

Food Habits of Adult Alewives in Lake Michigan Near Michigan City, Indiana, in 1971 and 1972

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Abstract

Food habits of alewives, *Alosa pseudoharengus*, ranging in size from 120 to 199 millimeters, collected along a transect in Lake Michigan near Michigan City, Indiana, were examined from June to October 1971, and May to September 1972. Fish were collected by gill netting or trawling at station depths ranging from 5 to 15 meters.

Zooplankton comprised the major portion of the alewife diet in both years. The copepod *Cyclops bicuspidatus* was the main zooplankton consumed. *Bosmina longirostris* and *Euryccercus lamellatus* were predominant cladoceran food items. Mean per cent volume of copepods and cladocerans in stomachs were similar in 1971 and 1972. Major non-zooplankton food items were chironomid larvae (*Cryptochironomus* and *Chironomus*) and larval alewives.

Seasonal changes in food habits were noted. Per cent volume of zooplankton and cladocera in stomachs increased to maxima in July followed by a general decline for the remainder of each year. Copepods were the dominant food item in June. Chironomid larvae were a major component of the diet in May 1972, and August of both years. The largest per cent volume of alewife larvae in stomachs occurred in September.

Introduction

General food habit studies of fishes are necessary for an adequate understanding of both inter- and intraspecific competition. Likewise, they yield significant information on the direct and indirect effects that a fish species may have on plankton, benthos or fish populations.

Rhodes (2) investigated alewife food habits for the Indiana waters of Lake Michigan in 1970. The present study was based upon Rhodes' work and was designed to deal in greater depth with food habits in relation to daily alewife movement patterns. Only food habits are reported herein.

Methods and Materials

Alewives were collected monthly at depths of 5, 10, and 15 m along a transect in Lake Michigan near Michigan City, Indiana. Gill net collections were made from June to October 1971, and May to September 1972. Nets were set parallel to shore for about 1 hour at sunrise, noon, sunset, and midnight in 1971 and at noon and midnight in 1972. A 16-foot bottom trawl was also used in 1971.

Stomachs were removed soon after capture from a minimum of two alewives per 5 mm length increment. A minimum of 20 stomachs were taken per collection. All stomachs were labeled, placed in cheesecloth and preserved in 10% formalin. Only stomachs which contained fish, fish eggs, chironomids, *Pontoporeia*, or a minimum of 300 identifiable microcrustaceans were included in the analysis. A maximum of 20 stomachs were examined per time period per day. These stomachs

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were selected by using a table of random numbers if more than 20 per category were available.

Stomachs which contained a minimum of 300 identifiable microcrustaceans were subsampled with a Henson-Stempel pipet and examined in a plexiglass counting cell at concentrations of 0.5-6.0% of total stomach contents. Stomachs not containing 300 identifiable microcrustaceans were examined at concentrations of 20-100%.

Food item volumes were determined indirectly using a method reported by McComish (1). Individual species were assigned a geometric figure which approximated their shape and measurements of about 30 specimens of each species were made with an ocular micrometer. The mean volume for each species was then calculated from these 30 measurements.

Plankton samples were taken adjacent to nets for correlation with alewife food habits in 1972. Plankton was collected with a Clarke-Bumpus high speed plankton sampler fitted with No. 20 bolting cloth.

Results and Discussion

Annual Changes in Food Habits

Eurycerus lamellatus was the most important cladoceran consumed in 1971 (Table 1), but *Bosmina longirostris* predominated in 1972. The mean per cent volume for *B. longirostris* was less than half the per cent volume reported by Rhodes (2) for 1972.

Cyclops bicuspidatus was the largest single food item consumed in 1972 followed closely by larval alewives. In 1971 the reverse was true. The 15% volume for 1971-72, approximately equaled the 18% reported consumed by alewives in 1970 (2).

Epischura lacustris was the main calanoid copepod in the 1971 diet while *Eurytemora affinis* was the predominant calanoid consumed in 1972. These two species composed 3% of the total 4% volume of all calanoids in 1971 and 2% of the total 3% volume in 1972. Mean percentage volumes of these two species in stomachs were similar to those reported by Rhodes (2).

Alewife larvae and eggs, but particularly larvae, constituted a large portion of the alewife diet. Larvae composed 20% of the mean volume of all food items while eggs amounted to 1%. Chironomids and alewife larvae were largely responsible for major differences in per cent volumes of food items reported in this study and that by Rhodes (2) who found no larval fish in stomachs.

In addition to the items discussed above, many other prey species formed a portion of the alewife diet. These items included: the cladocerans *Alona affinis*, *Bosmina coregoni*, *Ceriodaphnia* spp., *Chydorus sphaericus*, *Daphnia galeata*, *D. retrocurva*, *Diaphanosoma brachyurum*, *Holopedium gibberum*, *Leptodora kindtii*, and *Polyphemus pediculus*; the cyclopoid copepods *Cyclops vernalis*, *Eucyclops agilis*, and *Tropocyclops prasinus*; the calanoid copepods *Diaptomus* spp., *Limnocalanus macrurus*, and *Senecella calanoides*; harpacticoids; the malacostracan

Pontoporeia affinis; the chironomid larvae *Monodiamesa tuberculata*, *Paracladopelma nereis*, *P. cf. obscura*, *Polypedilum cf. scalaenum*, *Potthastia longimanus*, *Procladius cfr. bellus*, and *Psectrocladius* sp.; chironomid pupae; hydracarinans; turbellarians; nematodes; and the gastropods *Bulimus* sp. and *Valvata* sp. (3).

TABLE 1. Yearly per cent volume and per cent frequency of occurrence (parenthesis) of stomach contents of alewives collected in Lake Michigan near Michigan City, Indiana, 1971-72.

Organisms	1971	1972	Mean
Zooplankton -----	41 (88)	35 (90)	38 (89)
Cladocera -----	23 (75)	12 (66)	18 (70)
<i>Bosmina longirostris</i> -----	3 (52)	5 (60)	4 (56)
<i>Eurycerus lamellatus</i> -----	9 (41)	3 (13)	6 (27)
Copepoda -----	18 (83)	23 (75)	21 (79)
Cyclopoida -----	12 (80)	20 (72)	16 (76)
<i>Cyclops bicuspidatus</i> -----	11 (80)	20 (72)	15 (76)
Calanoida -----	4 (41)	3 (23)	3 (32)
<i>Epischura lacustris</i> -----	3 (9)	T (1)	2 (5)
<i>Eurytemora affinis</i> -----	T (6)	2 (11)	1 (9)
Malacostraca -----	T (2)	12 (20)	6 (11)
<i>Pontoporeia affinis</i> -----	T (2)	12 (20)	6 (11)
Insecta -----	13 (32)	19 (45)	16 (39)
Chironomid larvae -----	13 (29)	16 (42)	14 (36)
<i>Chironomus</i> spp. -----	1 (10)	5 (9)	3 (10)
<i>Cryptochironomus</i> spp. -----	12 (25)	8 (18)	10 (21)
Chordata -----	21 (21)	20 (19)	21 (20)
<i>Alosa pseudoharengus</i> -----	20 (16)	19 (14)	20 (15)
(larvae)			
<i>Alosa pseudoharengus</i> -----	1 (5)	2 (5)	1 (5)
(eggs)			
Unident. digested matter -----	24 (56)	13 (41)	18 (48)
Stomachs Examined -----	100	120	220 ¹

T Less than 0.5%.

¹ Sum of both years.

Seasonal Changes in Food Habits

Zooplankton volume in stomachs increased from 52% in June to 66% in July 1971, and from 18% in May to 68% in July 1972 (Table 2). Values decreased sharply in August and September during both years, while in October 1971, values increased to June levels. High volumes of larval alewives, chironomids, and *Pontoporeia* in August and September were responsible for low zooplankton per cent volumes during August and September in 1971 and 1972. Per cent volumes in 1970 (2) increased from June to September and declined slightly in October. During three months of 1971 (June, July, and Oct.) per cent frequencies of occurrence were 100% while during four months of 1972 (June, July, Aug. and Sept.) values were above 93%.

Cladoceran per cent volume changes in stomachs were similar to those of zooplankton except for October 1971, where volume increased

to July levels. Volumes were below 10% until July. The July peak of 1971 was 52% while that of 1972 was 29%. Per cent volume and per cent frequency of occurrence of cladocera in 1970 (2) generally increased throughout the summer to maxima of 71 and 100, respectively.

TABLE 2. Monthly per cent volume and per cent frequency of occurrence (parenthesis) of stomach contents of alewives collected in Lake Michigan near Michigan City, Indiana, 1971 (above) and 1972 (below), respectively.

Organisms	May	June	July	Aug.	Sept.	Oct.
Zooplankton -----		52 (100)	66 (100)	9 (77)	24 (53)	55 (100)
	18 (70)	58 (97)	68 (93)	22 (96)	10 (94)	
Cladocera -----		1 (23)	52 (100)	8 (68)	7 (47)	50 (100)
	1 (22)	1 (41)	29 (93)	19 (86)	10 (94)	
<i>Bosmina longirostris</i> --		T (8)	12 (100)	T (23)		1 (33)
	T (17)	1 (34)	16 (93)	9 (77)	T (82)	
<i>Eurycercus lamellatus</i> .		T (8)	22 (82)			24 (67)
		T (10)	13 (38)	T (4)	T (6)	
Copepoda -----		52 (100)	14 (100)	T (59)	18 (47)	5 (100)
	17 (74)	57 (100)	39 (83)	3 (54)	1 (47)	
Cyclopoida -----		39 (100)	12 (100)	T (46)	2 (47)	5 (100)
	6 (65)	51 (97)	39 (83)	2 (54)	T (47)	
<i>Cyclops bicuspidatus</i> --		39 (100)	12 (100)	T (46)	2 (47)	5 (100)
	6 (65)	50 (97)	39 (83)	2 (54)	T (47)	
Calanoida -----		1 (15)	2 (61)	T (23)	16 (40)	T (17)
	10 (35)	2 (28)	T (7)	1 (27)	T (24)	
<i>Epischura lacustris</i> --				T (9)	15 (40)	T (17)
				T (4)		
<i>Eurytemora affinis</i> ---		1 (15)	T (7)	T (4)		
	10 (30)	2 (14)	T (3)	T (4)		
Malacostraca -----				T (4)		T (17)
		10 (21)	8 (10)	31 (54)	12 (18)	
<i>Pontoporeia affinis</i> ---				T (4)		T (17)
		10 (21)	8 (10)	31 (54)	12 (18)	
Insecta -----		T (8)	2 (18)	62 (100)		T (17)
	55 (100)	12 (45)	1 (10)	26 (68)		
Chironomid larvae -----		T (8)	1 (11)	62 (100)		T (17)
	40 (100)	12 (45)	T (3)	25 (64)		
<i>Chironomus</i> spp. ----			T (2)	4 (41)		
	17 (22)			9 (27)		
<i>Cryptochironomus</i> spp.		T (8)	1 (7)	57 (96)		
	12 (26)	11 (21)		15 (41)		
Chordata -----			4 (11)	5 (9)	68 (13)	29 (50)
		4 (10)	4 (10)	17 (18)	76 (81)	
<i>Alosa pseudoharengus</i> -				5 (9)	68 (13)	29 (50)
(larvae)				17 (18)	76 (81)	
<i>Alosa pseudoharengus</i> -			4 (11)			
(eggs)		4 (10)	4 (10)			
		43 (85)	28 (50)	24 (82)	7 (20)	16 (33)
Unident. digested matter	27 (65)	16 (52)	16 (45)	4 (23)	2 (6)	
Stomachs Examined -----						
1971 -----		13	44	22	15	6
1972 -----	23	29	29	22	17	

T Less than 0.5%.

Bosmina longirostris was an important component of the diet in July 1971, and in both July and August 1972. Maximum abundance in 1972, when plankton samples were taken, occurred in June and July. In 1970 (2). *B. longirostris* reached its maximum per cent volume and per cent frequency of occurrence in alewife stomachs in September.

Eurycerus lamellatus was an important food item only in July and October 1971. The maximum volume of *E. lamellatus* in 1970 (2) occurred in September.

Copepods were important food items in June of each year when they contributed over 50% to the total food volume. Of the remaining months, only July 1972, was above 20% of the volume. Frequency of occurrence was 100% in June, July, and October 1971, and in June 1972, and was never less than 45% in any month of either year. Lowest values occurred in September of both years. Rhodes (2) found copepod per cent volume was maximum in July 1970, and per cent frequency of occurrence was maximum in September 1970.

Cyclops bicuspidatus was the dominant cyclopoid copepod consumed. Cyclopoid copepods were generally more important than calanoid copepods each month of the study with the exceptions of September 1971, and May 1972. *Cyclopoid bicuspidatus* was dominant in June and July of both years. Maximum plankton densities of *C. bicuspidatus* in 1972 also occurred in July. Rhodes (2) also reported a peak in July.

The calanoid copepod, *Eurytemora affinis*, occurred in stomachs between May and August. It comprised 10% of the volume in May, more than in any other month when it was consumed. According to Rhodes (2) maximum volume in 1970 occurred in August, but fish samples were not taken during May 1970. *Epishura lacustris* was the dominant calanoid copepod consumed in September when it comprised 15% of the volume.

The largest per cent volume and per cent frequency of occurrence of *Pontoporeia affinis* in alewife stomachs, 31 and 54%, respectively, occurred in August 1972. *Pontoporeia affinis* was of negligible importance in 1971. Per cent volume during June, July, and September 1972, ranged from 8 to 12%. Rhodes (2) found alewives consumed the largest volume of *P. affinis*, 22%, in October.

Chironomid larvae were significant foods in August 1971, and May and August 1972. Per cent volumes during these months were 62, 40, and 25%, respectively. Per cent frequencies of occurrence were 100, 100, and 64%. In 1970 alewife stomachs, chironomid larvae per cent volume and frequency of occurrence, 25 and 54% respectively, were maximum in June (2).

In 1971, the dominant chironomid larvae consumed was *Cryptochironomus* spp. In August, *Cryptochironomus* composed 57 of the total 62% volume for that month. In May 1972, *Chironomus* predominated at 17% volume. *Cryptochironomus* was dominant in June and August at 11 and 15% volumes, respectively.

Alewife larvae did not appear in stomachs until August. This would be expected since spawning is essentially completed by the end of July. Maximum per cent volume of alewife larvae consumed occurred in September of each year. In 1971, per cent volumes for August, September, and October were 5, 68, and 29%, respectively. In 1972, per cent volumes for August and September were 17 and 76%, respectively. Per cent frequencies of occurrence for 1971 ranged from 18 in August to 81% in September.

Summary

- 1) Zooplankton comprised the major portion of the alewife diet in both years. Per cent volume of plankton and cladocera reached a maximum in July of each year. Copepods were the dominant food item in June.
- 2) Chironomid larvae were a major component of the diet in May 1972, and August of both years. The largest per cent volume of alewife larvae in stomachs occurred in September.

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