497.90	25.21	6.30	12.61
	1	82	10.76	91.46	43.04	3125.90	21.52	5.38	5.38
	2	69	51.15	95.91	38.36	2941.18	6.39	44.76	25.58
	2	82	16.14	37.66	59.18	2222.02	5.38	16.14	21.52
	2	105	16.81	54.62	12.61	1953.78	8.40	8.40	21.01
	2	65	47.51	40.72	20.36	3237.56	13.57	13.57	13.57
	3	80	104.78	159.93	55.15	1847.43	16.54	88.24	93.75
	3	95	125.39	162.54	78.95	1630.03	13.93	55.73	23.22
	3	79	27.92	128.44	11.17	1379.37	11.17	33.51	44.68
	3	78	107.47	158.37	16.97	1662.90	11.31	50.90	96.15
	4	80	88.24	159.93	33.09	1119.49	16.54	60.66	66.18
	4	80	77.21	71.69	44.12	909.93	11.03	88.24	49.63

Continued on next page

Appendix Table 1c continued.

Date	Station	Revolutions	Daphnia longispina/m^3	Diaphanosoma brachyurum/m^3	Cyclops bicuspidatus thomasi/m^3	Diaptomus franciscanus/m^3	Epischura nevadensis/m^3	Daphnia longispina eggs/m^3	Diaphanosoma brachyurum eggs/m^3
5-25-69	4	105	79.83	105.04	12.61	773.11	8.40	54.62	33.61
	4	84	68.28	94.54	31.51	1071.43	10.50	47.27	57.77
6-13-69	1	71	298.26	894.78	18.64	3200.08	323.12	242.34	503.31
	1	78	265.84	786.20	11.31	3421.95	214.93	158.37	424.21
	1	80	253.68	783.09	11.03	3534.93	330.88	170.96	441.18
	1	78	243.21	797.51	16.97	3342.76	203.62	141.40	322.40
	2	88	100.27	606.62	20.05	2000.33	60.16	135.36	350.94
	2	78	107.47	548.64	11.31	2104.07	101.81	67.87	265.84
	2	79	161.95	619.88	22.34	2099.78	106.11	134.03	212.21
	2	87	177.48	628.80	5.07	2023.33	131.85	182.56	258.62
	3	88	250.67	646.72	35.09	2742.31	150.40	205.55	451.20
	3	82	317.43	882.35	53.80	3050.57	172.17	322.81	451.94
	3	89	312.29	659.29	24.79	2538.00	118.97	277.59	346.99
	3	86	271.89	856.70	35.91	2575.24	143.64	148.77	518.13
	4	78	265.84	1057.69	45.25	2703.62	158.37	209.28	356.33
	4	86	169.29	902.87	51.30	1995.55	112.86	107.73	487.35
	4	74	208.66	1067.17	71.54	2301.27	143.08	155.01	357.71
	4	80	204.04	799.63	27.57	2167.28	126.84	154.41	601.10
7- 1-69	1	90	498.37	2990.20	24.51	1642.16	57.19	310.46	1331.70
	1	96	283.39	3086.70	7.66	1432.29	45.96	160.85	1171.88
	1	92	407.61	2973.15	23.98	1486.57	63.94	303.71	1358.70
	1	86	307.80	2693.23	0	1761.29	34.20	196.65	1094.39
	2	80	705.88	5205.88	0	2022.06	36.76	477.94	1654.41
	2	85	470.59	4560.55	6.92	1404.84	27.68	394.46	1404.84
	2	91	420.17	4356.82	0	1519.07	84.03	284.42	1641.89
	2	88	521.39	4879.68	0	1871.66	20.05	207.22	1463.90
	3	82	502.15	5645.62	0	1621.23	28.69	164.99	1183.64
	3	90	509.80	5215.69	6.54	1254.90	52.29	241.83	1313.73

Continued on next page

Appendix Table 1c continued.

Date	Station	Revolutions	Daphnia longispina/m^3	Diaphanosoma brachyurum/m^3	Cyclops bicuspidatus thomasi/m^3	Diaptomus franciscanus/m^3	Epischura nevadensis/m^3	Daphnia longispina eggs/m^3	Diaphanosoma brachyurum eggs/m^3
7- 1-69	3	90	366.01	4359.48	0	1464.05	39.22	248.37	1111.11
	3	91	400.78	5061.41	6.46	1325.15	58.18	239.17	1254.04
	4	89	720.42	4573.69	6.61	1559.81	6.61	475.88	1566.42
	4	89	304.03	4619.96	0	1440.85	6.61	277.59	1473.89
	4	90	372.55	4627.45	13.07	1588.24	13.07	346.41	1427.84
	4	87	507.10	4699.12	6.76	1419.88	0	304.26	1440.16
8- 1-69	1	72	412.58	98.04	416.67	473.86	77.61	314.54	20.42
	1	84	374.65	49.02	416.67	462.18	66.53	318.63	10.50
	1	74	393.48	67.57	437.20	532.59	55.64	290.14	15.90
	1	85	363.32	58.82	380.62	453.29	41.52	249.13	6.92
	2	86	321.48	34.20	307.80	208.62	34.20	267.58	10.26
	2	77	233.00	42.02	374.33	297.94	38.20	175.71	3.82
	2	84	224.09	52.52	346.64	248.60	42.02	105.04	21.01
	2	80	257.35	51.47	352.94	261.03	25.74	143.38	3.68
	3	79	692.48	70.74	551.01	636.63	29.78	349.96	55.85
	3	84	577.73	115.55	532.21	570.73	38.52	371.15	28.01
	3	75	635.29	101.96	482.35	556.86	50.98	274.51	31.37
	3	70	495.80	92.44	495.80	701.68	50.42	273.11	33.61
	4	88	417.78	96.93	571.52	300.80	63.50	120.32	36.76
	4	85	619.38	96.89	612.46	252.60	93.43	242.21	62.28
	4	85	384.08	103.81	775.09	349.68	51.90	183.39	24.22
	4	80	345.59	117.65	647.06	330.88	55.15	128.68	36.76

Appendix Table 2a. Horizontal tows collected with Miller sampler in Odell and Woahink Lakes from November, 1968 through September, 1969. Odell Lake.

Date	Time	Depth (m)	Daphnia longispina/m^3	Cyclops bicuspidatus thomasi/m^3	Daphnia longispina eggs/m^3	Egg ratio (E)
7-10-69	12:08	0	100.00	770.00	10.00	.10
	12:08	4	9900.00	41800.00	2900.00	.29
	12:08	8	4300.00	68000.00	10400.00	2.42
	12:08	12	2000.00	43000.00	6800.00	3.40
	11:48	16	5700.00	68700.00	6800.00	1.19
	11:48	20	3100.00	61000.00	8900.00	2.87
	11:48	24	1700.00	52800.00	2800.00	1.65
	11:48	28	1900.00	79000.00	1800.00	.95
7-10-69	18:50	0	3400.00	19450.00	3200.00	.94
	18:50	4	14300.00	99600.00	13400.00	.94
	18:50	8	5800.00	70200.00	20100.00	3.47
	18:50	12	3000.00	61000.00	8000.00	2.67
	18:30	16	5300.00	78100.00	13600.00	2.57
	18:30	20	4100.00	62300.00	18200.00	4.44
	18:30	24	4700.00	69600.00	20900.00	4.45
	18:30	28	4300.00	81400.00	20400.00	4.74
7-10-69	23:59	0	8750.00	116250.00	12500.00	1.43
	23:59	4	19000.00	150500.00	32750.00	1.72
	23:59	8	4250.00	77500.00	5000.00	1.18
	23:59	12	4250.00	61250.00	7000.00	1.65
	23:40	16	2000.00	30750.00	5250.00	2.63
	23:40	20	3250.00	35250.00	6000.00	1.85
	23:40	24	3000.00	49000.00	7750.00	2.58
	23:40	28	5000.00	58250.00	10500.00	2.10
7-11-69	06:30	0	9250.00	25500.00	3000.00	.32
	06:30	4	13000.00	34000.00	11000.00	.85
	06:30	8	10000.00	101500.00	27250.00	2.72
	06:30	12	8750.00	120500.00	54750.00	6.26
	06:15	16	9000.00	95000.00	28000.00	3.11
	06:15	20	8500.00	85000.00	47250.00	5.56
	06:15	24	2750.00	81250.00	5000.00	1.82
	06:15	28	3250.00	63500.00	10000.00	3.08
7-24-69	12:35	0	1050.00	650.00	100.00	.10
	12:35	4	40200.00	5200.00	18200.00	.45
	12:35	8	28050.00	25650.00	30450.00	1.09
	12:35	12	14550.00	23400.00	18750.00	1.29
	12:15	16	9750.00	17400.00	11700.00	1.20
	12:15	20	8850.00	13050.00	7200.00	.81
	12:15	24	13050.00	13200.00	21300.00	1.63
	12:15	28	12150.00	16200.00	15150.00	1.25
7-24-69	18:23	0	37600.00	1050.00	38600.00	1.03
	18:23	4	63700.00	20400.00	45300.00	.71
	18:23	8	48450.00	24300.00	77700.00	1.60

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Appendix Table 2a continued.

Date	Time	Depth (m)	Daphnia longispina/m^3	Cyclops bicuspidatus thomasi/m^3	Daphnia longispina eggs/m^3	Egg ratio (E)
7-24-69	18:23	12	20400.00	32850.00	56100.00	2.75
	18:05	16	24000.00	14900.00	38900.00	1.62
	18:05	20	29550.00	26250.00	69000.00	2.34
	18:05	24	12000.00	34200.00	39000.00	3.25
	18:05	28	11800.00	36300.00	21400.00	1.81
7-25-69	01:05	0	62400.00	1600.00	99700.00	1.60
	01:05	4	51500.00	17900.00	62400.00	1.20
	01:05	8	23700.00	36300.00	8500.00	.30
	01:05	12	6000.00	15400.00	4800.00	.80
	00:45	16	23250.00	27150.00	30150.00	1.30
	00:45	20	16000.00	19900.00	17700.00	1.11
	00:45	24	6500.00	19200.00	5400.00	.83
	00:45	28	8000.00	19700.00	11400.00	1.42
7-25-69	07:08	0	31100.00	500.00	26650.00	.86
	07:08	4	33850.00	6050.00	14200.00	.42
	07:08	8	47400.00	26500.00	36300.00	.77
	07:08	12	9400.00	28200.00	18800.00	2.00
	06:53	16	36600.00	30500.00	71900.00	1.96
	06:53	20	14200.00	30900.00	23300.00	1.64
	06:53	24	6200.00	21200.00	8100.00	1.31
	06:53	28	7300.00	23800.00	4900.00	.67
8- 7-69	18:28	0	227100.00	1200.00	52200.00	.23
	18:28	4	73600.00	2600.00	21600.00	.29
	18:28	8	128750.00	19250.00	53000.00	.41
	18:28	12	78000.00	16500.00	30500.00	.39
	18:16	16	107500.00	7750.00	42750.00	.40
	18:16	20	34500.00	17250.00	17500.00	.51
	18:16	24	28000.00	17000.00	11500.00	.41
	18:16	28	30450.00	35100.00	14700.00	.48
8- 8-69	00:28	0	102000.00	1500.00	22200.00	.22
	00:28	4	105000.00	3500.00	21750.00	.21
	00:28	8	83750.00	7500.00	26750.00	.32
	00:28	12	63000.00	8600.00	29800.00	.47
8- 7-69	23:57	16	127500.00	14000.00	47500.00	.37
	23:57	20	78250.00	14500.00	34500.00	.44
	23:57	24	68500.00	18500.00	33500.00	.49
	23:57	28	30000.00	17700.00	9300.00	.31
8- 8-69	06:50	0	65750.00	750.00	13750.00	.21
	06:50	4	76000.00	1250.00	25000.00	.33
	06:50	8	96250.00	11000.00	39000.00	.41
	06:50	12	108750.00	12500.00	51500.00	.47
	06:18	16	129500.00	7000.00	43000.00	.33
	06:18	20		sample destroyed		
	06:18	24	70800.00	15200.00	37600.00	.53

Continued on next page

Appendix Table 2a continued.

Date	Time	Depth (m)	Daphnia longispina/m^3	Cyclops bicuspidatus thomasi/m^3	Daphnia longispina eggs/m^3	Egg ratio (E)
8- 8-69	06:18	28	103200.00	24200.00	44800.00	.43
8- 8-69	12:04	0	6100.00	0	300.00	.05
	12:04	4	260400.00	900.00	90900.00	.35
	12:04	8	85500.00	12750.00	32750.00	.38
	12:04	12	94500.00	12250.00	39750.00	.42
	11:40	16	193900.00	6650.00	78050.00	.40
	11:40	20	sample destroyed			
	11:40	24	121800.00	20100.00	50400.00	.41
	11:40	28	56000.00	30250.00	19250.00	.34
9-24-69	13:10	0	600.00	0	50.00	.08
	13:10	4	157500.00	2400.00	43200.00	.27
	13:10	8	58500.00	3000.00	19500.00	.33
	13:10	12	24000.00	6750.00	4750.00	.20
	12:50	16	94150.00	5950.00	37450.00	.40
	12:50	20	87150.00	2100.00	31150.00	.36
	12:50	24	31800.00	11100.00	15000.00	.47
	12:50	28	28000.00	4000.00	5000.00	.18
9-24-69	19:00	0	137250.00	2500.00	11500.00	.08
	19:00	4	125000.00	4250.00	58250.00	.47
	19:00	8	65250.00	6500.00	27500.00	.42
	19:00	12	13950.00	3150.00	3750.00	.27
	18:35	16	43200.00	4800.00	12400.00	.29
	18:35	20	24000.00	5700.00	5550.00	.23
	18:35	24	23250.00	5550.00	7650.00	.33
	18:35	28	35100.00	6000.00	7950.00	.23
9-25-69	00:50	0	111400.00	3800.00	15800.00	.14
	00:50	4	106400.00	1800.00	39400.00	.37
	00:50	8	127600.00	3800.00	48600.00	.38
	00:50	12	43350.00	7050.00	20250.00	.47
	00:25	16	43500.00	5550.00	12750.00	.29
	00:25	20	42150.00	4950.00	12600.00	.30
	00:25	24	26850.00	3150.00	7650.00	.28
	00:25	28	37050.00	3000.00	11100.00	.30
9-25-69	07:30	0	53550.00	1050.00	7350.00	.14
	07:30	4	85350.00	2250.00	21000.00	.25
	07:30	8	65000.00	4400.00	20600.00	.32
	07:30	12	29700.00	6600.00	7950.00	.27
	07:10	16	76800.00	5800.00	37400.00	.49
	07:10	20	37050.00	6300.00	15600.00	.42
	07:10	24	32250.00	5850.00	9150.00	.28
	07:10	28	31800.00	3150.00	10200.00	.32

Appendix Table 2b. Woahink Lake horizontal tows.

Date	Time	Depth (m)	Daphnia longispina/m^3	Diaphanosoma brachyurum/m^3	Cyclops bicuspidatus thomasi/m^3	Diaptomus franciscanus/m^3	Epischura nevadensis/m^3	Daphnia longispina eggs/m^3	Diaphanosoma brachyurum eggs/m^3	Daphnia longispina egg ratio (E)	Diaphanosoma brachyurum egg ratio (E)
11-13-68	17:06	0	1410.00	1980.00	780.00	900.00	180.00	690.00	30.00	.49	.02
	17:06	2	1410.00	1020.00	1425.00	720.00	135.00	495.00	0	.35	0
	17:06	4	1035.00	1095.00	2130.00	1350.00	270.00	300.00	0	.29	0
	17:06	6	240.00	495.00	795.00	525.00	90.00	30.00	30.00	.13	.06
	16:48	8	1620.00	2190.00	735.00	705.00	150.00	870.00	30.00	.54	.01
	16:48	10	1215.00	1695.00	810.00	495.00	90.00	630.00	75.00	.52	.04
	16:48	12	1245.00	1560.00	705.00	660.00	135.00	600.00	60.00	.48	.04
	16:48	14	585.00	975.00	735.00	420.00	75.00	225.00	0	.38	0
11-14-68	00:01	0	1920.00	1395.00	2730.00	1635.00	180.00	915.00	135.00	.48	.10
	00:01	2	1890.00	1695.00	2745.00	1230.00	240.00	675.00	90.00	.36	.05
	00:01	4	1980.00	1530.00	2340.00	1290.00	240.00	960.00	30.00	.48	.02
	00:01	6	1755.00	1020.00	1665.00	885.00	180.00	960.00	30.00	.55	.03
11-13-68	23:42	8	1695.00	1395.00	1290.00	930.00	180.00	585.00	30.00	.35	.02
	23:42	10	1515.00	1605.00	1815.00	735.00	150.00	750.00	60.00	.50	.04
	23:42	12	1395.00	1170.00	1545.00	855.00	165.00	555.00	60.00	.40	.05
	23:42	14	1290.00	1170.00	1335.00	690.00	135.00	420.00	75.00	.33	.06
11-14-68	07:49	0	2205.00	1290.00	1590.00	840.00	180.00	900.00	75.00	.41	.06
	07:49	2	1785.00	1215.00	1665.00	765.00	150.00	765.00	60.00	.43	.05
	07:49	4	1365.00	990.00	1470.00	1185.00	225.00	420.00	75.00	.31	.08
	07:49	6	705.00	495.00	825.00	615.00	105.00	105.00	0	.15	0
	07:30	8	1740.00	1590.00	945.00	1320.00	255.00	990.00	165.00	.57	.10
	07:30	10	1665.00	1380.00	1290.00	1065.00	210.00	900.00	120.00	.54	.09
	07:30	12	1380.00	870.00	1305.00	855.00	150.00	795.00	45.00	.58	.05
	07:30	14	1455.00	885.00	1335.00	615.00	120.00	660.00	0	.45	0
11-14-68	11:17	0	2745.00	675.00	1920.00	1320.00	270.00	840.00	90.00	.31	.13
	11:17	2	1965.00	735.00	1785.00	1290.00	225.00	690.00	60.00	.35	.08
	11:17	4	1410.00	465.00	1350.00	930.00	180.00	255.00	0	.18	0
	11:17	6	975.00	255.0	1140.00	570.00	105.00	195.00	0	.20	0
	11:01	8	2145.00	630.00	735.00	1215.00	240.00	1005.00	30.00	.47	.05
	11:01	10	1155.00	615.00	780.00	885.00	180.00	510.00	15.00	.44	.02
	11:01	12	1545.00	300.00	855.00	840.00	165.00	525.00	15.00	.34	.05
	11:01	14	990.00	465.00	1035.00	675.00	135.00	525.00	15.00	.53	.03
4-13-69	18:34	0	30.00	15.00	555.00	2340.00	630.00	0	0	0	0
	18:34	2	75.00	30.00	1680.00	8565.00	210.00	15.00	0	.20	0
	18:34	4	120.00	0	1160.00	27640.00	600.00	80.00	0	.67	0
	18:34	6	250.00	25.00	300.00	15750.00	175.00	75.00	0	.30	0

Continued on next page

Appendix Table 2b continued.

Date	Time	Depth (m)	Daphnia longispina/m^3	Diaphanosoma brachyurum/m^3	Cyclops bicuspidatus thomasi/m^3	Diaptomus franciscanus/m^3	Epischura nevadensis/m^3	Daphnia longispina eggs/m^3	Diaphanosoma brachyurum eggs/m^3	Daphnia longispina egg ratio (E)	Diaphanosoma brachyurum egg ratio (E)
4-13-69	18:17	8	60.00	0	225.00	5010.00	225.00	15.00	0	.25	0
	18:17	10	30.00	0	135.00	3180.00	195.00	0	0	0	0
	18:17	12	45.00	0	135.00	6900.00	270.00	60.00	0	1.33	0
	18:17	14	30.00	15.00	135.00	4155.00	120.00	0	0	0	0
4-14-69	01:08	0	60.00	60.00	120.00	4215.00	480.00	45.00	15.00	.75	.25
	01:08	2	75.00	125.00	1100.00	9875.00	500.00	125.00	25.00	1.67	.20
	01:08	4	560.00	0	960.00	31800.00	480.00	200.00	0	.36	0
	01:08	6	160.00	0	400.00	28000.00	680.00	80.00	0	.50	0
	00:50	8	175.00	0	200.00	12625.00	225.00	25.00	0	.14	0
	00:50	10	50.00	0	525.00	12075.00	375.00	100.00	0	2.00	0
	00:50	12	60.00	0	480.00	14490.00	300.00	0	0	0	0
	00:50	14	125.00	25.00	300.00	15725.00	300.00	50.00	0	.40	0
4-14-69	06:50	0	40.00	0	640.00	2040.00	340.00	40.00	0	1.00	0
	06:50	2	665.00	35.00	2205.00	11375.00	525.00	700.00	0	1.05	0
	06:50	4	400.00	160.00	960.00	29120.00	360.00	120.00	40.00	.30	.25
	06:50	6	175.00	0	275.00	17350.00	225.00	0	0	0	0
	06:31	8	150.00	90.00	690.00	9150.00	60.00	180.00	0	1.20	0
	06:31	10	225.00	75.00	475.00	11450.00	575.00	175.00	50.00	.78	.67
	06:31	12	280.00	0	630.00	15155.00	420.00	70.00	0	.25	0
	06:31	14	260.00	80.00	560.00	21420.00	120.00	160.00	0	.62	0
4-14-69	12:41	0	160.00	20.00	1140.00	740.00	350.00	60.00	0	.38	0
	12:41	2	210.00	135.00	1830.00	5730.00	345.00	180.00	45.00	.86	.33
	12:41	4	720.00	60.00	1290.00	26190.00	330.00	300.00	150.00	.42	2.50
	12:41	6	140.00	20.00	260.00	11020.00	240.00	0	40.00	0	2.00
	12:25	8	180.00	0	405.00	10740.00	90.00	75.00	0	.42	0
	12:25	10	135.00	30.00	390.00	10395.00	135.00	75.00	0	.56	0
	12:25	12	90.00	45.00	300.00	8115.00	60.00	30.00	30.00	.33	.67
	12:25	14	45.00	15.00	225.00	9870.00	135.00	105.00	0	2.33	0
5-25-69	18:52	0	1080.00	1060.00	490.00	1150.00	160.00	400.00	80.00	.37	.08
	18:52	2	740.00	1200.00	600.00	3730.00	160.00	470.00	170.00	.64	.14
	18:52	4	275.00	300.00	400.00	48900.00	475.00	0	50.00	0	.17
	18:52	6	200.00	225.00	150.00	26250.00	125.00	100.00	0	.50	0
	18:34	8	180.00	270.00	105.00	17610.00	30.00	30.00	30.00	.17	.11
	18:34	10	160.00	200.00	110.00	10390.00	20.00	30.00	70.00	.19	.35
	18:34	12	90.00	280.00	100.00	14280.00	20.00	10.00	40.00	.11	.14
	18:34	14	130.00	240.00	100.00	14950.00	40.00	50.00	50.00	.38	.21

Continued on next page

Appendix Table 2b.continued.

Date	Time	Depth (m)	Daphnia longispina/m^3	Diaphanosoma brachyurum/m^3	Cyclops bicuspidatus thomasi/m^3	Diaptomus franciscanus/m^3	Epischura nevadensis/m^3	Daphnia longispina eggs/m^3	Diaphanosoma brachyurum eggs/m^3	Daphnia longispina egg ratio (E)	Diaphanosoma brachyurum egg ratio (E)
5-26-69	00:39	0	915.00	1545.00	750.00	4365.00	120.00	195.00	45.00	.21	.03
	00:39	2	600.00	1050.00	600.00	5160.00	150.00	390.00	120.00	.65	.11
	00:39	4	285.00	705.00	810.00	15735.00	45.00	105.00	15.00	.37	.02
	00:39	6	75.00	175.00	175.00	41150.00	50.00	25.00	150.00	.33	.86
	00:19	8	300.00	725.00	400.00	10625.00	100.00	250.00	150.00	.83	.21
	00:19	10	75.00	600.00	675.00	37400.00	0	25.00	25.00	.33	.04
	00:19	12	125.00	325.00	100.00	20500.00	0	0	25.00	0	.08
	00:19	14	80.00	220.00	120.00	17440.00	0	60.00	0	.75	0
5-26-69	07:12	0	290.00	600.00	430.00	770.00	10.00	20.00	10.00	.07	.02
	07:12	2	690.00	900.00	800.00	2250.00	40.00	840.00	230.00	1.22	.26
	07:12	4	700.00	1160.00	1140.00	7180.00	100.00	260.00	40.00	.37	.03
	07:12	6	315.00	490.00	560.00	53410.00	35.00	105.00	70.00	.33	.14
	06:55	8	500.00	1150.00	825.00	11550.00	125.00	275.00	200.00	.55	.17
	06:55	10	375.00	1200.00	1075.00	29300.00	25.00	100.00	180.00	.27	.13
	06:55	12	125.00	525.00	575.00	36500.00	75.00	25.00	0	.20	0
	06:55	14	50.00	375.00	275.00	17925.00	0	50.00	25.00	1.00	.07
5-26-69	12:23	0	220.00	450.00	700.00	540.00	10.00	40.00	10.00	.18	.02
	12:23	2	800.00	790.00	710.00	960.00	110.00	490.00	160.00	.61	.20
	12:23	4	400.00	200.00	180.00	2590.00	20.00	60.00	60.00	.15	.30
	12:23	6	120.00	100.00	120.00	11880.00	20.00	40.00	20.00	.33	.20
	12:07	8	200.00	975.00	375.00	14300.00	50.00	75.00	275.00	.38	.28
	12:07	10	125.00	325.00	175.00	21050.00	50.00	50.00	0	.40	0
	12:07	12	100.00	425.00	125.00	24400.00	0	100.00	25.00	1.00	.06
	12:07	14	100.00	775.00	175.00	25975.00	25.00	50.00	0	.50	0
6-13-69	12:48	0	170.00	800.00	1090.00	200.00	0	0	0	0	0
	12:48	2	2700.00	6800.00	425.00	6725.00	900.00	1475.00	725.00	.55	.11
	12:48	4	3960.00	12720.00	200.00	33200.00	1040.00	2600.00	1000.00	.66	.08
	12:48	6	650.00	1975.00	125.00	29250.00	50.00	800.00	150.00	1.23	.08
	12:23	8	980.00	5980.00	60.00	11040.00	80.00	300.00	940.00	.31	.16
	12:23	10	500.00	3800.00	40.00	13000.00	20.00	20.00	740.00	.40	.19
	12:23	12	260.00	1760.00	80.00	13840.00	20.00	460.00	640.00	1.77	.36
	12:23	14	180.00	1360.00	40.00	8620.00	60.00	80.00	140.00	.44	.10
6-13-69	18:36	0	510.00	5490.00	75.00	2130.00	45.00	240.00	75.00	.47	.01
	18:36	2	2225.00	6075.00	550.00	9925.00	800.00	1675.00	525.00	.75	.09
	18:36	4	2050.00	7275.00	200.00	13875.00	175.00	1025.00	775.00	.50	.11

Continued on next page

Appendix Table 2b continued.

Date	Time	Depth (m)	Daphnia longispina/m^3	Diaphanosoma brachyurum/m^3	Cyclops bicuspidatus thomasi/m^3	Diaptomus franciscanus/m^3	Epischura nevadensis/m^3	Daphnia longispina eggs/m^3	Diaphanosoma brachyurum eggs/m^3	Daphnia longispina egg ratio (E)	Diaphanosoma brachyurum egg ratio (E)
6-13-69	18:36	6	350.00	1750.00	0	21300.00	100.00	375.00	250.00	1.07	.14
	18:20	8	1350.00	8000.00	100.00	12200.00	200.00	500.00	425.00	.37	.05
	18:20	10	360.00	5360.00	140.00	14100.00	240.00	200.00	840.00	.56	.16
	18:20	12	500.00	1400.00	60.00	12660.00	80.00	240.00	140.00	.48	.10
	18:20	14	210.00	840.00	15.00	9135.00	105.00	105.00	150.00	.50	.18
6-13-69	23:30	0	4250.00	9700.00	700.00	3975.00	3575.00	3275.00	1150.00	.77	.12
	23:30	2	2500.00	7875.00	600.00	3000.00	3400.00	1150.00	1125.00	.46	.14
	23:30	4	2150.00	9275.00	25.00	15225.00	650.00	1800.00	1625.00	.84	.18
	23:30	6	150.00	1410.00	30.00	33990.00	150.00	150.00	30.00	1.00	.02
	23:13	8	660.00	3900.00	150.00	13920.00	510.00	210.00	450.00	.32	.12
	23:13	10	325.00	2300.00	25.00	21850.00	225.00	100.00	300.00	.31	.13
	23:13	12	175.00	1175.00	25.00	18225.00	150.00	0	250.00	0	.21
	23:13	14	125.00	950.00	25.00	10525.00	150.00	150.00	250.00	1.20	.26
6-14-69	06:47	0	1095.00	5205.00	60.00	1245.00	1770.00	675.00	240.00	.62	.05
	06:47	2	810.00	5790.00	150.00	9780.00	4740.00	330.00	180.00	.41	.03
	06:47	4	1890.00	8850.00	150.00	19800.00	660.00	600.00	2280.00	.32	.26
	06:47	6	275.00	3900.00	75.00	38825.00	150.00	50.00	225.00	.18	.06
	06:28	8	1150.00	6200.00	100.00	12525.00	350.00	750.00	1375.00	.65	.22
	06:28	10	500.00	3225.00	75.00	16775.00	225.00	225.00	350.00	.45	.11
	06:28	12	400.00	1975.00	250.00	18575.00	125.00	275.00	225.00	.69	.11
	06:28	14	225.00	950.00	150.00	11150.00	50.00	325.00	125.00	1.44	.13
7- 1-69	13:50	0	555.00	3105.00	450.00	225.00	30.00	90.00	30.00	.16	.01
	13:50	2	3540.00	40020.00	420.00	6000.00	240.00	2280.00	6000.00	.64	.15
	13:50	4	6900.00	37860.00	420.00	17820.00	180.00	3420.00	10620.00	.50	.28
	13:50	6	1240.00	11560.00	200.00	9880.00	120.00	560.00	3600.00	.45	.31
	13:38	8	3060.00	22080.00	420.00	11700.00	60.00	1080.00	8340.00	.35	.38
	13:38	10	3060.00	29760.00	420.00	10740.00	0	1560.00	11100.00	.51	.37
	13:38	12	1760.00	16520.00	240.00	13080.00	40.00	760.00	7000.00	.43	.42
	13:38	14	420.00	5850.00	60.00	8220.00	0	240.00	900.00	.57	.15
7- 1-69	18:19	0	1620.00	18960.00	660.00	990.00	960.00	1050.00	270.00	.65	.01
	18:19	2	3000.00	42180.00	840.00	5040.00	780.00	2520.00	4380.00	.84	.10
	18:19	4	4980.00	27120.00	600.00	16500.00	180.00	2580.00	8640.00	.52	.32
	18:19	6	850.00	11300.00	300.00	13050.00	0	300.00	2000.00	.35	.18
	18:02	8	3480.00	20220.00	240.00	6540.00	60.00	1140.00	8700.00	.33	.43
	18:02	10	2100.00	13900.00	300.00	8200.00	0	900.00	7400.00	.43	.53

Continued on next page

Appendix Table 2b continued.

Date	Time	Depth (m)	Daphnia longispina/m^3	Diaphanosoma brachyurum/m^3	Cyclops bicuspidatus thomasi/m^3	Diaptomus franciscanus/m^3	Epischura nevadensis/m^3	Daphnia longispina eggs/m^3	Diaphanosoma brachyurum eggs/m^3	Daphnia longispina egg ratio (E)	Diaphanosoma brachyurum egg ratio (E)
7- 1-69	18:02	12	600.00	6210.00	450.00	7140.00	30.00	450.00	3270.00	.75	.53
	18:02	14	475.00	4400.00	125.00	4725.00	0	100.00	1275.00	.21	.29
7- 1-69	23:50	0	9150.00	56115.00	375.00	3105.00	690.00	5145.00	10200.00	.56	.18
	23:50	2	5550.00	60900.00	900.00	2325.00	975.00	4125.00	17850.00	.74	.29
	23:50	4	2430.00	36540.00	990.00	5040.00	630.00	630.00	11250.00	.26	.31
	23:50	6	650.00	7410.00	390.00	24700.00	0	325.00	1235.00	.50	.17
	23:40	8	1625.00	14040.00	195.00	5265.00	65.00	390.00	4160.00	.24	.30
	23:40	10	175.00	3900.00	200.00	6550.00	0	50.00	850.00	.29	.22
	23:40	12	180.00	5460.00	60.00	11490.00	0	30.00	1470.00	.17	.27
	23:40	14	225.00	4625.00	75.00	5025.00	25.00	75.00	1575.00	.33	.34
7- 2-69	06:38	0	1980.00	15510.00	900.00	570.00	600.00	1500.00	660.00	.76	.04
	06:38	2	3180.00	31200.00	900.00	4800.00	1440.00	1860.00	3840.00	.58	.12
	06:38	4	6300.00	54100.00	1000.00	13100.00	600.00	3000.00	12900.00	.48	.24
	06:38	6	1190.00	8960.00	280.00	21280.00	70.00	280.00	3150.00	.24	.35
	06:18	8	1820.00	24360.00	140.00	6930.00	70.00	560.00	8610.00	.31	.35
	06:18	10	950.00	9900.00	150.00	7050.00	0	100.00	5100.00	.11	.52
	06:18	12	630.00	6450.00	150.00	6900.00	0	450.00	2280.00	.71	.35
	06:18	14	390.00	5100.00	30.00	4560.00	60.00	270.00	1440.00	.69	.28
8- 1-69	19:25	0	3200.00	260.00	4000.00	820.00	0	1260.00	40.00	.39	.15
	19:25	2	3520.00	420.00	4640.00	780.00	240.00	1180.00	60.00	.34	.14
	19:25	4	4710.00	780.00	6540.00	690.00	240.00	2100.00	120.00	.45	.15
	19:25	6	2500.00	475.00	2575.00	2825.00	50.00	1050.00	125.00	.42	.26
	19:07	8	1700.00	450.00	2925.00	525.00	150.00	675.00	25.00	.40	.06
	19:07	10	1300.00	250.00	1850.00	825.00	100.00	475.00	0	.37	0
	19:07	12	1075.00	500.00	5400.00	4200.00	1375.00	525.00	125.00	.49	.25
	19:07	14	900.00	425.00	3725.00	800.00	5050.00	375.00	0	.42	0
8- 2-69	00:42	0	3060.00	360.00	2060.00	500.00	300.00	1120.00	20.00	.37	.06
	00:42	2	2640.00	400.00	3100.00	360.00	280.00	1200.00	40.00	.45	.10
	00:42	4	3400.00	675.00	4925.00	425.00	525.00	1550.00	125.00	.46	.19
	00:42	6	750.00	900.00	4500.00	1600.00	1075.00	375.00	75.00	.50	.08
	00:25	8	1775.00	575.00	3300.00	450.00	525.00	800.00	25.00	.45	.04
	00:25	10	1075.00	375.00	3700.00	625.00	75.00	600.00	25.00	.56	.07
	00:25	12	575.00	425.00	9350.00	15850.00	100.00	250.00	0	.43	0
	00:25	14	325.00	75.00	2225.00	15000.00	225.00	275.00	0	.85	0

Continued on next page

Appendix Table 2b continued.

Date	Time	Depth (m)	Daphnia longispina/m^3	Diaphanosoma brachyurum/m^3	Cyclops bicuspidatus thomasi/m^3	Diaptomus franciscanus/m^3	Epischura nevadensis/m^3	Daphnia longispina eggs/m^3	Diaphanosoma brachyurum eggs/m^3	Daphnia longispina egg ratio (E)	Diaphanosoma brachyurum egg ratio (E)
8- 2-69	06:00	0	2920.00	540.00	3740.00	500.00	20.00	1220.00	20.00	.42	.04
	06:00	2	3980.00	500.00	4900.00	340.00	20.00	1900.00	60.00	.48	.12
	06:00	4	4625.00	800.00	5300.00	525.00	300.00	2225.00	150.00	.48	.19
	06:00	6	4050.00	900.00	6825.00	3800.00	275.00	2250.00	50.00	.56	.06
	05:40	8	2825.00	425.00	2875.00	525.00	125.00	1025.00	50.00	.36	.12
	05:40	10	2000.00	425.00	2800.00	550.00	300.00	775.00	125.00	.39	.29
	05:40	12	600.00	425.00	5650.00	7825.00	150.00	150.00	0	.25	0
	05:40	14	275.00	150.00	2500.00	10800.00	0.	275.00	25.00	1.00	.17
8- 2-69	13:50	0	140.00	140.00	2220.00	60.00	0	0	0	0	0
	13:50	2	1460.00	440.00	2740.00	560.00	320.00	1340.00	20.00	.92	.05
	13:50	4	2875.00	625.00	2375.00	575.00	325.00	1300.00	25.00	.45	.04
	13:50	6	3150.00	550.00	2000.00	1575.00	100.00	1525.00	25.00	.48	.05
	13:33	8	3275.00	425.00	2025.00	475.00	225.00	1675.00	75.00	.51	.18
	13:33	10	3900.00	575.00	2825.00	2025.00	50.00	950.00	75.00	.24	.13
	13:33	12	1475.00	400.00	6500.00	6875.00	75.00	650.00	25.00	.44	.06
	13:33	14	950.00	125.00	6400.00	10775.00	175.00	275.00	25.00	.29	.20