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Food Habits of Young-of-the-Year Fishes in Abbey Pond, South Dakota

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FOOD HABITS OF

YOUNG-OF-THE-YEAR

FISHES IN

ABBEY POND, SOUTH DAKOTA

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Advisor Date

Head, Dept. of Wildlife and Fisheries Science Date

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RDR

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ABSTRACT

Randall D. Radant

Food habits of young-of-the-year largemouth bass (Micropterus salmoides), bluegill (Lepomis macrochirus), black crappie (Pomoxis nigromaculatus), yellow bullhead (Ictalurus natalis), and yellow perch (Perca flavescens) were studied during 1973 and 1974 in Abbey Pond, South Dakota. Organisms found in young-of-the-year fish stomachs and in plankton samples were identified and counted in the laboratory. Zooplankton, aquatic insects and fish were the most important food organisms consumed by young fishes. Using Ivlev's electivity index food electivity by the fishes for zooplankton was calculated.

The size-specific food habits of young-of-the-year largemouth bass progressed from entomostracans to aquatic insects to fish. In most cases zooplanktors were negatively elected for after mid August, 1973, and after the end of July, 1974. During the first half of the 1973 summer Chydorus sp. was positively elected for, while during the early summer of 1974, cyclopoid copepods were positively elected. Young-of-the-year blue-gill fed mostly on zooplankton and insect larvae. Zooplankton electivity by bluegill indicated that Chydorus sp. was positively elected and that Bosmina longirostris and Ceriodaphnia sp. were negatively elected. Entomostracans were the dominant food organisms for young black crappie throughout their first summer of life. Young black crappie exhibited positive electivity indices for cyclopoid copepods and negative electivity indices for Bosmina longirostris. Young-of-the-year yellow bullheads fed primarily on small crustaceans and immature insects. Hyalella sp. was a major food organism for young yellow bullheads of all sizes. Young-of-the-year yellow bullheads had positive electivity indices, in most cases, for Chydorus sp. and ostracods and negative indices for Daphnia ambigua, Ceriodaphnia sp. and Bosmina longirostris. Yellow perch young-of-the-year fed primarily on zooplankton and aquatic insects. Utilization of food organisms by yellow perch indicated a progression from microcrustaceans to aquatic insects. Young-of-the-year yellow perch had negative electivity indices for Daphnia galeata and D. ambigua and, with one exception, positive indices for Chydorus sp. Larval yellow perch fed almost exclusively on chlamydomonads and rotifers. Larval bluegill utilized cladocerans, copepods, rotifers and chlamydomonads as food.

Analysis of species food habits did not indicate niche segregation. The degree of overlapping food habits existing in Abbey Pond may be an important protection against overpopulation and may result in a more stable fish population.

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INTRODUCTION

The first summer of life is one of the most critical periods of time for most fishes. Because young fish are often specific for a food type, the food organisms present and utilized during this period are important for survival and development. Knowledge of food habits of young fish is important since food availability is critical in determining the size of the year class entering a population. A breakdown of the food chain at this point could be as disastrous as a direct fish kill (Siefert, 1972). Seaburg and Moyle (1964) emphasized the need for determining trends in feeding throughout a season, selective feeding and competition for food between different species, and relationships between food, feeding habits and growth of fish.

Abbey Pond is a highly productive body of water with a diverse fish population. The existence of a multispecies system in a South Dakota farm pond is unusual in that most farm ponds in the State typically contain only one or two fish species (Gengerke, 1972). Tang (1970) indicated that maximum fish production is attained by the association of fish species varying in food habits. This makes possible the effective utilization of the various available fish foods in a pond ecosystem. Ivlev (1961) indicated that competition for food among animals occupies a central position in the struggle for existence. Continued competition by fish for a limiting resource will result in the eventual elimination of one or more species from a system. Since the food and feeding habits of fishes form their ecological associations, an understanding of their food habits is necessary for proper management of the fisheries resource (Bailey and Harrison, 1945).

The objective of this study was to determine the food habits of the predominant young-of-the-year fish species in Abbey Pond. Plankton availability in the pond was also examined to determine its relationship to the food habits of young-of-the-year fish.

Our ability to evaluate competition between fishes and to describe the relationship the various species of fish have with the available food resources during their first summer of life should be improved following this study. This may indicate the mechanisms by which various species of fish are able to achieve a stable coexistence within a system. This information will assist in managing our fisheries resources.

DESCRIPTION OF STUDY AREA

Blue Cloud Abbey Pond is owned and administered by the Blue Cloud Abbey Monastery and is located on the eastern edge of the Coteau des Prairie in Grant County, South Dakota. The pond was constructed in 1954 by impounding an unnamed intermittent tributary of the Whetstone River. The primary use of the pond is for recreation.

The Coteau des Prairie is a plateau irregularly covered with glacial drift and characterized by chernozem soils (Schmidt, 1967). Average rainfall is 22.1 inches per year with temperature fluctuations from -35.5^{o} C (-32.0^{o} F) in winter to 42.4^{o} C (108.0^{o} F) in the summer. Average temperature for the year is 7.1^{o} C (44.8^{o} F). Agriculture is the major economic pursuit of the region. Cropland and pasture provide the main agricultural production.

The pond (Figure 1) has a surface area of 1.62 ha (4.05 acres) and encompasses a drainage area of approximately 404.8 ha (1,012.0 acres). Cropland and permanent pasture provide the predominant vegetative cover on the uplands while grass and willow cover occur adjacent to the pond. Surface runoff is the principal source of water for the pond and outflow is limited to periods of above normal run-off in the spring. The face of the earthen dam is covered with rocks to prevent erosion from wave action. Rock, sand and silt comprise the bottom of the pond. A feed-lot drained into a small settling pond near the upper end of the impoundment prior to 1968. Although this has since been discontinued it may have contributed to the present high productivity of the pond. Nuisance algal blooms were present during the summer of 1974. Throughout

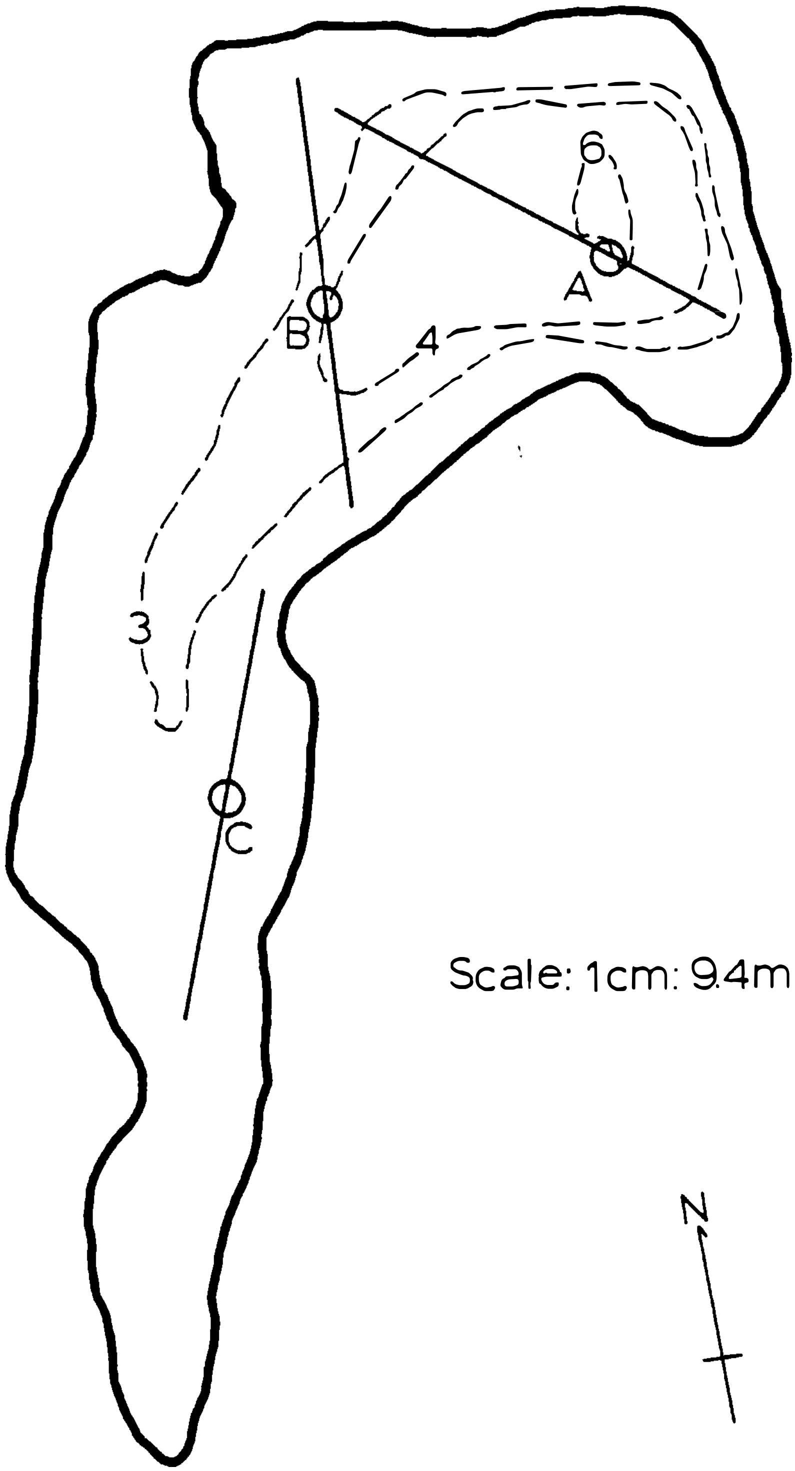

Figure 1. Bathymetric map of Abbey Pond (straight lines represent approximate location of Miller zooplankton tows and circles represent approximate location of Wisconsin phytoplankton pulls).

the summer of 1973 and 1974 dense mats of submerged vegetation formed a ring around the outer margins of the pond and clogged the shallow areas. Small willows are characteristic of more than 50% of the shoreline perimeter, and emergent cattails are present in some areas of open shoreline.

Physical characteristics of the pond include: shoreline length, 465.7 m, maximum depth, 6.09 m, mean depth, 2.9 m, volume, 46,920 m^3, mean slope, 9.4%, and shoreline development, 1.7 (Gengerke, 1972). Ranges of some physical and chemical properties of Abbey Pond during the study period were: water temperature ranged from a low of 4.5° C in November 1973 to a high of 24.5° C in June 1973; secchi disc visibility varied from 105.0 cm in June 1973 to 200.0 cm in May 1974; pH from 6.9 in August 1973 to 8.7 in September 1974; total alkalinity from 90.0 mg/l in June 1974 to 170.0 mg/l in June 1973; total hardness, from 195.0 mg/l in June 1974 to 300.0 mg/l in July 1973; and dissolved oxygen near the surface ranged from 7.8 mg/l in July 1974 to 14.0 mg/l in September 1974. These values as well as other limnological data (Appendix Table 1 and 2) are similar to those found by Schmidt (1967) for lakes in eastern South Dakota.

Thirteen fish species have been reported to occur in the pond (Table 1). With the stocking of northern pike (Esox lucius) in 1974, 7 of the 13 species of fish in the pond can be considered common. These include the northern pike, bluegill (Lepomis macrochirus), pumpkinseed (L. gibbosus), yellow perch (Perca flavescens), largemouth bass (Micropterus salmoides), black crappie (Pomoxis nigromaculatus), and

Table 1. Species of fish reported to occur in Abbey Pond.[1]

Common name	
Northern pike	*Esox lucius* Linnaeus
Largemouth bass	*Micropterus salmoides* (Lacepede)
Yellow perch	*Perca flavescens* (Mitchill)
Black crappie	*Pomoxis nigromaculatus* (Lesueur)
White crappie	*Pomoxis annularis* Rafinesque
Bluegill	*Lepomis macrochirus* Rafinesque
Pumpkinseed	*Lepomis gibbosus* (Linnaeus)
Yellow bullhead	*Ictalurus natalis* (Lesueur)
Black bullhead	*Ictalurus melas* (Rafinesque)
Walleye	*Stizostedion vitreum vitreum* (Mitchill)
White bass	*Morone chrysops* (Rafinesque)
Flathead catfish	*Pylodictis olivaris* (Rafinesque)
Fathead minnow	*Pimephales promelas* Rafinesque

[1]Names according to Trans. Amer. Fish. Soc., Spec. Publ. No. 6, A list of Common and Scientific Names of Fishes from the United States and Canada, 3rd Edition, 1970.

yellow bullhead (*Ictalurus natalis*). Estimates made in the fall of 1970 (Gengerke, 1972) indicated a total of 3,655 adult fish per hectare. A similar estimate for total population numbers was made in 1968 (Thorn, 1969).

METHODS

Water, phytoplankton, zooplankton and young-of-the-year fish samples were collected in 1973 and 1974. Phytoplankton, zooplankton, and young-of-the-year fish were sampled at 10-day intervals except during September and October, 1973, when samples were taken at 2 and 3 week periods, respectively. Water analyses were made once each month from June through December, 1973, and from May through September, 1974. A secchi disc was used to obtain an index of visibility. Water temperatures were measured at 1 meter intervals with a YSI Model 425c Tele-Thermometer. A YSI Model 54 dissolved oxygen meter was used to measure dissolved oxygen concentrations on the bottom and at the surface during 1974. All other chemical factors were analyzed as described in the Hach Chemical Company Catalogue No. 10.

Phytoplankton samples were obtained by making a vertical pull with a Wisconsin plankton net fitted with a No. 20 net. Three stations (Figure 1) were sampled on each sampling date. Each station represented a different area of the pond and different water depth; Station A represented the deep end of the pond with water depth averaging 4 to 6 m; Station B represented the middle of the pond with water depth averaging 3 to 4 m; and Station C represented the shallow portion of the pond with water depth averaging 1 to 2 m. Samples were preserved in Lugol's solution. Phytoplankton samples were diluted to convenient fixed volumes, and numbers determined by counting three 1-ml subsamples in a Sedgewick-Rafter counting chamber at 150X.

Zooplankton samples were obtained by making three oblique tows, on each sampling date, (Figure 1) with a metered Miller sampler (Miller, 1961) fitted with No. 10 netting. One tow was made near each of the three stations. Samples were preserved in Lugol's solution. Zooplankton samples were diluted to convenient fixed volumes, and three 1-ml subsamples were counted in a circular counting wheel (Ward, 1955).

Young-of-the-year fishes were collected with dip nets, meter nets, Miller sampler and seines. The best results were obtained by seining the north and northeastern portions of the pond with a 4.57 x 1.52 m (15 x 5 ft), 0.32 cm (1/8 in) mesh seine. Upon capture the fishes were placed in a 10% formalin solution. An attempt was made, on each sampling date, to collect 10 fish of each species during 1973 and 15 of each species during 1974. Stomach contents were examined from 218 largemouth bass, 205 bluegill, 82 black crappie, 38 yellow bullhead and 35 yellow perch. Total lengths of all fishes were recorded to the nearest millimeter. Stomach contents of postlarval fishes was determined from food present in the anterior portion of the digestive tract, including the esophagus. The entire digestive tract was utilized in larval fish food study. The ingested food organisms were identified and counted with the aid of compound and binocular microscopes. When large numbers of microcrustaceans were present in a stomach, the organisms were counted using the same procedures applied to zooplankton samples.

Selection of available zooplankton by young-of-the-year fishes was determined by use of the quantitative index of electivity E, described by Ivlev (1961). The electivity index is calculated by the formula:

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

where r_i is the relative quantity of the item in the digestive tract expressed as a percentage of the total digestive tract contents, and p_i is the relative quantity of the same item in the environment expressed as a percentage. E values for each major food group occur within the limits of +1 and -1, the former value indicating positive electivity and the latter, negative electivity, with 0 indicating random electivity for a food item.

Plankton and aquatic insects were identified with the following keys: Freshwater Biology (Edmonson, 1966); Freshwater Invertebrates of the United States (Pennak, 1953); Aquatic Insects of California (Usinger, 1963); and How to Know the Freshwater Algae (Prescott, 1964). Young-of-the-year fish were identified using techniques described by Gasaway and May (1967) and Norden (1961).

RESULTS AND DISCUSSION

Microcrustaceans, aquatic insects and fishes were the major food items of young-of-the-year fishes. All of the fish species studied were dependent on zooplanktors for food during early postlarval development. Some divergence in food habits appeared between the various species studied as the fishes increased in size. Food habits of young-of-the-year fishes appeared to be influenced by food availability, preference of each fish species and vulnerability of the prey to predation.

Available Food

Phytoplankton, zooplankton, aquatic insects and young-of-the-year fish were the major food groups available to the fishes. Phytoplankton populations during 1973 were dominated by three chrysophyte genera, *Tribonema, Fragilaria* and *Asterionella.* During 1974, in addition to the previous genera, two cyanophyte genera, *Anabaena* and *Aphanizomenon,* were prevalent, and these latter two occurred in large blooms from mid July through mid September. Total phytoplankton populations ranged from 0.1 to 59.7 X 10^3 cells/1 in 1973 and from < 0.1 to 770.2 X 10^3 cells/1 in 1974 (Appendix Tables 3 and 4).

Zooplankton populations were dominated in both years by *Daphnia galeata, D. ambigua Bosmina longirostris* and cyclopoid copepods. Total zooplankton populations ranged from 22.1 to 448.6 organisms/1 in 1973 and from 7.8 to 275.7 organisms/1 in 1974 (Figures 2 and 3; Appendix Tables 5 and 6). June and July peaks were dominated by cyclopoid copepods, *Daphnia galeata* and *D. ambigua,* while late summer and fall peaks were

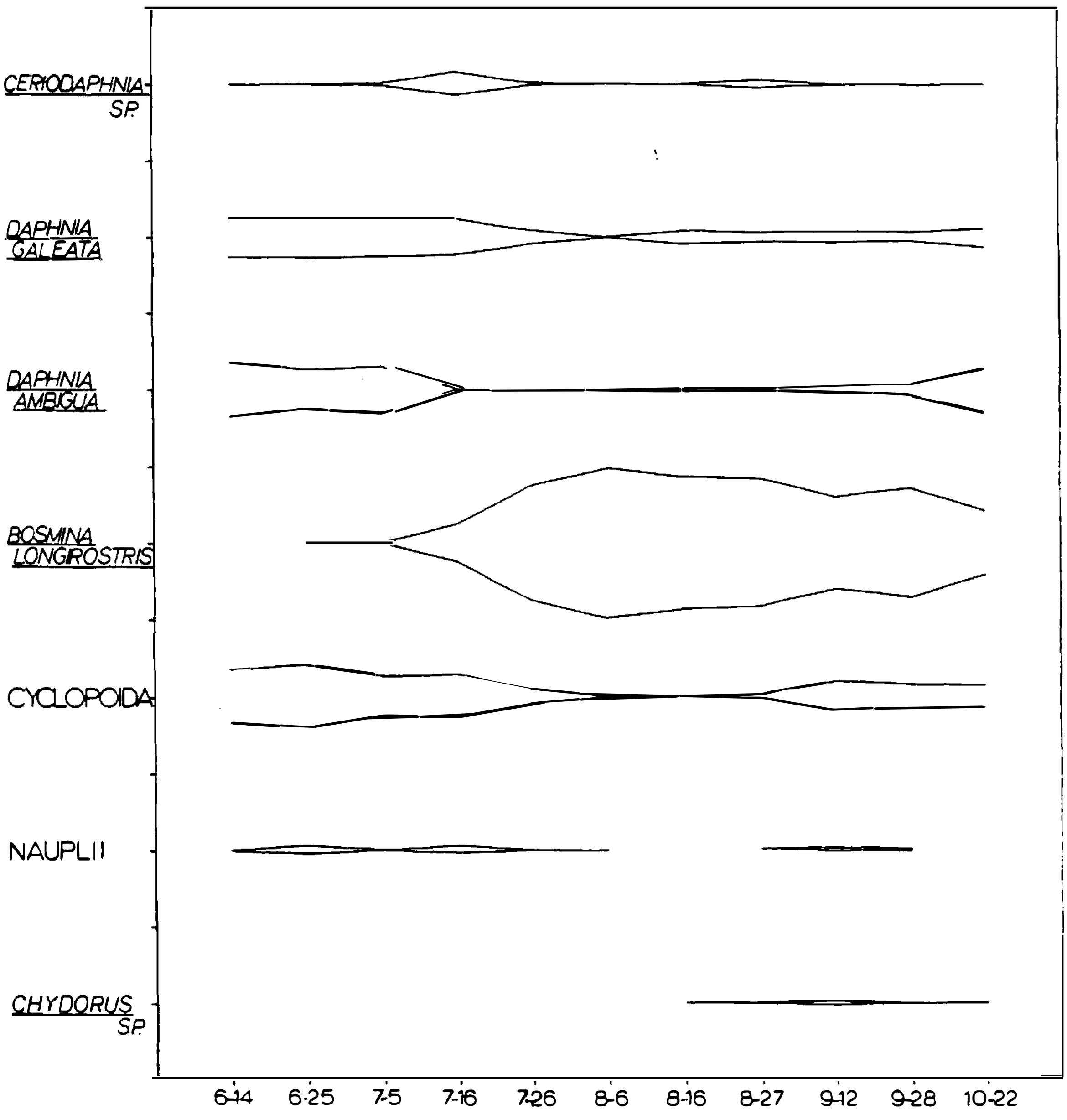

Figure 2. Zooplankton populations in Abbey Pond during 1973, expressed as percent of total population.

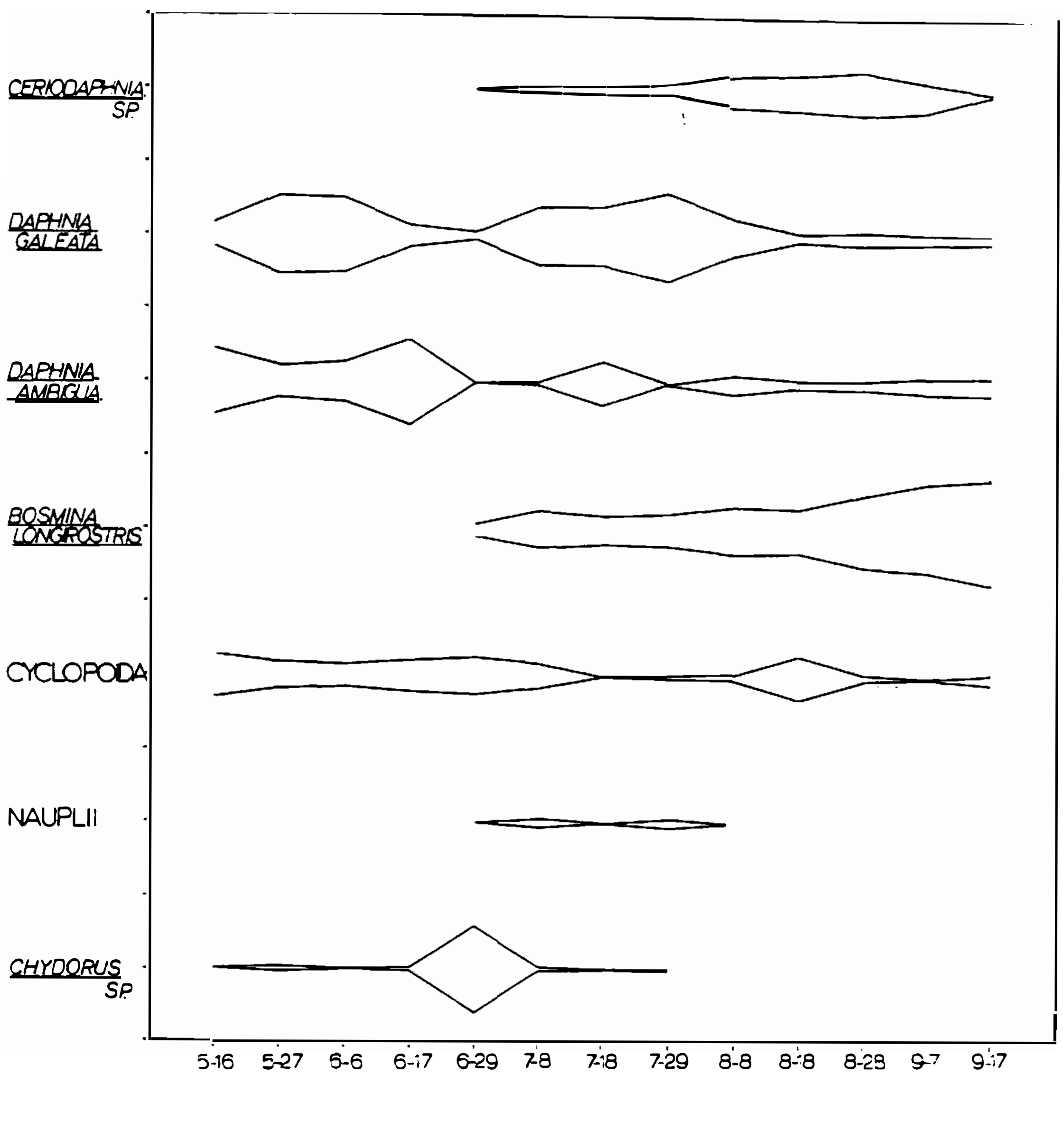

Figure 3. Zooplankton populations in Abbey Pond during 1974, expressed as percent of total population.

dominated by Bosmina longirostris. Cyclopoids, Daphnia galeata and D. ambigua experienced another population increase during September. These characteristic maxima in early summer and again in autumn are similar to diacmic populations described by Hutchinson (1967).

Although quantitative analyses of aquatic insect populations were not conducted, visual observations indicated the presence of large numbers in the pond. Ephemeropterans, chironomids and corixids were abundant during 1973 while odonates, corixids and chironomids were abundant during 1974.

Shoreline seining success indicated relatively large numbers of young-of-the-year fishes. Young-of-the-year fishes became abundant by mid July in both 1973 and 1974.

Food Habits

Largemouth Bass Sixteen different food organisms were consumed by young-of-the-year largemouth bass during the study, of which crustaceans, aquatic insects and fish were the most important food for young bass. Ephemeropterans had the highest percent occurrence in bass stomachs in 1973, and corixids occurred most frequently in 1974 (Figure 4). Average percent occurrence of food organisms in stomach samples for both years indicated corixids, odonates and Hyalella sp. as the most frequently occurring organisms in the stomachs of young bass. Cladoceran species, except Simocephalus serrulatus, did not occur in more than 27.0% of the stomach samples in 1973 or more than 13.0% in 1974. Average percent occurrence, obtained by combining data from both years, indicated that entomostracans were found in 66.4%, aquatic insects in 78.6% and

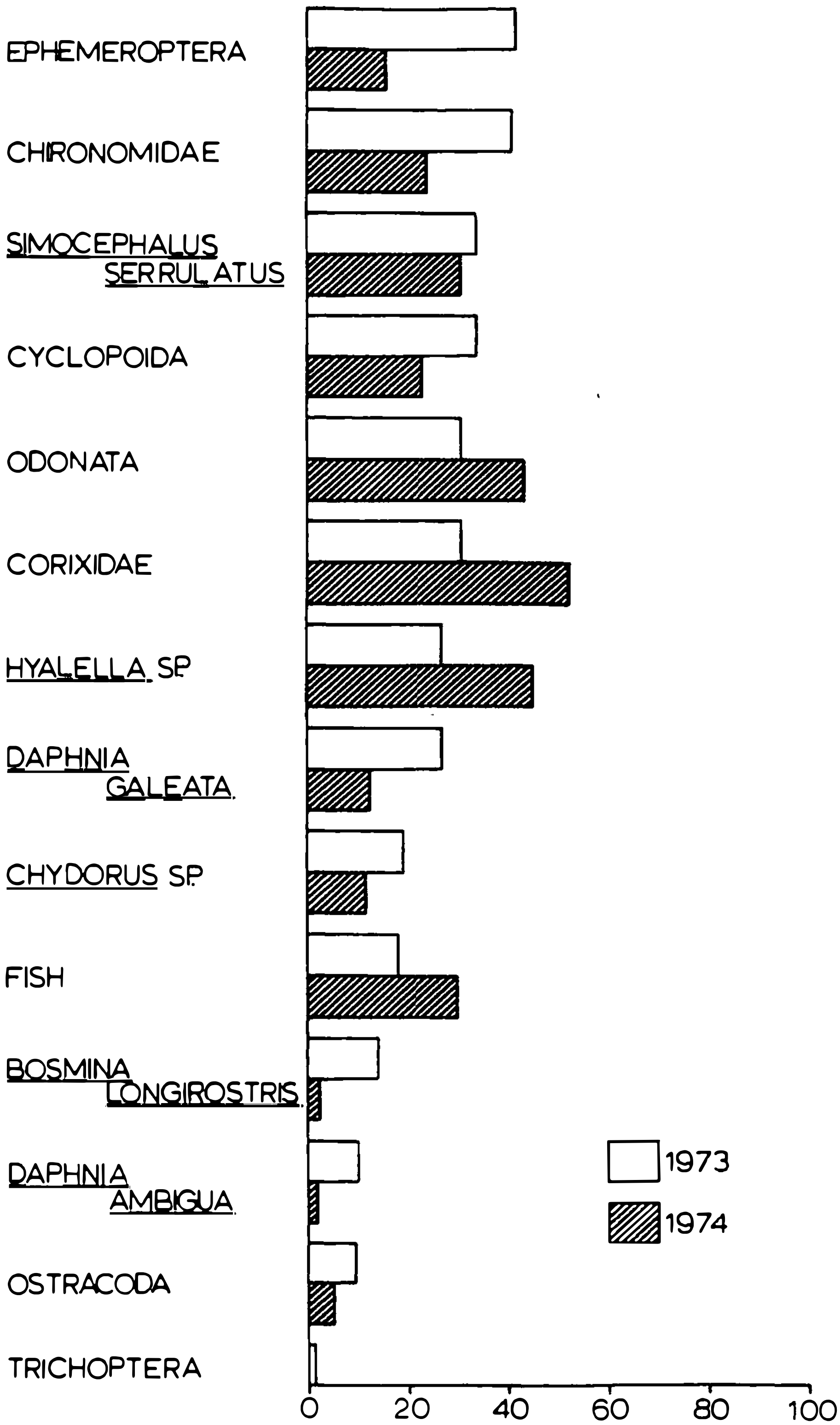

Figure 4. Percent occurrence of food organisms in stomachs of young-of-the-year largemouth bass from Abbey Pond, 1973 and 1974.

fish in 24.6% of all young-of-the-year largemouth bass stomachs.

Zooplankton and aquatic insects were the predominant food organisms by percent number per stomach for both years (Tables 2 and 3). Zooplankton was the predominant food organism in 60.0% and 12.5% of the samples, respectively, for the 2 years. Aquatic insects were the predominant food organism in 40.0% of the bass sampled during 1973 and 50.0% of the samples in 1974. In 1974, fish were the predominant food organism in 25.0% and Hyalella sp. in 12.5% of the samples. Young-of-the-year bass utilized less zooplankton in 1974 than in 1973. This was probably due to the greater availability of zooplankton in 1973 (Appendix Tables 5 and 6).

Turner and Kraatz (1920) stated that food organism size compared to largemouth bass size was the most important factor in food selection. A change in food habits with increasing size of the young bass was exhibited in both 1973 and 1974. The size-specific food habits of largemouth bass have been reported to progress from small crustaceans to aquatic insects to fish (Applegate et al., 1966; Clady, 1973; Harlan and Speaker, 1969; McCammon et al., 1964; Miller and Kramer, 1971; and Ridenhour, 1960). Stomach content analysis indicated that young-of-the-year bass in Abbey Pond followed this pattern. Bass 10.0 to 20.0 mm in length relied primarily on zooplankton for food. Aquatic insects and Hyalella sp. were included in the diet after the bass reached 20.0 mm in length and increased in importance with continued fish growth (Tables 4 and 5). The inclusion of fish in the diet of largemouth bass occurred at 50.0 mm in 1973 and at 30.0 mm in 1974. Although

Table 2. Stomach contents of young-of-the-year largemouth bass from Abbey Pond, 1973, expressed as percent number per stomach.

Item		Date									
		6-25	7-5	7-16	7-26	8-6	8-16	8-27	9-12	9-28	10-22
Arthropoda											
Crustacea											
Cladocera	*Daphnia galeata*	6.1	19.1	46.6		21.8					
	Daphnia ambigua	7.4	3.9	4.4			T[1]				
	Simocephalus serrulatus	17.7	6.9	T	42.2	4.3	2.3		24.9	44.9	12.3
	Bosmina longirostris		1.1	T		40.9	T				
	Ceriodaphnia sp.			T							
	Chydorus sp.	26.7	20.9	T	1.2	1.3				T	
Total Cladocera		57.9	51.9	51.0	43.4	68.3	2.3		24.9	44.9	12.3
Copepoda	Cyclopoida	5.4	1.2	24.0	1.4	6.5	T		1.0	T	
	Calanoida		T	2.5		T					
Total Copepoda		5.4	1.2	26.5	1.4	6.5	T		1.0	T	
Amphipoda	*Hyalella* sp.	4.8	1.3	8.6	12.5	4.9		3.5	9.1		
Ostracoda		3.3			T	T			T	T	22.4
Insecta											
Odonata			1.2	1.7	19.1	4.6	T	15.4	3.3	1.0	9.4
Ephemeroptera		T	17.1	4.8	11.4	7.1	88.4	34.3	T	1.9	
Diptera	Chironomidae	27.5	26.6	1.8	6.6	3.5	T	1.5	42.0	3.6	
Trichoptera							T				
Hemiptera	Corixidae	T	T	4.7	3.8	T	T		8.6	27.3	35.9
Fish					1.0	3.7	6.9	45.3	10.0	20.0	20.0
Sample size		10	10	10	10	10	10	10	10	10	10
Average number of food items/stomach		12.1	61.4	140.8	36.0	90.0	142.5	4.6	43.1	40.8	27.2

[1]Less than 1%

Table 3. Stomach contents of young-of-the-year largemouth bass from Abbey Pond, 1974, expressed as percent number per stomach.

Item		Date 6-29	7-18	7-29	8-8	8-18	8-28	9-7	9-17
Arthropoda									
Crustacea									
Cladocera	*Daphnia galeata*	4.8	12.1	6.2					
	Daphnia ambigua	T[1]							
	Simocephalus serrulatus	21.1	8.3	18.2	8.1				
	Bosmina longirostris	T					1.8		
	Ceriodaphnia sp.		T						
	Chydorus sp.	2.4		T					
Total Cladocera		28.3	20.4	24.4	8.1		1.8		
Copepoda	Cyclopoida	69.2	10.3	4.4	T				
Amphipoda	*Hyalella* sp.		2.2	17.9	52.4	27.2	17.9	17.3	8.0
Ostracoda			T	1.6					
Insecta									
Odonata			19.9	15.5	18.8	5.0	11.5	6.6	21.2
Ephemeroptera			6.0	1.1	1.7			2.3	
Diptera	Chironomidae	2.2	4.7		2.9	T		2.6	
Hemiptera	Corixidae	T	35.8	27.4	14.8	46.4	20.5	25.6	37.1
Fish				7.4	T	20.6	48.3	45.6	33.7
Sample size		15	15	15	15	15	13	15	15
Average number of food items/stomach		116.6	47.3	17.9	17.9	6.7	3.2	7.7	4.9

[1]Less than 1%

Table 4. Percent number of food organisms in stomachs of young-of-the year largemouth bass containing food organisms, from Abbey Pond, 1973.

Total length of fish (mm)	Number of fish	Food Organism								
		Cladocera	Copepoda	Amphipoda	Ostracoda	Odonata	Fish	Corixidae	Chironomidae	Ephemeroptera
10-19.9	7	85.9	2.1	12.0						
20-29.9	8	62.6	4.4	3.6	2.5	.4		.4	23.2	2.9
30-39.9	12	52.5	15.8	1.1		.9		.2	17.0	12.5
40-49.9	16	44.5	8.5	6.8	.3	7.0		2.1	3.9	26.9
50-59.9	16	39.6	3.4	20.8	.5	10.4	2.3	2.6	5.0	15.4
60-69.9	18	9.1		8.4	.4	14.1	9.6	15.0	12.0	31.4
70-79.9	11	33.6		1.5		1.4	23.6	17.9	8.6	13.4
80-89.9	7						57.2	23.8	19.0	
90-99.9	2						50.0			50.0
100-105	2						50.0	50.0		

Table 5. Percent number of food organisms in stomachs of young-of-the-year largemouth bass containing food organisms, from Abbey Pond, 1974.

Total length of fish (mm)	Number of fish	Food Organism								
		Cladocera	Copepoda	Amphipoda	Ostracoda	Odonata	Fish	Corixidae	Chironomidae	Ephemeroptera
10-19.9	8	17.2	81.9						0.9	
20-29.9	9	42.2	49.6	1.3		1.4		1.7	3.0	0.8
30-39.9	6	21.2	8.5	19.1	1.6	17.1	16.7	11.0	3.5	1.3
40-49.9	17	17.7	6.5	16.6	0.3	18.5	0.7	30.6	4.8	4.3
50-59.9	16	9.4		25.5	0.5	20.2	14.2	26.6	1.6	2.0
60-69.9	23	5.4	0.1	29.7	0.3	15.8	7.2	41.4		0.1
70-79.9	25	0.5		16.4		8.9	42.8	30.2	1.0	0.2
80-89.9	9			18.3		5.1	37.0	32.2	3.7	3.7
90-99.9	3					16.7	83.3			

larger bass consumed other organisms in addition to fish, the amounts in terms of volumes were minor. Turner and Kraatz (1920) indicated that fish became important in the diet of largemouth bass larger than 35.0 to 40.0 mm. Miller and Kramer (1971) reported that bass develop piscivorous food habits as early as 20.0 mm in size. As bass reached 70.0 mm, entomostracans became less important in their diet. Cladocerans were not found in bass larger than 80.0 mm while copepods were not found in bass larger than 70.0 mm. In a study by Rogers (1967) cladocerans and copepods were not found in largemouth bass larger than 40.0 and 45.0 mm, respectively. Analysis of largemouth bass stomachs from Abbey Pond indicated that the intermediate sizes of fish (30.0 to 50.0 mm) were less selective in food habits, with a great variety of food organisms included in their diets. This is similar to findings reported by Turner and Kraatz (1920).

Electivity indices for young-of-the-year largemouth bass predation on zooplankton indicated that, in most cases, as bass grew larger zooplanktors were negatively elected for. During the first half of the 1973 summer _Chydorus_ sp. was elected for, while ostracods, cyclopoids and _Daphnia_ spp. received intermittent positive electivity indices (Table 6). Young largemouth bass positively elected cyclopoid copepods throughout the early summer of 1974, with values ranging from +0.693 to +0.176. Ostracods and _Daphnia galeata_ had positive indices on various occasions (Table 7). _Bosmina longirostris_ experienced negative electivity by young bass throughout 1973 and 1974, with values ranging from -0.076 to -1.000. _Daphnia ambigua, Ceriodaphnia_ sp. and _Chydorus_

Table 6. Electivity indices of young-of-the-year largemouth bass for zooplankton in Abbey Pond, 1973.

	Date									
	6-25	7-5	7-16	7-26	8-6	8-16	8-27	9-12	9-28	10-22
Crustacea										
Cladocera										
<u>Daphnia galeata</u>	-0.621	-0.141	+0.329	-1.000	+0.931	-1.000	-1.000	-1.000	-1.000	-1.000
<u>Daphnia ambigua</u>	-0.543	-0.776	+0.796	-1.000	-1.000	-0.952	-1.000	-1.000	-1.000	-1.000
<u>Bosmina longirostris</u>	-1.000	-0.076	-0.993	-1.000	-0.413	-0.986	-1.000	-1.000	-1.000	-1.000
<u>Chydorus</u> sp.	+0.690	+0.991	+1.000	+0.655	+1.000	-1.000	-1.000	-1.000	+0.534	-1.000
Copepoda										
Cyclopoida	-0.773	-0.946	-0.160	-0.747	+0.955	+0.423	-1.000	-0.893	-0.968	-1.000
Ostracoda	+0.739	0.000	-1.000	-0.419	+1.000	-1.000	0.000	-0.053	+1.000	0.000

Table 7. Electivity indices of young-of-the-year largemouth bass for zooplankton in Abbey Pond, 1974.

	Date							
	6-29	7-18	7-29	8-8	8-18	8-28	9-7	9-17
Crustacea								
Cladocera								
Daphnia galeata	+0.032	-0.535	-0.812	-1.000	-1.000	-1.000	-1.000	-1.000
Daphnia ambigua	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
Bosmina longirostris	-0.955	-1.000	-1.000	-1.000	-1.000	-0.928	-1.000	-1.000
Ceriodaphnia sp.	-1.000	-0.835	-1.000	-1.000	-1.000	-1.000	-1.000	-1.000
Chydorus sp.	-0.925		-0.788		-1.000	-1.000	-1.000	-1.000
Copepoda								
Cyclopoida	+0.482	+0.693	+0.176	-0.783	-1.000	-1.000	-1.000	-1.000
Ostracoda		-0.627	+1.000	-1.000	-1.000	-1.000		-1.000

sp. were negatively elected for on all sample periods during 1974. Young-of-the-year bass negatively elected for zooplanktors after the end of July, 1974, and with two exceptions, after the middle of August, 1973.

Although Ivlev's electivity index can be used to illustrate predator electivity, certain limitations should be recognized. The accuracy of Ivlev's formula is dependent on the precision of zooplankton number estimation, because the component p_i expresses the relative quantity of a particular species of zooplanktor in the environment. The major assumption in this study was that the zooplankton estimates were representative of the zooplankton populations available to young-of-the-year fishes. Young-of-the-year fishes were sampled from heavily vegetated shoreline areas while zooplankton populations were sampled in open water areas in the center of the pond. Simocephalus serrulatus was not captured in the Miller sampler but did represent a large proportion of the zooplanktors consumed by young-of-the-year fishes. Simocephalus serrulatus is associated with aquatic vegetation, and the sampling technique used did not adequately sample these areas. Ostracod populations may also be misrepresented by standard sampling methods because they inhabit areas near the bottom and only occasionally move upward far enough to be captured in plankton nets. Electivity indices calculated for predation on ostracods may misrepresent the actual election for them by predators.

No estimate for abundance of young-of-the-year fish was made during the study; however, in both years there appeared to be large 0 age-classes of largemouth bass. Young-of-the-year bass concentrated in heavy vegetation around the periphery of the pond. These areas also provided refuge for other species of young-of-the-year fishes. Murphy (1949) found that high production of young largemouth bass was attained only when there was a good supply of prey species available when the bass reached a length of 63.0 to 75.0 mm. Because bluegill spawn later, large numbers of small bluegill were present in Abbey Pond when fingerling bass were ready to change from an invertebrate to a fish diet. Ball (1948) noted that bluegill were the staple food for largemouth bass in Third Sister Lake in Michigan. Although large numbers of variously sized bass were present in Abbey Pond, no instance of cannibalism was observed.

Bluegill Young-of-the-year bluegill utilized an assortment of aquatic invertebrates for food. A total of 15 different food organisms was consumed during the 2 year period. Microcrustaceans and insect larvae were the major foods for bluegill young-of-the-year. Cyclopoid copepods and *Chydorus* sp. were the most frequently occurring food organisms in the stomachs of young bluegill (Figure 5). Other organisms which occurred in more than 30.0% of the stomach samples during both years were *Bosmina longirostris*, ostracods, *Simocephalus serrulatus* and chironomids. Chironomids followed by immature odonates and ephemeropterans were the insects that occurred most frequently as food.

Cladocerans were the predominant food organisms by percent number throughout the 2 year period (Tables 8 and 9). Cladocerans were less predominant in 1974 than in 1973. This was probably due to reduced availability of zooplankton in 1974 (Appendix Tables 5 and 6). Of the

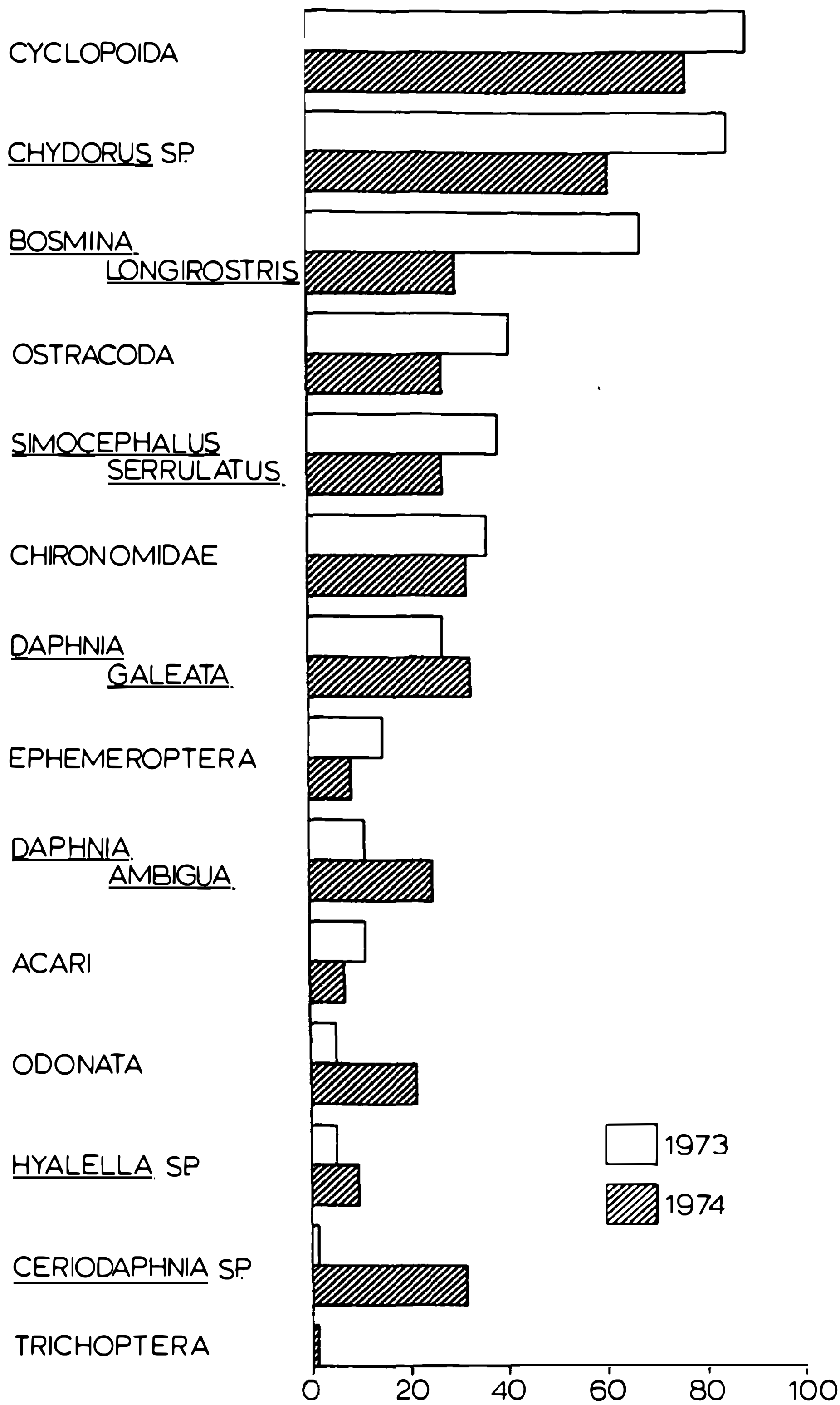

Figure 5. Percent occurrence of food organisms in stomachs of young-of-the-year bluegill from Abbey Pond, 1973 and 1974.

Table 8. Stomach contents of young-of-the-year bluegill from Abbey Pond, 1973, expressed as percent number per stomach.

Item		Date 7-16	7-26	8-6	8-16	8-27	9-12	9-28	10-22
Arthropoda									
Crustacea									
Cladocera	*Daphnia galeata*	60.0	T[1]	5.8	T	1.2			
	Daphnia ambigua	13.7			T				27.3
	Simocephalus serrulatus	3.0	34.0	12.3	3.5	T	T	6.1	
	Bosmina longirostris	12.9	T	60.7	66.9	16.7	16.2	12.2	25.9
	Ceriodaphnia sp.				T				
	Chydorus sp.	T	50.7	11.8	8.7	28.6	56.3	44.0	9.1
Total Cladocera		89.6	84.7	90.6	79.1	46.5	72.5	62.3	62.3
Copepoda	Cyclopoida	7.4	6.6	7.5	11.6	14.9	13.8	16.4	37.7
	Calanoida				1.1				
Total Copepoda		7.4	6.6	7.5	12.7	14.9	13.8	16.4	37.7
Arachnida	Acari		T		T	2.0	T	T	
Amphipoda	*Hyalella* sp.				T	T	T	T	
Ostracoda		T		T	5.4	33.5	13.1	18.2	
Insecta									
Odonata				T	T	T	T	T	
Ephemeroptera			2.4	T	T			T	
Diptera	Chrionomidae	1.9	3.8	1.3	1.6	1.4		2.3	
Sample size		10	10	10	10	10	10	10	10
Average number of food items/stomach		84.7	39.0	151.2	632.4	52.9	297.8	171.2	240.5

[1]Less than 1%

Table 9. Stomach contents of young-of-the-year bluegill from Abbey Pond, 1974, expressed as percent number per stomach.

Item		Date 7-18	7-29	8-8	8-18	8-28	9-7	9-17
Arthropoda								
Crustacea								
Cladocera	_Daphnia galeata_	15.2	6.0	7.2	3.6	7.1	T[1]	T
	Daphnia ambigua			3.8	1.1	1.4	11.8	T
	Simocephalus serrulatus	30.4	25.3	25.0			T	T
	Bosmina longirostris	1.6	12.8	T		5.3	8.2	24.4
	Ceriodaphnia sp.			12.7	18.4	23.7	14.8	T
	Chydorus sp.	6.2	4.9	12.3	9.7	16.4	17.2	17.1
Total Cladocera		53.4	49.0	61.0	32.8	53.9	52.0	41.5
Copepoda	Cyclopoida	14.2	25.8	20.4	55.6	37.2	10.9	18.4
Arachnida	Acari	1.8	3.6	T				
Amphipoda	_Hyalella_ sp.			5.4	3.7		T	6.8
Ostracoda			3.5	3.4	3.8	8.5	31.2	29.3
Insecta								
Odonata		6.2	16.0	3.0	T			
Ephemeroptera		4.4	1.5		T			T
Diptera	Chironomidae	20.0	T[1]	5.0	3.9	T	3.5	2.4
Hemiptera	Corixidae			T				
Trichoptera								T
Sample size		15	15	15	15	15	15	15
Average number of food items/stomach		21.0	24.7	34.6	36.1	63.5	65.6	72.8

[1]Less than 1%

various zooplanktor species available, Chydorus sp. was the predominant food organism in 37.5%, Bosmina longirostris in 25.0% and Daphnia galeata, cyclopoids, and ostracods in 12.5% of the samples during 1973. During 1974 cyclopoid copepods were the predominant food organism in 42.8% and Simocephalus serrulatus and ostracods in 28.6% of the samples.

Previous investigators (Applegate et al., 1966; Doxtater, 1964; Snow et al., 1960; and Ridenhour, 1960) have indicated that entomostracans are important food for bluegill less than 50.0 mm and that insects become increasingly important in the diet of bluegill greater than 50.0 mm. In the present study the sample size of bluegill greater than 45.0 mm in length was small, but the food habits of these fish did not appear to change appreciably from those fish less than 45.0 mm in length. Young-of-the-year bluegill of all size ranges consumed large numbers of cladocerans and copepods (Tables 10 and 11). All sizes of young bluegill utilized insect larvae during both years. The degree of utilization of insect larvae was small and did not appear to increase in importance as bluegill sizes increased from 15.0 to 55.0 mm.

Periods of predominance by various zooplanktors in young-of-the-year bluegill stomachs, except for three instances, did not correspond with a similar predominance of the same organism in the environment. Young-of-the-year bluegill appeared to exhibit a preference for some species of zooplanktors over other species of zooplanktors. Electivity indices for young-of-the-year bluegill consumption of zooplankton resulted in positive indices for Chydorus sp. in all cases. Values ranged

Table 10. Percent number of food organisms in stomachs of young-of-the-year bluegill containing food organisms, from Abbey Pond, 1973.

Total length of fish (mm)	Number of fish	Food Organisms							
		Cladocera	Copepoda	Amphipoda	Ostracoda	Odonata	Acari	Chironomidae	Ephemeroptera
15-19.9	7	92.1	6.4					1.5	
20-24.9	9	91.9	5.8		.2			1.9	.2
25-29.9	13	88.4	6.1		.1		.7	2.7	2.0
30-34.9	11	86.9	11.2	.4	.9	T[1]	T	.6	T
35-39.9	15	73.2	19.8	.2	5.2	T	.2	1.2	T
40-44.9	10	51.6	22.3		24.0	.1	.9	.9	.2
45-49.9	9	45.9	30.9		19.9	.9	2.0	.4	
50-55	7	51.7	10.5	.2	33.8		.5	3.3	

[1] Less than .1%

Table 11. Percent number of food organisms in stomachs of young-of-the-year bluegill containing food organisms, from Abbey Pond, 1974.

Total length of fish (mm)	Number of fish	Food Organisms									
		Cladocera	Copepoda	Amphipoda	Ostracoda	Odonata	Acari	Chironomidae	Ephemeroptera	Corixidae	Trichoptera
15-19.9	26	65.2	25.7		2.3	0.2	0.4	6.0	0.2		
20-24.9	29	60.8	20.1		0.8	8.4	1.6	5.8	2.5		
25-29.9	16	50.9	35.7	4.2	0.6	6.0	1.6	0.4	0.6		
30-34.9	16	34.2	36.0	4.0	15.1	2.1	0.5	7.6	0.1	0.4	
35-39.9	7	37.9	33.2	2.4	23.0			3.5			
40-44.9	11	8.3	12.6	9.4	63.7			5.8	0.1		0.1

from +0.336 to +1.000 for the 2 years (Tables 12 and 13). Gengerke (1972) obtained similar results for *Chydorus* sp. although it made up a minimal percentage of the total volume of stomach contents. Electivity indices, except in three instances, were positive for cyclopoid copepods, with values ranging from +0.080 to +0.961 during 1973 and 1974. *Bosmina longirostris* and *Ceriodaphnia* sp. were negatively elected for in all cases, with values ranging from -0.130 to -1.000 and -0.018 to -1.000, respectively.

Black Crappie Young-of-the-year black crappie fed almost entirely on entomostracans throughout their first summer of life. Similar observations have been reported by Reid (1950) and Ridenhour (1960). Of the fourteen organisms utilized as food by young-of-the-year black crappie, *Bosmina longirostris* occurred most frequently in the 1973 stomach samples while cyclopoid copepods were the most frequently occurring food organism in 1974 (Figure 6). Other major food organisms, ranked in decreasing order of percent occurrence in stomach samples, averaged for the two years, were cyclopoid copepods, *Bosmina longirostris, Daphnia galeata, D. ambigua, Ceriodaphnia* sp. and *Chydorus* sp. Chironomid larvae were the most frequently occurring insect foods in young-of-the-year black crappie during both study years.

Zooplankton was the predominant food organism consumed by young-of-the-year black crappie during the study period (Tables 14 and 15). Average number of food organisms per stomach ranged from 17.5 in August, 1974, to 2,008.1 in September, 1973. Cyclopoid copepods were the predominant food organisms in 50.0% of the samples in 1973 and

Table 12. Electivity indices of young-of-the-year bluegill for zooplankton in Abbey Pond, 1973.

	Date							
	7-16	7-26	8-6	8-16	8-27	9-12	9-28	10-22
Crustacea								
Cladocera								
Daphnia galeata	+0.437	-0.844	+0.763	-0.962	-0.673	-1.000	-1.000	-1.000
Daphnia ambigua	+0.930	-1.000	-1.000	-0.952	-1.000	-1.000	-1.000	+0.388
Bosmina longirostris	-0.303	-0.979	-0.237	-0.130	-0.666	-0.577	-0.713	-0.237
Chydorus sp.	+1.000	+0.990	+1.000	+0.881	+0.947	+0.921	+0.992	+0.965
Copepoda								
Cyclopoida	-0.591	-0.180	+0.961	+0.942	+0.747	-0.141	+0.080	+0.501
Ostracoda	-1.000	-1.000	+1.000	+0.971	+1.000	+0.985	+1.000	0.000

Table 13. Electivity indices of young-of-the-year bluegill for zooplankton in Abbey Pond, 1974.

	Date						
	7-18	7-29	8-8	8-18	8-28	9-7	9-17
Crustacea							
Cladocera							
Daphnia galeata	-0.448	-0.816	-0.570	-0.166	-0.054	-0.787	-0.788
Daphnia ambigua	-1.000	-1.000	-0.570	-0.607	-0.648	+0.080	-0.921
Bosmina longirostris	-0.849	-0.280	-0.962	-1.000	-0.498	-0.781	-0.497
Ceriodaphnia sp.	-1.000	-1.000	-0.300	-0.148	-0.145	-0.018	-0.690
Chydorus sp.	+1.000	+0.336	+1.000	+0.984	+0.970	+0.946	+0.902
Copepoda							
Cyclopoida	+0.768	+0.786	+0.676	+0.284	+0.801	+0.759	+0.458
Ostracoda	-1.000	+1.000	+0.688	+0.736	+0.915	+1.000	+0.996

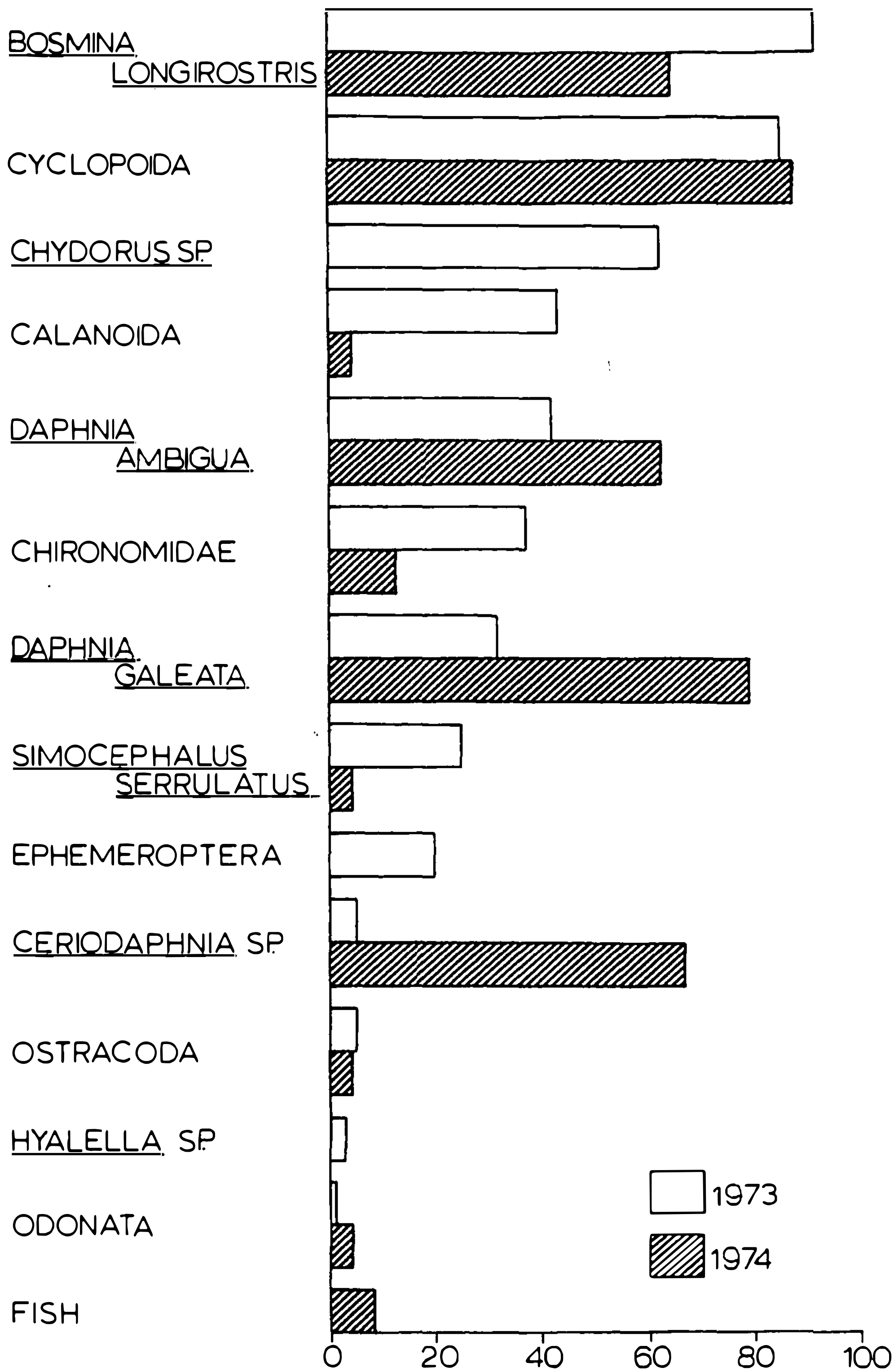

Figure 6. Percent occurrence of food organisms in stomachs of young-of-the-year black crappie from Abbey Pond, 1973 and 1974.

Table 14. Stomach contents of young-of-the-year black crappie from Abbey Pond, 1973, expressed as percent number per stomach.

Item		Date 7-26	8-6	8-16	8-27	9-12	9-28	10-22
Arthropoda								
Crustacea								
Cladocera	*Daphnia galeata*	1.1	22.2	2.6	3.3			4.8
	Daphnia ambigua	T[1]		T	2.7	34.6		11.3
	Simocephalus serrulatus	4.4	2.8					1.2
	Bosmina longirostris	6.3	38.5	55.7	23.7	40.6		34.4
	Ceriodaphnia sp.	T		T				T
	Chydorus sp.	12.1	6.7	T	6.2	T		4.4
Total Cladocera		23.9	70.2	58.3	35.9	75.2		56.1
Copepoda	Cyclopoida	64.1	21.1	35.6	63.6	20.3		36.9
	Calanoida	9.9	8.0	3.4		4.3		6.3
Total Copepoda		74.0	29.1	39.0	63.6	24.6		43.2
Amphipoda	*Hyalella* sp.	T			T			T
Ostracoda				T	T	T		T
Insecta								
Odonata		T						T
Ephemeroptera		T	T	1.0		T		T
Diptera	Chironomidae	1.0	T	T	T	T		T
Sample size		10	10	10	10	10	0	10
Average number of food items/stomach		193.4	425.5	1185.6	124.7	2008.1	-	557.2

[1]Less than 1%

Table 15. Stomach contents of young-of-the-year black crappie from Abbey Pond, 1974, expressed as percent number per stomach.

Item		Date			
		7-29	8-8	8-18	8-28
Arthropoda					
Crustacea					
Cladocera	*Daphnia galeata*	28.6		6.3	24.9
	Daphnia ambigua			1.6	7.9
	Simocephalus serrulatus		6.2		
	Bosmina longirostris				25.4
	Ceriodaphnia sp.			49.2	14.2
Total Cladocera		28.6	6.2	57.1	72.4
Copepoda	Cyclopoida	40.7	68.8	42.9	27.5
	Calanoida	2.5			
Total Copepoda		43.2	68.8	42.9	27.5
Ostracoda		0.3			
Fish		2.5			T[1]
Insecta					
Odonata		25.0			
Diptera	Chironomidae	0.4	25.0		T
Sample size		4	2	1	15
Average number of food items/stomach		40.5	17.5	63.0	1010.1

[1]Less than 1%

75.0% of the samples in 1974. Bosmina longirostris was the predominant food organism in 50.0% of the samples in 1973, and Ceriodaphnia sp. was the predominant food organism in 25.0% of the samples in 1974. Immature insects were taken in small amounts during both years and appeared to be of minor importance in the diet of young black crappie.

Cladocerans and copepods were the primary food organisms for young-of-the-year crappie in all size ranges (Tables 16 and 17). Consumption of insects did not appear to increase as the size of the crappie increased. Reid (1950) reported that young crappie did not utilize fish as food until they were approximately 61.0 mm. Reid (1950) also noted that there was a conspicuous decrease in the consumption of entomostracans and an increased utilization of larger food items as black crappie reached approximately 100 mm in length. No black crappie larger than 75.0 mm were taken during this study; however, two instances of black crappie, one 30.0 mm and the other 56.0 mm in length, utilizing fish in their diet were observed in 1974.

Electivity indices for utilization of zooplankton by young-of-the year black crappie indicated cyclopoid copepods to have positive indices in all but one sample during the study period (Tables 18 and 19). For the two years, positive values for cyclopoids ranged from +0.051 to +0.986. Bosmina longirostris was negatively elected for in all cases, with values ranging from -0.007 to -1.000. The phenomenon of larger zooplanktors being elected while smaller and more numerous zooplanktors were present has been reported by Cramer and Marzolf (1970) and Gerking (1962). This phenomenon may explain why B. longirostris was negatively

Table 16. Percent number of food organisms in stomachs of young-of-the-year black crappie containing food organisms, from Abbey Pond, 1973.

Total length of fish (mm)	Number of fish	Food Organisms						
		Cladocera	Copepoda	Amphipoda	Ostracoda	Ephemeroptera	Odonata	Chironomidae
30-34.9	4	36.6	61.2	.1		.5	.1	1.5
35-39.9	8	60.1	39.6			T[1]		.3
40-44.9	14	39.2	59.6		T	.5		.7
45-49.9	9	61.1	37.8			1.0		.1
50-54.9	12	62.7	36.9		.1	T		.3
55-59.9	7	63.9	36.0					.1
60-64.9	3	87.3	12.6		.1			
65-69.9	2	39.5	60.2		.2			.1
70-74.9	1	98.9	1.0			.1		

[1]Less than .1%

Table 17. Percent number of food organisms in stomachs of young-of-the-year black crappie containing food organisms, from Abbey Pond, 1974.

Total length of fish (mm)	Number of fish	Food Organisms					
		Cladocera	Copepoda	Fish	Ostracoda	Odonata	Chironomidae
30-34.9	2	48.6	46.4	5.0			
35-39.9	1	17.4	80.0		1.3		1.3
40-44.9	3	25.3	24.7			33.3	16.7
45-49.9	5	57.4	42.6				
50-54.9	9	75.5	24.5				T[1]
55-59.9	2	56.9	43.1	T			

[1]Less than 1%

Table 18. Electivity indices of young-of-the-year black crappie for zooplankton in Abbey Pond, 1973.

	Date						
	7-26	8-6	8-16	8-27	9-12	9-28	10-22
Crustacea							
Cladocera							
Daphnia galeata	-0.795	+0.932	-0.523	-0.316	-1.000		-1.000
Daphnia ambigua	-0.407	-1.000	-0.440	+0.060	+0.820		+0.016
Bosmina longirostris	-0.844	-0.437	-0.219	-0.558	-0.196		-0.007
Chydorus sp.	+0.960	+1.000	+0.035	+0.779	-0.893		+0.556
Copepoda							
Cyclopoida	+0.742	+0.986	-1.000	+0.934	+0.051		+0.336
Ostracoda	-1.000	0.000	-0.067	+1.000	-0.667		0.000

Table 19. Electivity indices of young-of-the-year black crappie for zooplankton in Abbey Pond, 1974.

	Date			
	7-29	8-8	8-18	8-28
Crustacea				
Cladocera				
<u>Daphnia galeata</u>	-0.349	-1.000	+0.113	+0.520
<u>Daphnia ambigua</u>	-1.000	-1.000	-0.465	+0.102
<u>Bosmina longirostris</u>	-1.000	-1.000	-1.000	-0.317
<u>Ceriodaphnia</u> sp.	-1.000	-1.000	+0.331	-0.382
<u>Chydorus</u> sp.	-1.000		-1.000	-1.000
Copepoda				
Cyclopoida	+0.858	+0.891	+0.156	+0.741
Ostracoda	+1.000	-1.000	-1.000	-1.000

elected for, even when it was the most numerous zooplanktor in the pond. The importance of cyclopoid copepods in the diet of young-of-the-year black crappie may be explained by the theory presented by Siefert (1972) in which he postulated that swimming movements, characterized by pronounced jerks, may attract predators.

Yellow Bullhead Twelve different food items were consumed by young-of-the-year yellow bullheads. Of these, an amphipod, *Hyalella* sp., microcrustaceans and insect larvae were the primary food organisms. *Hyalella* sp. occurred in the highest percentage of the stomachs of young yellow bullheads for both years (Figure 7). Average percent occurrence for the two year period indicated that *Chydorus* sp. and chironomid larvae were the second and third most frequently occurring food organisms in the stomach samples.

Little work has been done with food habits of young-of-the-year yellow bullheads. Ridenhour (1960) examined stomach contents of two yellow bullhead young-of-the-year and reported mostly immature insects and some *Hyalella* sp. *Hyalella* sp. was the predominant food organism in 37.5% of the composite samples for both years in Abbey Pond while *Chydorus* sp. and chironomids were the predominant food organisms in 25.0% of these samples (Tables 20 and 21). *Daphnia galeata* and *Hyalella* sp. shared predominance on one occasion in 1973.

Zooplankton was important in the diet of yellow bullheads less than 50.0 mm in length but decreased in importance as fish grew larger than 50.0 mm. Although *Hyalella* sp. was utilized by all sizes of yellow bullhead, it appeared to become more predominant as the fish increased

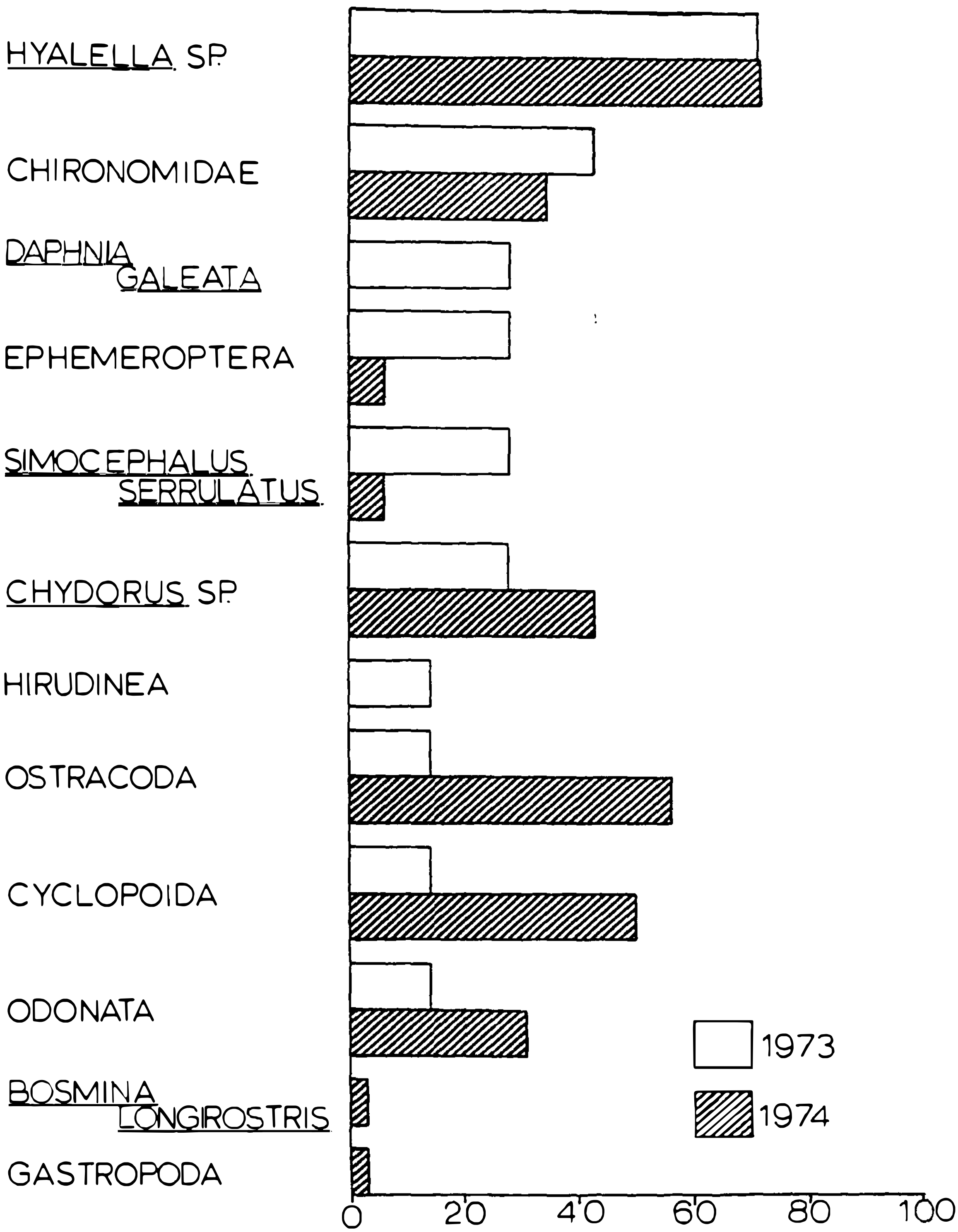

Figure 7. Percent occurrence of food organisms in stomachs of young-of-the-year yellow bullhead from Abbey Pond, 1973 and 1974.

Table 20. Stomach contents of young-of-the-year yellow bullhead from Abbey Pond, 1973, expressed as percent number per stomach.

Item		Date 7-16	7-26	9-12
Arthropoda				
Crustacea				
Cladocera	*Daphnia galeata*	33.3		7.2
	Simocephalus serrulatus		12.8	17.1
	Chvdorus sp.		80.9	5.7
Total Cladocera		33.3	93.7	30.0
Copepoda	Cyclopoida			1.7
Ostracoda				3.6
Amphipoda	*Hvalella* sp.	33.3	2.1	44.6
Insecta				
Odonata				T[1]
Ephemeroptera		20.1		7.2
Diptera	Chironomidae	13.3	4.2	6.3
Annelida	Hirudinea			6.2
Sample size		1	1	4
Average number of food items/stomach		15.0	47.0	33.0

[1]Less than 1%

Table 21. Stomach contents of young-of-the-year yellow bullhead from Abbey Pond, 1974, expressed as percent number per stomach.

Item		Date				
		7-18	7-29	8-8	8-18	8-28
Arthropoda						
Crustacea						
Cladocera	*Simocephalus serrulatus*	T[1]				20.0
	Chydorus sp.	60.4	18.6	4.5		
	Bosmina longirostris	T				
Total Cladocera		60.4	18.6	4.5		20.0
Copepoda	Cyclopoida	13.6	16.4	12.5		
Ostracoda		6.8	2.8	20.4	26.6	
Amphipoda	*Hyalella* sp.	5.7	32.9	58.3	35.0	20.0
Insecta						
Odonata		6.8	29.3	T		20.0
Ephemeroptera		T		T		
Diptera	Chironomidae	5.3		2.4	38.4	40.0
Gastropoda				T		
Sample size		14	4	11	2	1
Average number of food items/stomach		14.7	10.0	11.0	8.0	5.0

[1]Less than 1%

in size (Tables 22 and 23). All sizes of young-of-the-year yellow bullheads consumed insect larvae; however, there did not appear to be an increased utilization of insects with increased size of young bullheads.

Electivity indices calculated for predation on zooplankton indicated that young-of-the-year yellow bullheads elected against *Daphnia ambigua*, *Ceriodaphnia* sp. and *Bosmina longirostris* (Tables 24 and 25). *Chydorus* sp. was positively elected for in all but three instances during 1973 and 1974. Positive electivity values ranged from +0.424 to +1.000. Cyclopoid copepods and ostracods had positive electivity indices during the early sample periods in 1974 but were negatively elected for during latter sampling dates. Electivity indices varied during 1973 and may be a reflection of small sample size.

Yellow Perch Stomachs of young-of-the-year yellow perch were examined in 1973. Fourteen food organisms were represented in the stomach samples. Aquatic insects and microcrustaceans were the major organisms consumed by young yellow perch. Odonates were the most frequently occurring food organism in the stomach samples (Figure 8). *Simocephalus serrulatus*, ostracods and cyclopoid copepods were also frequently present in young-of-the-year yellow perch stomachs.

Entomostracans were the predominant food organism in 60.0% of the samples and aquatic insects were the predominant food organisms in 40.0% of the samples (Table 26). *Hyalella* sp. and chironomids were reported by Pycha and Smith (1954) to be major food items for young perch; however, in the present study they comprised only a small percentage of the total number of food organisms.

Table 22. Percent number of food organisms in stomachs of young-of-the-year yellow bullhead containing food organisms, from Abbey Pond, 1973.

Total length of fish (mm)	Number of fish	Food Organisms							
		Cladocera	Copepoda	Ostracoda	Amphipoda	Odonata	Chironomidae	Ephemeroptera	Annelida
20-29.9	1	33.3			33.3		13.4	20.0	
30-39.9	1	93.7			2.0		4.3		
40-49.9	1	90.9	6.8			2.3			
50-59.9	1				100.0				
60-69.9	2	14.3		7.1	39.3		12.5	14.3	12.5

Table 23. Percent number of food organisms in stomachs of young-of-the-year yellow bullhead containing food organisms, from Abbey Pond, 1974.

Total length of fish (mm)	Number of fish	Food Organisms							
		Cladocera	Copepoda	Ostracoda	Amphipoda	Odonata	Chironomidae	Ephemeroptera	Gastropoda
10-19.9	4	77.4	11.4	3.8	0.7	2.1	4.6		
20-29.9	12	48.8	15.0	7.6	14.5	9.1	4.7	0.3	
30-39.9	7	13.0	14.6	19.8	37.0	14.3		1.3	
40-49.9	7	2.9	8.5	12.0	55.7	2.0	18.0	0.9	
50-59.9	2		3.0	27.6	58.4		8.0		3.0

Table 24. Electivity indices of young-of-the-year yellow bullhead for zooplankton in Abbey Pond, 1973.

	Date					
	7-16	7-26	8-6	8-16	8-27	9-12
Crustacea						
Cladocera						
Daphnia galeata	+0.172	-1.000				+0.111
Daphnia ambigua	-1.000	-1.000				-1.000
Bosmina longirostris	-1.000	-1.000				-1.000
Chydorus sp.	0.000	+0.994				+0.424
Copepoda						
Cyclopoida	-1.000	-1.000				-0.830
Ostracoda	-1.000	-1.000				+0.945

Table 25. Electivity indices of young-of-the-year yellow bullhead for zooplankton in Abbey Pond, 1974.

	Date				
	7-18	7-29	8-8	8-18	8-28
Crustacea					
Cladocera					
Daphnia galeata	-1.000	-1.000	-1.000	-1.000	-1.000
Daphnia ambigua	-1.000	-1.000	-1.000	-1.000	-1.000
Bosmina longirostris	-0.931	-1.000	-1.000	-1.000	-1.000
Ceriodaphnia sp.	-1.000	-1.000	-1.000	-1.000	-1.000
Chydorus sp.	+1.000	+0.768	+1.000	-1.000	-1.000
Copepoda					
Cyclopoida	+0.758	-0.682	+0.521	-1.000	-1.000
Ostracoda	+0.624	+1.000	+0.940	+0.958	-1.000

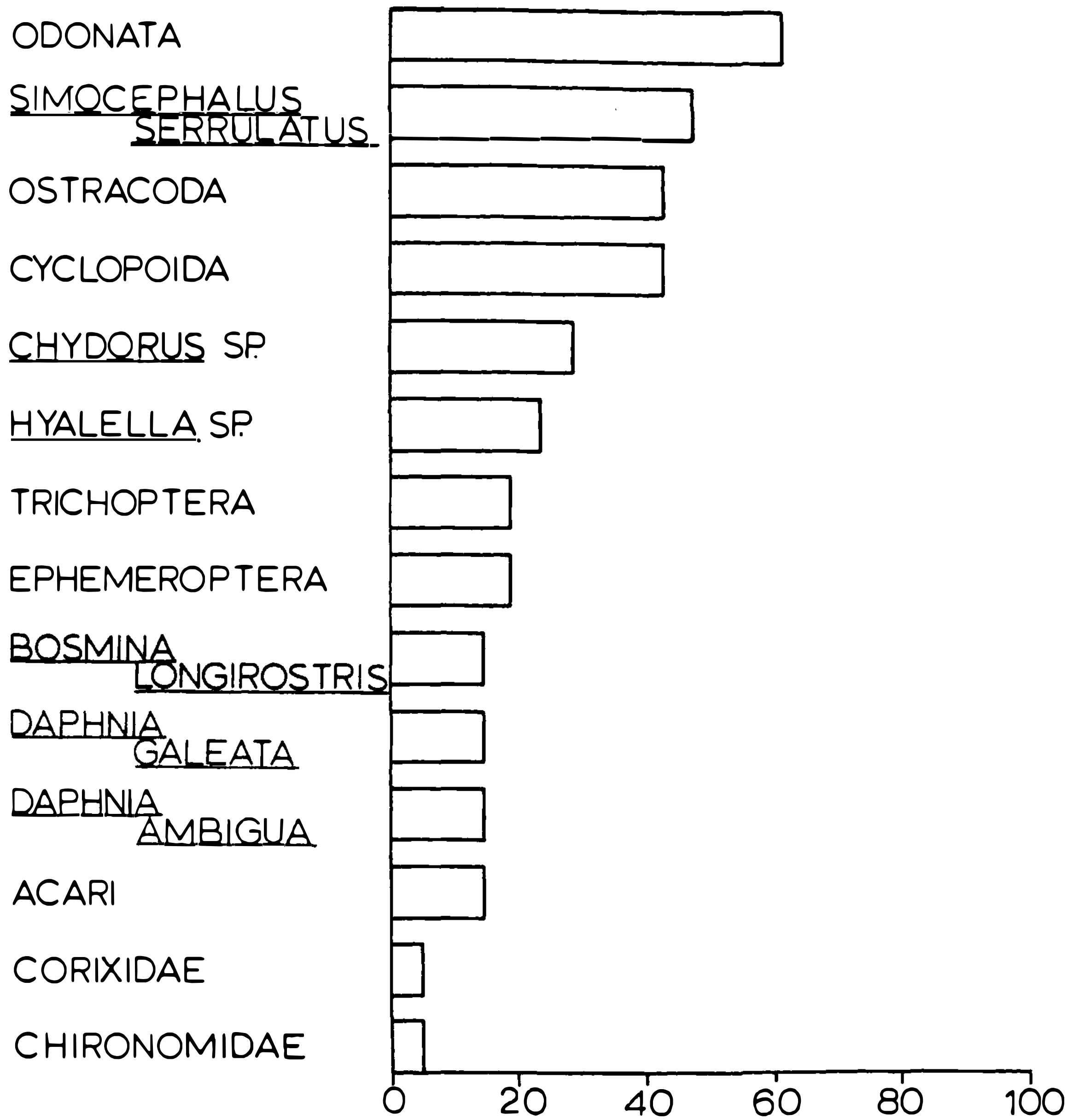

Figure 8. Percent occurrence of food organisms in stomachs of young-of-the-year yellow perch from Abbey Pond, 1973.

Table 26. Stomach contents of young-of-the-year yellow perch from Abbey Pond, 1973, expressed as percent number per stomach.

Item		Date				
		6-14	7-16	7-26	8-16	8-27
Arthropoda						
Crustacea						
Cladocera	*Daphnia galeata*	5.3				
	Daphnia ambigua	1.7				
	Simocephalus serrulatus	3.2	26.7	73.6	24.4	
	Bosmina longirostris				4.2	
	Chydorus sp.		13.3	T[1]	6.0	
Total Cladocera		10.2	40.0	73.6	34.6	
Copepoda	Cyclopoida	83.5		T	10.2	
	Calanoida	6.3				
Total Copepoda		89.8		T	10.2	
Ostracoda				T	30.3	11.0
Amphipoda	*Hyalella* sp.		6.7	7.5	T	5.6
Arachnida	Acari			T		2.8
Insecta						
Odonata			53.3	12.8	21.7	80.6
Ephemeroptera				4.7		
Diptera	Chironomidae			T		
Hemiptera	Corixidae				T	
Trichoptera					2.4	
Sample size		5	1	5	7	1
Average number of food items/stomach		58.2	15.0	135.0	57.1	36.0

[1]Less than 1%

It has been reported that during the life span of the yellow perch, it feeds first on entomostracans, then on aquatic insects and finally on fish (Clemens *et al.*, 1923; Parsons, 1950; Pearse and Achtenberg, 1920; Pycha and Smith, 1954; and Tharratt, 1959). Young perch in Abbey Pond rely initially on microcrustaceans and then switch to aquatic insects (Table 27). Yellow perch less than 30.0 mm fed entirely on cladocerans and copepods. Yellow perch relied initially on copepods, then cladocerans became the major food group consumed, and finally, at 70.0 mm, young perch relied primarily on insect larvae.

Electivity indices for predation on zooplankton by young-of-the-year yellow perch resulted in negative indices for *Daphnia* spp., with values ranging from -0.656 to -1.000 (Table 28). *Chydorus* sp. was randomly elected for in one instance and positively elected for on all other sampling dates. Cyclopoid copepods and ostracods were positively elected for on various sampling dates.

Larval Yellow Perch and Larval Bluegill Larval yellow perch and larval bluegill digestive tracts were examined in 1974 and found to contain seven different food items. Estimates of numbers of food items were obtained by procedures previously described for algae. Chlamydomonads were the primary food for larval yellow perch (Table 29). Major food items for larval bluegill were Chlamydomonads, rotifers, and microcrustaceans (Table 30). Stomachs of larval yellow perch averaged 3,636.4 food items per stomach. Larval bluegill averaged 55.3 food items per stomach.

Table 27. Percent number of food organisms in stomachs of young-of-the-year yellow perch containing food organisms, from Abbey Pond, 1973.

Total length of fish (mm)	Number of fish	Food Organisms: Cladocera	Copepoda	Acari	Amphipoda	Ostracoda	Odonata	Ephemeroptera	Chironomidae	Hemiptera	Trichoptera
10-19.9	1	6.3	93.7								
20-29.9	4	11.2	88.8								
30-39.9											
40-49.9	1	40.0			6.7		53.3				
50-59.9	2	58.8	2.8		13.4	2.1	16.3	5.5	1.1		
60-69.9	8	60.7	8.3	0.1	1.7	3.4	22.9	1.6		0.4	0.9
70-79.9	4	2.3		0.7	1.4	48.0	45.1				2.5

Table 28. Electivity indices of young-of-the-year yellow perch for zooplankton in Abbey Pond, 1973.

	Date						
	6-14	6-25	7-5	7-16	7-26	8-6	8-16
Crustacea							
Cladocera							
Daphnia galeata	-0.656			-1.000	-1.000		-1.000
Daphnia ambigua	-0.906			-1.000	-1.000		-1.000
Bosmina longirostris	0.000			-1.000	-1.000		-0.909
Chydorus sp.	0.000			+1.000	+0.254		+0.833
Copepoda							
Cyclopoida	+0.387			-1.000	-0.979		+0.939
Ostracoda	-1.000			-1.000	-0.912		+0.995

Table 29. Stomach contents of larval yellow perch from Abbey Pond, 1974, expressed as percent number per stomach.

Total length of fish (mm)	Number of fish	Food Organisms			
		Chlamydomadaceae	Rotifera	Cladocera	Cyclopoida
9.0-16.0	16	96.2	3.2	0.2	0.4

Average number of organisms per stomach --- 3636.4

Table 30. Stomach contents of larval bluegill from Abbey Pond, 1973, expressed as percent number per stomach.

Total length of fish (mm)	Number of fish	Food Organisms			
		Chlamydomadaceae	Rotifera	Cladocera	Cyclopoida
6.0-9.0	20	38.4	16.9	26.8	17.9

Average number of organisms per stomach --- 55.3

Because of difficulties in capturing larval fishes, adequate numbers were not available for extensive food habit analysis. Meter nets, small seines and dip nets proved ineffective in capturing larval fishes in Abbey Pond. All larval fishes examined were captured while conducting zooplankton tows with a Miller sampler.

SUMMARY AND CONCLUSIONS

Stomach contents of young-of-the-year largemouth bass, bluegill, black crappie, yellow bullhead and yellow perch from Abbey Pond, South Dakota, were analyzed from 25 June to 22 October, 1973 and from 29 June to 17 September, 1974. Microcrustaceans, aquatic insects and fish were the primary food organisms consumed by the 578 fishes examined.

Young-of-the-year largemouth bass food habits progressed from entomostracans to aquatic insects to fish. Microcrustaceans were of little importance in the diet of largemouth bass over 70.0 mm in size. Aquatic insects became increasingly important in the diet of bass 20.0 mm to 100.0 mm in total length and may serve as an important bridge for young bass switching from a diet of zooplankton to a diet of fish. Fish became increasingly important in the largemouth bass diet as bass neared 100 mm in total length. Simocephalus serrulatus, copepods, odonates, corixids, ephemeropterans, chironomids, Hyalella sp. and young-of-the-year bluegill were the major food organisms for young-of-the-year largemouth bass during this study. During the first half of the 1973 summer Chydorus sp. was positively elected for while in the early summer of 1974 cyclopoid copepods were positively elected for. With two exceptions all zooplanktors were negatively elected for by young-of-the-year largemouth bass after mid August, 1973, and after the end of July, 1974.

Young-of-the-year bluegill fed primarily on zooplankton and insect larvae. A wide variety of food organisms could be found in young bluegill stomachs on any sampling date. Major food organisms for young-of-the-year bluegill during this study included cladocerans, copepods, ostracods and chironomids. Zooplankton electivity by bluegill young-of-the-year indicated that Chvdorus sp. was positively elected and that Bosmina longirostris and Ceriodaphnia sp. were negatively elected.

Entomostracans were the predominant food organisms for young-of-the-year black crappie. Copepods, Bosmina longirostris, Daphnia spp., Chvdorus sp. and Ceriodaphnia sp. were the primary food organisms consumed by young black crappie during 1973 and 1974. Aquatic insects, although taken, appeared to be of minor importance to black crappie less than 75.0 mm in length. Young black crappie exhibited positive electivity indices for cyclopoid copepods and negative electivity indices for Bosmina longirostris.

Young-of-the-year yellow bullheads fed primarily on Hvalella sp., microcrustaceans and aquatic insects. Hyalella sp. was a major food organism for young-of-the-year yellow bullheads of all sizes. Yellow bullhead had negative electivity indices for Daphnia ambigua, Ceriodaphnia sp. and Bosmina longirostris and, in most cases, positive indices for Chydorus sp. and ostracods.

Young-of-the-year yellow perch fed primarily on zooplankton and aquatic insects. Utilization of food organisms by young perch indicated a progression from microcrustaceans to aquatic insects. Major food organisms consumed during 1973 were odonates, Simocephalus serrulatus, ostracods and cyclopoid copepods. Yellow perch had negative electivity indices for Daphnia galeata and D. ambigua. Except for one occasion Chydorus sp. was positively elected.

Larval yellow perch fed almost exclusively on rotifers and chlamydomonads. Larval bluegill utilized rotifers, cladocerans, copepods and chlamydomonads. Because larval fish have small mouths and are weak swimmers, food organisms must be vulnerable and small enough for the larvae to capture and ingest. Chlamydomonads and some microcrustaceans appear to meet these requirements.

Analysis of food habits of young-of-the-year fishes did not indicate complete niche segregation between the different species. Microcrustaceans and aquatic insects were utilized by all species of young-of-the-year fishes during their early development. This could lead to serious interspecific and intraspecific competition under limited food resource conditions. A limited zooplankton population would probably affect young-of-the-year black crappie the greatest because they depend on zooplankton throughout their first summer of life. As young black crappie increase in size, they require larger numbers of microcrustaceans to fill their stomachs to capacity and therefore abundant zooplankton populations become even more critical. Bluegill also depend on zooplankton for food throughout their first summer of life, and although insect larvae form an important part of their diet, a limitation of zooplanktors could affect survival and growth of young-of-the-year bluegill. Young-of-the-year largemouth bass, yellow bullheads and yellow perch demonstrate an initial dependence on microcrustaceans, but with increased size switch to other food items. Those fish which will utilize a variety of food items in their diet would probably be least affected by a shortage of a particular food organism.

The food supply in Abbey Pond would not appear to be an important limiting factor to fishes at this time. However, any event which would reduce zooplankton or insect populations in the pond could have serious consequences on survival and growth of young-of-the-year fishes. The degree of competition for a limited food resource that exists among fishes, may affect the subsequent year class strength of those fishes. The degree of overlapping food habits that exists in Abbey Pond may be an important protection against overpopulation and may result in a more stable fish population.

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APPENDIX

Appendix Table 1. Physical-chemical data for Abbey Pond 25 June through 16 November, 1973 (chemical analysis as mg/l).

	Sampling depth	Date 6-25	7-26	8-27	9-28	10-22	11-16
Temperature (C)	S[1]	24.5	22.0	23.0	14.5	14.0	4.5
	1 m	23.3	21.5	21.0	14.0	13.0	4.5
	2 m	18.5	21.0	21.0	13.8	12.5	4.5
	3 m	18.0	19.8	20.0	13.5	12.5	4.5
	4 m	17.0	19.0	19.0	13.5	11.0	4.5
Secchi disc visibility (cm)	S	105	100	125	190	125	195
pH	S	8.1	7.0	6.9	7.4	7.1	7.0
Dissolved oxygen	S	12	10	10	12	13	12
Total alkalinity	S	170	140	150	140	140	140
Calcium hardness	S	160	130	160	160	180	175
Total hardness	S	300	300	270	280	290	285
Turbidity (JTU)	S	25	5	8	10	0	0
Chloride	S	10	10	13	12.5	12.5	11.0
Sulfate	S	180	160	98	140	110	120

[1]Surface

Appendix Table 2. Physical-chemical data for Abbey Pond 15 May through 7 September, 1974 (chemical analysis as mg/l).

	Sampling depth	Date 5-15	6-17	7-8	8-18	9-7
Temperature (C)	S[1]	11.0	19.5	24.0	21.0	17.2
	1 m	11.0	18.5	24.0	21.0	16.9
	2 m	10.5	18.0	24.0	21.0	16.0
	3 m	10.5	18.0	24.0	21.0	15.8
	4 m	10.5	17.0	23.5	21.0	15.0
	5 m	10.5	13.5	22.5	20.5	15.0
	6 m	10.5	12.0	16.0	20.0	15.0
Secchi disc visibility (cm)	S	200	180	120	140	110
pH	S	8.0	7.9	8.0	8.6	8.7
Dissolved Oxygen	S	9.8	9.0	7.8	14.0	13.0
	B[2]	8.6	0.2	0.4	0.5	6.3
Phenophalein alkalinity	S	0	0	0	10	15
Total alkalinity	S	120	90	140	120	110
Calcium hardness	S	150	110	190	140	120
Total hardness	S	280	195	260	270	270
Turbidity (JTU)	S	5	10	7	9	10
Chloride	S	5	2.5	7	5	5
Sulfate	S	97	85	90	180	175

[1]Surface

[2]Bottom

Appendix Table 3. Phytoplankton density expressed as cells x 10^3/l and percent composition (in parenthesis) in Abbey Pond, 1973.[1]

	Date										
	6-14	6-25	7-5	7-16	7-26	8-6	8-16	8-27	9-12	9-28	10-22
Chlorophyta											
<u>Ankistrodesmus</u>	T[2] (T)[3]	.6 (16.1)	.4 (T)	T (T)	T (T)			T (3.9)		T (1.7)	
<u>Selenastrum</u>	2.2 (25.7)		1.5 (2.5)	T (T)							
<u>Pediastrum</u>	3.2 (37.6)	.2 (4.3)	.5 (T)		T (T)	T (1.2)					
Chrysophyta											
<u>Tribonema</u>	T (T)	T (T)	1.4 (2.3)	6.2 (66.9)	2.4 (84.6)	T (8.6)	T (1.9)		.2 (31.0)		T (T)
<u>Fragilaria</u>	T (T)	.2 (5.9)	5.2 (8.7)	2.1 (22.5)	.3 (11.1)	.2 (46.0)	.1 (61.9)	T (17.5)	.2 (39.8)	.4 (45.6)	1.0 (30.4)
<u>Asterionella</u>	.8 (8.9)	1.4 (35.0)	49.6 (82.7)	.7 (7.4)	T (2.9)	T (22.3)	T (20.7)	T (12.8)	.1 (26.0)	.4 (52.7)	2.1 (66.9)
<u>Synedra</u>	1.4 (17.0)	T (1.0)		T (T)				T (6.8)	T (2.4)		T (T)
<u>Dinobryon</u>	.7 (8.4)	1.5 (35.9)	.5 (T)		T (T)						
Cyanophyta											
<u>Coelosphaerium</u>	T (T)	T (1.0)	.6 (T)	T (T)		T (16.7)	T (13.9)	.1 (50.0)			T (T)
Total	8.3	3.9	59.7	9.0	2.7	.2	.1	.1	.5	.8	3.1

[1]Organisms making up < 1.0 percent of the total population (<u>Pinnularia</u>, <u>Nitzschia</u>, <u>Golinkina</u>, <u>Microspora</u>, <u>Stephanodiscus</u>, <u>Scenedesmus</u> and <u>Navicula</u>) were omitted from this table.

[2]Less than 100 organisms/l

[3]Less than 1%

Appendix Table 4. Phytoplankton density expressed as cells x 10^3/l and percent composition (in parenthesis) in Abbey Pond, 1974.[1]

	Date												
	5-16	5-27	6-6	6-17	6-29	7-8	7-18	7-29	8-8	8-18	8-28	9-7	9-17
Chrysophyta													
Trihonema			T[2]	5.0	12.4	737.9							
			(1.2)	(22.9)	(71.6)	(95.8)							
Asterionella	T	0.3	1.5	15.6	0.5	1.1	0.2				0.1	0.4	0.6
	(29.2)	(57.7)	(89.5)	(71.3)	(3.0)	(T)[3]	(T)				(1.1)	(5.6)	(8.8)
Fragilaria	T	0.2	0.1	1.0	1.0	0.3	T				T	0.1	0.2
	(56.6)	(36.7)	(6.1)	(4.7)	(5.8)	(T)	(T)				(T)	(1.8)	(2.9)
Cyanophyta													
Aphanizomenon					3.3	28.9	208.4	354.8	120.1	124.2	8.0	1.1	4.3
					(19.2)	(3.8)	(99.2)	(99.9)	(99.9)	(99.9)	(73.3)	(15.2)	(66.9)
Anabaena					T	2.0	1.4	0.5	T		2.7	5.6	1.4
					(T)	(T)	(T)	(T)	(T)		(24.7)	(75.6)	(21.1)
Total	T	0.5	1.6	21.6	17.2	770.2	210.0	355.3	120.1	124.2	10.8	7.2	6.5

[1] Organisms making up < 1.0 percent of the total population (Synedra, Spirogyra, Nitzhia, Coelosphaerium, Pedastrium, Eudorina and Golinka) were omitted from this table.

[2] Less than 100 organisms/l

[3] Less than 1%

Appendix Table 5. Density per liter and percent occurrence (in parenthesis) of zooplankton in Abbey Pond, 1973.

	Date										
	6-14	6-25	7-5	7-16	7-26	8-6	8-16	8-27	9-12	9-28	10-22
Crustacea											
Cladocera											
Daphnia galeata	24.9	11.1	46.8	18.9	8.9	3.5	27.1	1.4	10.8	11.4	14.2
	(25.4)	(25.9)	(25.3)	(23.5)	(9.2)	(T)[2]	(8.3)	(6.3)	(5.7)	(4.4)	(12.6)
Daphnia ambigua	33.4	10.5	57.0	.4	.1	1.0	7.9	.6	6.4	13.4	31.9
	(34.1)	(24.6)	(30.8)	(T)	(T)	(T)	(2.4)	(2.5)	(3.4)	(5.2)	(28.4)
Bosmina longirostris		.4	2.4	19.3	72.3	441.4	283.7	18.4	113.7	187.8	47.4
		(T)	(1.3)	(24.1)	(74.6)	(98.4)	(87.0)	(83.4)	(60.4)	(72.8)	(42.0)
Ceriodaphnia sp.	T[1]	.2	4.8	12.0	2.2	1.6	4.2	.9	1.8	1.2	.1
	(T)	(T)	(2.6)	(14.9)	(2.3)	(T)	(1.3)	(4.1)	(T)	(T)	(T)
Chydorus sp.	T	.3	.2	T	.2	T	1.8	.2	4.3	.4	.2
	(T)	(T)	(T)	(T)	(T)	(T)	(T)	(T)	(2.3)	(T)	(T)
immature daphnia	1.6	T	4.9	2.4	.5	.2			11.2	2.4	4.4
	(1.7)	(T)	(2.6)	(3.0)	(T)	(T)			(5.9)	(T)	(3.9)
Copepoda											
Cyclopoida	36.2	18.1	65.9	23.3	9.2	.7	1.0	.5	34.5	36.0	14.1
	(36.9)	(42.4)	(35.6)	(29.0)	(9.5)	(T)	(T)	(2.2)	(18.3)	(14.0)	(12.5)
Calanoida	.1	.4	.4	1.0	.3	.1	.1	.1	.3		.4
	(T)	(1.0)	(T)	(1.2)	(T)	(T)	(T)	(T)	(T)		(T)
Nauplii	1.4	1.4	2.8	2.7	1.1	.1		T	5.2	5.2	
	(1.4)	(3.2)	(1.5)	(3.4)	(1.1)	(T)		(T)	(2.7)	(2.0)	
Ostracoda	.2	.2		.3	2.0		.3		.2		
	(T)	(T)		(T)	(2.1)		(T)		(T)		
Total	97.8	42.6	185.2	80.3	96.8	448.6	325.8	22.1	188.4	257.8	112.7

[1]Less than 0.1 organism/l

[2]Less than 1%

Appendix Table 6. Density per liter and percent occurrence (in parenthesis) of zooplankton in Abbey Pond, 1974.

	Date												
	5-16	5-27	6-6	6-17	6-29	7-8	7-18	7-29	8-8	8-18	8-28	9-7	9-17
Crustacea													
Cladocera													
Daphnia galeata	17.8 (16.8)	13.9 (53.6)	99.8 (51.4)	7.0 (15.5)	1.4 (4.5)	50.4 (38.5)	31.3 (40.0)	4.6 (59.3)	60.7 (26.2)	5.3 (5.0)	21.7 (7.9)	14.9 (5.7)	5.3 (3.6)
Daphnia ambigua	46.2 (43.7)	5.5 (21.2)	53.5 (27.5)	25.9 (57.1)	T[1] (T)[2]	3.9 (3.0)	23.8 (30.3)	0.1 (T)	32.3 (13.9)	4.6 (4.4)	17.8 (6.5)	26.2 (10.0)	18.3 (12.4)
Bosmina longirostris	1.0 (1.0)	0.1 (T)	0.4 (T)	0.1 (T)	2.4 (7.4)	32.3 (24.7)	15.9 (20.2)	1.8 (22.9)	72.5 (31.3)	31.7 (29.9)	135.2 (49.0)	173.7 (66.4)	106.8 (72.6)
Ceriodaphnia sp.			0.1 (T)	T (T)	0.7 (2.2)	8.6 (6.5)	3.5 (4.5)	0.5 (6.5)	54.8 (23.6)	26.3 (24.8)	87.5 (31.7)	40.1 (15.3)	4.5 (3.0
Chydorus sp.	T (T)	0.7 (2.6)	2.1 (1.1)	1.1 (2.4)	19.7 (61.0)	4.3 (3.3)		0.2 (2.4)		T (T)	T (T)	1.2 (T)	1.3 (T)
immature daphnia	8.8 (8.3)	1.2 (4.5)	8.6 (4.4)	T (T)			1.2 (1.6)						
Copepoda													
Cyclopoida	31.7 (30.0)	4.1 (15.6)	27.1 (13.9)	10.3 (22.6)	7.8 (24.2)	22.8 (17.5)	1.5 (1.9)	0.2 (3.1)	9.2 (4.0)	33.0 (31.0)	11.3 (4.1)	3.9 (1.5)	10.0 (6.8)
Calanoida	0.3 (T)	0.1 (T)				0.3 (T)				T (T)		0.6 (T)	0.2 (T)
Nauplii		T (T)	2.4 (1.2)	0.7 (1.5)	0.1 (T)	8.0 (6.2)		0.4 (5.0)	1.0 (T)	4.5 (4.2)	0.5 (T)	1.0 (T)	0.5 (T)
Ostracoda		0.4 (1.4)	0.5 (T)	0.1 (T)		0.2 (T)	1.2 (1.6)		1.5 (T)	0.6 (T)	1.0 (T)		0.1 (T)
Total	104.8	26.0	194.5	45.2	32.1	130.8	78.4	7.8	232.0	106.0	275.7	261.6	147.0

[1]Less than 0.1 organism/l

[2]Less than 1%