FEEDING HABITS OF CATFISHES IN BARKLEY AND KENTUCKY LAKES

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Abstract: Indices of relative importance and forage ratios are presented for food items of channel (*Ictalurus punctatus*) and blue catfishes (*I. furcatus*) collected from two large impoundments in western Kentucky. Data reported include samples collected from September 1977 to April 1978. Young of the year catfishes from both lakes relied heavily on zooplankton and aquatic insects. Other food items which were seasonally important included debris, trichopterans, bryozoans, and fish. Teleosts were the most important food items of intermediate sized (150-300 mm TL) catfishes in both lakes. Hexageniid mayflies were important to Kentucky Lake catfishes, but not to Barkley Lake catfishes; the converse was true of bryozoans. Omnivorous feeding habits characterized large harvestable (> 300 mm TL) catfishes. Food items of harvestable catfishes included fish, insect larvae, debris, and one deermouse (*Peromyscus* sp.); pelecypods occurred consistently in the diet of Barkley Lake catfishes. Diversity of food items in catfish diets may be affected by the relative abundance of the 2 species in each lake. It is postulated that interactions between catfishes could alter availability and/or selection of food items.

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Channel and blue catfishes are valuable sport and food fishes in the southeastern United States. Commercial fisheries are important regionally, particularly in large impoundments. Kentucky and Barkley Lakes (Kentucky) formed by the impoundment of the Tennesee River (1948) and the Cumberland River (1968), respectively, support major catfish fisheries.

Concern over growth rates of catfishes in old (Kentucky Lake) and young (Barkley Lake) impoundments during the past 2 decades prompted initiation of these studies (Johnson et al. 1978). Matthai (1972) reported variation in growth within and between sizes and species of catfishes in these reservoirs.

The feeding ecology of these fishes is a possible source of variation in growth. Food item importance has been evaluated and environmental abundance related to feeding habits.

MATERIALS AND METHODS

This paper presents data from the latter part (September 1977 through April 1978) of a 3-year study of catfish growth and related parameters in Kentucky and Barkley Lakes. The project was supported by Project Number 2-277-R-3 Kentucky Department of Fish and Wildlife Resources and National Marine Fisheries Service (NOAA).

An otter trawl proved most effective in collection of young of year catfish though sample sizes were small. Most catfish were colected with experimental gill nets, though electrofishing was also utilized during April.

Fish were collected from the embayments and main channels adjacent to Donaldson Creek in Barkley Lake and Anderson Bay in Kentucky Lake. Young of year catfishes (< 150 mm TL) were preserved whole in 10% formalin while stomachs of larger fish (intermediate, 150-300 mm TL; harvestable, > 300 mm TL) were exised, stored on ice, and brought to the lab for processing. Stomach contents were identified and analyzed as numerical percentage (N%), frequency of occurrence (FO%), and percentage volume (V%). An index of relative importance was calculated according to Talent (1976) as:

$$IRI = FO\% \, (N\% + V\%).$$

A forage ratio for each food item was calculated as

$$FR = \frac{\text{\% by number of a food item in stomach contents}}{\text{\% by number of the food item in the environment}}$$

(Lagler 1956). Forage ratios greater than 1, 1, and less than 1 indicate selection for, no selection, and selection against a particular food item, respectively.

Benthic macroinvertebrates were collected with a Ponar dredge along a transect line at each of the stations (Donaldson and Anderson Bays) beginning in March 1978. Samples consisted of 3 grabs at each point along the transect; substrates from embayments, flood plains, secondary river channels, and main channels were included. Percentage species composition of benthos was calculated by number for each sample; although samples were pooled for calculation of forage ratios since fish captured from embayments and channels were not distinguished in the analysis. Forage ratios of organisms sampled in March were based on fish and benthos samples taken in the embayments only; no fish were captured outside of the embayments in March. Forage ratios could not be calculated for food items which were not captured in the benthos, or whose relative abundance could not otherwise be estimated (i.e., zooplankton, fishes, bryozoans, algae, and debris).

RESULTS AND DISCUSSION

The index of relative importance facilitates recognition of the value of food items in the diet of the consumer. Values may range from zero indicating no utilization to 20,000 indicating exclusive utilization. The estimates of forage ratios are weakened by the fact that catfishes are opportunistic feeders that often rely heavily on items whose relative abundance is not readily determined by the sampling methods employed. The Ponar dredge was inadequate for sampling chert and gravel shorelines characteristic of parts of the lake where catfish are commonly caught. *Stenonema* sp. (Ephemeroptera) are abundant on the rocky shoreline substrate. Submerged logs and other objects which offer substrate to organisms were also unavailable to sampling techniques used. Unquantified observation revealed that trichopteran larvae occurred in high population densities on submerged objects. Forage ratios may be exaggerated for organisms captured "incidentally" but which are abundant in feeding areas. Conversely, chance sampling of "patches" of particular organisms may cause underestimates of forage ratio values. Pooling of data within fish and benthos samples may also reduce the reliability of forage ratio values. Relative importance values are thought to be more reliable since they are not subject to the disadvantages cited above.

Food habits of Kentucky and Barkley Lake young of year catfishes parallel those of other populations. Zooplankton and aquatic insects, chiefly Diptera (Chironomidae) and Ephemeroptera (*Hexagenia*) are generally important items in the diet of young of year catfishes (Walburg 1975; Minckley 1962; Bonneau et al. 1972). Young of the year catfishes in both impoundments relied heavily on small organisms [leptodorids, bosminids, copepods and midges (Chaoborinae and Chironomidae)] particularly in September (Table 1). Bryozoans were the exclusive food of small blue catfish from Kentucky Lake in October. One channel catfish caught in December had fed exclusively on debris, while another in April contained only chironomid larvae. Young of year channel catfish from Barkley Lake exploited a variety of food items during the winter months, including midges (Chironomidae), caddisflies (Trichoptera), mayflies (Ephemeridae), bugs (*Hemiptera*), water mites (*Hydracarina*), bryozoans and fish remains. Debris was an important constituent of the diet of small catfishes in Barkley Lake throughout winter and into spring. Minckley (1962) found large volumes of debris, organic muck, in small blue catfish from the Ohio River (KY). Mayflies (Ephemeridae) were more important in the diet of young catfishes in Kentucky Lake. In Iowa young channel catfish (less than 114 mm) fed primarily on diptera larvae, though some trichopterans and

Table 1. Index of relative importance and forage ratios (in parentheses) of some food items consumed by channel (Ip) and blue (If) catfish less than 150 mm TL from Kentucky and Barkley Lakes.

Month	Sept.		Oct.		Nov.		Dec.		Apr.	
Species	Ip	If	Ip	If	Ip	If	Ip	If	Ip	If
Food Item										
					Kentucky Lake					
No. fish w/ food	1	3	0	1			1	0	3	3
Leptodoridae		858								
Bosminidae		858								
Copepoda		693								
Chaoborinae(L)		1511(1.5)								
Chironomidae(L)									2706(4.1)	1089(.92)
Trichoptera(L)		495								
Ephemeridae(N)		2046(.79)							5293(.41)	6901(.90)
Coleoptera	10,000									
Teleosts									1287	1089
Bryozoa				20,000						
Debris	10,000	1155					20,000			1089
					Barkley Lake					
No. fish w/ food	5	1	2	0	1	2	5	0	1	3
Leptoporidae	229									
Chaoborinae(L)	148(.01)									
Chaoborinae(P)	148(.01)									
Chironomidae(L)	10,080(6.2)		2650(1.1)				466(1.3)		20,000(5.0)	
Chironomidae(P)	540(.03)	20,000(6.7)								
Trichoptera	2216(2.3)		1850				326(1.5)			
Ephemeridae							326(8.0)			
Megaloptera	148									
Hemiptera							326			
Insect (unid.)							326			
Hydracarina							326			
Teleosts			1850			4500				4191
Bryozoa							326			
Algae			1850							
Debris			1850		20,000	4500	2880			4891

ephemerids were consumed (Bailey and Harrison 1948). Seasonal and geographic variation in feeding habits may well reflect changes in relative food item abundance.

Ephemerid nymphs (*Hexagenia* sp.) and fishes were consistently important constituents of the diet of intermediate-sized catfishes from Kentuky Lake (Table 2). Bryozoa and algae compensated for a decreased utilization of *Hexagenia* sp. in Barkley Lake (Table 2). Algae were also the primary winter food of catfish in Parker Canyon Lake, Arizona (Otte 1975) and plant material importance increased with fish size in backwaters of the Lower Colorado River (Singer 1973). Algae and chironomids were important components of the autumn diet, while aquatic vascular plants were utilized in spring. The relative absence of *Hexagenia* and other insects in the Barkley Lake catfish diet reflects their greater availability in Kentucky Lake. Hoopes (1960) noted the seasonal importance of *Hexagenia* (and Trichoptera) in the diet of catfish from the Mississippi River. Crayfish, considered important to Kentucky Lake catfish in March, were unimportant to Barkley Lake catfish. Crayfish were not collected in benthic samples.Otte (1975) associated the consumption of crayfish by channel catfish to crayfish activity (availability); crayfish were a primary food source during warm (active) months (April - Oct.). The diet of intermediate catfishes in these two impoundments supports the proposition that the importance of insects, crustaceans, fishes, algae and debris in the diet of catfishes varies with geographic location and seasonal availability of these food items (Bailey and Harrison 1948; Dendy 1946; Lambou 1961; Miller 1966; Otte 1975; Singer 1973).

Harvestable (> 300 mm) fish displayed the omnivorous feeding habits typical of large catfish (Table 3). Piscivory increased relative to that of smaller fishes in agreement with findings of Ware (1966) and Dendy (1946). The importance of *Hexagenia* sp. and chironomids in the diet of large catfish was confined to September samples in Barkley

Table 2. Index of relative importance and forage ratios (in parentheses) of some food items consumed by channel (Ip) and Blue (If) catfish between 150 - 300 mm TL from Kentucky and Barkley Lakes.

Month	Sept.		Oct.		Nov.		Dec.		Mar.		Apr.	
Species	Ip	If	Ip	If	Ip	If	Ip	If	Ip	If	Ip	If
Food Item												
					Kentucky Lake							
No. fish w/ food	3	3	1	3	1	2	0	5	1	11	3	6
Copepoda	627											
Chaoborinae(L)	627(.71)											
Chaoborinae(P)		495(0.5)										
Chironomidae(L)	1155(3.0)									90(.64)		
Ephemeridae(N)		1353(2.7)		2838(4.5)					14900(6.4)	2196(3.1)	858(.36)	306(.24)
Cambarinae										5056		
Pelecypoda				462(4.0)								
Teleosts	2973	1518	20,000	5762				20,000	5100		17,400	15,106
Bryozoa						7000				81		
Algae		1089		462						81		
Debris	1254	4158			20,000	3000				224		
					Barkley Lake							
No. fish w/ food	1	0	4	1	1	0	2	2	8	1	6	1
Chaoborinae(P)				20,000(2.6)								
Chironomidae(L)	18,260(6.6)								813(.40)		422(5.5)	8300(25)
Chironomidae(P)			425(.38)									
Culicidae											1324	
Trichoptera	820(.66)											
Ephemeridae									92(.26)			
Coleoptera			425									
Megaloptera	820											
Formicidae			975									
Insect (unid.)			2000									
Cambarinae									92			
Pelecypoda									286(1.3)			
Teleosts					5600		15,600	20,000	12,496	20,000	277	11,700
Bryozoa			4350		14400		3600				307	
Algae							3600				4465	

Lake and October in Kentucky Lake; conversely mayflies are more important in the spring diet of smaller catfish. The significance of debris (rocks, sticks, sand, etc.) in the diet of bottom feeding fishes remains nebulous. Pelecypods (Sphaeridae and *Corbicula* sp.) occurred consistently only in the diet of harvestable Barkley Lake catfishes. *Corbicula* are very abundant in the main channel of Barkley Lake. Adams (1892) suggested that catfish are able to tear live clams from their shells, but they may instead scavenge on free-floating clam bodies resulting from cold water mortality (Sickel, pers. comm.). Large clam bodies were only found in stomachs during winter; small clams were usually recovered complete with the shell. One mammal, a deermouse, was recovered from the stomach of a harvestable channel catfish from Barkley Lake in December. Others have recovered rats (Dendy 1946), snakes, coots (*Fulica americana*) and mergansers (*Mergus* sp.) (Jester 1962) from catfish stomachs, as well as blue crabs (*Calinectes sapidus*) that are utilized extensively by catfishes in estuarine waters (Lambou 1961; Menzel 1945).

The omnivorous and opportunistic habits of catfishes from Kentucky and Barkley Lakes are typical of the ictalurids. Young of the year, intermediate and harvestable catfish consumed organisms from at least 16, 16, and 19 food item categories, respectively (Table 4). Channel catfish exploited more food item categories than did blue catfish in Barkley Lake; diversity of diet in Kentucky Lake was similar for both species. Blue catfish utilized more different types of food in Kentucky Lake than they did in Barkley Lake though the reverse was true of channel catfish. Channel catfish diet appeared more diverse (2-4X) with reduced relative abundance of blue catfish; food items of blue catfish were more diverse (equal to channel) when relative numbers were equal. Relative abundance data for these catfishes show a 1:1 ratio in Kentucky Lake and a 1 blue: 3 channel ratio in Barkley Lake (Rice and Johnson, pers. comm.). Further investigation of feeding interaction between these fishes is required to establish if blue catfish may be limiting diet diversity of channel catfish (50% less in Kentucky Lake). In Kentucky Lake, blue catfish diversity of diet increases proportionately with relative abundance which is 3X that in Barkley Lake.

Table 3. Index of relative importance and forage ratios (in parentheses) of some food items consumed by channel (Ip) and blue (If) catfish, greater than 300 mm TL from Kentucky and Barkley Lakes.

Month	Sept.		Oct.		Nov.		Dec.		Mar.		Apr.	
Species	Ip	If	Ip	If	Ip	If	Ip	If	Ip	If	Ip	If
Food Item												
					Kentucky Lake							
No. fish w/ food	5	4	3	3	4	34	2	54	12	20	26	32
Chironomidae(L)									88(.79)			
Tipulidae									93	11		
Trichoptera									32			
Ephemeridae		775(1.8)		3819(3.3)	450(1.3)	152(1.4)			7(0.5)	766(3.4)	72(.13)	24(.06)
Isopoda			2451						56			
Cambarinae			426			9			35		49	
Pelecypoda						208(4.2)						
Teleosts	8760	12,675	3886	9581		6206	20,000	20,000	15,100	11,875	17,980	17,980
Bryozoa						272						
Algae			1683		11,025	247			320		12	
Debris	2160				450	143						
					Barkley Lake							
No. fish w/ food	4	2	5	3	6	1	13	24	34	9	19	14
Chaoborinae(L)	30(.01)											
Chaoborinae(P)	38(.01)											
Chironomidae(L)	5400(.48)				891(1.7)				120(.19)			
Chironomidae(P)	1800(1.4)				306(1.1)							
Trichoptera	30(.67)	1240(4.7)										
Ephemeridae	110(.25)	1290(31.3)	408(4.0)					16(4.0)	1(0.4)			
Heptageniidae									1(0.4)			
Megaloptera	175											
Insect (unid.)		1650			153							
Cambarinae									2			
Pelecypoda	28			667(6.7)					213(1.6)	72(.55)		392(2.0)
Teleosts	1660	5800	5240	10,653	1155	20,000	11,109	18,806	15,675	19,350	11,692	12,183
Mammalia (*Peromyscus* sp.)							96					
Bryozoa	203		1960		2706		651				121	14
Algae							48				496	126
Debris			408	693	306							21

Table 4. Numbers of food item categories exploited by channel (Ip) and blue (If) catfish from Kentucky (K) and Barkley (B) Lakes, collected September 1977 through April 1978. (Sample sizes in parentheses).

Fish Size	*Species*	*Lake*		*Total number of categories exploited; both species, both lakes*
		K	*B*	
Young-of-the-year	Ip	5(5)	9(14)	16
	If	9(7)	3(6)	
Intermediate	Ip	7(9)	13(22)	16
	If	11(30)	3(5)	
Harvestable	Ip	11(54)	17(81)	19
	If	11(148)	8(53)	

The problems with correlating forage availability to catfish feeding habits have been catalogued above. The obscurity of these data may be rectified by concurrent analysis of fish and available forage from the same habitat (location). More discrete analysis is necessary in order to associate forage availabilty to catfish growth. Other biological and physico-chemical (pollution) factors are also being considered in approaching this problem.

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