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Distribution, growth, selective feeding, and energy transformations of young-of-the-year blueback herring, *Alosa aestivalis* (Mitchill), in the James River, Virginia

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APPROVAL SHEET

DISTRIBUTION, GROWTH, SELECTIVE FEEDING,
AND ENERGY TRANSFORMATIONS OF YOUNG-OF-THE-YEAR
BLUEBACK HERRING, ALOSA AESTIVALIS (MITCHILL), IN THE
JAMES RIVER, VIRGINIA

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A Dissertation Presented to the Graduate
Faculty of the University of Virginia
in Candidacy for the Degree of
Doctor of Philosophy

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June

1972

APPROVAL SHEET

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of the requirements for the degree of
Doctor of Philosophy

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A positive relationship existed between standing crops of zooplankton and distribution, growth, and feeding of blueback herring. Zooplankton densities were highest upstream, where food consumption and growth rates were correspondingly highest. A progressive downstream decrease and upstream increase in fish abundance occurred during the study. Condition (K) decreased after flooding from Hurricane Camille.

Blueback herring fed primarily on copepods (*Eurytemora affinis*, *Cyclops vernalis*, and *Canthocamptus robertsoni*), but cladocerans (*Bosmina longirostris-coregoni* and *Diaphanosoma brachyura*) were also important. Selection (selectivity) was strongest for adult copepods and weakest for copepod nauplii. Selection for copepodites and *B. longirostris-coregoni* was moderate to weak. Feeding occurred only during daylight. Effect of predation on zooplankton populations is discussed.

Respiration experiments were carried out in the laboratory from November 1970 through March 1971. The regression of oxygen consumption on temperature (routine metabolism) was expressed as $\log Q = -1.4451 + 0.0548 T$, where Q = oxygen consumption ($\text{mg O}_2/\text{gram}$ wet weight/hr), and T = temperature (C).

ABSTRACT

Energy transformations and budget are computed for young-of-the-year blueback herring, Alosa aestivalis, in the James River, Virginia. Distribution, growth, and selective feeding are described.

Fish and zooplankton collections were made at five stations in the main channel of the James River from June through November 1969. Two 24 hr series of samples were collected in July and October 1968 in the Potomac River.

A direct relationship existed between standing crops of zooplankton and distribution, growth, and feeding of blueback herring. Zooplankton densities were highest upstream, where food consumption and growth rates were correspondingly highest. A progressive downstream decrease and upstream increase in fish abundance occurred during the study. Condition (K) decreased after flooding from Hurricane Camille.

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INTRODUCTION

Interest in ecological energetics has increased rapidly since Lindeman's (1942) paper on the trophic-dynamic aspect of ecology. Studies on energy transformations involved in growth (production), maintenance, and reproduction for a variety of aquatic and terrestrial species are reviewed by Slobodkin (1962), Englemann (1966), Phillipson (1966), and Morowitz (1968). Collection of data on energy budgets, however, has progressed slowly and many budgets lack sufficient data (Cummins et al., 1969).

Annual budgets have been proposed for ecosystems (Juday, 1940; Odum, 1957; Teal, 1957, 1962; King and Ball, 1967), portions of ecosystems (Englemann, 1961; Mann, 1964), and single populations (Richman, 1958; Comita, 1964; Cummins et al., 1969).

Application of the energetic approach to fish has been a relatively recent development. Winberg (1956) provided the theoretical basis for study of energy transformations in natural populations, but comparable studies have appeared only recently (Mann, 1964, 1965; Davis and Warren, 1965; Davies, 1963, 1964, 1966, 1967; Brocksen et al., 1968; Pandian, 1967a, 1967b; Wissing, 1969).

The single population approach to ecosystem energetics will eventually allow for model building at the ecosystem level. In the present study energy transformations and budget are computed for young-of-the-year blueback herring, Alosa aestivalis, in the James River, Virginia. Distribution, growth rates, and feeding habits are described.

The anadromous blueback herring occurs from northern Florida to Nova Scotia (Bigelow and Schroeder, 1953), and spawns from late March

through May at water temperatures from 21 to 24 C (Bigelow and Welsh, 1925). Transformation occurs at about 20 mm total length (Mansueti and Hardy, 1967), and young-of-the-year remain in the estuaries until fall before migrating to sea. Juveniles remain in the Atlantic for 3 or 4 years before returning to spawn.

Little has been published on young-of-the-year bluebacks. Massmann (1953) and Massmann, Ladd, and McCutcheon (1952) discussed relative abundance in Virginia estuaries. Davis and Cheek (1966) described distribution, food habits, and growth in the Cape Fear River System, North Carolina. Brooks (1968) and Brooks and Dodson (1965) considered prey size selection. Chittenden (1972) reported on salinity tolerance experiments. Mean freshwater discharge is about 7,500 cfs (Brehmer and Haltiwanger, 1966).

Phosphorous and nitrogen data indicate that the area extending 48 nautical miles downstream from Richmond is highly enriched. The City of Richmond and chemical industries in Hopewell are major contributors to nutrient enrichment (Brehmer and Haltiwanger, 1966).

Flooding occurred in the James Basin as a result of torrential rains from Hurricane Camille which fell on 19 to 20 August 1969 (U.S. Dept. Interior, 1969). Flow in the James at Cartersville, which is representative of flow into the James Estuary, averaged 20,400 cfs for the month; maximum daily flow (216,000 cfs) occurred on 21 August.

DESCRIPTION OF STUDY AREA

The James River (Figure 1), the southernmost major tributary of the Chesapeake Bay, drains 10,000 square miles and flows 350 miles in a southeasterly direction from the Allegheny Mountains to the Chesapeake Bay at Hampton Roads (Walburg and Sykes, 1957).

The James is tidal from Hampton Roads to Richmond, a distance of 85 nautical miles. The average zone of saltwater intrusion extends 30 nautical miles upstream from the mouth. The transition zone moves upstream and downstream as much as 15 miles with extremes in freshwater discharge. Mean freshwater discharge is about 7,500 cfs (Brehmer and Haltiwanger, 1966).

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Figure 1. Chart of the upper 2/3 of the tidal portion of the James River with sampling stations indicated. Station numbers are nautical miles from the river mouth.

weighed on an analytical balance. Stomach weight per gram of fish weight was computed to provide an estimate of stomach fullness.

MATERIALS AND METHODS

Zooplankton samples from the James River were taken immediately after a total of 360 fish collections and 200 zooplankton collections were made during daylight at five stations in the main channel (Figure 1) of the James River from June through November 1969. These stations represent the tidal freshwater nursery of the blueback herring. Fish collections were made at the middle of each month, except in October when it was necessary to sample at the end of the month. A 10 ft Cobb midwater trawl (1/2 inch mesh with a 1/8 inch cod-end liner) was towed from the R/V Langley at 5.6 knots. Twelve 5 min tows were made at each station, six at the surface and six at 5 m. Three tows were made upstream and three downstream at each depth.

Catches were counted or subsampled. A maximum of 100 bluebacks was randomly selected from each sample and preserved in 10% formalin. A total of 20,837 fish was measured to the nearest millimeter (fork length) and weighed to the nearest 0.1 gram. The first 20 bluebacks examined from each depth and station were retained for stomach analysis. Stomachs removed from 1149 fish were weighed on an analytical balance. Stomach contents were pooled by station and depth, preserved in 95% ethanol and congo red, and examined in water under a dissecting microscope. All identifiable organisms within five randomly selected grids (912 mm²) on a petri dish (5809 mm²) were counted.

Two 24 hr series of samples used for analysis of feeding periodicity were taken in the Potomac River on 24 and 25 July and 28 and 29 October 1968. Collections were made every 3 hr. Twenty fish randomly selected from 5 m samples were measured and weighed; stomachs were removed and

weighed on an analytical balance. Stomach weight per gram of fish weight was computed to provide an estimate of stomach fullness.

Zooplankton samples from the James River were taken immediately after fish collections were made. A Clarke-Bumpus sampler with a #20 mesh net (0.076 mm pore size) and a metering device was towed at 3.6 knots. Four 3 min tows were made at each station, two at the surface and two at 5 m. Samples were also collected with a small boat at the end of each month (except October), towing speed being about 3.6 knots.

Collections were preserved in 95% ethanol and congo red. Each sample was diluted to 125 ml and three 1 ml subsamples were removed. Each subsample was placed in a gridded petri dish, diluted with a soap solution, and all organisms except Rotifera within five randomly selected grids were counted.

Water temperature was measured with a stem thermometer and water samples were obtained with a Kemmerer sampler when fish and zooplankton collections were made. Dissolved oxygen was determined by the Winkler method.

Fish used in respiration experiments were collected with a 100 ft beach seine at Jamestown Beach from July through November 1970. Experiments were carried out in the laboratory from November 1970 through March 1971. Routine metabolism was determined with a recording volumetric respirometer (Figure 2) modified from Wells and Warinner (1968). Gas entering the circuit at air stone connector B lifted water into equilibration chamber C where dissolved respiratory gases were equilibrated with the gas phase. Oxygenated water returned to respiration chamber A while the gas phase was drawn through flask D containing a carbon dioxide absorbent (KOH) and then recirculated. As oxygen

Figure 2. Schematic diagram of recording volumetric respirometer.

A, fish chamber; B, air stone connector (Halvin Products Co., Inc., Brooklyn, N.Y.); C, equilibration chamber; D, carbon dioxide absorbent (KOH) chamber; E, air pump (Silent Giant, Aquarium Pump Supply, Inc., Prescott, Arizona); F, recording spirometer (Model 160, Custom Engineering and Development Co., St. Louis, Mo.); G, siphon tube used to fill fish chamber.

was consumed by the fish, pressure decreased and oxygen was added automatically by recording spirometer F.

The apparatus was submerged in a water bath containing a circulating heater (Porta-Temp, Precision Scientific Co., Chicago, Ill.). Respiration determinations were made on individual fish (from 16.4 to 28.7 C) under constant light and 11 C room temperature. Fish were fed Artemia nauplii and acclimated for at least 7 days at the temperature they would be subjected to in the respirometer. They were then starved for 24 hr before being placed in the 4.8 liter fish chamber. Oxygen consumption was measured for at least 24 hr; experiments ran from 24 to 91 hr. Blank determinations were run under the same experimental conditions after fish were removed, and the system was cleaned after each run. Results were expressed in mg O₂ per gram fish weight (wet and dry) per hour at standard temperature and pressure.

Distribution

The total number of fish from the six tows taken at surface and 5 m was averaged to give the mean number per 5 min tow (Table 1 and Figure 4). More bluebacks were captured at surface than 5 m at every station and month. A total of 143,828 fish were captured over the entire period; 124,944 (83.4%) came from the surface, while only 24,884 (16.6%) came from 5 m. The 5 m values were probably high since surface fish could have been captured while the net was being retrieved from 5 m.

There was a general downstream decrease and upstream increase in the mean number of bluebacks per tow. In June and July highest numbers occurred at J-10. In August there was an increase in abundance from J-40 to J-70. Fish were concentrated at J-60 in September (after

RESULTS

Temperature and Dissolved Oxygen

Temperature and dissolved oxygen differences between surface and 5 m in the James River were usually insignificant so values from both depths were averaged (Figure 3). A consistent temperature trend between stations was not apparent. Temperature differences during each sampling period were slight; maximum difference in mean temperature between stations for any period was 3.7 C.

Dissolved oxygen differences between stations were greater than temperature differences, but a pattern was not apparent. The range of individual values for the entire period was 2.0 to 10.0 mg/liter (25 to 100% saturation). The most obvious feature was an increase in dissolved oxygen associated with a seasonal decline in temperature.

Distribution

The total number of fish from the six tows taken at surface and 5 m was averaged to give the mean number per 5 min tow (Table 1 and Figure 4). More bluebacks were captured at surface than 5 m at every station and month. A total of 149,828 fish were captured over the entire period; 124,944 (83.4%) came from the surface, while only 24,884 (16.6%) came from 5 m. The 5 m values were probably high since surface fish could have been captured while the net was being retrieved from 5 m.

There was a general downstream decrease and upstream increase in the mean number of bluebacks per tow. In June and July highest numbers occurred at J-50. In August there was an increase in abundance from J-40 to J-70. Fish were concentrated at J-60 in September (after

Figure 3. Temperature (C) and dissolved oxygen (mg/liter) profiles from the James River in 1969. Solid line, temperature; broken line, dissolved oxygen.

Table 1. Mean number of young-of-the-year blueback herring per 5 min tow with a 10 ft Cobb trawl.

Collections were made at surface (S) and 5 meters (5m) in the James River in 1969.

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Collections were made at surface (S) and 5 meters (5m) in the James River in 1969.

Six tows were made at each depth

Date		Station										Grand average	
		J-40		J-50		J-60		J-70		J-80			
		S	5m	S	5m	S	5m	S	5m	S	5m	S	5m
June	16-19	896.5	210.7	2031.2	839.3	648.0	63.5	853.5	67.3	5.8	1.0	887.0	236.4
July	14-17	116.8	34.5	2842.0	284.2	2444.5	264.5	351.3	52.8	178.0	112.3	1186.5	149.7
Aug.	18-21	175.3	9.8	667.7	241.8	961.0	126.2	1194.0	241.0	6.8	0.3	601.0	123.6
Sept.	17-19	346.7	30.1	522.3	18.3	2220.8	532.5	362.7	80.0	29.5	3.3	696.4	132.8
Oct.	28-30	23.8	5.7	256.8	41.0	1111.7	106.8	2243.8	730.7	7.3	0.3	729.7	176.9
Nov.	18-20	29.3	7.7	10.0	3.2	48.7	16.0	236.3	20.0	0.0	0.0	64.9	9.4

Figure 4. Mean number of young-of-the-year blueback herring per 5 min tow with a 10 ft Cobb trawl from the James River in 1969. Hollow bar, surface; solid bar, 5 meters.

Hurricane Camille). In October and November bluebacks were again most abundant at J-70. Relatively few bluebacks were collected at J-40.

There was an increase in the grand average number per tow (Table 1)

Hurricane Camille). In October and November bluebacks were again most abundant at J-70. Relatively few bluebacks were collected at J-80.

There was an increase in the grand average number per tow (Table 1) from June to July (recruitment), a decrease from July to August, and an increase from August to October. The increase from August to October suggests that fish were moving out of tributaries and oxbows into the channel. By November most fish had migrated downstream.

Growth

There was a progressive downstream to upstream increase in size (Figure 5) that became more pronounced in time. Fish were approximately the same size in June, except at J-70 where they were relatively small. These fish may have hatched later than fish at the other stations. Each month from July to October there was an increase in size from J-40 to J-70. Fish at J-80 were about the same length as fish at J-70. In October several relatively large individuals were captured at J-40 and J-50, indicating the downstream migration of larger fish had begun. In November, when most fish had left the nursery, size was essentially the same at all stations.

Size differences between surface and 5 m were insignificant so mean lengths (Table 2) were calculated from the 12 samples collected at each station; lengths were subjected to Duncan's Multiple Range Test. Significant size differences existed between fish at J-40 and J-70 from July to November: July, 6.18 mm; August, 4.41 mm; September, 11.24 mm; October, 13.20 mm; November, 1.21 mm. Average length increased from 36.78 mm in June to 72.37 mm in November.

Mean weight (Table 3) increased from 0.80 g in June to 4.48 g in November. Weight increased seasonally at each station, except at J-40 and J-50 where there was a decrease from August to September.

Figure 5. Growth of young-of-the-year blueback herring from the James River in 1969. Central vertical line, mean; hollow bar, standard deviation on either side of mean; horizontal line, range. Sample size in parentheses.

Table 2. Mean Fork Length (mm) of *Parachanna niloticus* from June

Date

June 16-19

July 14-17

August 18-21

September 17-19

October 28-30

November 18-21

Table 2. Mean fork length (mm) of young-of-the-year blueback herring from the James River from June through November 1969. (*), (+) = Homogeneous subsets (Duncan's Multiple Range Test, $P < 0.05$)

Date	Station					Grand average
	J-40	J-50	J-60	J-70	J-80	
June 16-19	37.37 (*)	39.55	37.52 (*)	31.68	41.63	36.78
July 14-17	40.38	43.11	45.38	46.56 (*)	46.50 (*)	44.85
August 18-21	46.29	47.79 (+)	50.76 (*)	50.70 (*)	48.12 (+)	49.22
September 17-19	48.77	50.89	53.49	60.01 (*)	60.12 (*)	53.84
October 28-30	55.75	64.58 (*)	64.57 (*)	68.95 (+)	67.48 (+)	65.74
November 18-20	72.04 (*)	71.70 (*,+)	70.80 (+)	73.25		72.37

Table 3. Mean weight (g) of young-of-the-year blueback herring from the James River from June through November 1969

Date	Station					Grand average
	J-40	J-50	J-60	J-70	J-80	
June 16-19	0.84	0.95	0.81	0.53	1.25	0.80
July 14-17	1.07	1.37	1.55	1.70	1.68	1.51
August 18-21	1.64	1.73	2.00	2.02	1.82	1.87
September 17-19	1.55	1.61	2.06	3.02	3.06	2.14
October 28-30	2.12	3.23	3.33	3.90	3.90	3.46
November 18-20	4.47	4.73	4.38	4.52		4.48

The Condition Factor (K) (Table 4 and Figure 6) was determined from mean length and weight data using the formula (Beckman, 1948):

$$K = \frac{W \times 10^5}{L^3}$$

where W = mean weight,

and L = mean length.

There was no particular pattern of condition of fish between stations, but there was a marked decrease in condition after flooding from Hurricane Camille. The average K value was 1.60 in June, 1.68 in July, and 1.57 in August. In September, however, it had dropped to 1.37, and decreased from 1.22 in October to 1.18 in November.

Zooplankton Standing Crops

Zooplankton standing crops as number per liter and percent composition are presented in Appendix A (Tables A1 to A10). Dominant organisms with respect to numbers in plankton samples and/or stomachs are presented in Figures 7 and 8. These items constituted on the average not less than 96% of the plankton and not less than 92% of the stomach contents. Only sampling periods when fish were captured are included.

Copepod nauplii were generally more abundant at surface than 5 m. Numbers were highest at J-60 every month except August, when nauplii were most abundant at J-50. Copepodites, on the other hand, were more abundant at 5 m than at surface. Numbers were highest at J-60 every month. Eurytemora affinis (Calanoida) and Cyclops vernalis (Cyclopoida) were found at every station and were always more abundant at 5 m than at surface. Their density was usually highest at the midstream stations (J-50 to J-70), except in June when E. affinis was most abundant at J-40. Canthocamptus robertcookeri (Harpacticoida) was

Table 4. Condition factor (K) of young-of-the-year blueback herring from the James River from June through November 1969

Date	Station					Grand average
	J-40	J-50	J-60	J-70	J-80	
June 16-19	1.61	1.53	1.53	1.66	1.73	1.60
July 14-17	1.62	1.71	1.65	1.67	1.67	1.68
August 18-21	1.66	1.58	1.53	1.55	1.63	1.57
September 17-19	1.33	1.22	1.35	1.40	1.41	1.37
October 28-30	1.23	1.20	1.24	1.19	1.27	1.22
November 18-20	1.20	1.28	1.23	1.15		1.18

Figure 6. Condition factor (K) of young-of-the-year blueback
herring from the James River in 1969.

Figure 7. Dominant zooplankton standing crops as number per liter from the James River from 16-19 June to 18-21 August 1969. Hollow bar, surface; solid bar, 5 meters.

Figure 8. Dominant zooplankton standing crops as number per liter
from the James River from 16-19 September to 18-20
November 1969. Hollow bar, surface; solid bar, 5 meters.

NUMBER PER LITER AND DATE

collected only in November and in small numbers (0.03 to 0.05/liter).

Bosmina longirostris-coregoni and Diaphanosoma brachyurum were the dominant cladocerans. B. longirostris-coregoni was generally more abundant at 5 m than at surface; highest numbers were at J-60 from June to August, and at J-70 from September to November. It was more abundant than adult copepods each month. D. brachyurum was less abundant than B. longirostris-coregoni, but was also found in greater numbers at 5 m than at surface.

Acartia tonsa (Calanoida) was collected only in September and October at J-40. Small numbers (0.01 to 0.56/liter) of Diaptomus reighardi were taken upstream. Eucyclops agilis (Cyclopoida) was found only at J-80 in September and November. Two marine harpacticoid species, Canuella canadensis and Ectinosoma curticorne, occurred primarily at J-40. A single Microarthridion littorale (Harpacticoida) was collected at J-40 in November.

Ilyocyptus spinifer, Daphnia ambigua, Daphnia parvula, Ceriodaphnia lacustris, Moina brachiata, Alonella acutirostris, Camptocercus macrurus, Leydigia acanthocercoides, Leydigia quadrangularis, Alona quadrangularis, and Alona guttata were collected infrequently and in small numbers throughout the study, primarily from J-50 to J-70. Only M. brachiata and I. spinifer were taken at J-40. A single Bosminopsis deitersi was found at J-80 in September. Leptodora kindtii was taken occasionally at all stations except J-80.

The amphipod, Gammarus fasciatus, appeared in August and September samples, and the ostracod, Physocypria exquisita, was collected in June, July, and August in small numbers. A single mysid, Neomysis americana, was found at J-40 in November.

Dipteran larvae, Procladius adumbratus and Chaoborus sp., occurred

in samples from June to August, primarily at J-70 and J-80. An oligochaete, Pristina breviseta, was taken from J-50 to J-80, but most often at J-80.

Total number of zooplankton per liter by depth and station (Figure 9) shows that standing crops were higher at 5 m than at surface at only slightly more than half of the stations, and that, excluding J-80, there was an upstream increase in density. From June through August, and on 30 September and 18-20 November, zooplankton were most abundant at J-60. On 17-19 September and 28-30 October abundance was highest at J-70. Over the entire period zooplankton standing crops were higher at J-60 and J-70 than at the other stations, except on 21 July and 29 August. Few organisms were captured at J-80 (less than 3.25/liter). Standing crops increased from 16-19 June to 30 June, and were relatively high through 18-21 August. There was a significant reduction in density on 29 August, shortly after Hurricane Camille. By 17-19 September zooplankton populations at J-60 and J-70 had apparently recovered and standing crops were at pre-flood levels. There was a decrease in numbers from September to November.

Selective Feeding

Stomach contents as number per stomach and percent composition for the six sampling periods are presented in Appendix B (Tables B1 to B6). To compare the percent composition from a fish stomach sample and its corresponding plankton sample for each zooplankton organism an E index given by the following formula was used (Ivlev, 1961):

$$E = \frac{r_i - P_i}{r_i + P_i}$$

where E = electivity (selectivity),

r_i = % composition of plankter i in the stomach,

and P_i = % composition of plankter i in the plankton.

Figure 9. Total zooplankton standing crops as number per liter from the James River in 1969. Hollow bar, surface; solid bar, 5 meters.

This index yields E values between -1.0 and +1.0. An E of -1.0 indicates total selection against organism i (ie., present in plankton but absent in stomach), whereas an E approaching +1.0 indicates strong selection for the organism (ie., scarce in plankton but more common in stomach). The E index presents an unbiased comparison of the two corresponding percentages, r_i and P_i , irrespective of how large a percentage is present in either plankton or stomach (Cramer and Marzolf, 1970). Electivity values are found in Appendix C (Tables C1 to C6).

The percent composition in the plankton and stomachs of the seven dominant organisms presented in Figures 7 and 8 are illustrated by station and month in Figures 10 to 15. Corresponding E values are included. Data for J-80 were included, but numbers of organisms in the plankton and stomachs were so low that the information is not particularly useful. Percent composition values plotted in Figures 10 to 15 were, excluding J-80, averaged for each month (Figure 16). Mean electivity was determined from the average values.

Copepod nauplii were strongly selected against except at J-40 in July and August. Copepodites were more often selected for than against early in the season, and more often against than for later in the season. They were selected against at J-60 in June, J-60 and J-70 in August, and J-70 in October when the percent composition of Bosmina longirostris-coregoni was relatively high. Mean electivity was moderate to weak and decreased from June to November. Percentage in stomachs coincided approximately with percentage in the plankton. Eurytemora affinis and Cyclops vernalis were moderately to strongly selected for over the entire period, except at J-60 in June, and J-60 and J-70 in August when B. longirostris-coregoni was abundant, and at J-40 in July and August when nauplii were selected for. Mean electivity of E. affinis

Figure 10. Percentage in the plankton and stomachs, and electivity index (E) of the dominant zooplankton from the James River on 16-19 June 1969. Hollow bar, surface; solid bar, 5 meters.

Figure 11. Percentage in the plankton and stomachs, and electivity index (E) of the dominant zooplankton from the James River on 14-17 July 1969. Hollow bar, surface; solid bar, 5 meters.

Figure 12. Percentage in the plankton and stomachs, and electivity index (E) of the dominant zooplankton from the James River on 18-21 August 1969. Hollow bar, surface, solid bar, 5 meters.

Figure 13. Percentage in the plankton and stomachs, and electivity index (E) of the dominant zooplankton from the James River on 17-19 September 1969. Hollow bar, surface; solid bar, 5 meters.

Figure 14. Percentage in the plankton and stomachs, and electivity index (E) of the dominant zooplankton from the James River on 28-30 October 1969. Hollow bar, surface; solid bar, 5 meters.

Figure 15. Percentage in the plankton and stomachs, and electivity index (E) of the dominant zooplankton from the James River on 18-20 November 1969. Hollow bar, surface; solid bar, 5 meters.

Figure 16. Mean monthly percentage in the plankton and stomachs,
and mean electivity (E) of the dominant zooplankton
from the James River in 1969. _____, percentage
in the plankton; - - - - -, percentage in the stomachs;
....., electivity (E).

ELECTIVITY (E)

+1
0
-1

PERCENT

60
50
40
30
20
10
0

J J J A S O N J J J A S O N J J J A S O N J J J A S O N J J J A S O N J J J A S O N

NAUPLII

COPEPODITES

EURYTEMORA

CYCLOPS

CANTHOCAMPTUS

BOSMINA

DIAPHANOSOMA

MONTH

was negative in August but increased from August to November. Mean electivity of C. vernalis increased from June to November, despite a progressive decrease in its percentage in the plankton. Canthocamptus robertcokeri was not eaten regularly until October and November, when it was strongly selected for. Fish were apparently feeding in littoral regions for this species since it was not abundant in the plankton.

Bosmina longirostris-coregoni was generally selected against, except at J-60 and J-70 when it was relatively abundant in the plankton. Mean electivity was positive but low from June to October, and it decreased in time. Its percentage in the stomachs corresponded with its percentage in the plankton, except in October when selection was strong at J-70. Diaphanosoma brachyurum was consumed only from June to September, and was more often selected against than for. Mean electivity was positive only in September.

There was a direct relationship between percentage of copepodites and Bosmina longirostris-coregoni in the stomachs. When copepodites were more abundant in the plankton than B. longirostris-coregoni they were eaten to a greater extent than B. longirostris-coregoni. The reverse was true when B. longirostris-coregoni was more important in the plankton. The moderate selection for these two items was apparently related to their relative abundance in the plankton.

The grand average percent composition in the stomachs of copepodites (31.2%) and Bosmina longirostris-coregoni (25.9%) was about the same, but the percentage of nauplii, copepodites, and adult copepods (65.7%) was significantly greater than the two dominant cladocerans (28.7%). Copepods were therefore not only more strongly selected for than cladocerans, but their percentage in the diet was much higher. Other copepods, cladocerans, ostracods, insects, and oligochaetes accounted

for only 5.6% of the diet. August.

Acartia tonsa was eaten in small numbers in September. A few Diaptomus reighardi appeared in stomachs in June and September, primarily at J-80. Eucyclops agilis was consumed only at J-80, and its importance increased from June (0.32/stomach) to October (47.78/stomach). Halicyclops fosteri was eaten only in June, and Canuella canadensis and Ectinosoma curticorne were selected for occasionally but not every time they were present in the plankton. Microarthridion littorale was not found in the stomachs. Ilyocryptus spinifer, Daphnia ambigua, Daphnia parvula, Ceriodaphnia lacustris, Moina brachiata, Alonella acutirostris, Leydigia acanthocercoides, Leydigia quadrangularis, Alona quadrangularis, and Leptodora kindtii were eaten irregularly and in small numbers. A. acutirostris, however, was relatively important in the diet at J-60 in September and J-70 in October and November, and M. brachiata was important at J-70 in September. Electivity was most often -1.0 or +1.0, depending upon where the item was present (ie., plankton or stomach). Bosminopsis deitersi, Camptocercus macrurus, and Alona guttata were not found in stomachs during the study. Percentage of cladocerans was highest in stomachs from upstream stations. Gammarus fasciatus and Neomysis americana were not eaten, but Physocypria exquisita was found regularly in the diet every month at all station except J-40, which suggests that fish were feeding in littoral regions. It was strongly selected for, although numbers in stomachs were low. Procladius adumbratus was important at J-80 from June to September. Only a few Chaoborus sp. were eaten. A large number of Pristina breviseta was found in stomachs in June at J-80. Although no adult insects were found in the plankton, they were prey

at J-80 in June, July, and August.

Feeding periodicity determined from Potomac River samples (Figure 17) indicates that active feeding began at dawn and continued until dusk, and that stomachs emptied during the night. There was one peak in stomach weight per gram of fish in both July and October. The peak, where stomachs reached maximum fullness, occurred at dusk (about 1800). There was a decrease in stomach weight from dusk to dawn (about 0700), when the period of increase in stomach weight began. Bluebacks in the James probably exhibit the same feeding behavior as in the Potomac since the rivers are equally turbid.

A plot of stomach weight per gram of fish (Figure 18) indicates that in most cases stomachs from fish taken at surface were proportionally heavier (ie., more full) than stomachs from fish taken at 5 m. In addition, stomachs from fish taken at the mid stations (J-50 to J-70) were, from July to November, generally heavier than stomachs from fish taken at J-40 and J-80. Differences between stations were obviously partly dependent upon time of day at which samples were taken. Individual stations, however, were sampled at approximately the same time each month: J-40, 1100 to 1317; J-50, 1030 to 1300; J-60, 0725 to 0910; J-70, 0813 to 0913; J-80, 1205 to 1400. Values from J-40, J-50, and J-80 were therefore comparable, since samples from these stations were taken at about midday. Values from J-60 and J-70 would probably have been higher if these stations had been sampled at the same time as the other stations. Samples at J-60 and J-70 were taken earlier in the active feeding period (Figure 17) than samples from the other three station. With this in mind it is probable that the daily intake of food was greater at J-60 and J-70 than at the other stations throughout most of the season. The relatively high values in June could have been

Figure 17. Feeding periodicity of young-of-the-year blueback herring from the Potomac River on 24 and 25 July and 28 and 29 October 1968. Central horizontal line, mean; vertical line, range. S.R., sunrise; S.S., sunset.

Figure 18. Stomach weight (g) per gram of fish weight of young-of-the-year blueback herring from the James River, in 1969. Hollow bar, surface; solid bar, 5 meters.

due to the possibility that stomachs of smaller fish were proportionally larger than stomachs of older fish.

Respiration

Results of 10 respiration experiments with fish of about the same size are summarized in Table 5. Oxygen consumption of individual fish was measured during periods of routine swimming activity. Measurements were not begun until each fish adjusted to the respirometer and became quiet (usually 1 to 3 hr).

The regression of oxygen consumption on temperature, determined by fitting a straight line to temperature and the logarithm of oxygen consumption, was:

$$\text{Log } O = -1.4451 + 0.0548 T$$

where O = oxygen consumption (mg O_2 /gram wet weight/hr),

and T = temperature (C).

Oxygen consumption values computed from individual temperatures were the basis for the curve in Figure 19, with empirical data plotted. The correlation coefficient (r) was 0.9537, indicating a high degree of relationship between temperature and oxygen consumption.

Energy Transformations and Budget

The energy budget of an animal, the theory of which has been presented by Slobodkin (1962), provides a measure of its scope for growth (ie., the difference between energy of food consumed and all other energy utilizations and losses) under particular environmental conditions (Warren and Davis, 1967). In the present study growth and respiration values for the blueback were converted to their calorific equivalents and used in the following equation (Wissing, 1969) for computing an energy budget:

Table 5. Fork length, wet and dry body weight, water temperature, and oxygen consumption rate for young-of-the-year blueback herring from the James River

Experiment	Fork length (mm)	Wet body weight (g)	Dry body weight (g)	Oxygen consumption		Water temp. (C)
				(mg O ₂ /g wet weight/hr)	(mg O ₂ /g dry weight/hr)	
1	64	2.3	0.570	1.56	6.31	28.7
2	63	2.1	0.535	1.34	5.25	28.7
3	59	2.0	0.436	1.59	7.29	27.7
4	64	2.4	0.580	0.58	2.40	24.5
5	63	2.3	0.597	0.64	2.47	24.5
6	65	2.4	0.600	0.62	2.49	23.6
7	58	1.9	0.436	0.52	2.25	21.2
8	62	2.1	0.463	0.36	1.65	18.9
9	62	2.0	0.443	0.35	1.58	16.6
10	63	2.3	0.483	0.31	1.46	16.4

Figure 19. Regression of oxygen consumption ($\text{mg O}_2/\text{gram wet weight/hr}$) on temperature ($^{\circ}\text{C}$) for young-of-the-year blueback herring. Empirical data plotted as points.

$$E_I - E_{Eg} = E_G + E_M$$

where E_I = energy of food consumed (daily ration),

E_{Eg} = energy of egesta,

E_G = energy accumulated as growth (production),

and E_M = energetic cost of maintenance (total respiratory metabolism).

The maintenance component (E_M) includes energetic expenditures for swimming, standard metabolism, and processes of digestion, assimilation, and storage of food materials (non-specific dynamic action).

Energy of the daily ration (E_I) was determined by the respiratory method elaborated by Winberg (1956) to determine the energy of metabolism + energy of weight increase). Winberg associated the metabolic rate of feeding fish was about twice the rate associated with measurements on non-feeding fish, subject to undisturbed routine activity (routine metabolism). The routine metabolic rate of a bluegill for each of five time intervals (Table 6) was determined by fitting the mean temperature for each period into the oxygen consumption on temperature regression described previously. Oxygen consumption in mg O_2 /gram wet weight/hr was converted into g-cal./fish/day by using the mean weight per period and the oxy-calorific coefficient of 3.4 cal per mg of oxygen consumed (Brody, 1945; Kelber, 1961). This value was then doubled to give the energy of metabolism expected under normal environmental conditions.

its calorific equivalent, assuming 1 kcal per gram of wet weight (Winberg, 1956).

The sum of the calorific equivalents of growth in nature and two

Table 6. Growth rates (mm/day and g/day) and routine metabolic rate (g-cal/fish/day) for young-of-the-year blueback herring from the James River for five time intervals in 1969

Time interval	Days	Mean temp. (C)	Mean fork length (mm)	Growth (mm/day)	Mean wet weight (g)	Growth (g/day)	Wt. gain/day (% body wt.)	Routine metabolism (g-cal/fish/day)
June 16-July 14	28	28.3	40.82	0.29	1.16	0.03	2.6	121
July 14-Aug. 18	35	28.0	47.04	0.12	1.69	0.01	0.6	170
Aug. 18-Sept. 17	30	25.9	51.53	0.15	2.01	0.01	0.5	155
Sept. 17-Oct. 28	41	20.3	59.79	0.29	2.80	0.03	1.1	107
Oct. 28-Nov. 18	21	13.1	69.06	0.32	3.97	0.05	1.3	61

times the routine metabolism, as determined through respirometry, was assumed to be the energy requirement of the fish (ie., assimilated food energy). This approach was used by Mann (1965) in his studies of fish in the River Thames. The assimilation value was used in Winberg's formula to obtain the energy of the daily ration for each interval. Energy of egesta was determined by subtracting assimilated energy from energy of the daily ration. Soluble waste products (excretion) were not considered, but an error of only 3% is incurred in estimating the calorific content of food consumed by fish (Winberg, 1956).

Energy transformations of a blueback for five time intervals and the energy budget for the total 155 days of the study are presented in Table 7 and Figure 20. Efficiencies of growth and maintenance requirement as percentage of food assimilated are included. Fish biocontent was based on mean body weight per period.

Energy transformations (per day) of a young blueback intervals in 1969	June 16- July 14		July 14- Aug. 18	
	June 16- July 14	July 14- Aug. 18	July 14- Aug. 18	Aug. 18- Sept. 12
Fish biocontent (g-cal)	1160	1590		
Food consumed (g-cal)	340	438		
Egesta (g-cal)	68	88		
Food assimilated (g-cal)	272	350		
Maintenance require- ment (g-cal)	242	340		
Growth (g-cal)	30	10		
Growth (% of food consumed) ^a	8.8	2.3		
Growth (% of food assimilated) ^b	11.0	2.9		
Maintenance requirement (% of food assimilated)	89.0	97.1		

a, b Equivalent to Tyler's (1945) "coefficient of growth" and "coefficient of maintenance" respectively.

Table 7. Energy transformations (per day) of a young-of-the-year blueback herring for five time intervals in 1969

	June 16- July 14	July 14- Aug. 18	Aug. 18- Sept. 17	Sept. 17- Oct. 28	Oct. 28- Nov. 18	Mean ($\bar{x}$)
Fish biocontent (g-cal)	1160	1690	2010	2800	3970	
Food consumed (g-cal)	340	438	400	305	215	
Egesta (g-cal)	68	88	80	61	43	
Food assimilated (g-cal)	272	350	320	244	172	
Maintenance require- ment (g-cal)	242	340	310	214	122	
Growth (g-cal)	30	10	10	30	50	
Growth (% of food consumed) ^a	8.8	2.3	2.5	9.8	23.3	9.3
Growth (% of food assimilated) ^b	11.0	2.9	3.1	12.3	29.1	11.7
Maintenance requirement (% of food assimilated)	89.0	97.1	96.9	87.7	70.9	88.3

^{a,b} Equivalent to Ivlev's (1945) "coefficient of growth of the first and second order," respectively.

Figure 20. Energy budget of a young-of-the-year blueback herring
for a 155 day period in the James River in 1969.
kcal = kilocalories.

subject to higher rates of survival.

Density of food in an animal's immediate surroundings determines the amount of food it can obtain in a short period and the energy costs

DISCUSSION

A direct relationship existed between density of zooplankton and distribution and growth of young-of-the-year blueback herring. Zooplankton standing crops were highest upstream due primarily to nutrient enrichment from Hopewell and Richmond. Abundance of bluebacks later in the season, growth, and food consumption were correspondingly highest upstream.

Data on distribution (Table 1 and Figure 4) show that bluebacks were concentrated in surface waters, and suggest a general upstream migration. Evidence for movement upstream is, however, circumstantial because behavior of the blueback in the nursery is unknown. The downstream decrease in numbers could have been due not only to an upstream migration, but to movement to shoals or tributaries. The upstream increase in numbers could have resulted from fish moving upstream or out of tributaries or oxbows. The increase in grand average number per tow from August to October suggests that fish were moving out of tributaries and oxbows later in the season. In addition, survival rates may have been higher upstream which would have caused differences in abundance between upstream and downstream stations to be more pronounced.

In any case, it might be postulated that bluebacks moved upstream to more productive areas. Massmann (1953) found young-of-the-year bluebacks most abundant at upstream stations in five Virginia estuaries. Massmann (1953) also reported that juvenile American shad, Alosa sapidissima, were concentrated upstream from major spawning areas, and suggested that they moved upstream or that upstream spawnings were

subject to higher rates of survival.

Density of food in an animal's immediate surroundings determines the amount of food it can obtain in a short period and the energy costs of obtaining food. Thus, a useful measure of food as an environmental factor influencing growth of a predator is mean prey density over a period of time long enough for measurable weight changes to occur in the predator (Warren and Davis, 1967). Allen (1951) and Horton (1961) showed a relationship between density of benthos and food consumption and growth of brown trout, Salmo trutta. Johnson (1961, 1965) demonstrated that growth rates of juvenile sockeye salmon, Oncorhynchus nerka, were related to density of zooplankton.

Environmental factors such as temperature and oxygen that influence food consumption and metabolism either physiologically or behaviorally, activity of the predator, and quality of food also relate to growth and must be considered (Brett, 1970). Temperature and dissolved oxygen were essentially the same between stations on a seasonal basis: J-40, 24.0 C and 6.2 mg/liter; J-50, 23.5 C and 4.5 mg/liter; J-60, 23.5 C and 5.1 mg/liter; J-70, 24.2 C and 4.6 mg/liter; J-80, 23.7 C and 5.9 mg/liter. Therefore it is assumed that activity of fish was similar between stations. The same kinds of prey were consumed at each station (Figures 10 to 15), except at J-80 where littoral copepods (Eucyclops agilis), adult and larval insects, and oligochaetes were consumed to a greater extent than at other stations. This could explain why J-80 fish were about the same size as J-70 fish even though density of zooplankton was considerably lower at J-80. Food intake was less at J-80 than at J-70 (Figure 18), but this could be explained by differences in feeding behavior. Bluebacks at J-80 may have been feeding on adult and larval insects primarily in the evening, so

stomachs collected at midday would have contained less food than stomachs from the other stations.

Comparatively high growth rates of bluebacks at upstream stations (Figure 5) could therefore be attributed primarily to differences in prey density and levels of intra- and interspecific competition between upstream and downstream stations. Standing crops of zooplankton, including those most important in the diet, were higher at J-60 and J-70 (Figures 7 to 9) than at J-40 and J-50, and food consumption was correspondingly greater at J-60 and J-70 (Figure 18) than at other stations. Competition was apparently greater downstream than upstream. Selection for nauplii at J-40 in lieu of "preferred" prey supports this. Interspecific competition was primarily from the anchovy, Anchoa mitchilli, which feeds on copepods (Hildebrand and Schroeder, 1928). Relatively large numbers of anchovies (maximum of 462 per tow) were captured at J-40 and J-50 throughout the study. Anchovies were as numerous as bluebacks at J-40 in July and were more abundant than bluebacks at J-40 in August, October, and November. Laarman (1969) related reduced growth rates of coho salmon, Oncorhynchus kisutch, to interspecific competition from steelhead trout, Salmo gairdneri. The mean size of upstream fish may also have been influenced if there was an upstream migration and only larger fish were involved.

Decrease in condition (K) from August to November (Figure 6) may have been due to lower food availability as a result of the flood (Figure 9), to the normal seasonal decline in zooplankton populations, and to increased intraspecific competition due to increased numbers of bluebacks in the channel (Table 1). Berg and Grimaldi (1966) found that condition of coregonids was directly related to abundance of prey.

Food habits of bluebacks in the James River were similar to those

of bluebacks from the Cape Fear River (Davis and Cheek, 1966), where small crustaceans made up the major portion of the diet. Bluebacks in the James exhibited a selective feeding behavior (Figures 10 to 16). Copepod nauplii, although they constituted on the average almost half (46.9%) of the plankton, were strongly selected against, except at J-40 where plankton density was relatively low and competition for food was apparently high. Copepodites were moderately to weakly selected for, selection coincided with their relative abundance in the plankton, and mean electivity decreased in time. Adult copepods were moderately to strongly selected for even though they made up only a small percentage of the plankton (5.9%). Selection increased with size of fish. Bosmina longirostris-coregoni was generally selected against except when relatively abundant in the plankton. Mean electivity was weak and decreased with size of fish. Diaphanosoma brachyurum was usually selected against.

The selective phenomenon was discussed in detail by Ivlev (1961). Selective feeding has been observed in American smelt, Osmerus mordax (Reif and Tappa, 1966); rainbow trout, Salmo gairdneri, and yellow perch, Perca flavescens (Gailbraith, 1967); walleye, Stizostedion vitreum (Houde, 1967); gizzard shad, Dorosoma cepedianum (Cramer and Marzolf, 1970); bigmouth buffalo, Ictiobus cyprinellus (Starostka and Applegate, 1970); alewife, Alosa pseudoharengus (Brooks and Dodson, 1965; Wells, 1970; Hutchinson, 1971); and blueback herring (Brooks and Dodson, 1965).

Degree of food selectivity by plankton-feeding fish largely depends upon size, abundance, and mobility of food organisms. Selection is accomplished either by particle selection or by indiscriminant filtering, in which case spacing between gill rakers determines size of organisms captured. Smaller organisms which pass through the gill rakers or avoid

ingestion are not utilized. The result is a greater percentage of large organisms in the stomach compared to percentage in the plankton (Starostkda and Applegate, 1970). Nauplii were selected for by bluebacks in the James River at J-40 which indicates that they could be retained by the gill rakers. If fish were routinely filter-feeding, nauplii would have appeared in stomachs taken at the other stations. However, nauplii were not eaten extensively, even though they were the most abundant item in the plankton, which indicates that filter-feeding was unlikely. Bluebacks in the laboratory selected Artemia nauplii individually.

Bluebacks were apparently selecting individual organisms, and size, abundance, and mobility of prey probably all played a role in the selective mechanism. Adult copepods (Eurytemora affinis, 1.0 to 1.5 mm; Cyclops vernalis, 0.8 to 1.8 mm; Canthocamptus robertcokeri, 0.6 to 0.8 mm; from Ward and Whipple, 1959) were most strongly selected for, evidently on the basis of size. Intermediate sized copepodites were moderately to weakly selected for. The relatively small Bosmina longirostris-coregoni (0.25 to 0.31 mm; from Hutchinson, 1971) was selected against except when its percentage in the plankton was relatively high, which suggests that selection was influenced by relative abundance. The selection against Diaphanosoma brachyurum, even though it is larger (0.4 to 0.9 mm; from Ward and Whipple, 1959) than B. longirostris-coregoni, suggests that mobility was important. D. brachyurum may be an erratic swimmer which would make it less susceptible to predation than the other species. Cramer and Marzolf (1970) noted that gizzard shad selected against D. brachyurum.

Ivlev (1961) discussed the positive selection of larger, available food organisms by predatory fishes. Planktivorous fish in lakes first select larger prey species and then largest individuals of each species

(Brooks, 1968). Brooks (1968) observed in laboratory experiments that when nauplii, copepodites, and adults of Diaptomus minutus were fed to juvenile alewife, adults were eaten first, then copepodites, and finally nauplii.

Gailbraith (1967) showed that rainbow trout and yellow perch selected large Daphnia pulex over 1.3 mm long. A comparison of gill raker spacings in rainbow trout to size of prey indicated that smaller plankters should have been retained if filtration was the only mechanism involved.

Brooks and Dodson (1965) noted size differences in zooplankton populations where alewife and blueback herring were abundant. Relatively large zooplankton species were never dominant in lakes having Alosa, whereas they were always dominant in lakes devoid of Alosa. Population declines of Daphnia have been associated with size-selective predation by young-of-the-year threadfin shad, Dorosoma petenense (Applegate and Mullan, 1969). Hall demonstrated that large D. pulex were selected and smaller Daphnia galeata mendotae were rejected by adult cisco, Leucichthys artedi, and black crappie, Pomoxis nigromaculatus.

Food selection, and the evolutionary strategy implied by its existence, is normally expected only in those situations where loss of efficiency due to not utilizing all available resources is negligible in relation to efficiency gained by specialization (MacArthur and Levins, 1964). Thus, a predator will feed in a manner which will produce an optimum return for amount of energy expended.

The efficiency with which a species collects its food is an important factor governing its success in competition with other organisms at a given trophic level. Generally, in any ecosystem, the dominant species at each trophic level can be considered to be most efficient in utilizing the limiting resource (Cramer and Marzolf, 1970). In the James River the

blueback can be considered dominant since they constituted 76% of the total number of fish captured during the study. That they selected large food items and excluded smaller forms strongly suggests that they picked larger organisms individually by choice. This behavioral selection seems reasonable in view of the relative size of predator and prey. The only energetically economical way to eat large food items would be to pick them individually, because filter feeding would yield few large organisms.

Under intensive size-selective predation, abundance of large dominant species decreases. Lessened competition from large species permits numbers of small species to increase, even though the latter are preyed upon as larger species become scarce (Brooks, 1968, 1969). This obviously occurred in the James River. Numbers of adult copepods were considerably less than numbers of Bosmina longirostris-coregoni (Figures 7 and 8) over the entire season, particularly at the surface where bluebacks were concentrated (Figure 4) and feeding was most intense (Figure 18). The vertical migratory behavior of copepods may have contributed to their decreased abundance at the surface, but predation was obviously intense because copepods were eaten.

Smith (1963) concluded that removal of young individuals more effectively reduces population density than does removal of adults. Thus, if fish prey on both mature and immature forms, numbers of surviving adults may be insufficient to sustain the population. This was apparently the case in the James River since both immature and mature copepods were consumed. Intensive predation on large dominant copepods resulted in dominance of the smaller Bosmina longirostris-coregoni. This smaller form filled the niche that would normally be occupied by the dominant copepods. Brooks and Dodson (1965) and Gailbraith (1967) noted that when numbers of Daphnia were reduced by

selective predation, Bosmina became dominant. Reif and Tappa (1966) attributed the elimination of Daphnia pulex from Harveys Lake, Conn., and the survival of B. longirostris and Daphnia dubia to selective predation by American smelt.

Size selective predators feed using visual cues (Dodson, 1970) which would explain why bluebacks feed primarily during daylight (Figure 17). Turbidity probably reduces transmission of moonlight to a point where the fish can no longer see their prey. Massmann (1963) found that juvenile American shad in the Pamunkey and Mattaponi Rivers, Virginia, fed during the day, stomachs reaching maximum fullness in early evening.

Mean efficiency of maintenance requirement (percentage of food assimilated (Table 7) was within ranges computed from laboratory studies of other species: cutthroat trout, Salmo clarki, 56.7 to 93.4% (Brocksen, et al., 1968); longear sunfish, Lepomis megalotis megalotis, 66.7 to 95.3% (Gerking, 1952). However, maintenance efficiencies appear to be unusually high for the second two time intervals (97.1 and 96.9%). These figures may not be unrealistic if one considers that the blueback is normally an active and fast-swimming fish. Blueback schools held in aquaria were constantly in motion. Swimming was rapid and schools never held position. Individual fish in the respirometer were not affected by removal from the school. They were no more active or excited than when schooling. The combined effect of temperature and activity could account for the relatively high maintenance requirement. Note that weight gain as percentage of body weight (Table 6) decreased from June-July to a low of 0.5% in August-September, and then increased to October-November.

Higher growth efficiencies from September to November were due primarily to lower maintenance costs resulting from lower temperatures. The ration from October-November was less than the maintenance requirements

from June to September. This suggests there are temperatures at which maintenance costs may be low but at which fish are still metabolically able to utilize food efficiently for growth. Under these circumstances growth efficiencies will be high (Warren and Davis, 1967). As growth increased, the daily ration and condition (Figure 6) decreased from August to November, due probably to decreasing food availability (Figure 9) and increased competition (Table 1). Warren and Davis (1967), using unpublished data from Brocksen, showed that cutthroat trout had a higher growth efficiency in late winter than in spring due to lower maintenance costs.

increase and upstream increase in abundance suggested an upstream migration to more productive regions of the river.

Increased growth rates upstream were related to relatively high zooplankton standing crops. Interspecific competition for food was greater downstream than upstream. A decrease in condition (K) after flooding from Hurricane Camille may have been due to a decrease in food and an increase in competition from greater numbers of bluebacks in the channel.

Bluebacks fed primarily on copepods, but cladocerans were also important. A selective feeding behavior was demonstrated, and strength of selection (selectivity) was related to size of prey. Selection was strongest for adult copepods and weakest for copepod nauplii. Intense predation on adult copepods resulted in dominance of the smaller Bosmina longirostris-coregoni. Feeding occurred only during daylight indicating that visual cues were important.

Energy transformations of young-of-the-year blueback herring computed from growth and respirometry data show that the maintenance requirement was high and growth was low during summer, and that growth increased as temperature decreased due to lower maintenance costs.

SUMMARY

A direct relationship existed between density of zooplankton and distribution and growth of young-of-the-year blueback herring. Zooplankton standing crops were highest upstream where abundance later in the season, growth, and food consumption were correspondingly highest.

Blueback herring were concentrated at the surface. The downstream decrease and upstream increase in abundance suggested an upstream migration to more productive regions of the river.

Increased growth rates upstream were related to relatively high zooplankton standing crops. Interspecific competition for food was greater downstream than upstream. A decrease in condition (K) after flooding from Hurricane Camille may have been due to a decrease in food and an increase in competition from greater numbers of bluebacks in the channel.

Bluebacks fed primarily on copepods, but cladocerans were also important. A selective feeding behavior was demonstrated, and strength of selection (electivity) was related to size of prey. Selection was strongest for adult copepods and weakest for copepod nauplii. Intense predation on adult copepods resulted in dominance of the smaller Bosmina longirostris-coregoni. Feeding occurred only during daylight indicating that visual cues were important.

Energy transformations of young-of-the-year blueback herring computed from growth and respirometry data show that the maintenance requirement was high and growth was low during summer, and that growth increased as temperature decreased due to lower maintenance costs.

Appendix A
Zooplankton Standing Crops

Table A1. (Continued).

Table A1. Zooplankton standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 16-19 June 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Nauplii</u>	3.57 (26.4)	1.71 (6.5)	14.14 (76.5)	1.71 (10.1)	24.82 (32.8)	23.77 (27.6)	14.10 (39.6)	22.61 (31.3)	0.25 (43.8)	0.20 (48.7)
<u>Copepodites</u>	5.93 (43.7)	12.68 (47.8)	1.44 (7.8)	3.42 (20.4)	9.76 (12.9)	17.36 (20.1)	4.38 (12.3)	5.37 (7.5)	0.19 (33.3)	0.07 (17.1)
<u>Eurytemora affinis</u>	0.42 (3.1)	6.76 (25.5)	0.04 (0.2)	2.64 (15.7)	1.61 (2.1)	2.28 (2.6)	0.33 (0.9)	0.44 (0.6)		
<u>Acartia tonsa</u>										
<u>Diaptomus reighardi</u>										
<u>Cyclops vernalis</u>		1.75 (6.6)	0.03 (0.2)	3.45 (20.6)		2.76 (3.2)	0.17 (0.5)	1.19 (1.7)	0.04 (7.0)	
<u>Eucyclops agilis</u>										
<u>Halicyclops fosteri</u>	0.14 (1.0)	0.49 (1.8)								
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcookeri</u>										
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>										0.03 (0.2)

Table A1. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-coregoni</u>	3.23 (23.8)	2.77 (10.4)	2.65 (14.3)	3.69 (22.0)	34.18 (45.1)	31.37 (36.3)	12.75 (35.8)	36.56 (50.7)	0.03 (5.3)	
<u>Bosminopsis deitersi</u>										
<u>Ilyocryptus spinifer</u>			0.03 (0.2)					0.49 (0.7)	0.03 (5.3)	0.03 (7.3)
<u>Diaphanosoma brachyurum</u>	0.23 (1.7)	0.32 (1.2)	0.15 (0.8)	1.24 (7.4)	5.36 (7.1)	5.02 (5.8)	3.28 (9.2)	3.97 (5.5)		
<u>Daphnia ambigua</u>							0.07 (0.2)			0.03 (7.3)
<u>Daphnia parvula</u>										
<u>Ceriodaphnia lacustris</u>						0.23 (0.3)				0.04 (9.8)
<u>Moina brachiata</u>	13.56	26.52	18.48	16.78	75.73	86.35	35.60	72.07	0.57	0.41
<u>Alonella acutirostris</u>						1.81 (2.1)	0.42 (1.2)	0.15 (0.2)	0.03 (5.3)	
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>										
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table A1. (Continued).

Table A2. Zooplankton standing crops as number per liter. Percentage of total number of organisms

per liter in parentheses. Date: 30 June 1963. S, surface, 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>	0.04 (0.3)	5m	S	0.60 (3.6)	S	1.46 (1.7)	0.10 (0.3)	1.14 (1.6)	S	5m
<u>Gammarus fasciatus</u>	14.68 (87.1)	10.48 (46.6)	30.94 (85.8)	25.99 (48.4)	90.87 (44.0)	19.15 (10.6)	10.02 (15.4)	11.12 (13.2)		
<u>Physocypria exquisita</u>	0.80 (4.8)	4.97 (22.1)	1.75 (4.9)	7.76 (14.5)	10.09 (4.9)	21.05 (11.5)	4.12 (6.3)	8.13 (9.5)	0.03 (5.3)	0.04 (21.0)
<u>Neomysis americana</u>		0.47 (2.1)	0.03 (0.1)	6.01 (11.2)		2.16 (0.3)		0.68 (0.2)		
<u>Procladius adumbratus</u>						0.29 (0.3)		0.15 (0.2)		0.04 (9.8)
<u>Chaoborus sp.</u>										
<u>Pristina breviseta</u>		1.68 (7.5)	0.33 (0.9)	5.88 (11.0)	1.89 (0.9)	4.99 (2.7)		1.87 (2.2)		0.04 (9.8)
Total	13.56	26.52	18.48	16.78	75.73	86.35	35.60	72.07	0.57	0.41
<u>Microarthrodion littorale</u>										
<u>Canthocamptus robertcookeri</u>										
<u>Canella canadensis</u>										
<u>Ectinoseta curticorne</u>										

Table A2. Zooplankton standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 30 June 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<i>Nauplii</i>	14.68	10.48	30.94	25.99	90.87	19.15	10.02	11.12		
	(87.1)	(46.6)	(85.8)	(48.4)	(44.0)	(10.6)	(15.4)	(13.2)		
<i>Copepodites</i>	0.80	4.97	1.75	7.76	10.09	21.05	4.12	8.13		0.04
	(4.8)	(22.1)	(4.9)	(14.5)	(4.9)	(11.5)	(6.3)	(9.5)		(21.0)
<i>Eurytemora affinis</i>		0.47	0.03	6.01		2.16		0.68		
		(2.1)	(0.1)	(11.2)		(1.2)		(0.8)		
<i>Acartia tonsa</i>										
<i>Diaptomus reighardi</i>										
<i>Cyclops vernalis</i>		1.68	0.33	5.88	1.89	4.99		1.87		
		(7.5)	(0.9)	(11.0)	(0.9)	(2.7)		(2.2)		
<i>Eucyclops agilis</i>										
<i>Halicyclops fosteri</i>										
<i>Microarthridion littorale</i>										
<i>Canthocamptus robertcokeri</i>										
<i>Canuella canadensis</i>										
<i>Ectinosoma curticorne</i>										

Table A2. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-</u> <u>coregoni</u>	1.36 (8.1)	3.90 (17.3)	2.06 (5.7)	5.25 (9.8)	89.67 (43.4)	113.77 (62.4)	48.30 (74.0)	54.03 (63.2)	0.51 (92.7)	0.11 (57.9)
<u>Bosminopsis deitersi</u>										
<u>Ilyocryptus spinifer</u>								0.29 (0.3)		
<u>Diaphanosoma brachyurum</u>		1.00 (4.4)	0.42 (1.2)	1.79 (3.3)	12.10 (5.9)	17.64 (9.7)	2.64 (4.0)	3.11 (3.6)	0.04 (7.3)	
<u>Daphnia ambigua</u>								0.29 (0.3)		
<u>Daphnia parvula</u>								0.68 (0.8)		0.04 (21.1)
<u>Ceriodaphnia lacustris</u>										
<u>Moina brachiata</u>	16.84	22.50	36.05	53.63	206.51	182.35	65.29	85.46	0.55	0.19
<u>Alonella acutirostris</u>				0.06 (0.1)		2.98 (1.6)	0.21 (0.3)	4.23 (4.9)		
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>										
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table A2. (Continued). standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 14-17 July 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>			0.52 (1.4)	0.89 (1.7)	1.89 (0.9)	0.61 (0.3)		1.03 (1.2)		
<u>Gammarus fasciatus</u>	14.64 (89.5)	13.81 (39.4)	29.17 (88.2)	4.36 (13.2)	77.48 (53.9)	51.75 (29.0)	14.92 (44.1)	11.46 (33.4)	0.15 (45.5)	0.16 (29.6)
<u>Physocypria exquisita</u>	0.66 (4.0)	0.08 (23.0)	1.05 (3.2)	13.32 (41.0)	18.85 (13.0)	45.87 (28.6)	3.34 (14.4)	5.89 (13.3)	0.18 (34.5)	0.06 (11.1)
<u>Neomysis americana</u>		0.34 (1.3)		0.30 (0.4)		3.97 (2.3)				
<u>Procladius adumbratus</u>										
<u>Chaoborus sp.</u>										
<u>Pristina breviseta</u>	0.06 (0.3)	1.04 (1.1)		2.33 (7.9)		8.61 (5.0)	0.14 (0.6)	0.68 (0.8)		0.04 (21.1)
Total	16.84	22.50	36.05	53.63	206.51	182.35	65.29	85.46	0.55	0.19
<u>Microthrix</u>										
<u>Canthocamptus</u>										
<u>Canella canadensis</u>										
<u>Ectinosoma curticorne</u>										

Table A3. Zooplankton standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 14-17 July 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<i>Nauplii</i>	14.64	13.81	29.17	4.36	77.48	51.75	14.92	11.46	0.15	0.16
	(89.5)	(39.4)	(88.2)	(15.2)	(53.9)	(29.9)	(64.1)	(33.4)	(45.5)	(29.6)
<i>Copepodites</i>	0.66	8.05	1.05	13.39	18.65	45.87	3.34	5.89	0.18	0.06
	(4.0)	(23.0)	(3.2)	(47.0)	(13.0)	(26.6)	(14.4)	(17.3)	(54.5)	(11.1)
<i>Eurytemora affinis</i>		0.44		0.10		3.97		(0.5)		
		(1.3)		(0.4)		(2.3)		(0.5)		
<i>Acartia tonsa</i>										
<i>Diaptomus reighardi</i>										
<i>Cyclops vernalis</i>	0.03	1.09		2.53		8.61	0.14	1.59		
	(0.2)	(3.1)		(8.9)		(5.0)	(0.6)	(4.7)		
<i>Eucyclops agilis</i>										
<i>Halicyclops fosteri</i>		0.14				0.52				
		(0.4)				(0.3)				
<i>Microarthridion littorale</i>				0.17	4.45	5.15		0.20		
				(0.6)	(3.1)	(3.0)		(0.6)		
<i>Canthocamptus robertcokeri</i>										
<i>Canuella canadensis</i>										
<i>Ectinosoma curticorne</i>		0.03								
		(0.1)								
<i>Alona guttata</i>										

Table A3. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-coregoni</u>	0.35 (2.1)	8.63 (24.7)	2.00 (6.1)	3.78 (13.3)	33.78 (23.5)	37.78 (21.9)	3.05 (13.1)	12.64 (37.1)		
<u>Bosminopsis deitersi</u>										
<u>Ilyocryptus spinifer</u>				0.10 (0.4)	0.52 (0.3)			0.17 (0.5)		
<u>Diaphanosoma brachyurum</u>	0.69 (4.2)	2.78 (8.0)	0.81 (.25)	3.90 (13.7)	8.83 (6.1)	18.39 (10.7)	1.82 (7.8)	2.17 (6.4)		
<u>Daphnia ambigua</u>										
<u>Daphnia parvula</u>										
<u>Ceriodaphnia lacustris</u>									0.25 (46.3)	
<u>Moina brachiata</u>	16.37	34.97	33.03	28.48	143.73	0.52 (0.3)	23.27	34.12	0.33	0.54
<u>Alonella acutirostris</u>				0.17 (0.6)	4.45 (3.1)	5.15 (3.0)		0.20 (0.6)		
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>										
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table A3. (Continued). Standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 31 July 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>				0.15 (0.5)		0.54 (0.4)				
<u>Gammarus fasciatus</u>	18.12 (60.7)	18.99 (38.2)	27.60 (58.5)	17.72 (44.6)	36.71 (54.5)	32.20 (17.6)	3.36 (66.0)	0.68 (37.4)	0.06 (7.0)	
<u>Physocypria exquisita</u>	1.57 (5.3)	8.53 (17.2)	8.89 (18.9)	0.10 (0.4)	0.52 (0.3)	13.58 (7.4)	0.48 (9.4)	0.25 (19.7)	0.35 (41.2)	0.12 (100.0)
<u>Neomysis americana</u>		1.20 (2.4)	0.22 (0.5)	1.59 (4.0)		0.43 (0.2)				
<u>Procladius adumbratus</u>										
<u>Chaoborus sp. hardi</u>						0.56 (0.3)				
<u>Pristina breviseta</u>		1.35 (2.7)	0.74 (1.6)	2.12 (5.4)		1.33 (0.7)				0.25 (46.3)
<u>Cyclops vernalis</u>										
Total	16.37	34.97	33.03	28.48	143.73	172.56	23.27	34.12	0.33	0.54
<u>Halicyclops fuscicornis</u>		0.28 (0.6)								
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcookeri</u>										
<u>Canthocamptus condensis</u>		0.15 (0.3)								
<u>Polydora cornuta</u>		0.38 (0.8)		0.20 (0.5)						

Table A4. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-coregoni</u>	10.11 (33.9)	17.69 (35.7)	6.65 (14.1)	4.29 (10.8)	19.34 (28.7)	99.39 (54.3)	0.39 (7.7)	0.33 (18.1)	0.21 (24.7)	
<u>Bosminopsis deitersi</u>										
<u>Ilyocryptus spinifer</u>				0.97 (2.5)	0.35 (0.5)			0.10 (5.5)	0.05 (5.9)	
<u>Diaphanosoma brachyurum</u>	0.04 (0.1)	0.97 (2.0)	1.07 (2.3)	0.97 (2.5)	2.96 (4.4)	11.27 (6.2)	0.78 (15.3)	0.36 (19.8)		
<u>Daphnia ambigua</u>				0.22 (0.6)						
<u>Daphnia parvula</u>										
<u>Ceriodaphnia lacustris</u>					0.54 (0.8)				0.18 (21.2)	
<u>Moina brachiata</u>	29.84	0.5 (0.1)	0.17 (0.4)	39.59	57.37	183.20	5.09	1.82	0.85	0.12
<u>Alonella acutirostris</u>			1.25 (2.7)	2.79 (7.1)	1.93 (2.9)	22.89 (12.5)	0.08 (1.6)			
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>						0.43 (0.2)				
<u>Leydigia quadrangularis</u>						0.56 (0.3)				
<u>Alona quadrangularis</u>			0.22 (0.5)							
<u>Alona guttata</u>										

Table A4. (Continued) standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 18-21 August 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>			0.22 (0.5)							
<u>Gammarus fasciatus</u>	10.19 (78.3)	1.72 (19.7)	34.91 (70.5)	18.47 (46.2)	16.19 (33.0)	20.37 (17.0)	14.13 (30.2)	14.87 (16.6)	0.04 (57.1)	0.08 (53.3)
<u>Physocypria exquisita</u>	1.71 (13.1)	2.92 (33.5)	8.01 (16.2)	0.97 (2.5)	1.79 (3.6)	13.65 (11.3)	4.17 (8.9)	8.37 (9.4)	0.03 (42.9)	0.07 (46.7)
<u>Neomysis americana</u>		2.02 (23.2)	0.36 (0.7)	1.70 (4.3)		2.83 (2.3)	0.17 (0.4)	1.13 (1.3)		
<u>Procladius adumbratus</u>						0.56 (0.3)		0.10 (5.5)		
<u>Chaoborus sp. pharoi</u>										
<u>Pristina breviseta</u>		1.26 (14.4)	0.23 (0.5)	1.49 (3.7)	0.17 (0.3)	5.70 (4.7)		3.89 (4.4)	0.18 (21.2)	
<u>Diacyclops thomasi</u>										
<u>Cyclops fosteri</u>	29.84	49.59	47.03	39.59	67.37	183.20	5.09	1.82	0.85	0.12
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcokeri</u>										
<u>Canthocamptus canadensis</u>										
<u>Diacyclops thomasi</u>		0.03 (0.3)								

Table A5. Zooplankton standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 18-21 August 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Nauplii</u>	10.19 (78.3)	1.72 (19.7)	34.91 (70.5)	18.47 (46.2)	16.19 (33.0)	20.37 (17.0)	14.13 (30.2)	14.87 (16.6)	0.04 (57.1)	0.08 (53.3)
<u>Copepodites</u>	1.71 (13.1)	2.92 (33.5)	8.01 (16.2)	12.74 (32.0)	1.79 (3.6)	13.65 (11.3)	4.17 (8.9)	8.37 (9.4)	0.03 (42.9)	0.07 (46.7)
<u>Eurytemora affinis</u>		2.02 (23.2)	0.36 (0.7)	1.70 (4.3)		2.83 (2.3)	0.17 (0.4)	1.13 (1.3)		
<u>Acartia tonsa</u>	0.19 (1.5)	0.18 (1.8)	1.03 (3.3)	1.28 (3.2)	2.26 (4.6)	0.84 (5.6)	0.52 (2.0)	0.50 (3.7)		
<u>Diaptomus reighardi</u>										
<u>Cyclops vernalis</u>		1.26 (14.4)	0.23 (0.5)	1.49 (3.7)	0.17 (0.3)	5.70 (4.7)		3.89 (4.4)		
<u>Eucyclops agilis</u>										
<u>Halicyclops fosteri</u>		0.06 (0.17)								
<u>Microarthridion littorale</u>					0.55 (1.1)	7.38 (6.1)	0.72 (1.5)	2.92 (3.3)		
<u>Canthocamptus robertcokeri</u>										
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>		0.03 (0.3)								
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table A5. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-</u> <u>coregoni</u>	0.93 (7.1)	0.46 (5.3)	4.08 (8.3)	3.45 (8.7)	28.29 (57.4)	64.40 (53.1)	26.70 (57.0)	54.06 (60.7)		
<u>Bosminopsis deitersi</u>		0.03 (0.3)		0.23 (0.6)						
<u>Ilyocryptus spinifer</u>										
<u>Diaphanosoma brachyurum</u>	0.19 (1.5)	0.16 (1.8)	1.63 (3.3)	1.26 (3.2)	2.26 (4.6)	6.84 (5.6)	0.92 (2.0)	3.30 (3.7)		
<u>Daphnia ambigua</u>										
<u>Daphnia parvula</u>										
<u>Ceriodaphnia lacustris</u>										
<u>Moina brachiata</u>	13.02	8.72	49.45	39.87	49.25	121.17	46.81	89.08	0.07	0.15
<u>Alonella acutirostris</u>					0.55 (1.1)	7.38 (6.1)	0.72 (1.5)	2.92 (3.3)		
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>										
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table A5. (Continued).

standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 29 August 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>			0.23 (0.5)	0.53 (1.3)			0.54 (0.6)			
<u>Gammarus fasciatus</u>	3.50 (51.7)	0.06 (0.7)	3.31 (56.0)	3.53 (49.5)	7.14 (57.5)	6.26 (50.5)	1.56 (62.9)	0.76 (55.3)	0.60 (63.1)	0.13 (100.0)
<u>Physocypria exquisita</u>	1.79 (26.4)	0.03 (0.3)	1.40 (23.6)	0.23 (0.6)	1.48 (11.9)	2.30 (18.6)	0.64 (25.8)	0.25 (18.1)	0.13 (13.7)	
<u>Neomysis americana</u>			0.05 (0.8)	0.61 (8.5)		0.31 (2.5)				
<u>Procladius adumbratus</u>										
<u>Chaoborus sp. richardi</u>			0.05 (0.9)	0.05 (0.7)	0.06 (0.5)	0.01 (0.1)				
<u>Pristina breviseta</u>	0.16 (2.4)	0.05 (0.8)		0.10 (1.4)	0.15 (1.2)					
<u>Leptodora agilis</u>										
Total	13.02	8.72	49.45	39.87	49.25	121.17	46.81	89.08	0.07	0.15

Microarthridion littoraleCanthocamptus robertcokeriCanvella canadensisEctinosoma curticorne

Table A6. Zooplankton standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 29 August 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Nauplii</u>	3.50	4.22	3.31	3.53	7.14	6.26	1.56	0.76	0.60	0.13
	(51.7)	(67.9)	(56.0)	(49.5)	(57.5)	(50.5)	(62.9)	(55.3)	(63.1)	(100.0)
<u>Copepodites</u>	1.79	1.68	1.40	2.04	1.48	2.30	0.64	0.25	0.13	
	(26.4)	(27.0)	(23.6)	(28.5)	(11.9)	(18.6)	(25.8)	(18.1)	(13.7)	
<u>Eurytemora affinis</u>			0.05	0.61		0.31				
			(0.8)	(8.5)		(2.5)				
<u>Acartia tonsa</u>					1.01		0.17	0.14	0.09	
					(8.1)		(6.9)	(10.1)	(9.5)	
<u>Diaptomus reighardi</u>			0.05	0.05	0.06	0.01				
			(0.8)	(0.7)	(0.5)	(0.1)				
<u>Cyclops vernalis</u>	0.16	0.05		0.10	0.15					
	(2.4)	(0.8)		(1.4)	(1.2)					
<u>Eucyclops agilis</u>								0.05		
								(4.3)		
<u>Halicyclops fosteri</u>					0.32	0.01		0.06		
					(2.4)	(0.1)		(4.3)		
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcokeri</u>										
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>										
<u>Aloa quadrangularis</u>										
<u>Aloa guttata</u>										

Table A6. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-coregoni</u>	1.32 (19.5)	0.22 (3.5)	0.58 (9.8)	0.66 (9.2)	2.14 (17.2)	1.93 (15.6)		0.05 (3.6)	0.04 (4.2)	
<u>Bosminopsis deitersi</u>										
<u>Ilyocryptus spinifer</u>			0.05 (2.5)			0.10 (0.8)	0.06 (2.4)			
<u>Diaphanosoma brachyurum</u>			0.19 (3.2)	0.05 (0.7)	1.01 (8.1)	1.14 (9.2)	0.17 (6.9)	0.14 (10.1)	0.09 (9.5)	
<u>Daphnia ambigua</u>			0.10 (1.7)	0.05 (0.7)		0.22 (1.8)				
<u>Daphnia parvula</u>			0.05 (0.8)	0.06 (0.8)	0.06 (0.5)	0.10 (0.8)	0.05 (2.0)	0.06 (4.3)		
<u>Ceriodaphnia lacustris</u>			0.05 (0.8)		0.06 (0.5)			0.06 (4.3)	0.09 (9.5)	
<u>Moina brachiata</u>	5.77	6.22	5.93	7.15	0.32 (2.6)	0.01 (0.1)	2.48	0.06 (4.3)	0.95	0.13
<u>Alonella acutirostris</u>										
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>										
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table A6. (Continued).

standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 16-19 September 1969. S: surface; 5m: 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>										
<u>Gammarus fasciatus</u>	3.52	1.31	3.04	3.46	100.83	37.78	52.53	40.15	2.09	1.73
	(70.6)	(34.3)	(51.1)	(44.2)	(78.8)	(36.7)	(45.4)	(25.8)	(64.3)	(82.9)
<u>Physocypria exquisita</u>	1.17	1.68	0.05	3.03	23.17	37.84	9.27	24.87	0.35	0.12
	(23.4)	(44.0)	(2.5)	(38.6)	(18.1)	(36.8)	(8.0)	(16.1)	(10.8)	(5.7)
<u>Neomysis americana</u>		0.24	0.13	0.23		17.44	0.23	1.08		
		(5.3)	(2.2)	(2.9)		(17.0)	(0.2)	(0.7)		
<u>Procladius adumbratus</u>		0.05								
		(0.8)								
<u>Chaoborus</u> sp. <u>ghardi</u>					0.06		0.05	0.06		
					(0.5)		(2.0)	(4.3)		
<u>Pristina breviseta</u>		0.29		0.27	0.25	2.51		0.76	0.09	
		(7.6)		(3.4)	(0.2)	(2.4)		(0.5)	(9.5)	
<u>Stethopsyllus agilis</u>										0.12
Total	6.77	6.22	5.93	7.15	12.42	12.38	2.48	1.38	0.95	0.13
<u>Stethopsyllus fenneri</u>		0.04								
		(1.0)								
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcookeri</u>										
<u>Canthocamptus canadensis</u>										
<u>Stethopsyllus curtiorne</u>										

Table A7. (Continued).

Table A7. Zooplankton standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 16-19 September 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
Organism	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Nauplii</u>	3.52	1.31	3.04	3.46	100.83	37.78	52.53	40.15	2.09	1.73
	(70.6)	(34.3)	(51.1)	(44.2)	(78.8)	(36.7)	(45.4)	(25.8)	(64.3)	(82.9)
<u>Copepodites</u>	1.17	1.68	2.47	3.03	23.17	37.84	9.27	24.87	0.35	0.12
	(23.4)	(44.0)	(41.6)	(38.6)	(18.1)	(36.8)	(8.0)	(16.1)	(10.8)	(5.7)
<u>Eurytemora affinis</u>	0.17	0.24	0.13	0.23	1.52	17.44	0.23	1.08		
	(3.4)	(6.3)	(2.2)	(2.9)	(1.2)	(17.0)	(0.2)	(0.7)		
<u>Acartia tonsa</u>		0.09								
		(2.4)								
<u>Diaptomus reighardi</u>					0.13					
					(0.1)					
<u>Cyclops vernalis</u>		0.29		0.27	0.25	2.51		0.76		
		(7.6)		(3.4)	(0.2)	(2.4)		(0.5)		
<u>Eucyclops agilis</u>					0.58	0.59	10.35	18.89		0.12
					(0.5)	(0.6)	(8.9)	(12.2)		(5.7)
<u>Halicyclops fosteri</u>		0.04		0.04		0.46	0.23	1.08		
		(1.0)		(0.5)		(0.4)	(0.2)	(0.7)		
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcokeri</u>										
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>										

Table A7. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-</u> <u>coregoni</u>	0.13 (2.6)	0.04 (1.0)	0.04 (0.7)	0.16 (2.0)	1.40 (1.1)	2.28 (2.2)	38.03 (32.8)	56.91 (36.8)	0.68 (20.9)	
<u>Bosminopsis deitersi</u>							0.26 (0.2)			
<u>Ilyocryptus spinifer</u>		0.04 (1.0)							0.13 (4.0)	
<u>Diaphanosoma brachyurum</u>	0.17 (3.4)	0.09 (2.4)	0.22 (3.7)	0.66 (8.4)	1.52 (1.2)	3.26 (3.2)	5.04 (4.3)	10.02 (6.5)		
<u>Daphnia ambigua</u>										
<u>Daphnia parvula</u>										
<u>Ceriodaphnia lacustris</u>			0.04 (0.7)						0.12 (5.7)	
<u>Moina brachiata</u>	4.99	3.82	5.94	7.85	12.7 (0.5)	10.5 (0.6)	11.35 (8.9)	18.89 (12.2)	3.25	2.09
<u>Alonella acutirostris</u>				0.04 (0.5)		0.46 (0.4)	0.23 (0.2)	1.08 (0.7)		
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>										
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table A7. (Continued).

standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 30 September 1969. S, surface; 5m, 5 meters.

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>			0.04 (0.7)			0.67 (0.7)		1.08 (0.7)		
<u>Gammarus fasciatus</u>	1.83 (94.8)	3.89 (66.3)	61.74 (97.0)	10.68 (69.3)	59.90 (97.6)	57.30 (62.7)	0.26 (0.2)	7.76 (40.0)	0.87 (93.5)	1.08 (80.0)
<u>Physocypria exquisita</u>	0.05 (2.6)	1.42 (24.2)	1.36 (2.1)	2.39 (15.5)	5.02 (7.3)	24.17 (26.5)	2.60 (19.9)	2.81 (14.5)		
<u>Neomysis americana</u>		0.08 (1.4)	0.04 (0.1)	1.05 (6.8)		1.74 (1.9)		0.15 (0.8)		
<u>Procladius adumbratus</u>		0.04 (0.7)								
<u>Chaoborus sp. bighardi</u>										
<u>Pristina breviseta</u>		0.10 (1.7)	0.04 (0.7)	0.35 (2.3)		0.37 (0.4)				0.12 (5.7)
<u>Bythotrephes cederstroemi</u>										
<u>Diacyclops thomasi</u>										
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcokeri</u>										
<u>Canella canadensis</u>										
<u>Parthenocera curtigorne</u>		0.21 (3.6)								
Total	4.99	3.82	5.94	7.85	127.88	102.83	115.94	154.84	3.25	2.09

Table A8. Zooplankton standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 30 September 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
Nauplii	1.83 (94.8)	3.89 (66.3)	61.74 (97.0)	10.68 (69.3)	59.90 (87.6)	57.30 (62.7)	6.18 (47.2)	7.76 (40.0)	0.87 (93.5)	1.08 (80.0)
Copepodites	0.05 (2.6)	1.42 (24.2)	1.36 (2.1)	2.39 (15.5)	5.02 (7.3)	24.17 (26.5)	2.60 (19.9)	2.81 (14.5)		
<u>Eurytemora affinis</u>		0.08 (1.4)	0.04 (0.1)	1.05 (6.8)		1.74 (1.9)		0.15 (0.8)		
<u>Acartia tonsa</u>		0.04 (0.7)								
<u>Diaptomus reighardi</u>										
<u>Cyclops vernalis</u>		0.10 (1.7)	0.04 (0.1)	0.35 (2.3)		0.37 (0.4)				
<u>Eucyclops agilis</u>										
<u>Halicyclops fosteri</u>		0.04 (0.7)								
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcokeri</u>										
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>		0.21 (3.6)								

Table A8. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-coregoni</u>	0.05 (2.6)	0.04 (0.7)	0.33 (0.5)	0.42 (2.7)	1.80 (2.6)	5.26 (5.8)	3.71 (28.4)	7.25 (37.4)		0.12 (8.9)
<u>Bosminopsis deitersi</u>									0.06 (6.5)	
<u>Ilyocryptus spinifer</u>							0.12 (0.9)			
<u>Diaphanosoma brachyurum</u>		0.04 (0.7)		0.11 (0.7)	1.51 (2.2)	1.74 (1.9)	0.12 (0.9)	0.42 (2.2)		
<u>Daphnia ambigua</u>										
<u>Daphnia parvula</u>										
<u>Ceriodaphnia lacustris</u>							0.12 (0.9)			
<u>Moina brachiata</u>	1.93	5.86	0.05 (0.1)	15.42	68.46	91.32	0.23 (1.8)	19.38	0.93	0.15 (11.1)
<u>Alonella acutirostris</u>				0.11 (0.7)		0.74 (0.8)		0.99 (5.1)		
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>										
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table A8. (Continued).

Table A9. Zooplankton standing crops as number per liter. Percentage of total number of organisms

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
	J-40		J-50		J-60		J-70		J-80	
<u>Leptodora kindtii</u>			0.05 (0.1)	0.31 (2.0)	0.23 (0.3)					
<u>Gammarus fasciatus</u>	5.48 (80.6)	5.97 (64.7)	33.24 (97.6)	1.05 (6.2)	47.27 (95.2)	32.35 (61.2)	17.20 (65.5)	33.22 (39.1)	0.24 (80.0)	0.61 (76.1)
<u>Physocypria exquisita</u>	1.85 (15.8)	2.98 (27.6)	0.20 (0.6)	7.76 (46.4)	6.79 (12.2)	14.60 (27.6)	1.10 (4.2)	10.00 (11.7)	0.06 (20.0)	0.09 (11.3)
<u>Neomysis americana</u>	0.10 (0.9)	0.40 (3.7)		6.49 (38.8)		1.09 (2.1)		1.79 (2.1)		
<u>Procladius adumbratus</u>	0.03 (0.3)	0.03 (0.3)								
<u>Chaoborus sp.</u>										
<u>Pristina breviseta</u>		0.10 (0.9)		0.28 (1.7)			0.12 (0.9)			
Total	1.93	5.86	63.61	15.42	68.46	91.32	13.08	19.38	0.93	1.35
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcookeri</u>										
<u>Canuella canadensis</u>	0.21 (1.8)	0.03 (0.3)								
<u>Ectinosoma curticorne</u>	0.04 (0.3)	0.10 (0.9)		0.03 (0.2)						

Table A9. Zooplankton standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 28-30 October 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<i>Nauplii</i>	9.48	6.97	33.24	1.05	47.27	32.35	17.20	33.22	0.24	0.61
	(80.6)	(64.7)	(97.6)	(6.2)	(85.2)	(61.2)	(65.5)	(39.1)	(80.0)	(76.1)
<i>Copepodites</i>	1.85	2.98	0.20	7.76	6.79	14.60	1.10	10.00	0.06	0.09
	(15.8)	(27.6)	(0.6)	(46.4)	(12.2)	(27.6)	(4.2)	(11.7)	(20.0)	(11.3)
<i>Eurytemora affinis</i>	0.10	0.40		6.49		1.09		1.79		
	(0.9)	(3.7)		(38.8)		(2.1)		(2.1)		
<i>Acartia tonsa</i>	0.03	0.03								
	(0.3)	(0.3)								
<i>Diaptomus reighardi</i>										
<i>Cyclops vernalis</i>		0.10		0.28						
		(0.9)		(1.7)						
<i>Eucyclops agilis</i>										
<i>Halicyclops fosteri</i>				0.03						
				(0.2)						
<i>Microarthridion littorale</i>					0.47	1.09	0.79	1.46		
					(0.8)	(2.1)	(3.0)	(1.7)		
<i>Canthocamptus robertcokeri</i>										
<i>Canuella canadensis</i>	0.21	0.03								
	(1.8)	(0.3)								
<i>Ectinosoma curticorne</i>	0.04	0.10		0.03						
	(0.3)	(0.9)		(0.2)						

Table A9. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-coregoni</u>	0.03 (0.3)	0.17 (1.6)	0.60 (1.8)	1.00 (6.0)	1.02 (1.8)	3.23 (6.1)	7.01 (26.7)	38.65 (45.4)		0.03 (3.8)
<u>Bosminopsis deitersi</u>										
<u>Ilyocryptus spinifer</u>						0.18 (0.3)				
<u>Diaphanosoma brachyurum</u>						0.18 (0.3)				
<u>Daphnia ambigua</u>										
<u>Daphnia parvula</u>										
<u>Ceriodaphnia lacustris</u>										0.07 (8.8)
<u>Moina brachiata</u>	11.74	10.78	34.04	16.72	55.55	52.90	26.27	85.12	0.30	0.80
<u>Alonella acutirostris</u>				0.08 (0.5)	0.47 (0.8)	1.09 (2.1)	0.79 (3.0)	1.46 (1.7)		
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>						0.18 (0.3)				
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table A9. (Continued).

Table A10. Zooplankton standing crops as number per liter. Percentage of total number of organisms

per liter in parentheses Date: 18-20 November 1969 S. surface: 5m 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>							0.17 (0.6)			
<u>Gammarus fasciatus</u>	3.73 (68.1)	2.87 (59.6)	2.46 (48.3)	2.11 (39.1)	33.80 (67.8)	23.03 (42.2)	9.05 (32.9)	7.00 (26.2)	0.57 (93.4)	0.07 (12.9)
<u>Physocypria exquisita</u>	1.71 (31.2)	1.69 (35.1)	2.23 (43.8)	2.78 (51.7)	12.40 (24.9)	19.72 (36.2)	5.26 (19.2)	5.07 (18.1)		0.25 (46.3)
<u>Neomysis americana</u>		0.03 (0.6)		0.03 (0.6)	0.09 (0.2)	4.15 (7.6)	0.21 (0.8)	1.33 (5.0)		
<u>Procladius adumbratus</u>										
<u>Chaoborus sp.</u>										0.04 (7.1)
<u>Pristina breviseta</u>				0.07 (1.3)		0.19 (0.3)		0.12 (0.4)		0.07 (8.8)
<u>Eurytemora affinis</u>									0.04 (0.8)	0.03 (0.6)
<u>Total</u>	11.74	10.78	34.04	16.72	55.55	52.90	26.27	85.12	0.30	0.80
<u>Microarthridion littorale</u>		0.03 (0.6)								
<u>Canthocamptus robertcokeri</u>				0.03 (0.6)			0.05 (0.2)			
<u>Canuella canadensis</u>										
<u>Retinosoma curtisborne</u>		0.17 (3.5)								

Table A10. Zooplankton standing crops as number per liter. Percentage of total number of organisms per liter in parentheses. Date: 18-20 November 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Nauplii</u>	3.73 (68.1)	2.87 (59.6)	2.46 (48.3)	2.11 (39.1)	33.80 (67.8)	23.03 (42.2)	9.05 (32.9)	7.00 (26.2)	0.57 (93.4)	0.07 (12.9)
<u>Copepodites</u>	1.71 (31.2)	1.69 (35.1)	2.23 (43.8)	2.78 (51.7)	12.40 (24.9)	19.72 (36.2)	5.26 (19.2)	5.07 (18.1)		0.25 (46.3)
<u>Eurytemora affinis</u>		0.03 (0.6)		0.03 (0.6)	0.09 (0.2)	4.15 (7.6)	0.21 (0.8)	1.33 (5.0)		
<u>Acartia tonsa</u>										
<u>Diaptomus reighardi</u>										0.04 (7.4)
<u>Cyclops vernalis</u>				0.07 (1.3)		0.19 (0.3)		0.12 (0.4)		
<u>Eucyclops agilis</u>									0.04 (6.6)	0.03 (5.6)
<u>Halicyclops fosteri</u>			0.04 (0.8)	0.06 (1.1)	0.71 (1.4)	3.94 (7.2)	1.31 (4.8)	1.34 (5.0)		
<u>Microarthridion littorale</u>		0.03 (0.6)						0.12 (0.4)		
<u>Canthocamptus robertcokeri</u>				0.03 (0.6)	0.07 (0.1)		0.05 (0.2)			
<u>Canuella canadensis</u>				0.07 (1.3)				0.06 (0.2)		
<u>Ectinosoma curticorne</u>		0.17 (3.5)				0.21 (0.4)				
<u>Alona guttata</u>								0.06 (0.2)		

Table A10. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-coregoni</u>	0.04 (0.7)		0.36 (7.1)	0.23 (4.3)	2.77 (5.6)	2.92 (5.4)	11.55 (42.1)	11.74 (43.7)		
<u>Bosminopsis deitersi</u>										
<u>Ilyocryptus spinifer</u>						0.39 (0.7)				
<u>Diaphanosoma brachyurum</u>										
<u>Daphnia ambigua</u>										
<u>Daphnia parvula</u>										
<u>Ceriodaphnia lacustris</u>										
<u>Moina brachiata</u>	5.48	4.82	5.09	5.38	49.84	54.55	27.43	26.84	0.61	0.54
<u>Alonella acutirostris</u>			0.04 (0.8)	0.06 (1.1)	0.71 (1.4)	3.94 (7.2)	1.31 (4.8)	1.34 (5.0)		
<u>Camptocercus macrurus</u>								0.12 (0.4)		
<u>Leydigia acanthocercoides</u>					0.07 (0.1)					
<u>Leydigia quadrangularis</u>				0.07 (1.3)				0.06 (0.2)		
<u>Alona quadrangularis</u>						0.21 (0.4)				
<u>Alona guttata</u>								0.06 (0.2)		

Table A10. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>										
<u>Gammarus fasciatus</u>										
<u>Physocypria exquisita</u>										
<u>Neomysis americana</u>		0.03								
		(0.6)								
<u>Procladius adumbratus</u>										
<u>Chaoborus sp.</u>										
<u>Pristina breviseta</u>									0.15	
									(27.8)	
Total	5.48	4.82	5.09	5.38	49.84	54.55	27.43	26.84	0.61	0.54

Appendix B
Stomach Contents

Table B1. Stomach contents as number per stomach. Percentage of total number of organisms per stomach in parentheses. Date: 16-19 June 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Nauplii</u>					0.32 (0.3)	1.59 (9.4)	10.83 (6.6)	0.32 (0.7)		
<u>Copepodites</u>	217.85 (48.8)	97.78 (49.5)	25.80 (64.8)	14.01 (34.1)	3.19 (3.0)	3.82 (22.6)	24.84 (15.2)	24.21 (53.6)		
<u>Eurytemora affinis</u>	201.29 (45.1)	75.75 (38.4)	4.78 (12.0)	14.65 (35.5)		0.64 (3.8)	4.78 (2.9)	1.91 (4.2)		
<u>Acartia tonsa</u>										
<u>Diaptomus reighardi</u>								0.32 (0.7)	2.55 (5.8)	1.06 (1.8)
<u>Cyclops vernalis</u>	7.96 (1.8)	5.41 (2.7)	5.73 (14.4)	7.64 (18.6)	0.64 (0.6)	0.64 (3.8)	6.37 (3.9)	3.82 (8.4)	0.96 (2.2)	2.12 (3.6)
<u>Eucyclops agilis</u>									0.32 (0.7)	
<u>Halicyclops fosteri</u>	8.28 (1.9)									
<u>Canthocamptus robertcokeri</u>										
<u>Canuella canadensis</u>	0.96 (0.2)									
<u>Ectinosoma curticorne</u>	0.32 (0.1)	0.64 (0.3)								
<u>Bosmina longirostris-coregoni</u>	9.24 (2.1)	16.88 (8.6)	1.59 (4.0)	3.19 (7.8)	101.60 (96.1)	9.56 (56.6)	110.52 (67.6)	5.41 (12.0)	0.32 (0.7)	1.06 (1.8)

Table B1. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Ilyocryptus spinifer</u>								0.32 (0.7)	26.44 (59.8)	35.04 (60.1)
<u>Diaphanosoma brachyurum</u>		0.32 (0.2)	0.64 (1.6)	0.32 (0.8)		1.59 (9.4)	10.83 (6.6)	6.05 (13.4)	7.01 (15.8)	11.68 (20.0)
<u>Daphnia ambigua</u>	445.90	197.42	39.82	41.09	105.75	16.89	163.41	45.23	44.29	1.06 (1.8)
<u>Daphnia parvula</u>	38.6	39.1	40.1	40.8	38.1	0.32 (1.9)	0.96 (0.6)	0.32 (0.7)	0.32 (0.7)	41.0
<u>Ceriodaphnia lacustris</u>							0.32 (0.2)	0.32 (0.7)		
<u>Moina brachiata</u>	20	20	20	20	20	20	2.87 (1.8)	1.59 (3.5)	20	1.06 (1.8)
<u>Alonella acutirostris</u>	1246	1317	1032	1102	0730	0756		0.32 (0.7)		
<u>Leydigia acanthocercoides</u>			0.32 (0.8)		0.64 (0.6)					
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>							0.64 (0.4)			
<u>Leptodora kindtii</u>				0.32 (0.8)						
<u>Physocypria exquisita</u>		0.64 (0.3)	0.64 (1.6)	0.64 (1.6)		0.32 (1.9)	0.96 (0.6)			
<u>Procladius adumbratus</u>			0.32 (0.8)				0.32 (0.2)	0.32 (0.7)	5.73 (12.9)	6.37 (10.9)
<u>Chaoborus sp.</u>									0.64 (1.4)	

Table Bl. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Pristina breviseta</u>									26.44	35.04
									(59.8)	(60.1)
Insecta (adult)		0.32		0.32					7.01	11.68
		(0.2)		(0.8)					(15.8)	(20.0)
Total	445.90	197.42	39.82	41.09	105.75	16.89	163.41	45.23	44.29	58.39
Fork length (mm)	38.6	39.1	40.1	40.8	38.1	38.7	35.7	30.0	43.5	41.0
Number of stomachs examined	20	20	20	20	20	20	20	20	20	6
Time sample taken	1246	1317	1032	1102	0730	0756	0825	0850	1215	1243
<u>Diacyclops agilis</u>									0.32	0.96
									(5.0)	(10.4)
<u>Halicyclops fosteri</u>										
<u>Canthocamptus robertcokeri</u>				0.32						
				(0.3)						
<u>Canthocamptus canadensis</u>										
<u>Eutima curticornis</u>										
<u>Bosmina longirostris-coregoni</u>	12.42	6.37	15.29	10.19	28.98	6.05	10.83	3.82	0.32	
	(23.4)	(5.1)	(7.3)	(8.6)	(65.5)	(30.1)	(23.4)	(29.2)	(5.0)	

Table B2. Stomach contents as number per stomach. Percentage of total number of organisms per stomach in parentheses. Date: 14-17 July 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Nauplii</u>	27.07	71.98	1.59	0.64	0.32		0.96			
	(50.8)	(57.1)	(0.8)	(0.5)	(0.7)		(2.1)			
<u>Copepodites</u>	6.69	37.90	163.07	56.69	6.05	11.15	19.75	7.64		0.64
	(12.6)	(30.1)	(77.5)	(48.0)	(13.7)	(55.5)	(42.7)	(58.4)		(6.9)
<u>Eurytemora affinis</u>			1.59	8.28			0.32			
			(0.8)	(7.0)			(0.7)			
<u>Acartia tonsa</u>										
<u>Diaptomus reighardi</u>										
<u>Cyclops vernalis</u>		0.32	23.25	36.31	0.64	0.96	6.69	0.64	0.64	
		(0.3)	(11.1)	(30.7)	(1.4)	(4.8)	(14.5)	(4.9)	(10.0)	
<u>Eucyclops agilis</u>									0.32	0.96
									(5.0)	(10.4)
<u>Halicyclops fosteri</u>										
<u>Canthocamptus robertcokeri</u>				0.32						
				(0.3)						
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>										
<u>Bosmina longirostris-coregoni</u>	12.42	6.37	15.29	10.19	28.98	6.05	10.83	3.82	0.32	
	(23.4)	(5.1)	(7.3)	(8.6)	(65.5)	(30.1)	(23.4)	(29.2)	(5.0)	

Table B2. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Ilyocryptus spinifer</u>							1.27 (2.7)		0.96 (15.3)	
<u>Diaphanosoma brachyurum</u>	6.69 (12.6)	8.92 (7.1)	0.96 (0.5)	0.32 (0.3)	5.10 (11.5)	0.64 (3.2)	0.96 (2.1)		1.27 (13.9)	
<u>Daphnia ambigua</u>	53.19	125.81	209.57	118.17	44.28	20.08	46.21	13.06	6.37	9.24
<u>Daphnia parvula</u>	39.6	42.5	44.3	42.8	45.1	45.5	46.7	47.1	48.5	47.5
<u>Ceriodaphnia lacustris</u>							0.96 (2.1)	0.32 (2.5)		
<u>Moina brachiata</u>						0.32 (1.6)	0.64 (1.4)			
<u>Alonella acutirostris</u>		0.32 (0.3)	1.59 (0.8)	2.55 (2.2)	2.87 (6.5)	0.96 (4.8)	2.87 (6.2)			0.32 (5.0)
<u>Leydigia acanthocercoides</u>			1.59 (0.8)	1.59 (1.3)						
<u>Leydigia quadrangularis</u>			0.32 (0.2)							
<u>Alona quadrangularis</u>										
<u>Leptodora kindtii</u>				0.32 (0.3)						
<u>Physocypria exquisita</u>			0.32 (0.2)	0.96 (0.8)	0.32 (0.7)		0.32 (0.7)	0.32 (2.5)	1.27 (19.9)	1.27 (13.8)
<u>Procladius adumbratus</u>							0.32 (0.7)	0.32 (2.5)	1.27 (19.9)	6.37 (68.9)
<u>Chaoborus sp.</u>							0.32 (0.7)			

Table B2. (Continued).

Table B3. Stomach contents as number per stomach. Percentage of total number of organisms per

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Pristina breviseta</u>										
Insecta (adult)									1.27	
	31.85	239.19	0.64	2.23	1.59		0.96		(19.9)	
	(62.1)	(91.4)	(0.8)	(2.2)	(0.2)		(1.4)			
Total	53.19	125.81	209.57	118.17	44.28	20.08	46.21	13.06	6.37	9.24
	(37.3)	(8.4)	(38.8)	(37.2)	(1.1)	(1.1)	(1.5)	(8.1)	(33.3)	(4.8)
Fork length (mm)	39.6	42.5	44.3	42.8	45.1	45.5	46.7	47.1	48.5	47.5
			(3.8)	(1.7)				(1.9)		
Number of stomachs examined	20	20	20	20	20	20	20	20	20	20
Time sample taken	1130	1225	1030	1120	0725	0800	0820	0845	1205	1330
<u>Encyclops arilis</u>										
			(33.1)	(35.1)	(0.1)		(0.9)	(3.8)	(16.7)	
<u>Halicyclops forsteri</u>										
<u>Canthocamptus robertcookeri</u>										
<u>Canuella canadensis</u>										
<u>Ectinosoma curtinorne</u>										
<u>Bosmina longirostris-coregoni</u>										
	0.64	4.14	7.33	830.65	71.03	141.41	54.15		3.19	
	(0.2)	(5.4)	(7.4)	(95.7)	(64.2)	(97.2)	(81.0)		(25.0)	

Table B3. Stomach contents as number per stomach. Percentage of total number of organisms per stomach in parentheses. Date: 18-21 August 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Nauplii</u>	31.85	239.19	0.64	2.23	1.59			0.96		
	(62.1)	(91.4)	(0.8)	(2.2)	(0.2)			(1.4)		
<u>Copepodites</u>	19.11	21.98	29.30	36.95		1.27	2.23	5.41	0.64	9.56
	(37.3)	(8.4)	(38.0)	(37.2)		(1.1)	(1.5)	(8.1)	(33.3)	(75.0)
<u>Eurytemora affinis</u>			4.46	14.65				1.27		
			(5.8)	(14.7)				(1.9)		
<u>Acartia tonsa</u>										
<u>Diaptomus reighardi</u>			0.64	0.32				0.96		
			(0.8)	(0.3)				(1.4)		
<u>Cyclops vernalis</u>			25.48	35.04	0.64	37.27	1.27	2.55	0.32	
			(33.1)	(35.1)	(0.1)	(33.6)	(0.9)	(3.8)	(16.7)	
<u>Eucyclops agilis</u>										
<u>Halicyclops fosteri</u>										
<u>Canthocamptus robertcokeri</u>										
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>										
<u>Bosmina longirostris-coregoni</u>	0.64	4.14	7.33	830.65	71.03	141.41	54.15		0.64	3.19
	(0.2)	(5.4)	(7.4)	(95.7)	(64.2)	(97.2)	(81.0)		(33.3)	(25.0)

Table B3. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Ilyocryptus spinifer</u>										
<u>Diaphanosoma brachyurum</u>	0.32 (0.6)		7.96 (10.3)	0.64 (0.6)			0.64 (1.0)		0.32 (16.7)	
<u>Daphnia ambigua</u>	51.28	261.81	77.08	99.71	966.64	110.84	145.95	66.30	1.92	12.75
<u>Daphnia parvula</u>	46.9	46.1	48.8	48.7	51.9	49.9	51.0	51.0	48.8	50.0
<u>Ceriodaphnia lacustris</u>	20	20	20	20	20	20	20	20	20	2
<u>Moina brachiata</u>	1213	1240	0.64 (0.8)	0.32 (0.3)	0.64 (0.8)	0.32 (0.3)	0.96 (1.4)		0.96 (1.4)	
<u>Alonella acutirostris</u>			1.91 (2.5)	1.27 (1.3)	33.44 (3.9)	37.27 (33.6)	0.32 (0.2)	0.96 (1.4)		
<u>Leydigia acanthocercoides</u>			1.91 (2.5)	0.32 (0.3)						
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Leptodora kindtii</u>			0.32 (0.4)	0.32 (0.3)						
<u>Physocypria exquisita</u>			0.32 (0.4)	0.64 (0.6)	0.32 (0.1)	1.27 (1.1)				
<u>Procladius adumbratus</u>							0.32 (0.2)		0.64 (33.3)	
<u>Chaoborus sp.</u>										

Table B3. (Continued). Counts as number per stomach. Percentage of total number of organisms per stomach in parentheses. Date: 17-19 September 1969. S. surface: 5m. 5 meters.

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Pristina breviseta</u>										
Insecta (adult)	13.38 (34.4)		0.96 (3.3)				10.64 (3.0)	2.87 (1.2)		0.32 (16.7)
Total	51.28	261.81	77.08	99.71	866.64	110.84	145.55	66.90	1.92	12.75
Fork length (mm)	46.9	46.1	48.8	48.7	51.9	49.9	51.0	51.0	48.8	50.0
Number of stomachs examined	20	20	20	20	20	20	20	20	20	2
Time sample taken	1213	1240	1125	1300	0831	0900	0845	0913	1335	1400
<u>Eucyclops affinis</u>										
<u>Halicyclops fosteri</u>										
<u>Canthocamptus robertcokeri</u>										
<u>Gammarus canadensis</u>										
<u>Leptocorina curvicauda</u>										
<u>Boeckia longirostris</u>	1.91 (4.9)	0.64 (0.6)		0.32 (1.7)			1.27 (3.4)	173.90 (49.5)	64.66 (28.0)	0.96 (6.7)

Table B4. Stomach contents as number per stomach. Percentage of total number of organisms per stomach in parentheses. Date: 17-19 September 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
Nauplii	13.38 (34.4)		0.96 (3.3)				10.64 (3.0)	2.87 (1.2)	1.27 (11.4)	2.23 (15.6)
Copepodites	22.66 (58.3)	25.16 (22.8)	8.28 (28.9)	10.51 (55.0)	11.78 (68.5)	8.92 (25.5)	79.94 (22.8)	79.94 (34.8)	2.23 (20.0)	6.69 (46.7)
<u>Eurytemora affinis</u>	0.32 (0.8)	64.97 (58.8)	0.96 (3.3)	1.59 (8.3)	0.64 (3.7)	13.06 (37.3)	11.78 (3.4)	5.73 (2.5)	0.96 (8.6)	
<u>Acartia tonsa</u>	0.32 (0.8)		0.32 (1.1)	0.32 (1.7)						
<u>Diaptomus reighardi</u>									0.32 (2.9)	0.32 (2.2)
<u>Cyclops vernalis</u>		10.51 (9.5)	2.23 (7.8)	4.46 (23.3)	3.82 (22.2)	10.83 (30.9)	25.80 (7.3)	31.85 (13.8)	1.27 (11.4)	0.32 (2.2)
<u>Eucyclops agilis</u>									3.82 (34.3)	1.59 (11.1)
<u>Halicyclops fosteri</u>										
<u>Canthocamptus robertcokeri</u>		5.73 (5.2)								
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>										
<u>Bosmina longirostris-coregoni</u>	1.91 (4.9)	0.64 (0.6)		0.32 (1.7)			1.27 (3.6)	173.90 (49.5)	64.66 (28.0)	0.96 (6.7)

Table B4. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Ilyocryptus spinifer</u>		0.64 (0.6)						0.32 (0.1)		
<u>Diaphanosoma brachyurum</u>	0.32 (0.8)		13.06 (45.6)	0.32 (1.7)	0.32 (1.9)		0.96 (0.3)			
<u>Daphnia ambigua</u>	38.91	110.51	28.68	19.11	17.20	35.04	351.11	230.61	11.14	14.34
<u>Daphnia parvula</u>	50.0	63.1	52.6	51.7	55.0	0.32 (0.9)	60.2	0.64 (0.3)	59.5	60.2
<u>Ceriodaphnia lacustris</u>	20	20	20	20	20	20	20	20	20	20
<u>Moina brachiata</u>	1200	1240	0.32 (1.1)	1.59 (8.3)	0.64 (3.7)	0900	46.50 (13.2)	43.32 (18.8)	1215	1241
<u>Alonella acutirostris</u>		1.27 (1.1)						0.96 (0.4)		
<u>Leydigia acanthocercoides</u>		1.27 (1.1)								
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>		0.32 (0.3)								
<u>Leptodora kindtii</u>										
<u>Physocypria exquisita</u>			2.55 (8.9)			0.64 (1.8)				0.32 (2.2)
<u>Procladius adumbratus</u>							0.32 (0.1)	0.32 (0.1)	1.27 (11.4)	1.91 (13.3)
<u>Chaoborus sp.</u>							1.27 (0.4)			

Table B4. (Continued). Contents as number per stomach. Percentage of total number of organisms per

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Pristina breviseta</u>										
Insecta (adult)	11.78	1.59								
Total	38.91	110.51	28.68	19.11	17.20	35.04	351.11	230.61	11.14	14.34
Fork length (mm)	50.0	63.1	52.6	51.7	55.0	54.8	60.2	60.7	59.5	60.2
Number of stomachs examined	20	20	20	20	20	20	20	20	20	20
Time sample taken	1200	1240	1105	1133	0735	0800	0820	0850	1215	1241
<u>Eucyclops agilis</u>										
<u>Haliencyclops fosteri</u>										
<u>Canthocamptus robertoekeri</u>	1.27	2.87	4.14	8.28	0.64	3.50		1.59		
<u>Canuella canadensis</u>										
<u>Setinosema curticorne</u>	1.59	0.64								
<u>Rosalia longirostris</u>	4.78	8.92			2.55	11.78	6.37	358.65	135.68	
<u>coregoni</u>										

Table B5. Stomach contents as number per stomach. Percentage of total number of organisms per stomach in parentheses. Date: 28-30 October 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Nauplii</u>	11.78	1.59								
	(33.8)	(7.3)								
<u>Copepodites</u>	14.33	7.01	15.29	15.93	9.24	5.41	8.60	15.61	18.79	
	(40.9)	(32.3)	(19.6)	(24.9)	(36.8)	(34.0)	(2.4)	(7.6)	(37.3)	
<u>Eurytemora affinis</u>	1.27	0.32	49.37	29.94	1.91		3.50	36.00	1.27	3.19
	(3.6)	(1.5)	(63.3)	(46.8)	(7.6)		(1.0)	(17.6)	(2.5)	(5.9)
<u>Acartia tonsa</u>										
<u>Diaptomus reighardi</u>										
<u>Cyclops vernalis</u>		0.32	8.28	6.69	0.32		0.96	4.14	0.64	
		(1.5)	(10.6)	(10.4)	(1.3)		(0.3)	(2.0)	(1.3)	
<u>Eucyclops agilis</u>									29.30	47.78
									(58.3)	(88.2)
<u>Halicyclops fosteri</u>										
<u>Canthocamptus robertcokeri</u>	1.27	2.87	4.14	8.28	0.64	3.50		1.59		
	(3.6)	(13.2)	(5.3)	(12.9)	(2.5)	(22.0)		(0.8)		
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>	1.59	0.64								
	(4.5)	(3.0)								
<u>Bosmina longirostris-coregoni</u>	4.78	8.92	2.55	11.78	6.37	336.65	135.68			
	(13.6)	(41.2)	(4.0)	(46.8)	(40.0)	(93.2)	(66.3)			

Table B5. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Ilyocryptus spinifer</u>				0.32 (0.4)						
<u>Diaphanosoma brachyurum</u>										
<u>Daphnia ambigua</u>	35.02	21.67	78.04	64.03	25.16	15.92	360.86	204.49	50.32	54.16
<u>Daphnia parvula</u>	55.5	57.2	63.9	64.6	66.1	64.2	71.9	68.7	67.6	65.5
<u>Ceriodaphnia lacustris</u>	20	23	20	20	20	20	20	20	20	2
<u>Moina brachiata</u>	1100	1125	1055	1120	0755	0823	0815	0845	1205	1235
<u>Alonella acutirostris</u>				0.32 (0.5)	1.27 (5.0)		10.83 (3.0)	11.15 (5.5)		
<u>Leydigia acanthocercoides</u>			0.64 (0.8)	0.32 (0.5)		0.64 (4.0)				
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Leptodora kindtii</u>										
<u>Physocypria exquisita</u>										
<u>Procladius adumbratus</u>							0.32 (0.1)			3.19 (5.9)
<u>Chaoborus sp.</u>								0.32 (0.2)	0.32 (0.6)	

Table B5. (Continued). Organisms as number per stomach. Percentage of total number of organisms per stomach in parentheses. Date: 18-20 November 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Pristina breviseta</u>										
Insecta (adult)							0.32			
							(0.3)			
Total	35.02	21.67	78.04	64.03	25.16	15.92	360.86	204.49	50.32	54.16
Fork length (mm)	55.5	57.2	63.9	64.6	66.1	64.2	71.9	68.7	67.6	65.5
Number of stomachs examined	20	20	20	20	20	20	20	20	20	2
Time sample taken	1100	1125	1055	1120	0755	0823	0815	0845	1205	1235
<u>Eucyclops agilis</u>	0.32		3.82	2.68	3.50	3.50	6.05	8.92		
	(2.3)		(10.2)	(6.1)	(7.7)	(3.8)	(5.3)	(8.0)		
<u>Helicyclops fosteri</u>										
<u>Canthocamptus robertcookeri</u>	4.14	5.10	5.41	9.39	3.19	5.41	2.55	2.87		
	(29.5)	(94.1)	(14.5)	(21.5)	(7.1)	(5.9)	(2.7)	(2.6)		
<u>Candella canadensis</u>										
<u>Dotinosoma cuthberti</u>										
<u>Desmire longirostris-coregoni</u>	0.32		0.96	1.34	6.37	3.50	17.84	9.24		
	(2.3)		(2.6)	(3.1)	(14.1)	(3.8)	(18.7)	(8.3)		

Table B6. Stomach contents as number per stomach. Percentage of total number of organisms per stomach in parentheses. Date: 18-20 November 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<i>Nauplii</i>							0.32 (0.3)			
<i>Copepodites</i>	6.69 (47.8)	0.32 (5.9)	12.42 (33.3)	17.77 (40.8)	14.97 (33.0)	28.03 (30.7)	11.78 (12.3)	19.75 (17.7)		
<i>Eurytemora affinis</i>	2.55 (18.1)		13.70 (36.8)	11.06 (25.4)	11.15 (24.7)	39.86 (43.7)	43.00 (45.0)	49.69 (44.3)		
<i>Acartia tonsa</i>							0.32 (0.3)			
<i>Diaptomus reighardi</i>										
<i>Cyclops vernalis</i>	0.32 (2.3)		3.82 (10.2)	2.68 (6.1)	3.50 (7.7)	3.50 (3.8)	6.05 (6.3)	8.92 (8.0)		
<i>Eucyclops agilis</i>										
<i>Halicyclops fosteri</i>										
<i>Canthocamptus robertcokeri</i>	4.14 (29.5)	5.10 (94.1)	5.41 (14.5)	9.39 (21.5)	3.19 (7.1)	5.41 (5.9)	2.55 (2.7)	2.87 (2.6)		
<i>Canuella canadensis</i>										
<i>Ectinosoma curticorne</i>										
<i>Bosmina longirostris-coregoni</i>	0.32 (2.3)		0.96 (2.6)	1.34 (3.1)	6.37 (14.1)	3.50 (3.8)	17.84 (18.7)	9.24 (8.3)		

Table B6. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Ilyocryptus spinifer</u>							0.64 (0.7)			
<u>Diaphanosoma brachyurum</u>										
<u>Daphnia ambigua</u>	14.02	5.42	37.27	43.59	45.23	91.45	95.56	111.91		
<u>Daphnia parvula</u>	72.2	72.9	74.7	63.1	69.4	70.3	74.3	72.9		
<u>Ceriodaphnia lacustris</u>							0.32 (0.3)	20		
<u>Moina brachiata</u>	1213	1243	1200	1229	0945	0937	0813	0840		
<u>Alonella acutirostris</u>			0.32 (0.9)		4.46 (9.9)	5.41 (5.9)	11.47 (12.0)	12.74 (11.4)		
<u>Leydigia acanthocercoides</u>				0.32 (0.8)		1.91 (2.1)				
<u>Leydigia quadrangularis</u>				0.34 (0.8)	1.27 (2.8)	3.19 (3.5)	1.59 (1.7)	5.73 (5.1)		
<u>Alona quadrangularis</u>						0.32 (0.3)				
<u>Leptodora kindtii</u>										
<u>Physocypria exquisita</u>			0.64 (1.7)	0.67 (1.5)	0.32 (0.7)	0.32 (0.3)		0.32 (0.3)		
<u>Procladius adumbratus</u>								1.59 (1.4)		
<u>Chaoborus sp.</u>							0.32 (0.3)	0.64 (0.6)		

Table B6. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Pristina breviseta</u>										
Insecta (adult)										
Total	14.02	5.42	37.27	43.59	45.23	91.45	95.56	111.81		
Fork length (mm)	72.2	72.9	74.7	69.1	69.4	70.3	74.3	72.9		
Number of stomachs examined	20	20	20	19	20	20	20	20		
Time sample taken	1213	1243	1200	1229	0845	0910	0813	0840		

Appendix C
Electivity (E)

Table C1. Selection (Electivity of Ivlev, 1961) of zooplankton by young-of-the-year blueback herring. Date: 16-19 June 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
Nauplii	-1.00	-1.00	-1.00	-1.00	-0.98	-1.00	-1.00	-0.96	-1.00	-1.00
Copepodites	+0.06	+0.02	+0.79	+0.25	-0.95	+0.06	+0.11	+0.75	-1.00	-1.00
<u>Eurytemora affinis</u>	+0.87	+0.20	+0.97	+0.39	-1.00	+0.10	+0.53	+0.75		
<u>Acartia tonsa</u>										
<u>Diaptomus reighardi</u>								+1.00	+1.00	
<u>Cyclops vernalis</u>	+1.00	-0.42	+0.97	-0.05		+0.09	+0.77	+0.66	-0.52	+1.00
<u>Eucyclops agilis</u>									+1.00	
<u>Halicyclops fosteri</u>	+0.31	-1.00								
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcokeri</u>										
<u>Canuella canadensis</u>	+1.00									
<u>Ectinosoma curticorne</u>	+1.00	+1.00		-1.00						

Table Cl. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-</u> <u>coregoni</u>	-0.84	-0.09	-0.56	-0.48	+0.36	+0.22	+0.31	-0.62	-0.77	+1.00
<u>Bosminopsis deitersi</u>		-1.00								
<u>Ilyocryptus spinifer</u>		+1.00	+1.00	+1.00		+1.00	+1.00		-1.00	
<u>Diaphanosoma brachyurum</u>	-1.00	-1.00	+0.33	-0.80	-1.00	+0.24	-0.16	+0.42		
<u>Daphnia ambigua</u>			+1.00			-1.00	+1.00	+0.56	+1.00	+0.05
<u>Daphnia parvula</u>						+1.00	+1.00	+1.00	+1.00	
<u>Ceriodaphnia lacustris</u>						-1.00	+1.00	+1.00	+1.00	+0.72
<u>Moina brachiata</u>		+1.00		+1.00			+1.00	+1.00	+1.00	+1.00
<u>Alonella acutirostris</u>			+1.00		+1.00	-1.00	-1.00	+0.56	-1.00	
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>										
<u>Leydigia quadrangularis</u>							+1.00			
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table Cl. (Continued). Electivity of Ivlev, 1961) of zooplankton by young-of-the-year blueback herring. Date: 14-17 July 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>	-1.00			-0.64		-1.00	-1.00	-1.00		
<u>Gammarus fasciatus</u>	-0.28	-1.00	-0.98	-0.94	-0.97	-1.00	-0.94	-1.00	-1.00	-1.00
<u>Physocypria exquisita</u>	+0.52	+1.00	+1.00	+1.00	+0.03	+1.00	+1.00	+0.54	-1.00	-0.23
<u>Neomysis americana</u>		-1.00	+1.00	+0.89		-1.00	+1.00			
<u>Procladius adumbratus</u>			+1.00			-1.00	+1.00	+0.56	+1.00	+0.05
<u>Chaoborus sp. hardi</u>									+1.00	
<u>Pristina breviseta</u>	-1.00	-0.82	+1.00	+0.55	+1.00	-0.02	+0.52	+0.02	+1.00	+0.72
<u>Insecta (adult)</u>		+1.00		+1.00					+1.00	+1.00
<u>Haliencyclops fassati</u>		-1.00								
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertsoni</u>				+1.00						
<u>Canuella canadensis</u>										
<u>Limnocalanus curticornis</u>		-1.00								

Table C2. Selection (Electivity of Ivlev, 1961) of zooplankton by young-of-the-year blueback herring. Date: 14-17 July 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Nauplii</u>	-0.28	+0.18	-0.98	-0.94	-0.97	-1.00	-0.94	-1.00	-1.00	-1.00
<u>Copepodites</u>	+0.52	+0.13	+0.92	-0.01	+0.03	+0.35	+0.50	+0.54	-1.00	-0.23
<u>Eurytemora affinis</u>		-1.00	+1.00	+0.89		-1.00	+1.00			
<u>Acartia tonsa</u>										
<u>Diaptomus reighardi</u>										
<u>Cyclops vernalis</u>	-1.00	-0.82	+1.00	+0.55	+1.00	-0.02	+0.92	+0.02	+1.00	
<u>Eucyclops agilis</u>									+1.00	+1.00
<u>Halicyclops fosteri</u>		-1.00								
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcokeri</u>				+1.00						
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>		-1.00								

Table C2. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-</u> <u>coregoni</u>	+0.84	-0.66	+0.09	-0.21	+0.47	+0.16	+0.28	-0.12	+1.00	
<u>Bosminopsis deitersi</u>										
<u>Ilyocryptus spinifer</u>			+1.00	+0.33	+1.00	-1.00	+1.00	-1.00	+1.00	+1.00
<u>Diaphanosoma brachyurum</u>	+0.50	-0.06	-0.67	-0.96	+0.31	-0.54	-0.58	-1.00		
<u>Daphnia ambigua</u>							+1.00	+1.00	+1.00	+1.00
<u>Daphnia parvula</u>							+1.00			
<u>Ceriodaphnia lacustris</u>							+1.00	+1.00		-1.00
<u>Moina brachiata</u>	+1.00					+0.68	+1.00		+1.00	
<u>Alonella acutirostris</u>		+1.00	+1.00	+0.57	+0.35	+0.23	+1.00	-1.00	+1.00	-1.00
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>			+1.00	+1.00						
<u>Leydigia quadrangularis</u>			+1.00							
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table C2. (Continued). Selectivity of Ivlev, 1961) of zooplankton by young-of-the-year blueback

herring. Date: 18-21 August 1969. S. surface. 5m. 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>				-0.25		-1.00				
<u>Gammarus fasciatus</u>	-0.12	+0.65	-0.98	-0.91	-0.99	-1.00	-1.00	-0.84	-1.00	-1.00
<u>Physocypria exquisita</u>	+0.48	-0.60	+1.00	+0.33	+1.00	-1.00	+1.00	+1.00	+1.00	+1.00
<u>Neomysis americana</u>		-1.00	+0.78	+0.55		-1.00	-1.00	+0.19		
<u>Procladius adumbratus</u>							+1.00	+1.00	+1.00	+1.00
<u>Chaoborus sp.</u>							+1.00			
<u>Pristina breviseta</u>		-1.00	+0.97	+0.81	-0.58	-1.00	+1.00	-0.07		-1.00
<u>Insecta (adult)</u>	+1.00								+1.00	
<u>Salvelinus fontinalis</u>		-1.00								
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcookeri</u>										
<u>Canuella canadensis</u>										
<u>Ectinosora curticoe</u>				-1.00						

Table C3. (Continued)
 Selection (Electivity of Ivlev, 1961) of zooplankton by young-of-the-year blueback
 herring. Date: 18-21 August 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
Nauplii	-0.12	+0.65	-0.98	-0.91	-0.99	-1.00	-1.00	-0.84	-1.00	-1.00
Copepodites	+0.48	-0.60	+0.40	+0.08	-1.00	-0.82	-0.71	-0.07	-0.13	+0.23
<u>Eurytemora affinis</u>	-0.43	-1.00	+0.78	+0.55	-1.00	-1.00	-1.00	+0.19		
<u>Acartia tonsa</u>										
<u>Diaptomus reighardi</u>										
<u>Cyclops vernalis</u>		-1.00	+0.97	+0.81	-0.50	-1.00	+1.00	-0.07		
<u>Eucyclops agilis</u>			+1.00	+1.00				+1.00	+1.00	
<u>Halicyclops fosteri</u>		-1.00	+1.00	+1.00	+0.56	+0.69	+0.76	+0.40		
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcokeri</u>			+1.00	+1.00						
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>				-1.00						

Table C3. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-</u> <u>coregoni</u>	-1.00	-0.93	-0.21	-0.08	+0.25	+0.09	+0.26	+0.14		+1.00
<u>Bosminopsis deitersi</u>										
<u>Ilyocryptus spinifer</u>										
<u>Diaphanosoma brachyurum</u>	-0.43	-1.00	+0.51	-0.68	-1.00	-1.00	-1.00	-0.57		
<u>Daphnia ambigua</u>										
<u>Daphnia parvula</u>										
<u>Ceriodaphnia lacustris</u>										
<u>Moina brachiata</u>			+1.00	+1.00				+1.00		
<u>Alonella acutirostris</u>			+1.00	+1.00	+0.56	+0.69	-0.76	-0.40		
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>			+1.00	+1.00						
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table C3. (Continued). Selectivity of Ivlev, 1961) of zooplankton by young-of-the-year blueback

herring Date: 12-19 September 1969 S. surface: 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>			-0.11	-0.63				-1.00		
<u>Gammarus fasciatus</u>	-0.34	-1.00	-0.88	-1.00	-1.00	-1.00	-0.88	-0.91	-0.70	-0.68
<u>Physocypria exquisita</u>	+0.43	-1.00	+1.00	0.00	+1.00	+1.00	+0.48	+0.37	+0.30	+0.78
<u>Neomysis americana</u>	+1.00	+0.81	+0.20	+0.48	+1.00	+0.37	+0.89	+0.56	+1.00	
<u>Procladius adumbratus</u>	+1.00	-1.00	+1.00	+1.00			+1.00		+1.00	
<u>Chaoborus sp. ghardi</u>					-1.00				+1.00	+1.00
<u>Pristina breviseta</u>		+0.11	+1.00	+0.75	+0.98	+0.86	+1.00	+0.93	+1.00	+1.00
<u>Insecta (adult)</u>									+1.00	+0.32
<u>Halobella</u>		-1.00								
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcookeri</u>		+1.00								
<u>Canella canadensis</u>										
<u>Retinosoma curticorne</u>										

Table C4. (Continued)
 Selection (Electivity of Ivlev, 1961) of zooplankton by young-of-the-year blueback
 herring. Date: 17-19 September 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
Nauplii	-0.34	-1.00	-0.88	-1.00	-1.00	-1.00	-0.88	-0.91	-0.70	-0.68
Copepodites	+0.43	-0.32	-0.18	+0.18	+0.58	-0.18	+0.48	+0.37	+0.30	+0.78
<u>Eurytemora affinis</u>	+1.00	+0.81	+0.20	+0.48	+1.00	+0.37	+0.89	+0.56	+1.00	
<u>Acartia tonsa</u>	+1.00	-1.00	+1.00	+1.00						
<u>Diaptomus reighardi</u>					-1.00				+1.00	+1.00
<u>Cyclops vernalis</u>		+0.11	+1.00	+0.75	+0.98	+0.86	+1.00	+0.93	+1.00	+1.00
<u>Eucyclops agilis</u>									+1.00	+0.32
<u>Halicyclops fosteri</u>		-1.00								
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcookeri</u>		+1.00								
<u>Canuella canadensis</u>										
<u>Ectinosoma curticorne</u>										

Table C4. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-</u> <u>coregoni</u>	+0.31	-0.25	-1.00	-0.08	-1.00	+0.24	+0.20	-0.14	-1.00	+1.00
<u>Bosminopsis deitersi</u>							-1.00			
<u>Ilyocryptus spinifer</u>		-0.25	+1.00			+1.00		+1.00	-1.00	+1.00
<u>Diaphanosoma brachyurum</u>	-0.62	-1.00	+0.85	-0.66	+0.23	-1.00	-0.87	-1.00		
<u>Daphnia ambigua</u>							+1.00	+1.00	+1.00	+1.00
<u>Daphnia parvula</u>						+1.00	+1.00	+1.00		
<u>Ceriodaphnia lacustris</u>			-1.00							-1.00
<u>Moina brachiata</u>			+1.00	+1.00	+0.76	-1.00	+0.19	+0.21		
<u>Alonella acutirostris</u>		+1.00		-1.00		-1.00	-1.00	-0.27		
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>		+1.00								
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>		+1.00								
<u>Alona guttata</u>										

Table C4. (Continued). Selectivity of Ivlev, 1961) of zooplankton by young-of-the-year blueback

herring. Date: 28-30 October 1969. S. surface: 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>			-1.00			-1.00		-1.00		
<u>Gammarus fasciatus</u>	-0.41	-0.80	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
<u>Physocypria exquisita</u>	+0.44	+0.08	+1.00	-0.30	+0.50	+1.00	-0.27	-0.21	+0.30	+1.00
<u>Neomysis americana</u>	+0.60	-0.42	+1.00	+0.09	+1.00	-1.00	+1.00	+0.79	+1.00	+1.00
<u>Procladius adumbratus</u>	-1.00	-1.00					+1.00	+1.00	+1.00	+1.00
<u>Chaoborus sp.</u>							+1.00			
<u>Pristina breviseta</u>		+0.25	-1.00	+0.72	+1.00		+1.00	+1.00	+1.00	-1.00
<u>Insecta (adult)</u>									+1.00	+1.00
<u>Halicyclops fuscicornis</u>				-1.00						
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertsoni</u>	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00		+1.00		
<u>Canuella canadensis</u>	-1.00	-1.00								
<u>Scutellum curticorne</u>	+0.88	+0.54		-1.00						

Table C5. Selection (Electivity of Ivlev, 1961) of zooplankton by young-of-the-year blueback herring. Date: 28-30 October 1969. S, surface; 5m, 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
Nauplii	-0.41	-0.80	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
Copepodites	+0.44	+0.08	+0.94	-0.30	+0.50	+0.10	-0.27	-0.21	+0.30	-1.00
<u>Eurytemora affinis</u>	+0.60	-0.42	+1.00	+0.09	+1.00	-1.00	+1.00	+0.79	+1.00	+1.00
<u>Acartia tonsa</u>	-1.00	-1.00								
<u>Diaptomus reighardi</u>										
<u>Cyclops vernalis</u>		+0.25	+1.00	+0.72	+1.00		+1.00	+1.00	+1.00	
<u>Eucyclops agilis</u>									+1.00	+1.00
<u>Halicyclops fosteri</u>				-1.00						
<u>Microarthridion littorale</u>										
<u>Canthocamptus robertcokeri</u>	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00		+1.00		
<u>Canuella canadensis</u>	-1.00	-1.00								
<u>Ectinosoma curticorne</u>	+0.88	+0.54		-1.00						

Table C5. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-</u> <u>coregoni</u>	-0.96	+0.93	-1.00	-0.20	+0.93	+0.74	+0.55	+0.19		-1.00
<u>Bosminopsis deitersi</u>										
<u>Ilyocryptus spinifer</u>			+1.00			-1.00				
<u>Diaphanosoma brachyurum</u>						-1.00				
<u>Daphnia ambigua</u>							+1.00		+1.00	+1.00
<u>Daphnia parvula</u>							+1.00			
<u>Ceriodaphnia lacustris</u>										-1.00
<u>Moina brachiata</u>										
<u>Alonella acutirostris</u>				0.00	+0.72	-1.00	0.00	+0.53		
<u>Camptocercus macrurus</u>										
<u>Leydigia acanthocercoides</u>			+1.00	+1.00		+0.86				
<u>Leydigia quadrangularis</u>										
<u>Alona quadrangularis</u>										
<u>Alona guttata</u>										

Table C5. (Continued). Electivity of Ivlev, 1961) of zooplankton by young-of-the-year blueback

herring. Date: 18-20 November 1969. S. surface: 5m. 5 meters

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>							-1.00			
<u>Gammarus fasciatus</u>	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-0.98		
<u>Physocypria exquisita</u>	+0.21	-0.71	-0.14	-0.12	+0.14	-0.08	-0.22	-0.01		
<u>Neomysis americana</u>	+1.00	-1.00	+1.00	+0.95	+0.98	+0.70	+0.95	+0.80		
<u>Procladius adumbratus</u>							+1.00		+1.00	+1.00
<u>Chaoborus sp. ghardi</u>							+1.00			
<u>Pristina breviseta</u>	+1.00		+1.00	+0.65	+1.00	+0.85	+1.00	+0.90		-1.00
<u>Insecta (adult)</u>										
<u>Halicyclops foveolatus</u>										
<u>Microarthridion littorale</u>		-1.00								
<u>Canthocamptus robertsoni</u>	+1.00	+1.00	+1.00	+0.95	+1.00	+1.00	+0.86	+1.00		
<u>Cercaria canadensis</u>										
<u>Entinosema curticoxae</u>		-1.00								

Table C6. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Bosmina longirostris-</u> <u>coregoni</u>	+0.53		-0.46	-0.16	+0.43	-0.17	-0.38	-0.68		
<u>Bosminopsis deitersi</u>					+1.00					
<u>Ilyocryptus spinifer</u>			+1.00	+1.00		-1.00	+1.00	+1.00		
<u>Diaphanosoma brachyurum</u>			-1.00							
<u>Daphnia ambigua</u>								+1.00		
<u>Daphnia parvula</u>							+1.00	+1.00		
<u>Ceriodaphnia lacustris</u>							+1.00			
<u>Moina brachiata</u>										
<u>Alonella acutirostris</u>			+0.06	-1.00	+0.75	-0.10	+0.43	+0.39		
<u>Camptocercus macrurus</u>								-1.00		
<u>Leydigia acanthocercoides</u>				+1.00	-1.00	+1.00				
<u>Leydigia quadrangularis</u>			-0.24	+1.00	+1.00	+1.00	+1.00	+0.92		
<u>Alona quadrangularis</u>						-0.14				
<u>Alona guttata</u>								-1.00		

Table C6. (Continued).

Organism	Station and depth									
	J-40		J-50		J-60		J-70		J-80	
	S	5m	S	5m	S	5m	S	5m	S	5m
<u>Leptodora kindtii</u>										
<u>Gammarus fasciatus</u>					+1.00					
<u>Physocypria exquisita</u>			+1.00	+1.00		+1.00		+1.00		
<u>Neomysis americana</u>										
<u>Procladius adumbratus</u>								+1.00		
<u>Chaoborus</u> sp.							+1.00	+1.00		
<u>Pristina breviseta</u>										
Insecta (adult)										

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