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Feeding Selectivity of Young-of-the-Year Smallmouth Bass, Micropterus dolomieui Lacepede, in Four Rearing Ponds

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FEEDING SELECTIVITY OF YOUNG-OF-THE-YEAR SMALLMOUTH BASS, *MICROPTERUS DOLOMIEUI* LACEPEDE, IN FOUR REARING PONDS

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GORDON BRENT MANNING

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INTRODUCTION

The types of food utilized by young-of-the-year smallmouth bass, *Micropterus dolomieui* Lacepede, are well known. Important food studies of smallmouth bass have been made by Wickliff (1920), Sibley and Rimsky-Korsakoff (1931), Tester (1932), Surber (1940), Lackner (1950), and Robertson (1951). Each of these studies has been of the food of fry and fingerlings from lakes and streams except that of Robertson (1951). Robertson's study involved the types of food eaten by young smallmouth bass in one hatchery pond in Benton County, Arkansas.

The purpose of this study is to determine if selectivity of food exists by analyzing the types of food consumed by young smallmouth bass in four hatchery ponds and comparing them to the potential food items available as measured by zooplankton and benthic sampling.

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DESCRIPTIONS OF THE REARING PONDS

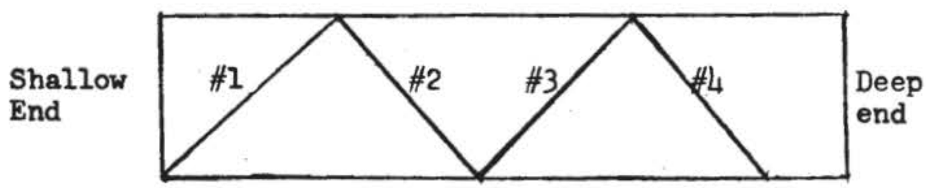
The field work was conducted during the spring and summer of 1973 by Dr. Homer Buck at Stephen A. Forbes State Park near Kinmundy, Illinois. The four identical rearing ponds have a maximum depth of six feet and a minimum depth of one-half foot with a moderately sloped but even bottom. Each pond has a surface area of approximately one acre. The ponds had been drained in the fall of 1972 to eliminate contamination by other fish species. The bottoms of the four ponds were uniform, being primarily sand in the shallow areas and sandy-muck in the deeper areas.

The ponds were stocked with adult smallmouth bass which produced the young-of-the-year during the spring of 1973. No forage fish were allowed in the ponds. The only food available consisted of that which was produced in the ponds and the terrestrial and air borne materials deposited within.

METHODS AND EQUIPMENT

PLANKTON SAMPLING

Zooplankton collections were made every other week beginning on 14 June 1973 and continuing through 29 August 1973. One continous long plankton haul was made in zig-zag fashion for the entire length of each pond with a Turtox #6 standard plankton net (see diagram).



The zooplankton was sampled at a depth of 0' to 1' on transect #1; at 1'to 2' on transect #2; at 2' to 3' on transect # 3, and at 3' to 4' on transect #4. The samples were preserved in 10% formalin. These samples were later used to determine numbers per liter and relative abundance of the numbers of each genus present. Counting and identification of the zooplankton was done in a Sedgewick Rafter cell after recording the volume of the concentrate and preparing a 1:20 dilution of each sample. Zooplankters were identified with the aid of keys by Pennak (1953), Wilson (1959), Brooks (1959), Yeatman (1959), and Eddy and Hodson (1961).

BOTTOM SAMPLING

Benthos was sampled three times in each pond during middle and late summer. Each pond was visually divided into thirds and 10 random dredge samples

(6" x 6" Ekmann) were taken in each third of each pond. The ten samples from each area were then combined, washed, and preserved in 10% formalin.

In the laboratory, each of these combined samples was passed through a 30-mesh screen. The organisms were separated by hand from the residue containing sand particles and detritus and were retained for indentification, tabulation, and reference. Benthic organisms were identified with the aid of keys by Hilsenoff (1975), Pennak (1953), and Eddy and Hodson (1961).

FISH COLLECTIONS

Beginning on 16 June 1973, ten young smallmouth bass were collected from each pond by seining the shorelines. The fish were sampled in this manner and preserved in 10% formalin every other week during the summer until 21 August 1973.

The total length of each fish was recorded to the nearest millimeter. Each stomach was then removed by dissection and all recognizeable contents identified. The contents from ten smallmouth bass were analyzed for each date and combined. Numbers present and frequency of occurrence were considered in determining the importance of the food items found in the bass (Windell, 1968). Detritus was not considered in the analysis of the stomachs. Most detritus was probably taken accidentally while obtaining other food items (Wickliff, 1920).

Selection of available food in the environment by fish was determined by use of the quantitive Index of Electivity (E), described by Ivlev (1961). The Electivity Index is calculated by the formula: $E = \frac{ri-pi}{ri+pi}$

where ri is the relative quantity of any food organism in the digestive tract expressed as a percentage of the total, and pi is the relative quantity of the same organism in either the benthic or zooplankton community expressed as a percentage. E values occur within the limits of +1 and -1 for each major food group. Complete positive selection is indicated by +1 and complete rejection by -1.

PHYSICAL AND CHEMICAL WATER PARAMETERS

Methyl-orange and phenolphthalein alkalinities, were determined by titration (Table 1). Dissolved oxygen and water temperatures were determined by the use of a Yellow Springs Instrument Model #54 (Table 2). A Beckman O-Matic pH meter was utilized to analyze pH (Table 1). Nitrate, nitrite, ortho-phosphates, ammonia, and hardness calculations were made at the Illinois Natural History Survey Laboratory at the University of Illinois utilizing a Technicon CSM-6 Automatic Analyzer (Table 3). The preceeding parameters were determined only to give an indication of the type and quality of environment required to sustain the zooplankton and benthic communities which were encountered in the four rearing ponds. The parameters were not analyzed quantitatively with respect to limiting factors affecting the numbers found in the aquatic community.

RESULTS

ZOOPLANKTON

As illustrated in Table 4, The primary constituents of the zooplankton community in all four ponds were found to be cladocerans (of the genus Diaphanasoma), and calanoid copepods (of the genus Diaptomus). The only exception occurred in pond three on 29 August 1973, when another cladoceran, Ceriodaphnia, comprised a greater percentage of the population than did either Diaptomus or Diaphanasoma. The change in population composition actually existed or the data were affected by fluctuations within the zooplankton populations. According to Wells (1960), all zooplankton sampling is biased to some degree by the equipment and characteristics of plankton itself: the erratic horizontal distribution, pronounced diurnal and seasonal changes in vertical distribution and seasonal changes of species composition and abundance.

Rotifers were not considered in this study due to the large mesh size of the zooplankton net used to obtain samples (Turtox #6). Most rotifers easily pass through this net during sampling.

Table 1. Average Alkalinity and pH, from June to September 1973, in four smallmouth bass rearing ponds at Illinois Natural History Survey laboratories, Kinmundy, Illinois.

POND	Alkalinity: Phenolphthalein	Alkalinity: Methyl Orange	Alkalinity: Total	pH
1	0.1	6.47	65.7	8.17
2	0.04	6.45	65.0	8.06
3	0.01	5.24	52.5	8.02
4	0.02	6.60	66.2	8.15

Table 2. Average temperature (T) and dissolved oxygen (DO) at one foot depth intervals in four smallmouth bass rearing ponds, from June to September 1973, at Illinois Natural History Survey laboratories, Kinmundy, Illinois.

POND	SURFACE		1'		2'		3'		4'		5'		6'		BOTTOM	
	T	DO	T	DO	T	DO	T	DO	T	DO	T	DO	T	DO	T	DO
1	26.2	7.12	26.2	7.08	26.2	7.91	26.1	7.02	26.1		25.9	6.96	25.8	5.57	25.8	4.9
2	26.3	6.99	26.2	6.89	26.2	6.46	26.2	6.82	26.2		26.1	6.70	26.0	6.23	26.0	6.0
3	25.3	7.25	25.3	7.18	25.2	7.14	25.0	6.96	24.5		24.1	6.53	23.6	5.68	24.0	4.3
4	24.7	7.30	24.6	7.21	24.3	7.14	23.6	6.07	22.9		22.1	4.76	21.8	2.28	21.7	1.8

Table 3. Water quality data for July, August, and September 1973, in four smallmouth bass rearing ponds, at Illinois Natural History laboratories, Kinmundy, Illinois.

Date 1973 Parameter	Pond	7-6	7-24	7-30	8-20	8-27	9-4	9-13	9-17	$\bar{X}$
AMMONIA Mg/L	1	.08	.05	.05	.07	.10	.15	.17	.07	.092
	2	.15	.05	.10	.21	.10	.13	.06	.15	.119
	3	.13	.03	.08	.09	.08	.10	.13	.20	.087
	4	.13	.05	.07	.13	1.05	.15	.31	.20	.145
Hardness Mg/L	1	51	42	66	54	50	57	60	54	54.2
	2	66	33	70	58	64	68	49	51	57.4
	3	53	32	56	30	54	49	47	45	45.7
	4	56	42	63	33	42	58	55	51	50.0
Nitrate Mg/L	1	0	0	0	0	0	0	0	0	0
	2	0	0	0	.03	.02	0	0	0	.006
	3	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	.01	.02	.004
Nitrite Mg/L	1	0	0	0	0	0	0	0	0	0
	2	0	0	0	.01	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	.03	.03	.007
Ortho-PO_4 Mg/L	1	.02	.01	.02	.05	.05	.03	.35	.01	.067
	2	.02	.01	.01	.05	.03	.01	.01	.01	.019
	3	.02	.02	.01	.04	.04	.02	.25	.03	.054
	4	.02	.01	.01	.04	.05	.02	.69	.21	.131

Table 4. Numbers per liter and percent composition of zooplankton communities in four smallmouth bass young-of-the-year rearing ponds from 14 June-29 August 1973, at Illinois Natural History laboratories, Kinmundy, Illinois.

Date	June 14							
Pond	1		2		3		4	
	#/l	%	#/l	%	#/l	%	#/l	%
Taxa								
Entomostraca								
Cladocera								
Diaphanosoma sp.	5.7	54	3.5	29	4.5	43	5.7	40
Daphnia sp.	.1	1	.4	3	.9	8	.6	4
Eubosmina sp.	--	--	.6	5	.03	*	.03	*
Ceriodaphnia sp.	--	--	--	--	--	--	--	--
Copepoda								
Diaptomus sp.	2.2	21	6.0	49	2.6	24	7.5	52
Orthocyclops sp.	2.3	22	1.3	11	.7	7	--	--
Cyclopoid copepodids	--	--	--	--	.6	6	.1	1
Calanoid copepodids	--	--	.4	3	1.3	12	.3	2
Insecta								
Diptera larvae								
Chaoboridae	.2	2	--	--	--	--	--	--
Total number/Liter	10.6		12.3		10.6		14.4	

Date	June 25-28							
Pond	1		2		3		4	
	#/l	%	#/l	%	#/l	%	#/l	%
Taxa								
Entomostraca								
Cladocera								
Diaphanosoma sp.	4.0	33	4.2	40	3.1	29	3.8	37
Daphnia sp.	2.3	19	.1	1	2.2	20	1.4	14
Eubosmina sp.	--	--	.2	2	--	--	--	--
Ceriodaphnia sp.	--	--	--	--	--	--	--	--
Copepoda								
Diaptomus sp.	3.5	29	4.2	40	4.4	41	4.1	39
Orthocyclops sp.	2.0	16	1.4	14	.5	5	.2	2
Cyclopoid copepodids	.21	2	.2	2	.1	1	.1	1
Calanoid copepodids	.1	*	.2	2	.4	3	.7	7
Insecta								
Diptera larvae								
Chaoboridae	--	--	--	--	--	--	--	--
Total number/Liter	11.9		10.4		10.8		10.4	

Date	July 10							
Pond	1		2		3		4	
	#/l	%	#/l	%	#/l	%	#/l	%
Taxa								
Entomostraca								
Cladocera								
Diaphanosoma sp.	8.1	64	7.7	57	4.0	40	2.2	23
Daphnia sp.	.03	*	.06	*	1.4	14	1.6	7
Eubosmina sp.	.03	*	--	--	--	--	.03	*
Ceriodaphnia sp.	--	--	--	--	--	--	--	--
Copepoda								
Diaptomus sp.	3.0	24	5.3	39	4.2	41	3.8	40
Orthocyclops sp.	1.1	9	.5	4	.5	5	1.8	19
Cyclopoid copepodids	.4	3	--	--	--	--	.09	1
Calanoid copepodids	--	--	.06	*	--	--	--	--
Insecta								
Diptera larvae								
Chaoboridae	--	--	--	--	--	--	--	--
Total number/Liter	12.7		13.6		10.2		9.6	

* Less than 1 percent
-- Organisms not present

Table 4. (continued)

July 25							
1		2		3		4	
#/l	%	#/l	%	#/l	%	#/l	%
6.6	61	6.8	53	9.2	40	5.3	41
--	--	--	--	2.3	15	.3	3
.6	5	--	--	--	--	--	--
--	--	--	--	--	--	3.1	25
2.8	26	3.6	29	4.2	28	3.3	26
.8	8	1.2	9	1.1	7	.03	2
--	--	.3	4	1.0	6	.4	3
--	--	.6	4	.7	5	.2	2
--	--	--	--	--	--	--	--
10.7		12.6		15.2		12.7	

August 8							
1		2		3		4	
#/l	%	#/l	%	#/l	%	#/l	%
7.6	67	7.2	22	5.5	53	7.3	64
.1	1	--	--	1.7	16	.6	5
--	--	--	--	.03	*	--	--
--	--	--	--	.6	6	--	--
3.2	28	2.1	75	2.5	24	2.8	25
.1	1	--	--	.1	1	.4	4
.4	3	.2	2	.03	*	.2	2
.03	*	.03	*	--	--	--	--
--	--	--	--	--	--	--	--
9.6		11.4		10.4		11.3	

August 29							
1		2		3		4	
#/l	%	#/l	%	#/l	%	#/l	%
8.2	84	3.9	41	1.6	18	4.7	35
--	--	.2	2	--	--	1.3	13
.4	4	--	--	--	--	--	--
.1	1	.1	1	3.9	43	.9	9
.6	6	5.1	53	3.1	34	3.8	38
.4	3	.1	1	--	--	.3	3
.2	2	.2	2	.5	6	.2	2
--	--	.1	1	--	--	.2	--
--	--	--	--	--	--	--	--
9.9		9.5		9.2		9.9	

BOTTOM FAUNA

The results from the three periods of benthos sampling are illustrated in Tables 5, 6, and 7. Numerically, the most commonly occurring taxa in all four ponds were larval members of the families Chaoboridae and Chironomidae of the order Diptera, and the genus Hyalella of the order Amphipoda. Hexagenia naiads (Ephemeroptera) were also abundant, but only during the 25-26 September sampling period.

POND 1

The most abundant organisms, comprised 48% of the population during 20 July 1973, were larval members of the family Chironomidae. The chironomid larvae were followed in numerical abundance by Hyalella, which comprised 20% of the benthic population and chaoborid larvae (phantom midges) which comprised 14% (Table 5).

During the 13-15 August sampling Hyalella were the most abundant organisms. Hyalella comprised 37% of the population with chironomid and chaoborid larvae comprising 31 and 29% respectively (Table 6).

The 25-26 September sampling showed the Chaoboridae larvae to be 57% of the population with Hyalella next in numerical importance at 13%.

POND 2

In all three sampling periods Hyalella were the principal benthic organisms, making up more than 50% of the population (Tables 5, 6, 7). Next in order of numerical value were chironomid larvae comprising 13, 26, and 10% on 20 July, 13-15 August, and 25-26 September respectively.

POND 3

During the first two sampling periods, chironomid larvae comprised more than 75% of the Pond Three benthic population (Tables 6, 7). The last sampling period changed drastically as ephemeropterans, of the genus Hexagenia, were predominant. They made up 41% of the population while the chironomid larvae made up only 16% of

Table 5. Number per square meter (M^2) and percent composition of benthic organisms found in four smallmouth bass young-of-the-year rearing ponds on 20 July 1973, at Illinois Natural History Survey laboratories, Kinmundy, Illinois.

Taxa	Ponds 1 #/M²	%	2 #/M²	%	3 #/M²	%	4 #/M²	%	$\bar{X}$* #/M²	%
Nematoda	39	6	89	9	16	<1	31	3	47	4
Annelida										
Oligochaeta	--	--	--	--	--	--	--	--	--	--
Arthropoda										
Crustacea										
Amphipoda										
Hyalella sp.	196	20	598	60	27	2	10	<1	208	20
Insecta										
Ephemeroptera naiads										
Caenis sp.	1	<1	3	<1	37	3	7	4	13	1
Hexagenia sp.	--	--	3	<1	11	<1	27	3	11	1
Odonata naiads										
Gomphus sp.	--	--	1	<1	1	<1	--	--	1	<1
Megaloptera larvae										
Sialis sp.	--	--	4	<1	16	<1	11	1	9	<1
Trichoptera larvae										
Oecetis sp.	3	<1	--	--	--	--	--	--	1	<1
Coleoptera larvae										
Hydrophilide										
Berosus sp.	7	1	3	<1	--	--	--	--	3	<1
Diptera larvae										
Tipulidae	--	--	1	<1	6	<1	--	--	2	<1
Culicidae	11	1	--	--	--	--	--	--	3	<1
Chaoboridae	139	14	153	16	159	12	848	84	325	31
Chironomidae	471	48	128	13	980	77	70	7	413	39
Ceratopogonidae	3	<1	6	<1	7	<1	1	<1	6	<1
Unidentified pupae	1	<1	3	<1	1	<1	--	--	1	<1
Mollusca										
Gastropoda										
Physidae	21	2	--	--	3	<1	--	--	6	<1
Pelecypoda										
Sphaeriidae	69	7	--	--	--	--	--	--	17	2

* Arithmetic mean of the four pond samples combined.

Table 6. Number per square meter (M^2) and percent composition of benthic organisms found in four smallmouth bass young-of-the-year rearing ponds on 13-15 August 1973, at Illinois Natural History Survey laboratories, Kinmundy, Illinois.

Pond	1		2		3		4		$\bar{x}$ *	
	#/M^2	%	#/M^2	%	#/M^2	%	#/M^2	%	#/M^2	%
Taxa										
Nematoda	--	--	13	1	16	<1	40	4	17	1
Arthropoda										
Crustacea										
Amphipoda										
Hyalella sp.	426	37	552	51	54	3	23	3	264	20
Ephemeroptera naiads										
Caenis sp.	--	--	7	<1	9	<1	42	5	14	1
Hexagenia sp.	4	<1	7	<1	99	5	229	25	85	6
Odonata naiads										
Gomphus sp.	1	<1	--	--	--	--	--	--	<1	<1
Libellula sp.	3	<1	77	7	10	<1	3	<1	17	1
Pachidiplax sp.	3	<1	30	3	--	--	--	--	--	--
Megaloptera larvae										
Sialis sp.	4	<1	21	2	46	2	23	3	24	2
Trichoptera larvae										
Oecetis sp.	4	<1	--	--	4	<1	3	<1	3	<1
Coleoptera larvae										
Hydrophilidae										
Berosus sp.	1	<1	3	4	--	--	--	--	1	<1
Diptera larvae										
Tipulidae	--	--	--	--	--	--	3	<1	<1	<1
Culicidae	--	--	--	--	--	--	3	<1	1	<1
Chaoboridae	342	29	53	5	156	7	249	27	201	15
Chironomidae	365	31	285	26	1659	80	257	28	641	49
Ceratopogonidae	4	<1	--	--	3	<1	4	<1	3	<1
Unidentified pupae										
Mollusca										
Gastropoda										
Physidae	6	<1	1	1	1	<1	--	--	2	<1

* Arithmetic mean of the pond samples combined.

Table 7. Number per square meter (M^2) and percent composition of benthic organisms found in four smallmouth bass young-of-the-year rearing ponds on 25-26 September 1973, at Illinois Natural History Survey laboratories, Kinmundy, Illinois.

Taxa	Ponds 1 #/M^2	1 %	2 #/M^2	2 %	3 #/M^2	3 %	4 #/M^2	4 %	$\bar{x}$* #/M^2	$\bar{x}$* %
Nematoda	116	10	49	6	54	8	--	--	55	6
Annelida										
Oligochaeta	--	--	1	<1	--	--	--	--	<1	<1
Arthropoda										
Crustacea										
Amphipoda										
Hyalella ap.	143	13	414	53	75	10	33	5	166	19
Insecta										
Ephemeroptera naiads										
Caenis sp.	1	<1	--	--	1	<1	4	<1	2	<1
Hexagenia sp.	10	<1	40	5	289	41	678	74	255	29
Odonata naiads										
Libellula sp.	24	2	106	14	40	6	1	<1	43	5
Pachidiplax sp.	13	1	17	2	7	1	--	--	9	<1
Megaloptera larvae										
Sialis sp.	--	--	4	<1	62	9	9	<1	19	2
Trichoptera larvae										
Oecetis sp.	32	3	29	4	16	2	4	<1	14	3
Coleoptera larvae										
Hydrophilidae										
Berosus sp.	--	--	1	<1	3	<1	--	--	1	<1
Diptera larvae										
Tipulidae	1	<1	--	--	6	<1	--	--	2	<1
Culicidae	--	--	--	--	--	--	1	<1	1	<1
Chaoboridae	633	57	21	3	24	3	76	8	189	22
Chironomidae	105	9	77	10	113	16	93	10	96	11
Ceratopogonidae	19	2	1	<1	9	1	4	<1	6	<1
Unidentified pupae	9	<1	11	<1	13	2	7	<1	11	1

* Arithmetic mean of the four pond samples combined.

the population.

POND 4

Chaoboridae larvae were the most abundant organisms in Pond Four during the first sampling period making up 84% of the population (Table 5). Hexagenia naiads, chironomid and chaoborid larvae were most abundant in the second sampling period making up 25, 28, and 27% of the population respectively (Table 6). On the last sampling period the population underwent a definite shift as Hexagenia were found to comprise 74% of the population. The earlier predominants were 10% or less of the benthic population (Table 7).

FISH STOMACHS

This study was conducted to determine if selectivity of food organisms by young-of-the-year smallmouth bass exists. Tables 8, 9, 10, and 11 show percent occurrence and percent composition of food organisms in 302 stomachs. The Tables also show the mean total length of the bass (10 per sample) and the date each was taken. Figures 1, 2, 3, and 4 show graphically the percent occurrence of the most frequently occurring food items in the stomachs of the smallmouth bass and the percent composition of the most frequently occurring members of the zooplankton and benthic communities in each pond from 12-14 June until 21-29 August 1973. The 25-26 September benthic data are included to show the dynamic trend of the benthic communities at the time of the last smallmouth bass sampling. Table 12 is a summary of the total number of bass stomachs examined, the total percent occurrence, and the percent composition of those organisms found in the stomachs.

Figure 5 shows graphically an Electivity Index (Ivlev, 1961). E values for each major food group occur within the limits of +1 and -1, the former value indicating complete positive selection and the latter, complete rejection of a food item.

In percent composition of total organisms eaten, and in percent occurrence, Diaphanasoma were the predominant organisms eaten (Table 12). They totaled 73.9%

Table 8. The number, percent composition, and percent occurrence of organisms found in smallmouth bass stomachs from Pond One, 16 June through 21 August 1973. Smallmouth bass mean total lengths, range and stomach samples were based on ten fish per date. All samples were obtained from Illinois Natural History Survey laboratories, Kinmundy, Illinois.

Date 1973 Pond 1	5-16 A	5-16 B	5-16 C	6-4 A	6-4 B	6-4 C	6-13 A	6-13 B	6-13 C	6-28 A	6-28 B	6-28 C
Total length (mm)		9.0			26.2			33.9			43.8	
Range (mm)		8-10			24-32			33-36			39-54	
Taxa												
Nematoda	-	-	-	-	-	-	-	-	-	-	-	-
Arthropoda												
Crustacea												
Cladocera												
Diaphanosoma sp.	-	-	-	227	57	90	25	21	10	1772	92	100
Daphnia sp.	-	-	-	6	1	20	3	3	10	123	6	60
Eubosmina sp.	33	63	70	-	-	-	-	-	-	-	-	-
Chydorus sp.	8	15	20	8	2	20	-	-	-	-	-	-
Copepoda												
Cyclopoid copepods	7	13	50	142	34	90	63	53	50	20	1	50
Amphipoda												
Hyalella sp.	-	-	-	21	5	70	10	8	30	5	<1	30
Insecta												
Ephemeroptera naiads												
Caenis sp.	-	-	-	1	<1	10	3	3	30	1	<1	10
Hexagenia sp.	-	-	-	3	<1	10	-	-	-	-	-	-
Odonata naiads												
Anisoptera												
Libellulidae	-	-	-	-	-	-	1	1	10	1	<1	10
Gomphidae												
Zygoptera												
Argia sp.	-	-	-	-	-	-	2	2	10	-	-	-
Hemiptera nymphs												
Diptera larvae												
Chironomidae	4	8	30	1	1	10	11	9	60	3	<1	20
Ceratopogonidae	-	-	-	-	-	-	-	-	-	3	<1	10
Chaoboridae	-	-	-	-	-	-	-	-	-	3	<1	20
Unident., pupae	-	-	-	-	-	-	1	1	10	-	-	-
subadults	-	-	-	-	-	-	-	-	-	-	-	-
adults	-	-	-	-	-	-	-	-	-	-	-	-

Date 1973 Pond 1	7-11 A	7-11 B	7-11 C	7-23 A	7-23 B	7-23 C	8-7 A	8-7 B	8-7 C	8-21 A	8-21 B
Total length (mm)		55.0			58.0			61.6			63.8
Range (mm)		45-74			49-65			56-68			54-74
Taxa											
Nematoda	1	1	10	1	<1	10	57	2	30	1	<1
Arthropoda											
Crustacea											
Cladocera											
Diaphanosoma sp.	2569	98	80	199	84	70	3709	98	100	283	88
Daphnia sp.	-	-	-	-	-	-	-	-	-	1	<1
Eubosmina sp.	-	-	-	-	-	-	-	-	-	-	-
Chydorus sp.	1	<1	10	11	<1	10	-	-	-	-	-
Copepoda											
Cyclopoid copepods	2	<1	20	8	3	30	7	<1	40	6	2
Amphipoda											
Hyalella sp.	40	2	50	28	12	70	4	<1	40	5	2
Insecta											
Ephemeroptera naiads											
Caenis sp.	-	-	-	-	-	-	-	-	-	1	<1
Hexagenia sp.	-	-	-	-	-	-	-	-	-	-	-
Odonata naiads											
Anisoptera											
Libellulidae	-	-	-	-	-	-					
Gomphidae							6	<1	30	-	-
Zygoptera											
Argia sp.	-	-	-	-	-	-	-	-	-	1	<1
Hemiptera nymphs											
Diptera larvae											
Chironomidae	-	-	-	2	<1	20	-	-	-	8	3
Ceratopogonidae	-	-	-	1	<1	10	-	-	-	11	3
Chaoboridae	-	-	-	-	-	-	4	<1	20	2	<1
Unident., pupae	-	-	-	1	<1	10	9	<1	30	-	-
subadults	-	-	-	-	-	-	-	-	-	-	-
adults	-	-	-	-	-	-	1	<1	10	-	-

A=Number of organisms in the stomachs of ten smallmouth bass.
B=Percent composition of ingested organisms in the stomachs of ten smallmouth bass.
C=Percent occurrence of ingested organisms in the stomach of ten smallmouth bass.

Table 9. The number, percent composition, and percent occurrence of organisms found in smallmouth bass stomachs from Pond Two, 16 June through 21 August 1973. Smallmouth bass mean total lengths, range and stomach samples were based on ten fish per date. All samples were obtained from Illinois Natural History Survey laboratories, Kinmundy, Illinois.

Date 1973	5-16			6-1			6-12			6-26			7-11			7-23			8-7			8-21		
Pond 2	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Total length (mm)	11.3			20.3			30.3			42.8			55.7			60			66.3			69.8		
Range (mm)	10-12			16-22			21-34			36-51			46-60			45-66			62-75			64-82		
Taxa																								
Nemotoda	-	-	-	4	9	30	-	-	-	-	-	-	6	2	30	9	4	20	54	3	70	116	50	60
Arthropoda																								
Crustacea																								
Cladocera																								
Diaphanosoma sp.	22	8	80	20	44	70	114	52	80	23	6	50	176	62	50	121	54	40	1790	95	80	52	22	10
Daphnia sp.	101	38	100	-	-	-	5	3	10	4	1	10	-	-	-	-	-	-	-	-	-	-	-	-
Eubosmina sp.	6	2	50	12	27	30	1	1	10	2	1	20	-	-	-	-	-	-	-	-	-	-	-	-
Chydorus sp.	-	-	-	2	4	20	6	3	40	252	64	20	-	-	-	-	-	-	-	-	-	-	-	-
Copepoda																								
Cyclopoid copepods	129	40	100	-	-	-	10	5	20	2	1	20	1	1	10	-	-	-	-	-	-	-	-	-
Calanoid copepods	2	1	20	-	-	-	-	-	-	-	-	-	1	1	10	-	-	-	-	-	-	-	-	-
Amphipoda																								
Hyalella sp.	-	-	-	2	4	10	11	6	40	91	23	80	74	26	80	86	39	60	35	2	50	35	15	60
Insecta																								
Ephemeroptera naiads																								
Caenis sp.	-	-	-	1	2	10	9	5	30	11	3	40	-	-	-	2	4	20	-	-	-	9	4	30
Odonata naiads																								
Anisoptera																								
Libellulidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	20	10	4	50
Gomphidae																								
Zygoptera																								
Argia sp.	-	-	-	-	-	-	1	1	10	2	1	20	1	1	10	-	-	-	1	1	10	4	2	30
Hemiptera nymphs																								
Corixidae	-	-	-	-	-	-	3	2	20	1	1	10	-	-	-	2	1	20	-	-	-	1	1	10
Diptera larvae																								
Chironomidae	3	1	20	-	-	-	3	2	20	-	-	-	15	5	10	1	1	10	5	1	20	1	1	10
Chaoboridae	-	-	-	-	-	-	-	-	-	-	-	-	9	3	40	-	-	-	-	-	-	-	-	-
Unident., pupae	1	1	10	3	7	10	23	12	20	6	2	30	1	1	10	2	4	20	-	-	-	-	-	
subadults	-	-	-	-	-	-	5	3	30	-	-	-	-	-	-	-	-	-	-	-	-	5	2	30
adults	-	-	-	1	2	10	3	2	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

A=Number of organisms in the stomachs of ten smallmouth bass.
B=Percent composition of ingested organisms in the stomachs of ten smallmouth bass.
C=Percent occurrence of ingested organisms in the stomachs of ten smallmouth bass.

Table 10. The number, percent composition, and percent occurrence of organisms found in smallmouth bass stomachs from Pond Three, 16 June through 21 August 1973. Smallmouth bass mean total lengths, range and stomach ssamples were based on ten fish per date. All samples were obtained from Illinois Natural History Survey laboratories, Kinmundy, Illinois.

Date 1973 Pond 3	5-16			6-1			6-13			6-28			7-11			7-23			8-7			8-21		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Total length (mm)	11.1			22.8			31.1			37.2			50.0			56.2			72.0			72.0		
Range (mm)	10-12			21-25			23-36			30-43			42-66			50-67			60-85			60-85		
Taxa																								
Nematoda	-	-	-	-	-	-	-	-	-	-	-	-	11	2	40	11	4	30	32	4	30	-	-	-
Arthropoda																								
Crustacea																								
Cladocera																								
Diaphanosoma sp.	34	54	90	314	89	100	5	3	30	107	57	30	41	6	60	140	55	50	194	21	50	10	59	100
Daphnia sp.	6	10	40	22	6	40	-	-	-	1	<1	10	526	72	70	44	17	30	1	<1	10	1	6	50
Eubosmina sp.	6	10	50	3	<1	10	-	-	-	1	<1	10	2	<1	10	-	-	-	-	-	-	-	-	-
Ceriodaphnia sp.	7	11	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chydorus sp.	-	-	-	14	4	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copepoda																								
Cyclopoid copepods	10	16	50	-	-	-	89	51	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amphipoda																								
Hyalella sp.	-	-	-	-	-	-	64	37	80	31	17	70	9	1	20	36	14	60	566	62	90	-	-	-
Insecta																								
Ephemeroptera naiads																								
Caenis sp.	-	-	-	-	-	-	5	3	50	22	12	80	7	<1	20	12	5	60	39	4	40	1	6	50
Hexagenia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	<1	10	-	-	-
Odonata naiads																								
Anisoptera																								
Libellulidae	-	-	-	-	-	-	2	<1	20	6	3	40	8	1	20	7	3	30	55	6	60	4	24	100
Gomphidae																								
Zygoptera																								
Argia sp.	-	-	-	-	-	-	3	2	10	12	6	50	-	-	-	1	<1	10	10	1	60	-	-	-
Hemiptera nymphs																								
Corixidae	-	-	-	-	-	-	1	<1	10	-	-	-	-	-	-	1	<1	10	-	-	-	-	-	-
Diptera larvae																								
Chironomidae	-	-	-	-	-	-	4	2	20	5	3	30	86	12	80	2	<1	20	2	<1	20	1	6	50
Ceratopogonidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaoboridae	-	-	-	-	-	-	1	<1	10	-	-	-	43	6	10	-	-	-	-	-	-	-	-	-
Unident., pupae	-	-	-	-	-	-	1	<1	10	2	1	20	-	-	-	-	-	-	11	1	30	-	-	-

A=Number of organisms in the stomachs of ten smallmouth bass.
B=Percent composition of ingested organisms in the stomachs of ten smallmouth bass.
C=Percent occurrence of ingested organisms in the stomachs of ten smallmouth bass.

Table 11. The number, percent composition, and percent occurrence of organisms found in smallmouth bass stomachs from Pond Four, 16 June through 21 August 1973. Smallmouth bass mean total lengths, range and stomach samples were based on ten fish per date. All samples were obtained from Illinois Natural History Survey laboratories, Kinmundy, Illinois.

Date 1973	5-16			5-29			6-13			6-26			7-10			7-24			8-3			8-21		
Pond 4	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Total length (mm)					9.2			16.3			32.4			42.5			50.2			63.0			67.8	
Range (mm)					8-11			14-21			25-38			35-51			42-58			55-69			46-82	
Taxa																								
Nematoda				-	-	-	-	-	-	-	-	-	5	2	30	4	3	30	29	4	40	94	16	70
Crustacea																								
Cladocera																								
Diaphanosoma sp.				-	-	-	208	92	70	1	1	10	107	46	30	43	28	10	633	81	50	282	48	70
Daphnia sp.				2	3	10	3	1	10	116	66	40	18	8	20	3	2	10	2	1	10	6	1	20
Ceriodaphnia sp.				-	-	-	-	-	-	-	-	-	3	1	10	-	-	-	-	-	-	-	-	-
Copepoda																								
Cyclopoid copepods				-	-	-	-	-	-	-	-	-	4	2	20	-	-	-	-	-	-	4	1	20
Calanoid copepods				1	1	10	3	1	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nauplii				5	6	40	-	-	-	-	-	-	-	-	-	-	-	-	--	-	-	-	-	-
Amphipoda																								
Hyalella sp.				65	82	60	1	1	10	23	13	70	20	9	20	32	21	10	61	8	30	15	3	20
Insecta																								
Ephemeroptera naiads																								
Caenis sp.				-	-	-	1	1	10	15	9	70	17	7	30	21	14	10	3	1	20	27	5	50
Hexagenia sp.				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44	8	60
Odonata naiads																								
Anisoptera																								
Libellulidae				-	-	-	1	1	10	9	5	40	20	9	40	-	-	-	24	3	50	14	2	50
Gomphidae																								
Gomphus sp.				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	10	-	-	-
Zygoptera																								
Argia sp.				-	-	-	1	1	10	-	-	-	-	-	-	-	-	-	1	1	10	6	1	20
Hemiptera nymphs																								
Corixidae				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	20	13	2	30
Diptera larvae																								
Chironomidae				6	8	20	7	3	20	12	7	70	25	11	20	27	18	10	20	3	40	32	5	70
Ceratopogonidae				-	-	-	-	-	-	-	-	-	2	1	10	-	-	-	-	-	-	-	-	-
Unident., pupae				-	-	-	-	-	-	-	-	-	10	4	20	24	16	10	-	-	-	6	1	40
adults				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	10

*Number of organisms in the stomachs of ten smallmouth bass.
-Percent composition of ingested organisms in the stomachs of ten smallmouth bass.
•Percent occurrence of ingested organisms in the stomachs of ten smallmouth bass.

le 12. Total number, percent composition, and percent occurrence of food organisms found in the stomachs of 302 smallmouth bass from four young-of-the-year rearing ponds, 16 June - 21 August 1973, at Illinois Natural History Survey laboratories, Kinmundy, Illinois.

Taxa	Total Number	Percent Composition[a]	Percent Occurrence*
Nematoda	435	2.4	17.9
Arthropoda			
Crustacea			
Cladocera			
Diaphanasoma sp.	13231	73.9	60.6
Daphnia sp.	994	5.6	18.2
Eubosmina sp.	66	0.4	8.6
Ceriodaphnia sp.	10	0.1	0.7
Chydorus sp.	292	1.6	5.6
Copepoda			
Cyclopoid copepods	504	2.8	19.9
Calanoid copepods	7	0.1	1.6
Nauplii	5	0.1	1.3
Amphipoda			
Hyalella sp.	1370	7.6	40.1
Insecta			
Ephemeroptera naiads			
Caenis sp.	208	1.2	21.5
Hexagenia sp.	48	0.3	2.6
Odonata naiads			
Anisoptera			
Libellulidae	170	0.9	16.6
Gomphidae			
Gomphus sp.	1	0.1	0.3
Zygoptera			
Argia sp.	46	0.3	8.9
Hemiptera nymphs			
Corixidae	26	0.1	4.3
Diptera larvae			
Chironomidae	286	1.6	19.5
Ceratopogonidae	17	0.1	1.9
Chaoboridae	62	0.3	3.6
Unidentified pupae,	102	0.6	9.6
subadults,	10	0.1	1.9
adults	6	0.1	1.6

[a]Percent Composition= percentage of total organisms found in all the stomach aamples combined.

*Percent Occurrence= percentage total stomachs containing that organism.

of all organisms eaten and occurred in 60.6% of the stomachs examined.

Hyalella, at 7.6%, were next in order of total organisms eaten. They also were second in percentage of occurrence, being found in 40.1% of all stomachs analyzed (Table 12). Individuals of the genus Daphnia were third, comprising 5.6% of the total organisms eaten, followed by cyclopoid copepods (2.8%), nematodes (2.4%), chironomid larvae (1.6%), cladocerans of the genus Chydorus (1.6%), and Caenis naiads (1.2%).

The preceding order of importance differed with respect to percent occurrence as Caenis naiads were found in 21.5% of the stomachs sampled, cyclopoid copepods in 19.9%, chironomid larvae in 19.5%, Daphnia in 18.2%, nematodes in 17.9%, and Odonata naiads, of the family Libellulidae in 16.6% of the stomachs. Cladocerans (of the genus Eubosmina), damselfly naiads (Argia) and dipterous pupae were found in approximately nine percent of the stomachs. The remainder of the organisms listed in Table 12 were found in six percent or less of the stomachs.

POND 1

In Pond One, Diaphanasoma were not utilized as a food source during the first sampling period (Table 8). They comprised 57% of the organisms eaten during the second sampling period and were found in 90% of the stomachs. During the third sampling period Diaphanasoma decreased as a food source (comprising only 21% of the total organisms eaten) and were present in only 10% of the stomachs. During the remaining five sampling periods Diaphanasoma never constituted less than 84% of the total organisms eaten, and were consistently in at least 60% of the stomachs each sampling period.

Chydorus and cyclopoid copepods were next in percent composition during the first sampling date. In Pond One they comprised 15 and 13% respectively of the total organisms eaten. During the second sampling period Chydorus were only two percent of the total organisms eaten, while cyclopoid copepods increased to 34%

and were found in 90% of the stomachs. Cyclopoid copepods were again important in percent composition and percent occurrence in the third sampling period comprising 53% of the organisms eaten and being found in 50% of the stomachs examined.

During the last five sampling periods Hyalella were next in numerical importance to Diaphanasoma (Table 8). Nematodes were numerically important on one occasion, as 57 individuals were utilized by three bass as a food source.

POND 2

During the first sampling period Daphnia and cyclopoid copepods comprised 38 and 49% of the total organisms eaten and both were in 100% of all stomachs examined (Table 9).

The second sampling period showed Diaphanasoma to be 44% of the total organisms consumed and in 70% of the stomachs. Eubosmina were 27% of the total organisms consumed and in 30% of the stomachs.

Within the third sampling period Diaphanasoma comprised 59% of the total organisms eaten and were in 80% of the stomachs. Dipterous pupae comprised 12% of total organisms consumed and were in 20% of the stomachs.

During the fourth sampling period Chydorus comprised 64% of the total organisms consumed and were found in 20% of the stomachs with Hyalella being 23% of the total organisms consumed and in 80% of the stomachs.

During the fifth and sixth sampling periods Diaphanasoma were predominant, comprising 62 and 54% of the total number of organisms eaten respectively. Hyalella were next in importance, comprising 26 and 39% of the total number of organisms consumed.

The seventh sampling period showed Diaphanasoma to be 95% of the total number of organisms taken and in 80% of the stomachs, while during the eighth sampling period Diaphanasoma were found to be only 22% of the total number of organisms consumed and in 10% of the stomachs. Nematodes totaled 50% of the total organisms consumed, and were in 60% of the stomachs. These were followed by Hyalella.

POND 3

As shown in Table 10, zooplankton was the most utilized food source during the first two sampling periods. Diaphanasoma were the most important zooplankters utilized during both periods, making up 54% of the total organisms eaten and were in 90% of the stomachs in the first sampling period. In the second period, they made up 90% of the total organisms eaten and were in 100% of the stomachs sampled. During the third sampling period cyclopoid copepods and Hyalella comprised 51 and 37% respectively of the total organisms eaten. Hyalella were found in 80% of the stomachs and cyclopoid copepods in 20%.

Diaphanasoma comprised 57% of the organisms eaten and were found in only 30% of the stomachs during the fourth sampling period. Hyalella and Caenis naiads were next in abundance, being 17 and 12% respectively of the total organisms sampled, and found in 70 and 30% respectively of the stomachs sampled. During the fifth sampling, Daphnia, found in 70% of the stomachs sampled, and chironomid larvae, found in 80% of the stomachs sampled, were 72 and 12% respectively of the total organisms eaten.

During the sixth period Diaphanasoma, Daphnia and Hyalella comprised 55, 17, and 14% of the total organisms eaten. Diaphanasoma were found in 50% of the stomachs sampled, with Daphnia in 30% and Hyalella in 60%.

Hyalella, Diaphanasoma, and libelullid naiads comprised 62, 21, and 6% of the total organisms eaten and were found in 90, 50, and 60% respectively of the stomachs sampled during the seventh sampling period (Table 10). In the eighth period, only two smallmouth bass stomachs were available for examination. Diaphanasoma and libellulid naiads were found in both.

POND 4

No stomachs were available for examination during the first sampling period. As shown in Table 11, during the second sampling period, Hyalella and chironomid larvae comprised 82 and 8% respectively of the total organisms eaten with yalella found in 60% of the stomachs examined. The third period showed Diaphana-oma to make up 92% of the total organisms eaten and to be in 70% of the stomachs.

During the fourth sampling period Daphnia, Hyalella, and Caenis naiads were 6, 13, and 9% respectively of the total organisms eaten. Daphnia were found in 0% of the stomachs examined with Hyalella and Caenis naiads each in 70%.

Diaphanasoma, chironomid larvae, Hyalella and Caenis naiads were found to e 46, 11, 9, and 9% respectively of the total number of organisms eaten during he fifth sampling period. None of these organisms were in more than 40% of the tomachs sampled.

During the sixth sampling period Diaphanasoma, Hyalella, chironomid larvae, iipterous pupae and Caenis naiads comprised 28, 21, 18, 16, and 14% respectively of the total organisms consumed. None of these were found in more than 10% of the stomachs.

The seventh period showed Diaphanasoma to be 81% of the total organisms consumed and in 50% of the stomachs. Hyalella made up eight percent of the total organisms consumed and were found in 30% of the stomachs.

The eighth sampling period also showed Diaphanasoma to be numerically most important, comprising 48% of the organisms eaten and in 70% of the stomachs sampled. Diaphanasoma were followed in numerical importance by nematodes and lexagenia naiads which were 16 and 8% of the total organisms eaten, and were in '0 and 60% respectively of the stomachs sampled.

DISCUSSION

The purpose of this study was to analyze the types of food consumed by fry and fingerling smallmouth bass in four hatchery ponds and to compare them to the potential food items available as measured by plankton and bottom sampling. This was done to determine if the young smallmouth bass had been selective in obtaining particular food items or simply fed at random.

In determining selectivity one must first consider the size of the smallmouth bass being discussed. It can be seen by examining tables 8, 9, 10, and 11 that bass approximately 30 mm in length and smaller selected zooplankton as their major food source. This was due to the relative size of the smallmouth bass and zooplankton and was to be expected as Wickliff (1930), Tester (1932), and Robertson (1951) all reported that zooplankton was a primary food source of smallmouth bass this size. Zooplankton (primarily cladocerans) remained numerically important throughout the entire study, but after the bass reached approximately 30 mm the food sources utilized became more diversified. The extended dependence on zooplankton as a food source throughout the study was probably due (as postulated by Robertson, 1951) to the lack of forage fish in any of the study ponds. Siefert (1968), working with white crappie, noted that early larvae fed exclusively on zooplankton and showed an obvious preference for smaller organisms. This is congruent with the data presented in tables 8, 9, 10, and 11. Most of the organisms selected during this early stage of life were small.

The question still exists as to whether selectivity extends beyond the point of actively selecting organisms which are quite small. Bailey _et al_. (1975) speculated that it is highly probable that different species of zooplankton vary in quality as food. It would logically follow that different genera of zooplankton also vary in food quality. If this is the case, those fish with the ability to actively select a higher quality food source would have a decided advantage over those fish that did not or were unable to select higher quality food sources. Bailey _et al_. (1975) reported that chum salmon selected zooplankton which were, for the most part, larger than the average zooplankton of the same species collected with the Clarke-Bumpus sampler. Robertson (1951) reported that the total length of individuals of the genus _Ceriodaphnia_ varied from 0.3 to 0.55 mm and individuals of the genus _Diaphanasoma_ varied from 0.38 to 0.88 mm. He postulated that, if there was an abundant supply of the 0.88 mm organisms, it would be only logical that they would be taken instead of those 0.4 to 0.5 mm. in length. It would follow that relatively larger prey which were equally abundant would be selected before smaller prey.

In Pond One during the first sampling date, Eubosmina were selected by 70% of the bass and comprised 63% of the total organisms consumed even though they did not show up in the zooplankton sampling. Perhaps these organisms, during this sampling period, were found in the vertical water column where they were easily obtained by the smallmouth bass, or they were larger than the numerically more abundant members of the genus Diaphanasoma.

In Pond Two during the first sampling period, Daphnia and cyclopoid copepods were selected by the bass. Again neither of these organisms were the predominant members of the zooplankton community. Individuals of the genus Daphnia are usually larger than members of the genera Diaphanasoma and Diaptomus which were more abundant.

In Pond Three the predominant members of the zooplankton community, Diaphanasoma, were the primary food source. They may have been selected because of their high relative abundance. Diaptomus, the other abundant member of the zooplankton community in all three ponds, were rejected as a food source, probably because of their limnetic characteristics. They tend to be found in deeper waters while cyclopoid copepods, which were selected in Pond Two, tend to be littoral (nearer to the shoreline) where one would expect to find schools of very young smallmouth bass (Lagler, 1956).

It may also be considered that these fish are small and weak swimmers, therefore a potential food item must be small enough to ingest, slow enough to capture, and in the immediate vicinity of the fish. The feeding of smallmouth bass upon a single genus or two of food organisms may be afforded by a form of facilitation. If the feeding action of a school of young bass is initiated by the feeding of one or several members of that school, and feeding is promoted for the individual fish by being in a school, then the fact that one or two genera of food organisms are often the most numerous in the stomachs is logical.

Data from the second sampling period tend to support this theory. In Pond One, 89% of the food organisms consumed are of two genera (Table 8). In Pond Two, 80% are of three genera (Table 9). In Pond Three, 89% of the organisms consumed are of one genus and in Pond Four, 90% of the organisms consumed are of two genera (Tables 10 and 11). If a school of smallmouth bass should encounter a large group of food organisms and feed by a facilitative method, it would explain the low number of genera constituting major portions of food.

In contemplating selectivity by smallmouth bass 30 mm or larger, one must consider the fact that they are large enough to swim freely and readily obtain items such as necton, plankton, benthos and those organisms which fall into the water. For purposes of this study the frequency of occurrence, and numerical method as described by Windell, (1968) were used: His volumetric, gravimetric, points' and dominance method were considered, but were not used because of this study's magnitude. In analyzing stomach contents, one should realize that just because an organism is predominant, it may not necessarily be the most valuable food source. For instance, one libellulid naiad may be several hundred times larger than a member of the genus <u>Diaphanasoma</u>, yet <u>Diaphanasoma</u> may be much more abundant. Figures 1-4 demonstrate the compositions of the organisms in the ponds and the number of stomachs each organism occurs in, thus taking into consideration size differences of varied genera. If a food item is valuable it should occur in more stomachs. In comparing Figures 1-4 with Figure 5 one should see any existing trends in selectivity.

In Pond One, there tended to be net positive selection of <u>Diaphanasoma</u> from 14 June until 29 August 1973. This was probably due to the extreme abundance of the plankter. <u>Daphnia</u> tended to be selected in Pond One during the for the individual fish by being in a school, then the fact that one or two genera of food organisms are often the most numerous in the stomachs is logical.

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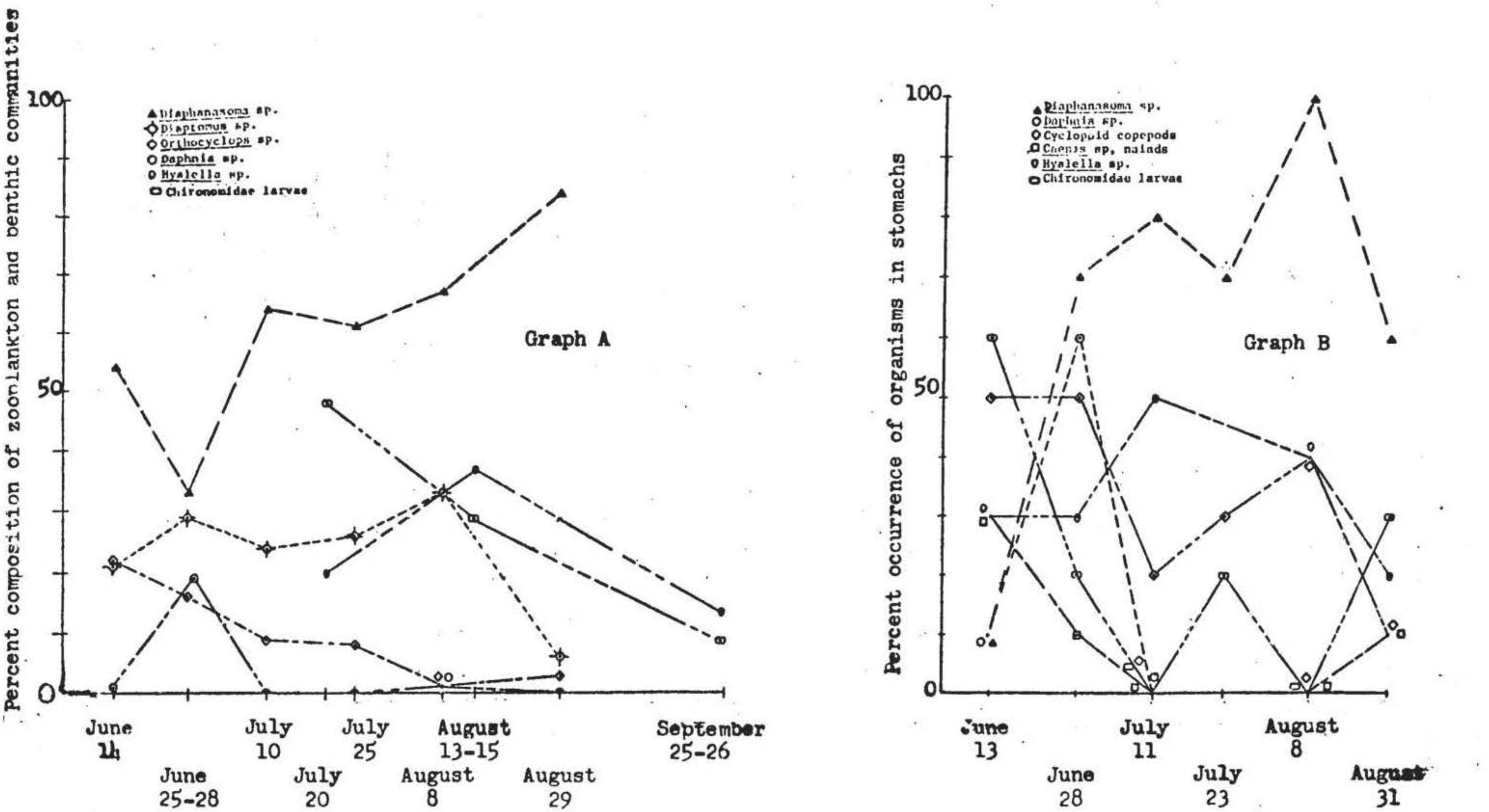

Figure 1. A comparison of food organisms present and those selected as food by smallmouth bass in Pond One. Graph A illustrates the percent composition by number of the most frequently occurring members of the zooplankton community (sampled from 14 June - 29 August 1973) and benthic community (sampled from 20 July - 25-26 September 1973). Graph B illustrates those organisms most frequently occurring in the stomachs of 60 smallmouth bass from Illinois Natural History Survey laboratories, Kinmundy, Illinois.

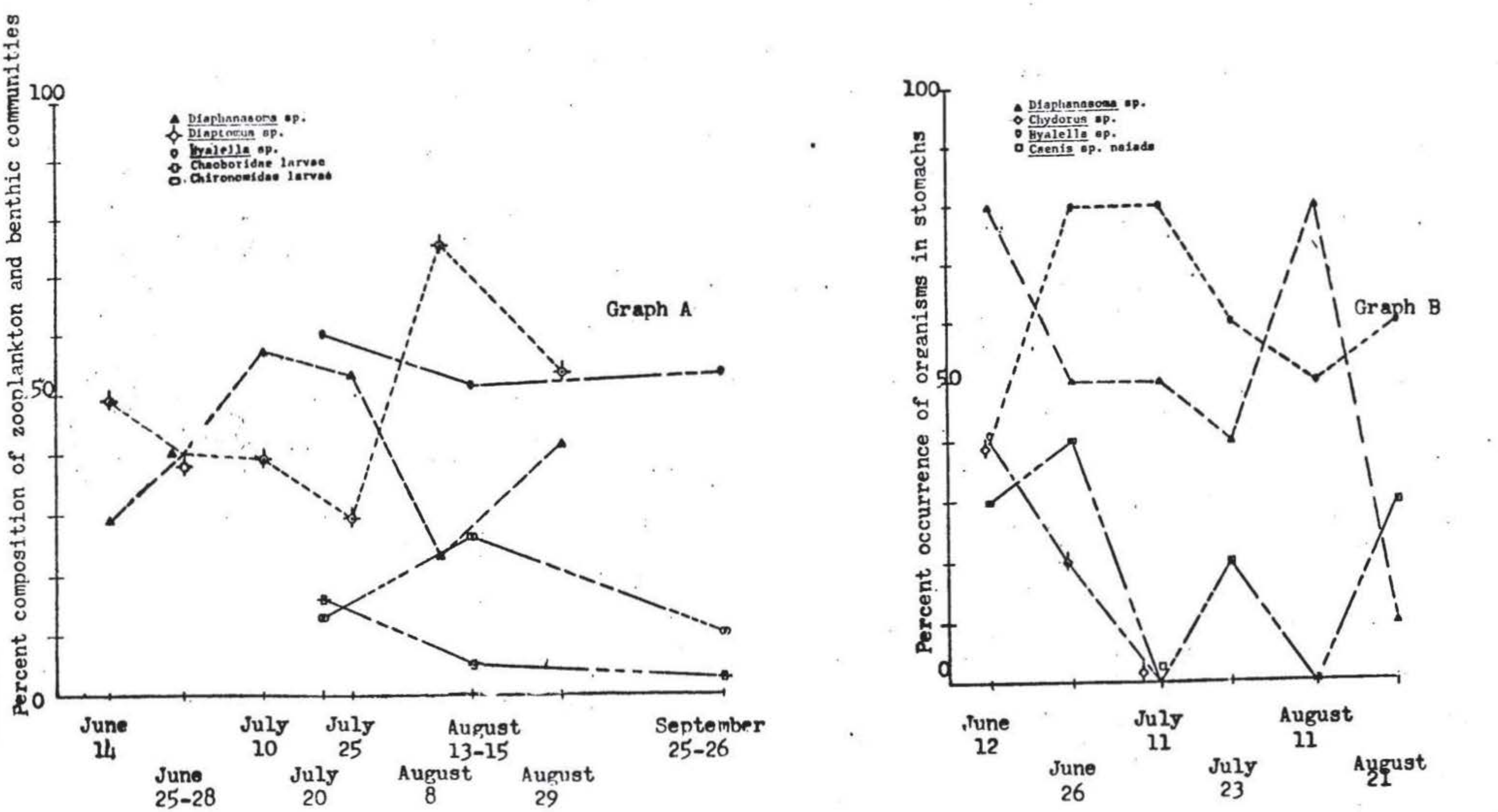

Figure 2. A comparison of food organisms present and those selected as food by smallmouth bass in Pond Two. Graph A illustrates the percent composition by number of the most frequently occurring members of the sooplankton community (sampled from 14 June - 29 August 1973) and benthic community (sampled from 20 July - 25-26 September 1973). Graph B illustrates those organisms most frequently occurring in the stomachs of 60 smallmouth bass from Illinois Natural History Survey laboratories, Kinmundy, Illinois.

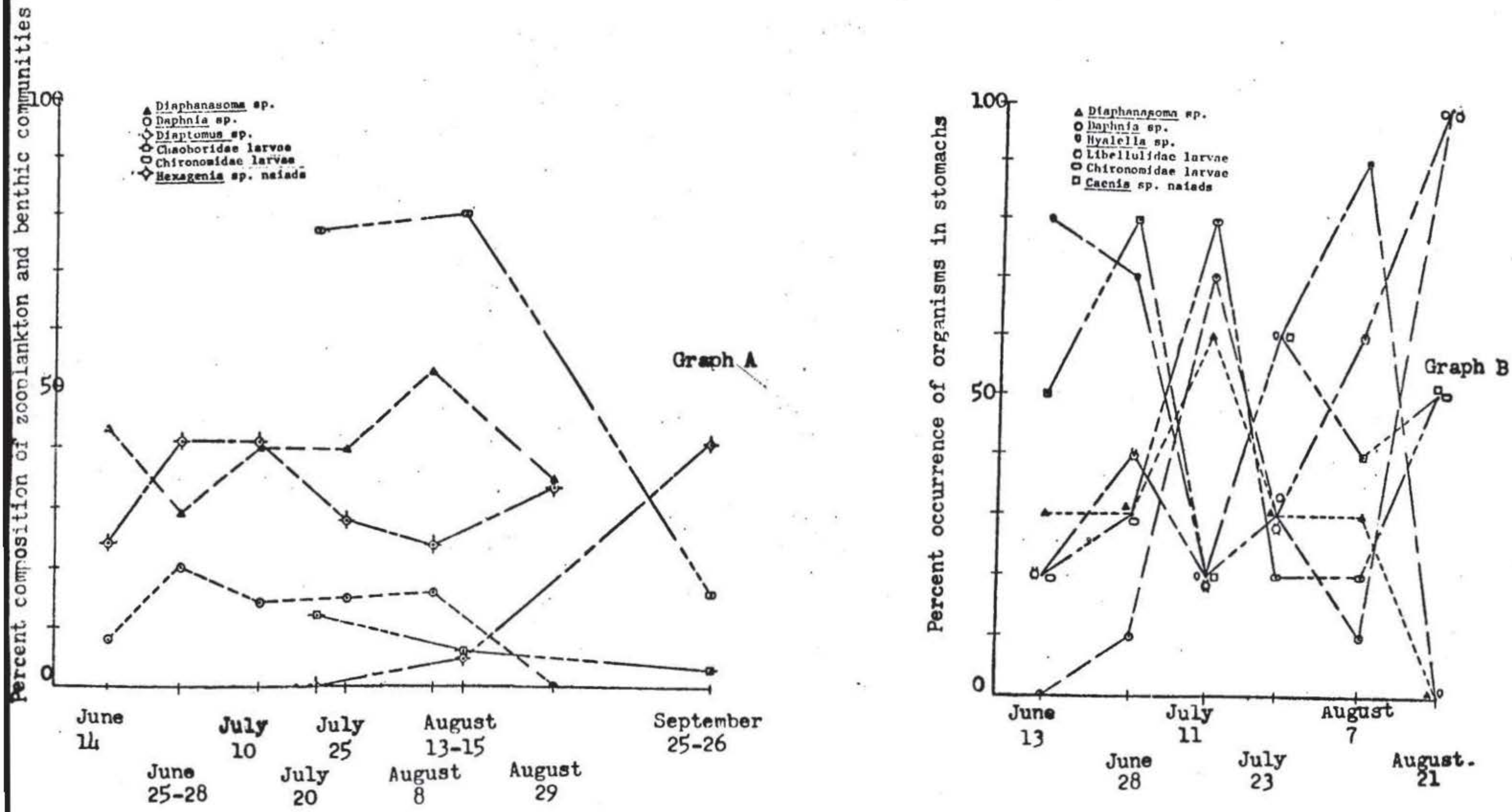

Figure 3. A comparison of food orgamisms present and those selected as food by smallmouth bass in Pond Three. Graph A illustrates the percent composition by number of the most frequently occurring members of the zooplankton community (sampled from 14 June - 29 August 1973) and benthic community (sampled from 20 July - 25-26 September 1973). Graph B illustrates those organisms most frequently occurring in the stomachs of 60 smallmouth bass from Illinois Natural History Survey laboratories, Kinmundy, Illinois.

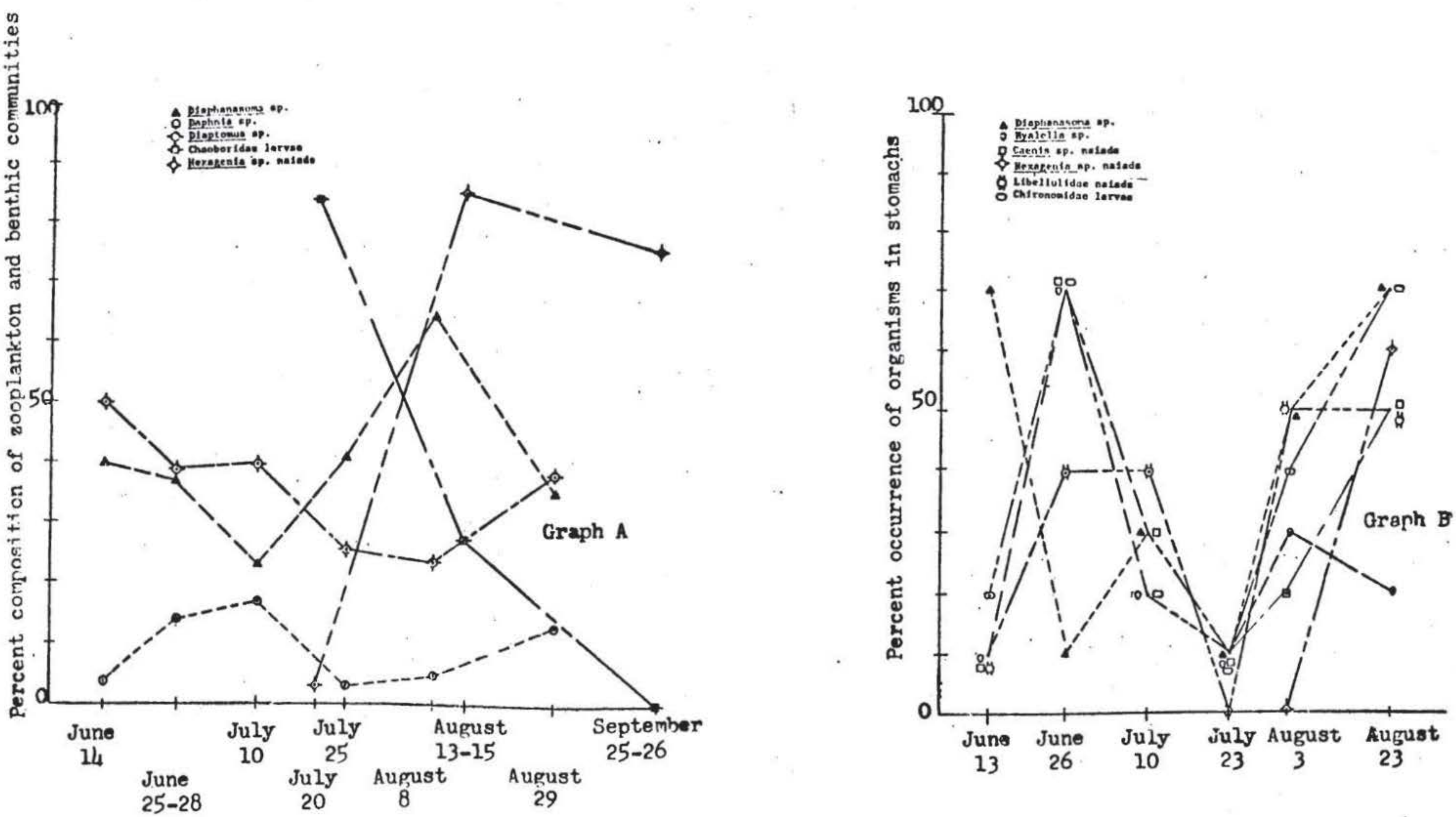

Figure 4. A comparison of food organisms present and those selected as food by smallmouth bass in Pond Four. Graph A illustrates the percent composition by number of the most frequently occurring members of the zooplankton community (sampled from 14 June - 29 August 1973) and benthic community (sampled from 20 July - 25-26 September 1973). Graph B illustrates those organisms most frequently occurring in the stomachs of 60 smallmouth bass from Illinois Natural History Survey laboratories, Kinmundy, Illinois.

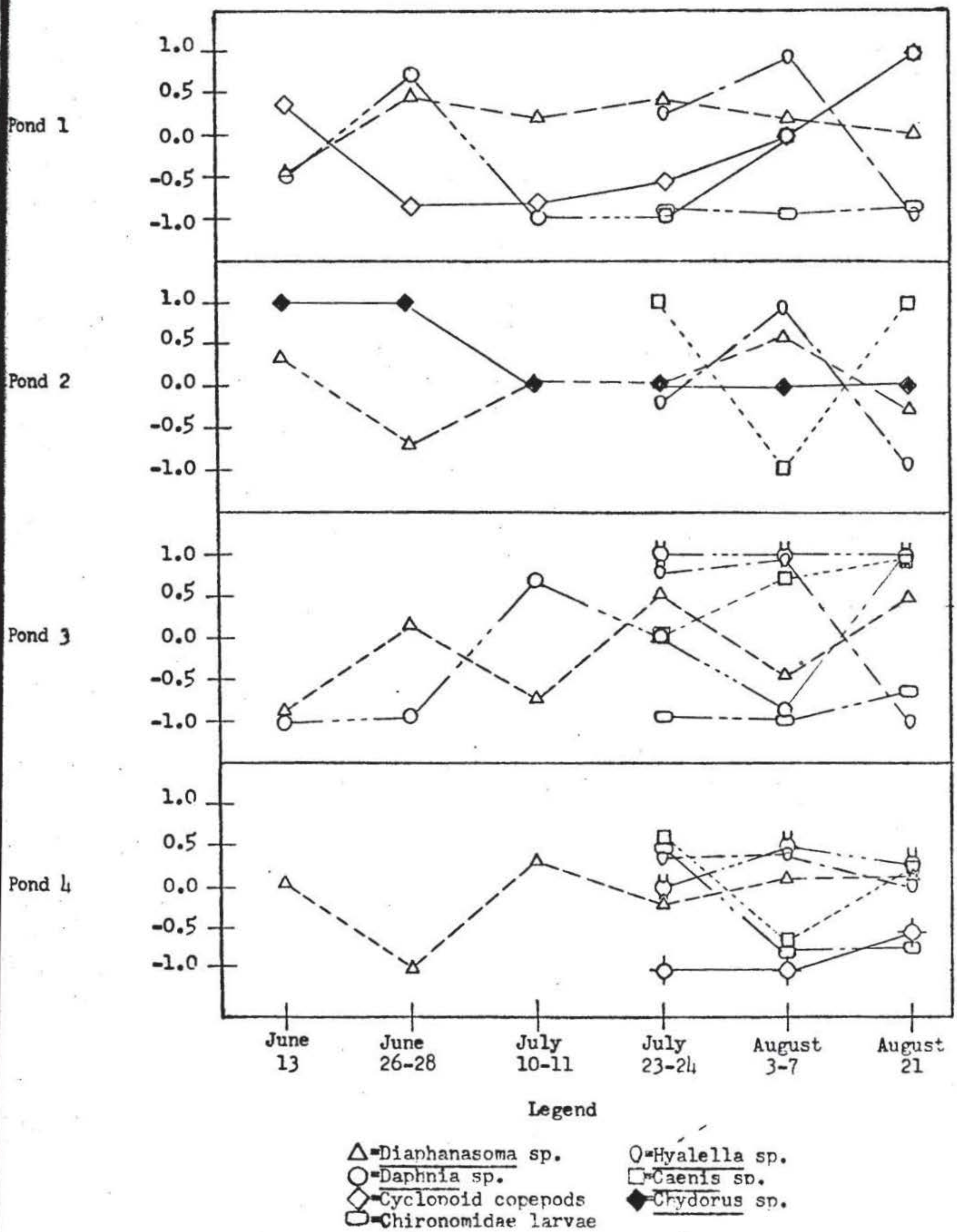

Figure 5. Electivity indexes indicating selection or rejection of food organisms by smallmouth bass in four young-of-the-year rearing ponds at Illinois Natural History Survey laboratories, Kinmundy, Illinois, from 13 June through 21 August 1973.

28 June sampling period. This was probably due to their increased abundance. Cyclopoid copepods were selected during the 14 June and 28 June sampling periods and not again until the last sampling period when their population started to rise. These three zooplankters seem to indicate that an organism may be selected when it is present in sufficient quantities; when only a few members of the population exist the smallmouth bass will not actively seek them out. Caenis naiads which are normally larger than Hyalella and chironomid larvae (the benthic numerical dominants), were actively being selected in the last sampling period (Figure 5). Hyalella were once found in 50% of the stomachs (Figure 1). Thus, even though low in the Electivity Index and in stomach numerical value, Hyalella were selected to some degree as food organisms.

In Pond Two, Diaphanasoma (Figure 5), had a relatively low Electivity Index, but were found in a high percent of the stomachs. This again was probably due to the high abundance of Diaphanasoma.

Chydorus were selected and utilized as a food source during the first two sampling periods. The high Electivity Index value may result from the fact that the sampling net was large in mesh size and allowed Chydorus, a relatively small zooplankter, to slip through. Hyalella were found in a high number of stomachs but were not high in Electivity Index value. Hyalella were also most abundant in the benthic population and were selected to some extent. Caenis naiads were found in a relatively low number of stomachs but were not found at all in benthic samples. They therefore were high in Electivity Index value (Figure 5). As demonstrated by the Electivity Indexes of Ponds One, Two, and Three (Figure 5), Caenis naiads were selected in the last sampling period when the smallmouth bass were larger. Robertson (1951) suggested that bass 90 mm or larger were unable to utilize zooplankton in their diet. Data from Ponds One, Two, and Three would tend to support this as Caenis were positively selected by smallmouth bass which had an average total length approaching 60-70 mm (Tables 8, 9, 10, and 11).

It can be seen by examining Figures 3 and 5 that Diaphanasoma were not selected in Pond Three. During the 11 July sampling period Diaphanasoma were found in 60% of the stomachs examined, yet had a very low Electivity Index value. This was due to the large abundance of the organism in the environment and few of them being found in many of the stomachs. This would indicate that Diaphanasoma were not actively being selected, but were being taken at random due to their great abundance.

Daphnia were not consistently selected or rejected in Pond Three (Figure 5). They tended to be selected during 11 July and 23 July, possibly because of the relative size of the fish and the organism. Daphnia are not usually as large as Hyalella or as small as Diaphanasoma, therefore would be a logical food of a midrange sized fish.

Hyalella and chironomid larvae were rejected during the last three sampling periods and libellulid naiads and Caenis naiads were selected. This again was probably related to the relative size of the smallmouth bass and the organisms. Chironomid larvae and Hyalella were not selected because of their small size and the relatively large size of the bass. Libellulid naiads and Caenis naiads were positively selected because of their larger size.

The smallmouth bass in Pond Four were apparently spawned about one sampling period after the bass in the other three ponds. No sample was available during the first period and the mean size of the second period (Pond Four) was similar to that of the first period of the other three ponds. Diaphanasoma were again taken in Pond Four when abundant; however, according to Figures 4 and 5, they were not actively selected. Hyalella were selected during the 26 June sampling period, (Figure 5). This again was probably due to high relative abundance of the organism although no benthic data were available to support this hypothesis.

Caenis naiads were also positively selected during two out of three of the sampling periods (Figure 5). *Caenis* naiads, found in a high percentage of the stomachs, were probably selected due to their size.

Hexagenia naiads, according to Figures 1-4 and Tables 8-11 were not selected. During the last sampling period *Hexagenia* naiads were found in 60% of the stomachs sampled. This was due to the larger relative size of the average *Hexagenia* naiads. The larger smallmouth bass would logically select *Hexagenia* naiads during the last period. One naiad would probably fill the stomach of a smallmouth bass, thus the low Electivity Index which is based on numerical value. Libellulid naiads were selected during the 3 August and 21 August sampling period. Being selected during the last two periods and in 50% of the stomachs indicates that the size of the libellulid naiads may play an important role in selection. Chironomid larvae were not selected during the last two sampling periods. This was due to the size of the food organisms in relation to the size of the fish. Chironomid larvae, being small, were rejected by smallmouth bass in the 50-74 mm size range.

The average growth rate of the smallmouth bass in Pond One was .56 mm per day, Pond Two .60 mm per day, Pond Three .73 mm per day, and Pond Four .75 mm per day. The growth rates were based on average lengths of the first and last collections. Robertson (1951) reported an average of .98 mm growth per day over approximately the same time period encountered in this study. Wickliff (1930) suggested the growth rate to be .8 to .9 mm per day and to be directly related to the food supply. If the growth rates of the bass in the four ponds being investigated were directly related to the food supplies, then the food supplies present in the four ponds were not conducive to optimum growth. The low growth rates may have been the result of the lack of forage fish available to the young bass or could have been related to intraspecific competition within each of the ponds.

The author believes that the establishment of the fact of selectivity in the feeding habits of young-of-the-year smallmouth bass is important. It may be of considerable value to those in hatchery work, or those wishing to establish as efficiently as possible, a smallmouth bass population in a reservoir, stream, or lake. If placement of smallmouth bass can be carefully matched to areas where food organisms known to be selected are abundant, then the probability of successful stocking will increase.

This study was one of preliminary groundwork. Much more work would be beneficial in dealing with feeding selectivity. For instance, a comparative study assessing the value of an area with forage fish versus a similar area lacking forage fish would be interesting. In such a study one could determine the optimum time of transfer of smallmouth bass from a rearing pond into a more natural environment (stream, pond, lake, or impoundment).

Young-of-the-year selectivity should be explored in other species of fish. Studies involving the young-of-the-year of common species of fish may explain the sometimes disastrous failures common to stocking.

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