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Food Selectivity of Bigmouth Buffalo (Ictiobus cyprinellus, Valenciennes) in Lake Poinsett, South Dakota

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FOOD SELECTIVITY OF BIGMOUTH BUFFALO (*Ictiobus cyprinellus*, Valenciennes) IN LAKE POINSETT, SOUTH DAKOTA

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, 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 Adviser Date

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Abstract

Victor J. Starostka

Food habits of bigmouth buffalo fry, subadults, and adults were studied in Lake Poinsett, South Dakota, from January to November, 1968. Fifty-six fry fed primarily (75.0% by volume) on benthic organisms. Four hundred fifty-five subadults and adults fed entirely on plankton. Daphnia pulex adults comprised 83.7 to 96.7% of the food items during periods of ice cover (January to April). Daphnia pulex adults and juveniles comprised 68.5% by volume and cyclopoid copepods 29.7% of the diet from April to July. Summer (July to October) samples showed ingestion of D. pulex adults and juveniles (36.9%), Anacystis sp. (22.3%), and Daphnia galeata mendotae (16.0%). Fall (October) samples showed ingestion of D. pulex (adults and juveniles) and D. galeata mendotae which totalled 60.9%. Cyclopoid copepods contributed 23.0%.

Food selectivity of subadult and adult bigmouth buffalo for eight categories of zooplankton was determined using the index described by Ivlev (1961). Selectivity for D. pulex averaged +0.48 for the sampling period. Calanoid copepods were negatively selected for the entire period with a mean of -0.74. The other six categories (Diaphanasoma brachyurum, Daphnia galeata mendotae, Daphnia pulex juveniles, Bosmina longirostris, Chydorus sphaericus, and cyclopoid

copepods) appeared to be taken when available; without selection. Selectivity appeared to be dependent on the morphology of the gill rakers for all organisms except calanoid copepods which appeared to avoid ingestion.

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INTRODUCTION

Bigmouth buffalo in Lake Poinsett are important both economically and biologically. There has been an average harvest of 69.7 kg per ha during the period 1961 - 1967 (Congdon, 1969), suggesting it is a major species in the lake. Bigmouth buffalo may compete with game species for food items, especially plankton essential during the early life stages of most fish. Previous studies (Moen, 1954; Scidmore and Woods, 1959; Johnson, 1963; and McComish, 1967) have shown that bigmouth buffalo are primarily planktivores. Whether they feed on a restricted portion of the plankton, in direct competition with other species, or consume what is most abundant, without direct competition is not known. The objective of this study was to determine what bigmouth buffalo consume in relation to what is available.

Galbraith (1967) studied rainbow trout (*Salmo gairdneri*) and yellow perch (*Perca flavescens*) predation on *Daphnia* and suggested that these fish were able to discriminate when feeding, or seek out concentrations of zooplankton larger than can be explained by mechanical gill raker selection. Gerking (1962) observed that bluegills (*Lepomis macrochuris*) selected large *Daphnia* exclusively although smaller zooplankters were present and often more numerous. Hall (1964) noted that ciscoes, *Leucichtys artedi* (*Coregonus artedii*), and black crappies, *Pomoxis nigromaculatus*, fed on large *Daphnia pulex* but did not eat the smaller adults of

Daphnia galeata mendotae. Brooks and Dodson (1965) indicated that alewives (*Alosa pseudoharengus* and *A. aestivalis*) were able to eliminate *Daphnia* and cause an over-all drop in size distribution of zooplankton in Connecticut lakes.

Johnson (1963) compared the gill rakers of bigmouth buffalo and cisco (*Coregonus* sp.), another planktivore, and concluded that bigmouth buffalo appeared to be more efficient plankton strainers. He added that they appeared to feed on what foods were available, rather than seeking out particular foods.

STUDY AREA

Lake Poinsett, the largest natural lake in South Dakota, has a maximum width of 6.2 km, maximum length of 11.6 km and a surface area of 3682 hectares. The bottom consists of sand and rubble grading to silt in deeper areas. The lake is windswept and devoid of higher aquatic vegetation. Maximum depth is 5.5 m and shore development is 1.6. Drainage into the lake occurs mainly from lakes to the west and north during periods of high water. An outlet to the Big Sioux River is located in the northeast corner of the lake.

METHODS

Fifty-six bigmouth buffalo fry ranging from 12.5 to 21.0 mm total length were captured during the period 17-28 June 1968 with a beach seine in areas used as spawning sites by adult buffalo earlier in June. Water depth over the spawning area was less than 0.6 m. The entire digestive tracts of fry were removed, dissected, and all items counted individually.

Four hundred fifty-five subadult and adult bigmouth buffalo ranging from 236 to 833 mm total length were captured from January to November, 1968. Samples of 15 to 25 fish were obtained monthly from commercial fishermen during ice cover. Open water samples of 15 to 25 fish were taken biweekly with gill nets. The anterior portion of the digestive tract, from the esophagus to the first major curve of the small intestine, was removed. Stomach contents from each sampling period were pooled and analyzed (Borgeson, 1963).

Plankton samples were taken with a water core plankton sampler (Applegate, Fox, and Starostka, 1968) during ice cover. Open water samples were taken with a metered Miller Sampler (Miller, 1961) equipped with a No. 10 net. All plankton samples were taken in conjunction with fish sampling for stomach contents.

Stomach and plankton samples were diluted to fixed volumes and a 2 cc subsample counted in a circular counting chamber at 30X.

Cladocerans were identified to species, phytoplankton to genus, insects to family, and copepods to suborder using keys in Freshwater Biology (Edmondson, 1959).

The volume of each organism was determined by averaging the dimensions of 20 individuals per sample (Table 1). Volume was calculated by assigning the dimensions to a geometric figure most closely resembling the organism.

An electivity index (Ivlev, 1961) was used to determine if bigmouth buffalo adults selected certain food items. The indices were calculated using the formula:

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

where E represents the electivity (selectivity), r_i represents the per cent occurrence of a food item in the stomach, and p_i represents the per cent occurrence of the same organism in the environment. Values obtained range from -1 to +1; the former indicates complete selection against an item (avoidance) while the latter indicates exclusive selection for a food item. An index of zero indicates no selective processes at work in the utilization of a food item.

A selectivity index was not determined for *Anacystis* sp. because of fragmentation of colonies in the tow net samples.

Table 1. Mean calculated volumes of major food organisms of fry, subadult, and adult bigmouth buffalo January to November, 1968, Lake Poinsett, South Dakota.

Organism	Volume in microliters
Phytoplankton	
Cyanophyta	
Anacystis sp.	0.02
Zooplankton	
Crustacea	
Cladocera	
Diaphanasoma brachyurum	0.40
Daphnia galeata mendotae	0.60
Daphnia pulex (adult)	1.80
Daphnia pulex (juvenile)	0.50
Bosmina longirostris	0.05
Leydigia quadrangularis	0.06
Chydorus sphaericus	0.04
Copepoda	
Calanoida	0.50
Cyclopoida	0.20
Benthos	
Insecta	
Diptera	
Tendipedidae	
Pupa	18.00
Larva	1.00

RESULTS AND DISCUSSION

Food Habits of Bigmouth Buffalo Fry

Bigmouth buffalo fry fed primarily on benthic organisms (Table 2). Dipteran (Tendipedidae) pupae and larvae comprised 62.9% and Crustacea 37.0% of the food items by volume. Cyclopoid copepods contributed 15.5% and copepod nauplii 6.0%. Cladocerans were represented by *Daphnia pulex* and *Leydigia quadrangularis* which contributed 3.4 and 12.1%, respectively. Johnson (1963) and McComish (1967) found copepods and cladocerans to be of major importance in the diet of young-of-the-year bigmouth buffalo. Fry in Lake Poinsett appear to rely heavily on Dipteran pupae and larvae, and *L. quadrangularis*, a benthic cladoceran, which together comprised 75.0% of the diet. Since no detritus or inorganic matter was ingested, it is suggested that fry fed by sight.

Food Habits of Subadult and Adult Bigmouth Buffalo

Plankton made up 100% of the subadult and adult bigmouth buffalo (236 - 833 mm) diet (Table 3). Bigmouth buffalo 22 - 235 mm in length were not captured. This indicated poor recruitment since fish within this size range were taken in commercial operations in adjacent lakes. Moen (1954), Scidmore and Woods (1959), Johnson (1963), and McComish (1967) also found zooplankton the major food of bigmouth buffalo.

Table 2. Food of 56 bigmouth buffalo fry taken during 17-28 June 1968, Lake Poinsett, South Dakota.

	Total Number	Mean No./ Stomach	% Number	Ttl. Vol. in (ml)	% Volume
Phytoplankton					
Chlorophyta					
Pediastrum sp.	26	0.5	T*	T	T
Cyanophyta					
Anacystis sp.	52	0.9	1.7	T	T
Zooplankton					
Crustacea					
Cladocera					
Diaphanasoma brachyurum	5	T	T	T	T
Daphnia pulex	20	T	T	0.04	3.4
Bosmina longirostris	1	T	T	T	T
Copepoda					
Calanoida	4	T	T	T	T
Cyclopoida	588	10.5	19.6	0.18	15.5
Nauplii	1582	28.2	52.7	0.07	6.0
Benthos					
Insecta					
Diptera					
Tendipedidae					
Pupae	14	0.3	T	0.25	21.5
Larvae	482	8.6	16.1	0.48	41.4

* Trace (T) = Less than one per cent.

Table 3. Stomach contents of adult bigmouth buffalo expressed as mean number per stomach and mean per cent volume (parentheses) seasonally from January to November, 1968.

Organism	Winter Jan-Mar	Spring Apr-June	Summer July-Sept	Fall Oct
Phytoplankton				
Chlorophyta				
Pediastrum sp.		0.1	0.2	
		(T)*	(T)	
Cyanophyta				
Anacystis sp.		275	71,583	4,167
		(T)	(22.1)	(2.1)
Zooplankton				
Rotifera				
Keratella cochlearis		0.1	1.1	
		(T)	(T)	
Keratella quadrata		0.03	0.03	
		(T)	(T)	
Crustacea				
Cladocera				
Diaphanasoma brachyurum		78	1,132	433
		(T)	(8.0)	(2.1)
Daphnia galeata mendotae			1,846	1,300
			(16.0)	(19.7)
Daphnia pulex (adults)	1,653	770	635	833
	(89.8)	(35.7)	(25.6	(37.7)
Daphnia pulex (juveniles)	126	3,484	696	267
	(2.0)	(32.8)	(11.3)	(3.3)
Bosmina longirostris		78	2,571	67
		(T)	(2.9)	(T)
Leydigia quadrangularis		287	107	
		(T)	(T)	
Chydorus sphaericus		27	7371	11,667
		(T)	(5.0)	(11.7)
Copepoda				
Calanoida	54	274	1348	67
	(1.4)	(3.3)	(1.3)	(T)
Cyclopoida	188	4344	4150	4567
	(6.6)	(26.4)	(6.2)	(23.0)
Total number	62	148	179	66
Number with food	22	88	111	7
Ave. vol (ml)/stomach containing food	3.3	4.0	5.2	2.3

* Trace (T) = Less than one per cent.

Daphnia pulex adults comprised 83.7 to 96.7% of the food items during the period of ice cover (January to April). An adult was defined as equal to or larger in size than the smallest reproducing individual. Daphnia pulex juveniles and copepods made up the remaining volume. Spring samples (April to July) showed heavy utilization of D. pulex adults and juveniles (68.5%) with cyclopoid copepods rising sharply to 29.7% of the total volume. Anacystis sp., Pediastrum sp., Keratella cochlearis, K. quadrata, Chydorus sphaericus, and L. quadrangularis were taken in minor amounts. The ingestion of L. quadrangularis indicates some feeding near the bottom since it is primarily a benthic cladocrean. Daphnia pulex adults comprised 25.6% of the summer (July to October) food volume. Daphnia galeata contributed 16.0% and Anacystis sp. 22.3%. The increase of Anacystis sp. is directly correlated with a late summer bloom (Figure 1). Diaphanasoma brachyurum and C. sphaericus contributed 7.7 and 5.0%, respectively. The 14 October sample represented the bulk of fall data. Three additional samples (26 October, 1 and 8 November) representing 50 fish were taken but only one stomach contained food. A drop in water temperature from 12 C on 14 October to 6 C on 26 October may have resulted in a cessation of feeding. The one fish containing food during this period utilized L. quadrangularis heavily (91.0%) and C. sphaericus to a lesser extent (9.0%). The 14 October sample showed utilization of D. pulex (adults and juveniles) and D. galeata which totalled 60.7%. Anacystis sp. dropped sharply and was of minor importance. Chydorus sphaericus increased slightly to 11.7% and cyclopoid copepods increased sharply to 23.0%.

Food Selectivity

Food selectivity by bigmouth buffalo for eight major categories of zooplankton is shown in Figures 2 to 9. Diaphanasoma brachyurum (Figure 2) was highly selected when it initially appeared in June but was negatively selected during July when it occurred as 8.8% of the plankton. In August it occurred as 16.1% of the plankton (Table 4) but appeared to be taken without selection. Per cent occurrence dropped during the fall but selection increased during September and October.

Daphnia galeata mendotae had a mean index of -0.11 which is similar to the index of D. pulex juveniles (-0.03). Hall (1964) observed that adult cisco and black crappie fed extensively on large D. pulex in the early spring but not on the smaller adults of D. galeata mendotae. If it is assumed that juvenile D. pulex are comparable with adult D. galeata mendotae, Hall's observation is also true in this study. Figure 3 shows D. pulex juveniles were avoided in late winter and early spring while the larger adult D. pulex were heavily selected. In the fall when D. galeata mendotae appeared, it was negatively selected (Figure 4) while large D. pulex was positively selected. The selectivity for D. pulex adults increased steadily from July to September and decreased slightly in

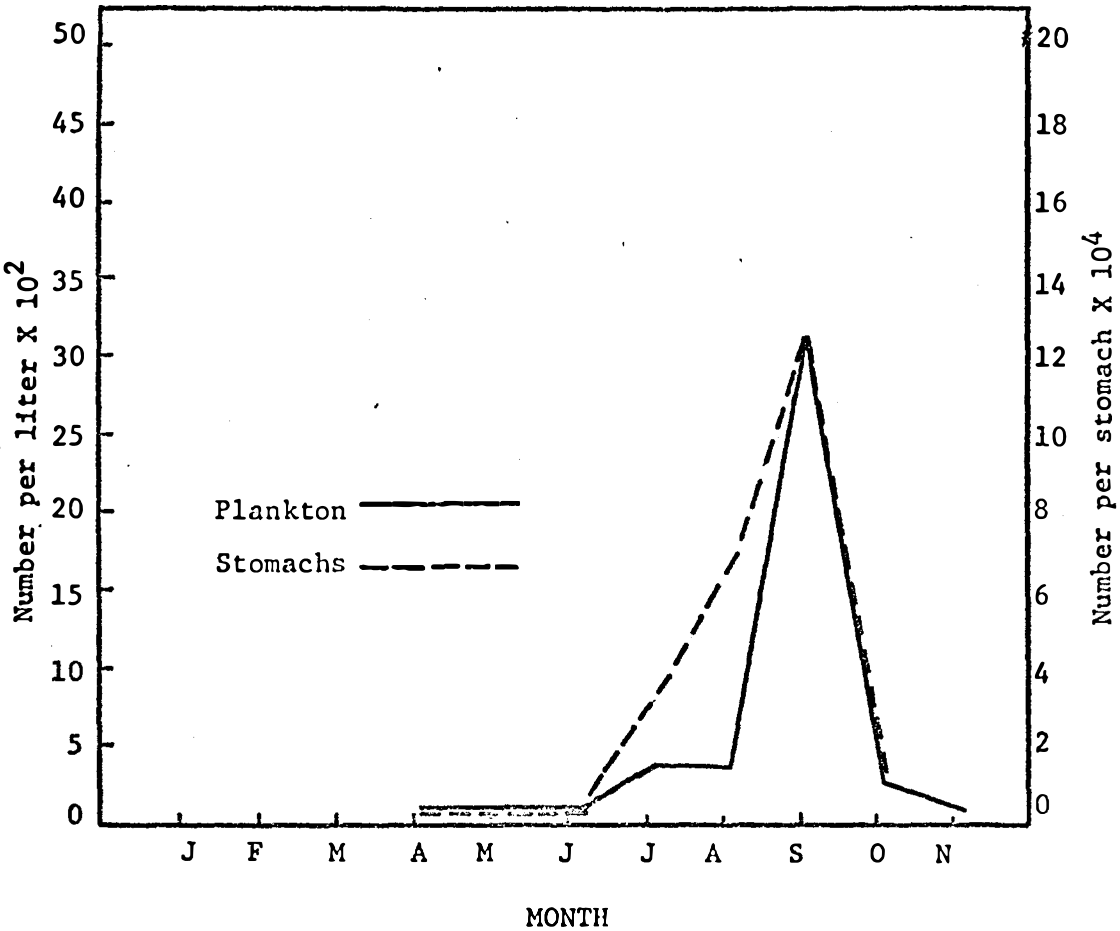


Figure 1. Comparison of *Anacystis* sp. in plankton and bigmouth buffalo stomachs January to November 1968, Lake Poinsett, South Dakota.

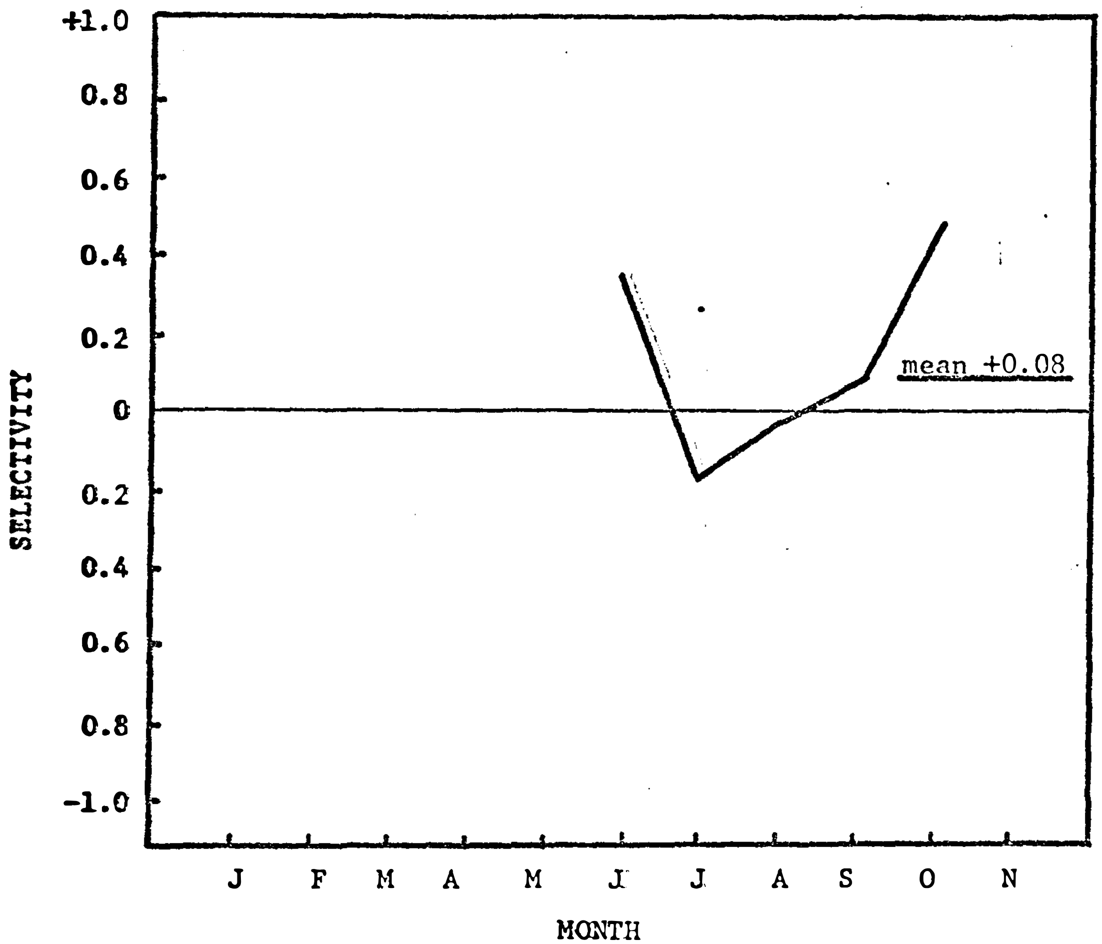


Figure 2. Monthly food selectivity index for <u>Diaphanasoma brachyurum</u> by subadult and adult bigmouth buffalo, January to November 1968, Lake Poinsett, South Dakota.

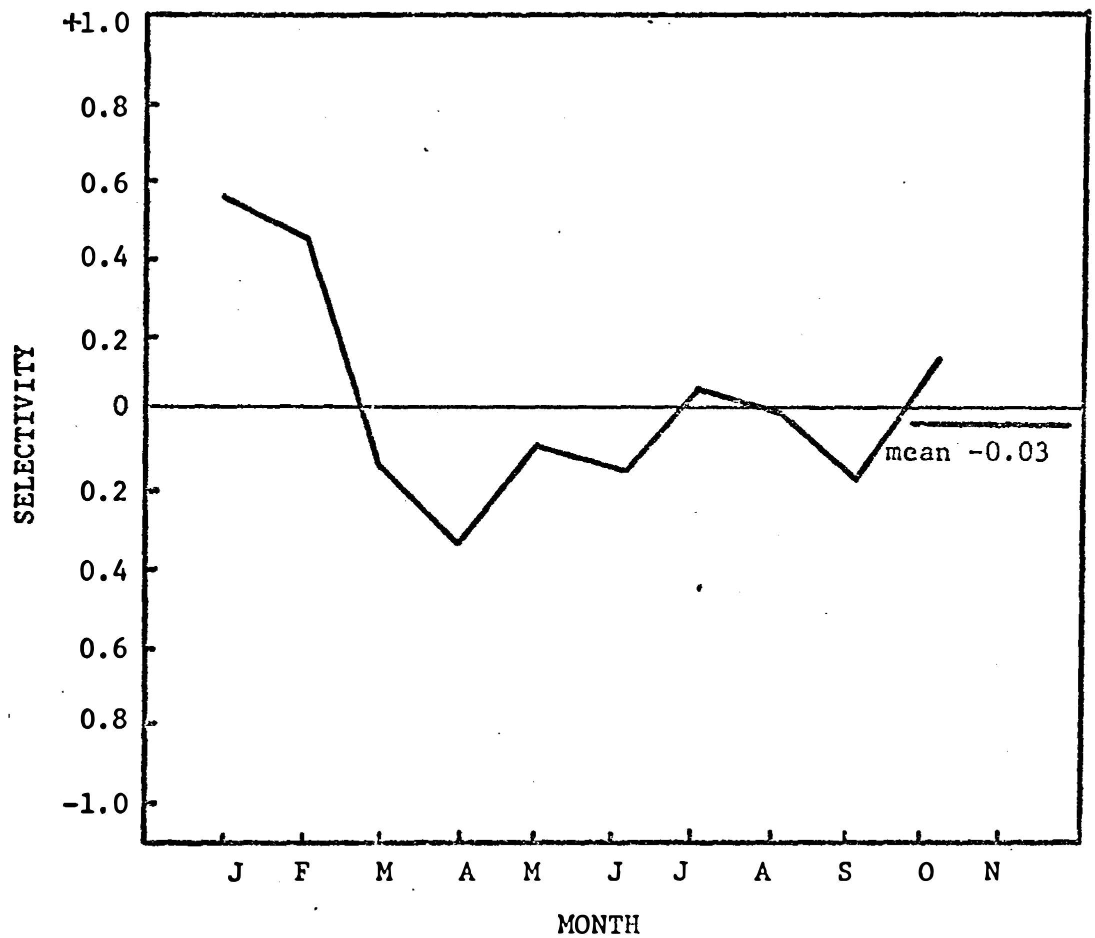


Figure 3. Monthly food selectivity index for Daphnia pulex juveniles by subadult and adult bigmouth buffalo, January to November 1968, Lake Poinsett, South Dakota.

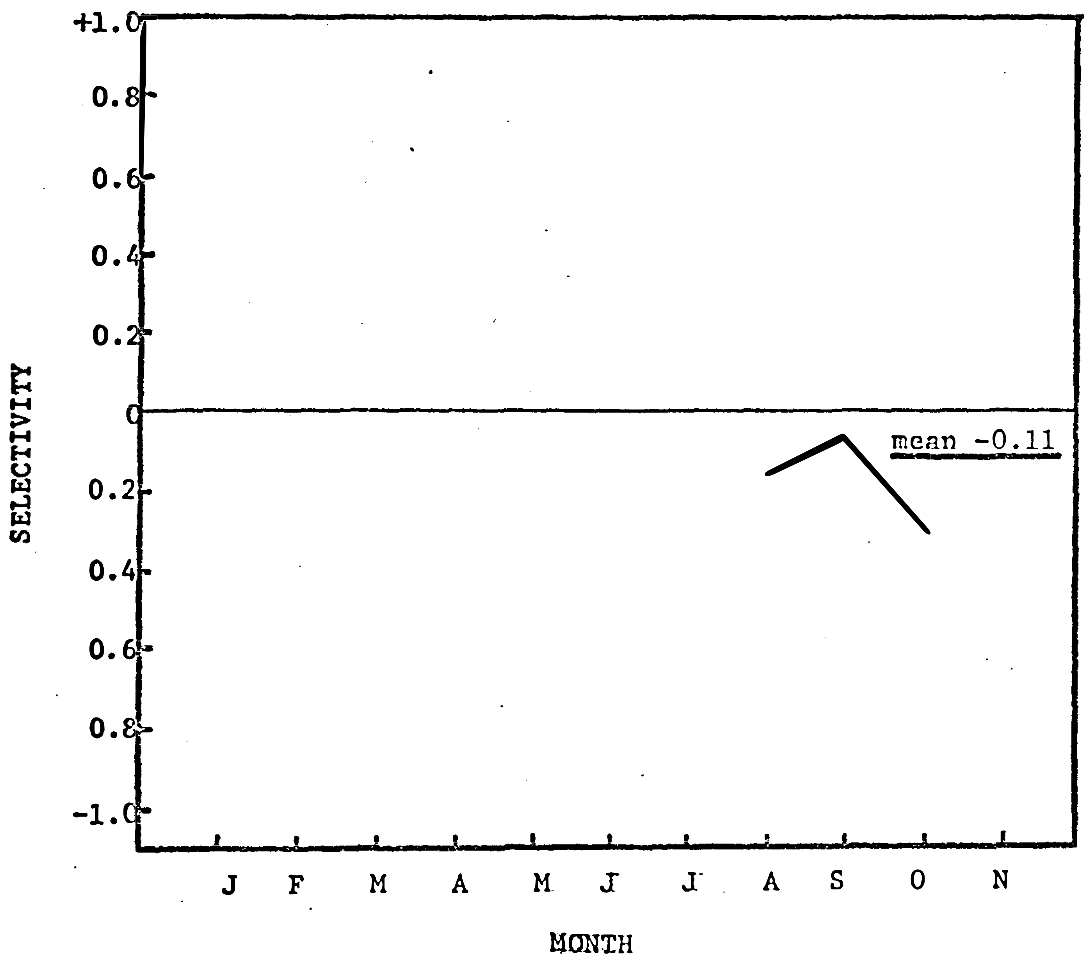


Figure 4. Monthly food selectivity index for <u>Daphnia galeata mendotae</u> by subadult and adult bigmouth buffalo, January to November 1968, Lake Poinsett, South Dakota.

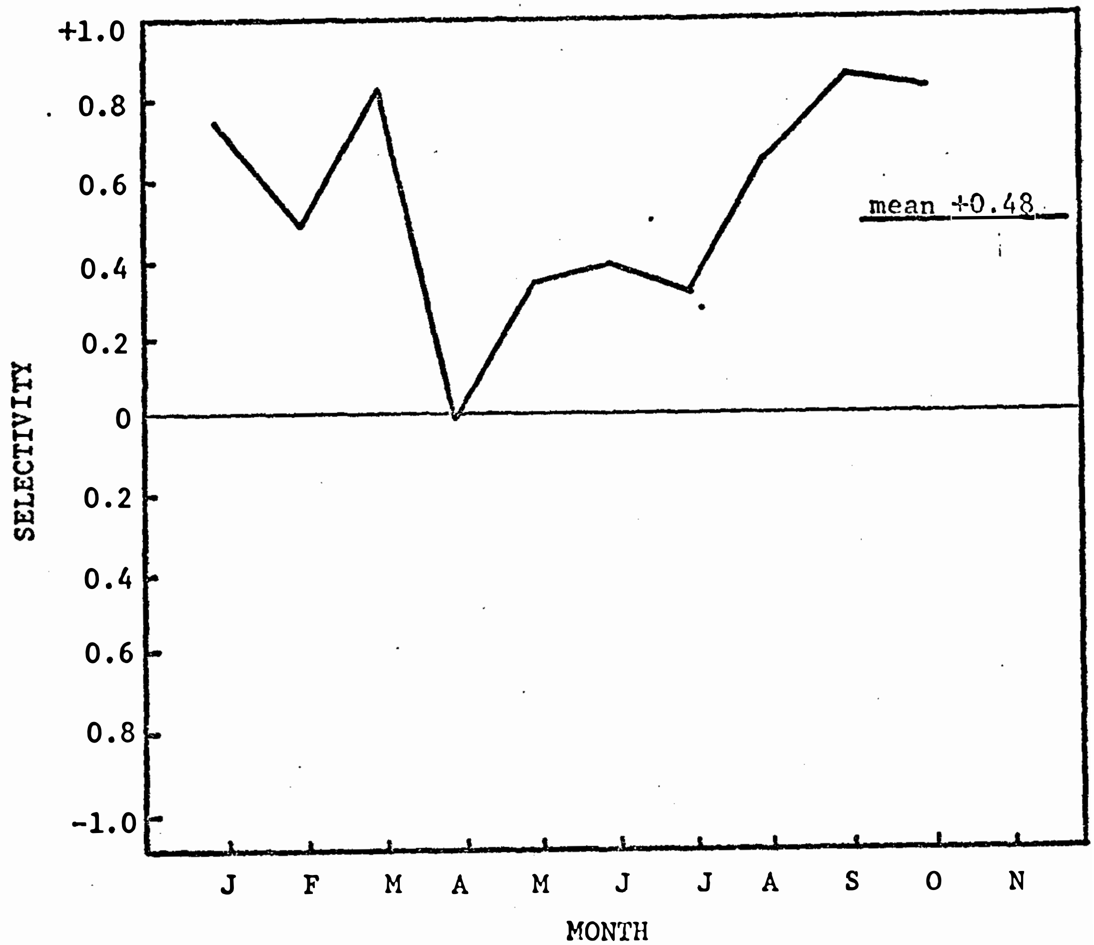
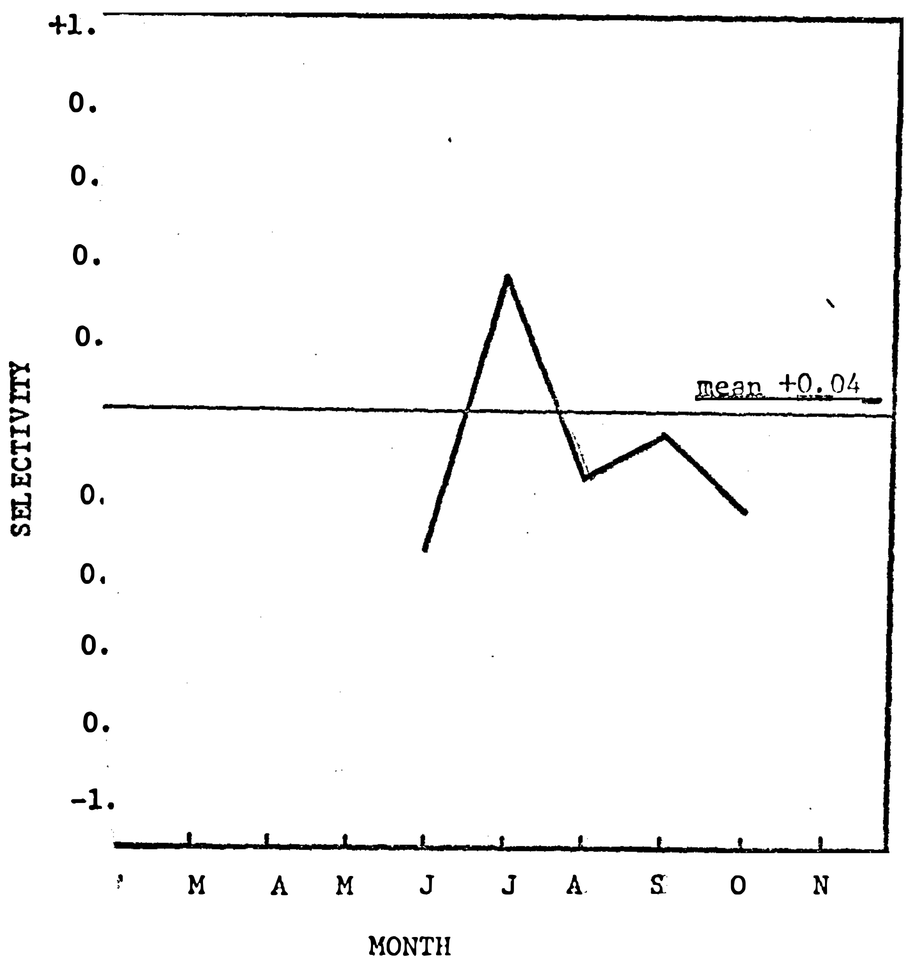


Figure 5. Monthly food selectivity index for *Daphnia pulex* adults by subadult and adult bigmouth buffalo, January to November 1968, Lake Poinsett, South Dakota.



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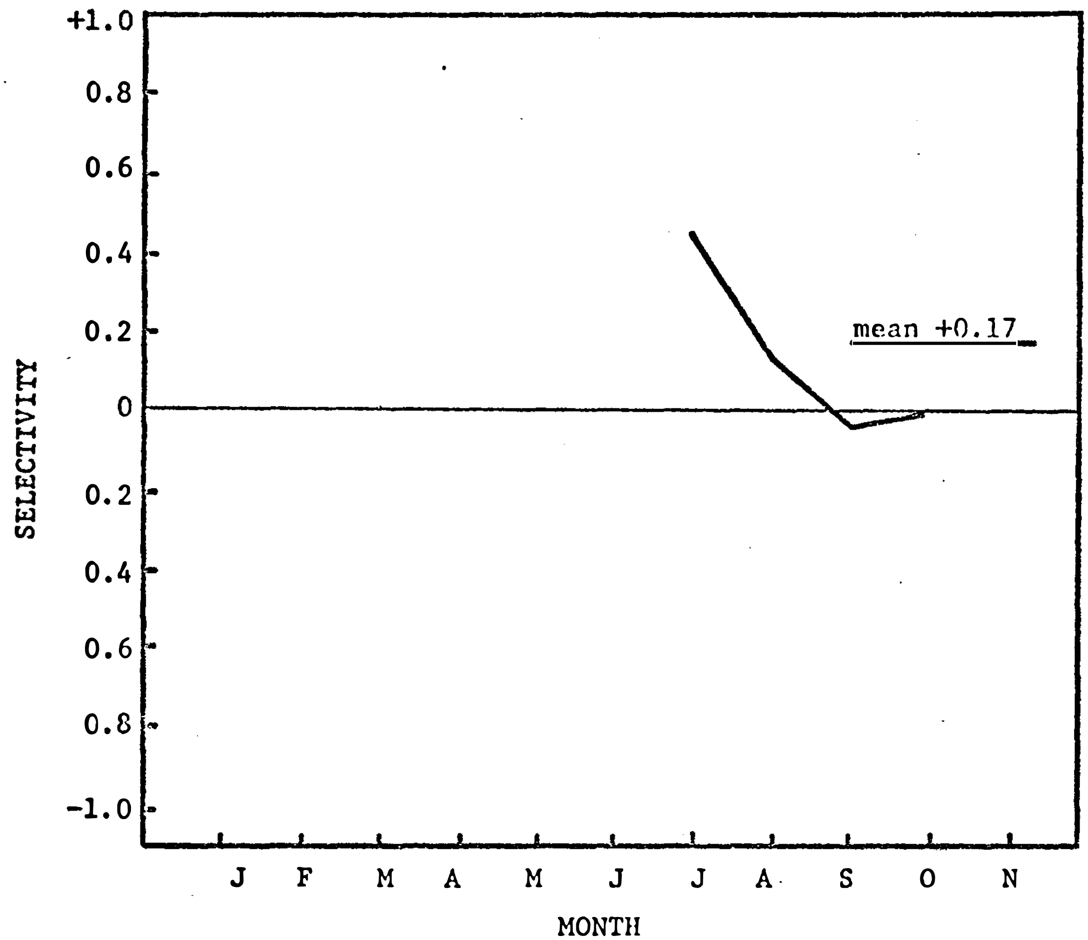

Figure 7. Monthly food selectivity index for *Chydorus sphaericus* by subadult and adult bigmouth buffalo, January to November 1968, Lake Poinsett, South Dakota.

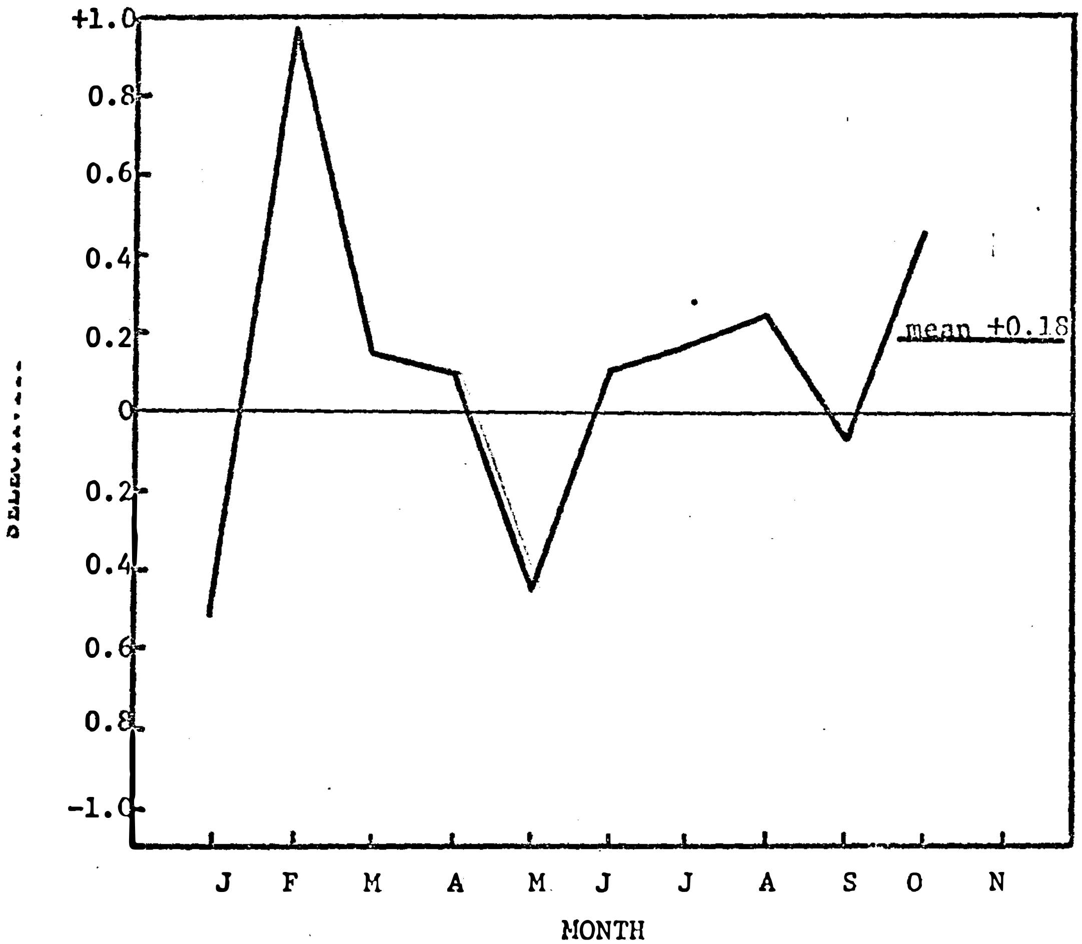

Figure 8. Monthly food selectivity index for cyclopoid copepods by subadult and adult bigmouth buffalo, January to November 1968, Lake Poinsett, South Dakota.

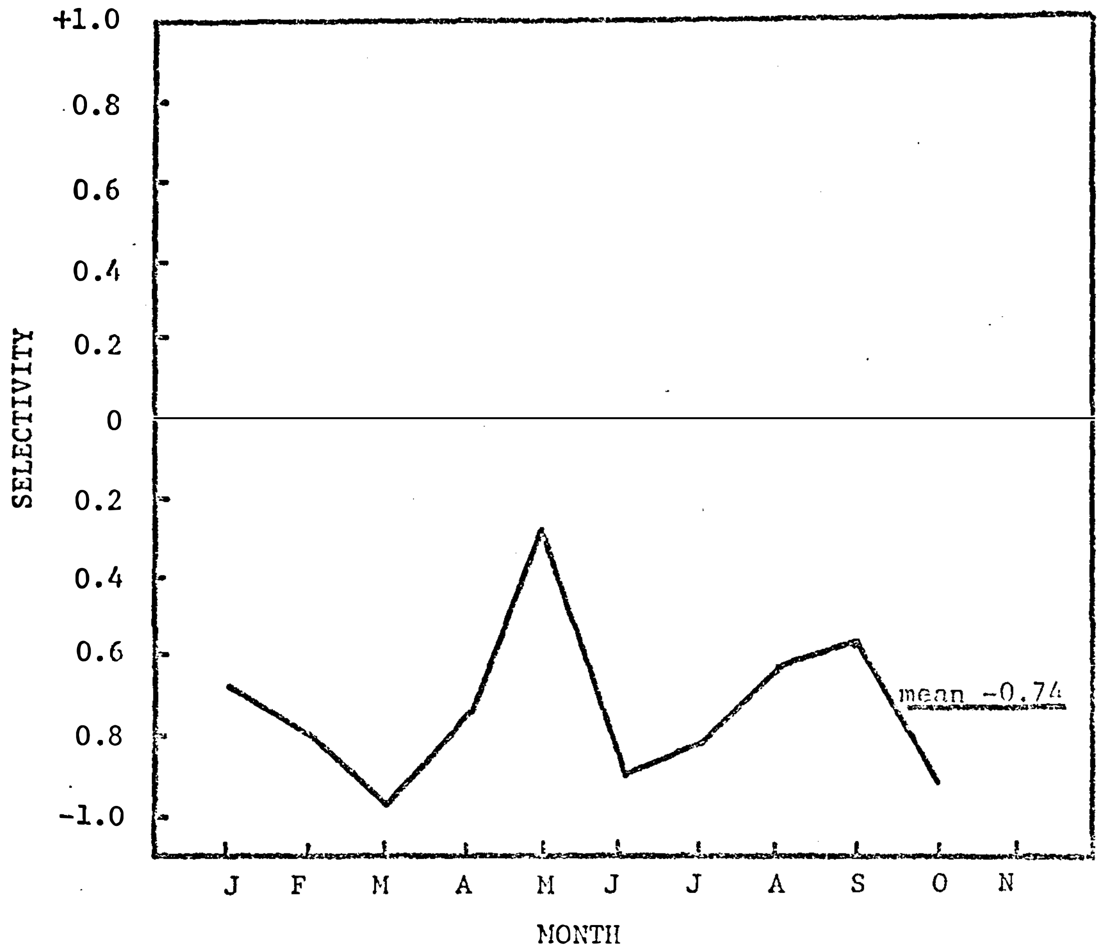

Figure 9. Monthly food selectivity index for calanoid copepods by subadult and adult bigmouth buffalo, January to November 1968, Lake Poinsett, South Dakota.

Table 4. Mean number per liter and per cent occurrence (parentheses) in plankton samples taken in conjunction with bigmouth buffalo stomach samples to determine selectivity of feeding January to November. 1968.

	January	February	March	April	May	June
Phytoplankton						
Cyanophyta						
Anacystis sp.				9	30	20
Zooplankton						
Crustacea						
Cladocera						
Diaphanasoma brachyurum						0.2
						(T)*
Daphnia galeata mendotae						
Daphnia pulex	2.2	3.2	2.5	6.5	8.9	4.0
(adults)	(13.9)	(20.0)	(17.5)	(7.6)	(4.9)	(4.3)
Daphnia pulex	0.3	0.3	2.5	26.2	80.7	35.3
(juveniles)	(1.9)	(1.7)	(17.5)	(30.6)	(45.0)	(37.6)
Bosmina longirostris				0.1	0.3	2.7
				(T)	(T)	(2.9)
Chydorus sphaericus						0.1
						(T)
Copepoda						
Calanoida	11.6	12.6	7.6	4.7	7.9	9.3
	(69.4)	(78.3)	(53.1)	(5.5)	(4.4)	(9.9)
Cyclopoida	2.4		1.7	48.1	81.6	42.4
	(14.8		(11.9)	(56.2)	(45.5)	(45.1)

* Trace (T) = Less than one per cent.

Table 4. (Continued).

	July	August	September	October	November
Phytoplankton					
Cyanophyta					
Anacystis sp.	357	327	3,181	251	91
Zooplankton					
Crustacea					
Cladocera					
Diaphanasoma	12.8	27.9	7.3	1.2	0.3
brachyurum	(8.8)	(16.1)	(2.5)	(T)	(T)
Daphnia galeata		28.9	41.3	15.8	6.6
mendotae		(16.7)	(13.9)	(11.1)	(8.3)
Daphnia pulex	5.2	1.3	0.1	0.8	0.8
(adults)	(3.6)	(T)	(T)	(T)	(T)
Daphnia pulex	26.1	3.0	1.1	1.4	1.8
(juveniles)	(17.6)	(1.7)	(T)	(1.0)	(2.3)
Bosmina	43.1	36.3	15.6	1.0	1.7
longirostris	(29.6)	(21.0)	(5.2)	(T)	(2.1)
Chydorus	0.7	58.3	223.8	92.3	34.2
sphaericus	(T)	(33.7)	(75.2)	(64.9)	(43.2)
Copepoda					
Calanoida	36.5	12.1	3.4	12.1	11.1
	(25.1)	(7.0)	(1.1)	(8.5)	(14.0)
Cyclopoida	21.2	5.4	4.4	17.7	22.6
	(14.6)	(3.1)	(1.5)	(12.4)	(28.6)

* Trace (T) = Less than one per cent.

October while the indices of D. pulex juveniles steadily decreased and D. galeata fluctuated between -0.06 and -0.30.

Daphnia pulex adults were the most selected item in the diet of bigmouth buffalo (Figure 5). Only one negative reading was recorded from January to November. This reading coincided with a great increase of D. pulex juveniles and cyclopoid copepods during late April and early May. At all other times D. pulex adults were selected even when plankton samples showed trace per cent occurrence. Galbraith (1967) observed that rainbow trout (Salmo gairdneri) and yellow perch (Perca flavescens) selected large D. pulex exclusively although other zooplankters were present. Daphnia over 1.3 mm were selected over smaller, although often more numerous individuals. Galbraith concluded that rainbow trout and yellow perch discriminated when feeding or sought out concentrations of large Daphnia since the gill raker openings of these fish were small enough to accommodate smaller plankters. Gerking (1962) discussed selective feeding of bluegills (Lepomis macrochirus) on Daphnia and found the mode of Daphnia sizes consumed to be 1.11 - 1.12 mm. After comparing net plankton to bluegill stomach samples, he concluded that bluegills fed on a restricted part of the plankton.

Selectivity of Bosmina longirostris (Figure 6) roughly followed its per cent occurrence. Highest selectivity occurs when it reached 29.6% occurrence, then decreased slowly to avoidance in late summer and fall. Since it is only a little larger (0.4 mm) than gill raker accessory teeth openings of bigmouth buffalo, many Bosmina probably escape ingestion. Gerking (1962) observed that Bosmina were never found in bluegill stomachs although common in the plankton.

Chydorus sphaericus appeared in June plankton as a trace and built up rapidly to 75.2 and 64.9% occurrence in September and October. Chydorus is smaller (0.3 mm) than Bosmina and subject to less retention by the accessory teeth. Although making up to 11.7% of the diet, its selectivity declined steadily from July to September (Figure 7).

Selectivity of cyclopoid copepods (Figure 8) fluctuated greatly during most of the sampling period. Average length of cyclopoid copepods (0.75 mm) was such that most should have been retained by the gill rakers and accessory teeth. Positive selectivity was greatest during February when it reached +0.98.

Calanoid copepods (Figure 9) were negatively selected for the entire period with a mean of -0.74, even though their average length was greater than cyclopoid copepods. Houde (1967) observed that walleye (Stizostedion vitreum vitreum) fry always negatively selected Diaptomus, a calanoid copepod, but did select Epischura, a large calanoid copepod, positively on a few sampling dates. Houde showed that Cyclops, though smaller, was selected positively over Diaptomus and Epischura, until Epischura contributed 15% or more of the copepod numbers in the plankton. It appeared the calanoid copepods were able to avoid predation by bigmouth buffalo. Clifford (1969) observed that bigmouth buffalo occupied all depth strata of Lake Poinsett. This suggested feeding at all levels and appeared to rule out negative selection on the basis of occupying different strata.

A close association existed between Anacystis sp. in plankton and stomach samples (Figure 1). A build-up of Anacystis sp. in the stomach closely matched that in the net plankton. Moen (1954) found Microcystis (Anacystis) occasionally comprised up to 51%, but seldom exceeded 10%, of the diet of bigmouth buffalo in Iowa.

Gill rakers from six bigmouth buffalo ranging from 14.5 to 60.9 cm in total length were removed and examined. The width of gill raker openings along the entire gill arch showed little variation within a given fish. All gill rakers had accessory teeth which extended perpendicular to the gill raker and often branched at the tip. Accessory teeth diminished the total width of the gill raker opening and would have made it difficult for anything other than the smallest plankton (less than 0.2 - 0.3 mm) to pass. The accessory teeth existed only as swellings along the gill rakers of the 14.5 cm fish. The distance between gill rakers was 0.25 mm but the swellings reduced the distance to 0.1 mm. As fish became larger the distance between gill rakers increased but the accessory teeth grew longer maintaining the space between gill rakers at 0.2 - 0.3 mm (Figure 10). Accessory teeth were more dense and rigid at the base of the gill raker, gradually becoming more pliable and less dense toward the tip.

Selectivity, if mechanical, should depend on the availability of the organism. Organisms larger than the width of the gill rakers

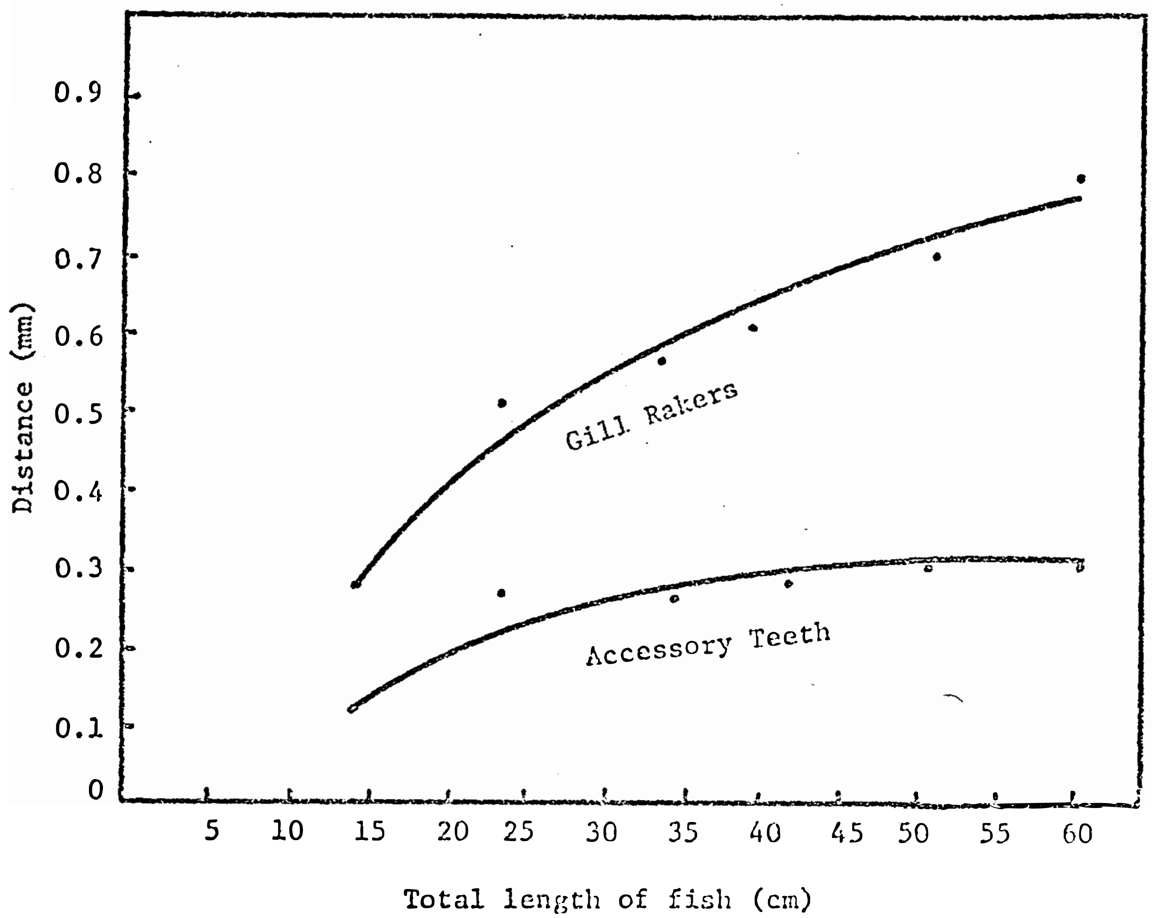

Figure 10. Relationship of distance between gill rakers and accessory teeth to total length of six bigmouth buffalo of increasing size, Lake Poinsett, South Dakota.

should be retained with 100 per cent efficiency while those smaller than gill raker openings but larger than the openings between accessory teeth, should be retained to some extent but less than 100%. Organisms smaller than 0.2 - 0.3 mm should not be positively selected at all. The loss of smaller organisms would tend to increase the selectivity index of larger organisms. Smaller organisms which pass through the gill rakers are lost from the stomach contents but larger organisms are consumed with almost 100% efficiency. The result is a greater percentage of large organisms in the stomach compared to the percentage in the plankton. This does not take into account the actions of the organism which, from the selectivity indices, appeared to play a significant role.

Selectivity on the basis of average volume of food items is shown in Figure 11. Although volume cannot be justly compared to the dimensional configuration of an organism, it can be used as a relative index of dimensions. From the selectivity indices and Figure 11 it was apparent that Daphnia pulex was taken with greater efficiency than any of the other organisms. Calanoid copepods appeared to avoid ingestion even when they comprised a considerable percentage of the total population. Langford (1953) found that certain zooplankters exhibited negative rheotaxis when sampled with pumps. His data showed that calanoid copepods were sampled with only about one-third the efficiency of cyclopoid copepods. It is possible that calanoid copepods were able to avoid feeding bigmouth buffalo which would be reflected in the consistently negative

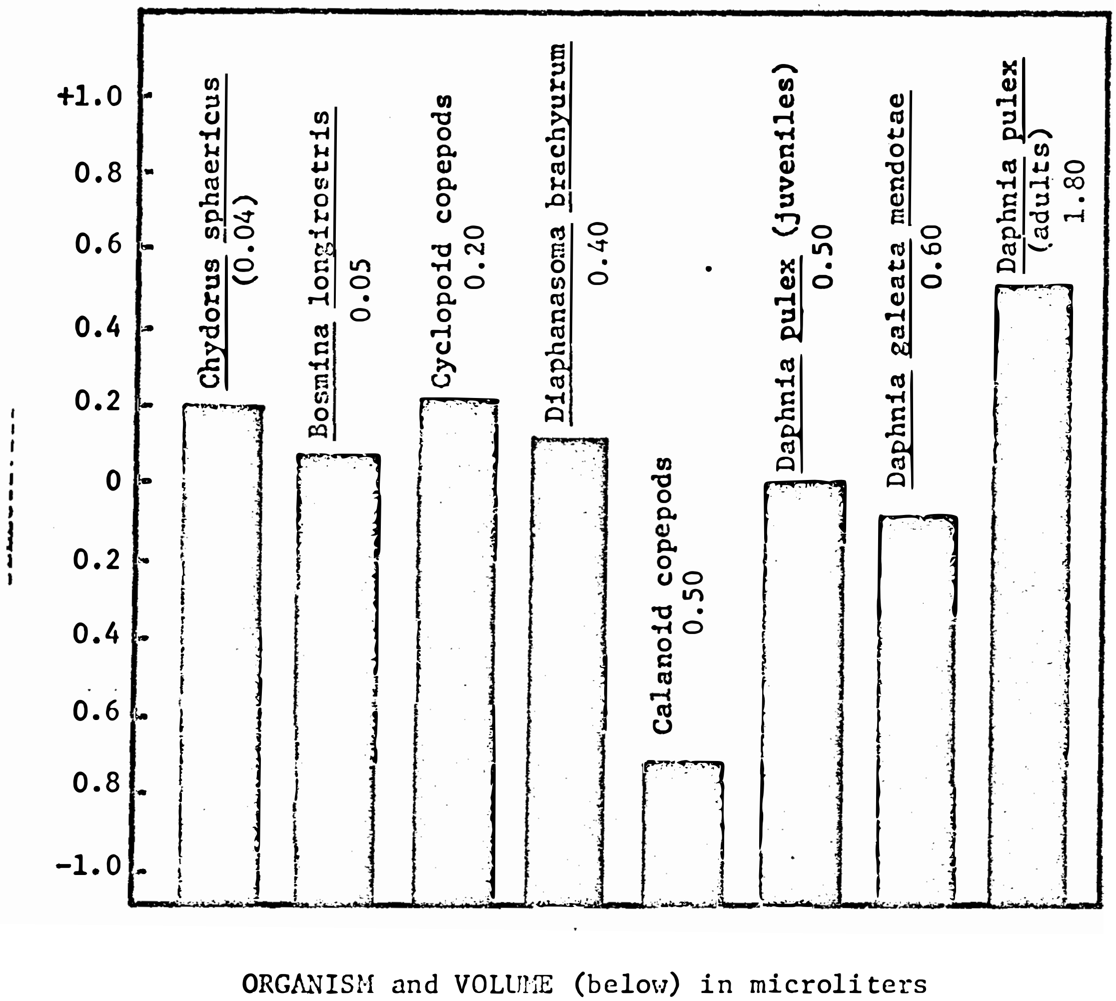

Figure 11. Mean selectivity indices for eight food categories ingested by bigmouth buffalo January to November 1968, Lake Poinsett, South Dakota, as related to volume.

indices. Keratella was ingested in minor amounts, although it is small enough to pass through the gill rakers and accessory teeth.

Bigmouth buffalo in Lake Poinsett were very efficient consumers of zooplankton present. In most cases, they consumed zooplankton in the same proportion found in the water. Morphology of gill rakers was such that a wide range of zooplankton sizes (0.2 - 2.0 mm) were taken. Efficiency was greatest for adult Daphnia pulex which was the largest food item present. Negative selectivity for calanoid copepods suggests that avoidance may also be an important factor in the food selectivity of subadult and adult bigmouth buffalo.

LITERATURE CITED

Applegate, R.L., A.C. Fox, and V.J. Starostka. 1968. A water core plankton sampler. J. Fish. Res. Bd. Canada 25(8): 1741-1742.

Borgeson, D.P. 1963. A rapid method for food-habit studies. Trans. Amer. Fish. Soc. 92: 434-435.

Brooks, J.L., and S.I. Dodson. 1965. Predation, body size, and composition of plankton. Science 150: 28-35.

Clifford, T.J. 1969. Summer movement of bigmouth buffalo in Lake Poinsett, South Dakota. Unpublished M.S. thesis, South Dakota State University, 34p.

Congdon, J.C. 1969. The fish population of Lake Poinsett, South Dakota, as indicated by the catch of four types of gear. Unpublished M.S. thesis, South Dakota State University, 61p.

Edmondson, W.T. (Editor). 1959. Freshwater biology. John Wiley and Sons, Inc., New York, 1248p.

Galbraith, M.G. 1967. Size-selective predation on Daphnia by rainbow trout and yellow perch. Trans. Amer. Fish. Soc. 96(1): 1-10.

Gerking, S.D. 1962. Production and food utilization in a population of bluegill sunfish. Ecol. Monogr. 32: 31-78.

Hall, J.D. 1964. An experimental approach to the dynamics of a natural population of Daphnia galeata mendotae. Ecology 45: 95-112.

Houde, H.D. 1967. Food of pelagic young of the walleye, Stizostedion vitreum vitreum, in Oneida Lake, New York. Trans. Amer. Fish. Soc. 96(1): 17-24.

Ivlev, V.S. 1961. Experimental ecology of the feeding of fishes. Translated from Russian by Douglas Scott. Yale University Press, New Haven: 302p.

Johnson, R.P. Studies on the life history and ecology of the bigmouth buffalo, Ictiobus cyprinellus (Valenciennes), J. Fish. Res. Bd. Canada 20(6): 1397-1429.

Langford, R.R. 1953. Methods of plankton collection and a description of a new sampler. J. Fish. Res. Bd. Canada 10: 238-252.

McComish, T.S. 1967. Food habits of the bigmouth and smallmouth buffalo in Lewis and Clark Lake and the Missouri River. Trans. Amer. Fish. Soc. 96(1): 70-74.

Miller, D. 1961. A modification of the small Hardy plankton sampler for simultaneous high speed plankton hauls. Bull. Mar. Ecol. 5: 165-172.

Moen, T. 1954. Food of the bigmouth buffalo, _Ictiobus cyprinellus_ (Valenciennes), in northwest Iowa lakes. Proc. Iowa Acad. Sci. 61: 561-569.

Scidmore, W.J. and D.E. Woods. 1959. Some observations on competition between several species of fish for summer foods in four southern Minnesota lakes in 1955, 1956, and 1957. Minnesota Fish and Game Invest., Fish Series 2: 13-24.