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Source: *The American Midland Naturalist*, Vol. 94, No. 2 (Oct., 1975), pp. 284-295
Published by: The University of Notre Dame
Stable URL: https://www.jstor.org/stable/2424427
Accessed: 19-06-2019 20:28 UTC

Ecology, Foods and Feeding of the Longnose Shiner, Notropis longirostris (Hay), in Mississippi

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Abstract: *Notropis longirostris* (Hay), the longnose shiner, was studied in the Jourdan River system, Hancock and Pearl River counties, Mississippi, from May 1970 through May 1972. Occurrence of *N. longirostris* was significantly related to shore vegetation, bottom type, stream width, gradient and current. It was the most abundant species in stream sections characterized by large, open sandbars, clean, white, shifting sand bottoms, and a rapid fluctuation in flow rate and water depth. It occurred in the shallow areas along the edges of the sandbars where flow is low to moderate and the bank gradually slopes into the creek. *Ammocrypta beani* was most closely associated with *N. longirostris* although *Notropis venustus* was also commonly taken with the latter.

The dominant food items were dipteran larvae, emerging or newly emerged dipterans, and other aquatic insects. Changes in foods with season were noted. Larger fish consumed a greater variety of food items. There was marked periodicity in diel feeding activity in May 1971. Feeding was most intensive during morning and early afternoon hours.

Introduction

Notropis longirostris, the longnose shiner, is a common cyprinid in coastal drainages from eastern Louisiana to western Florida and southwestern Georgia (Hubbs and Walker, 1942; Caldwell, 1966; Moore, 1968). Ramsey (1965) also reported this species from the Altamaha River drainage along the eastern coast of Georgia. It occurs over clean, shifting sand bottoms in shallow areas with low to moderate flow and is often the most abundant species in the stream sections it inhabits.

The habitat and reproduction of *N. longirostris* were reported on by Hubbs and Walker (1942). Moore (1944), Bailey *et al.* (1954) and Cook (1959) considered the life history and ecology of the species; however, the information available is incomplete. This study was undertaken as part of a larger investigation into the life history and ecology of this cyprinid (Heins, 1972).

Study Area

Catahoula Creek (Fig. 1, stations 1-8), the main tributary of the Jourdan River drainage, originates in Pearl River Co., Miss., at an elevation ca. 71.6 m above mean sea level and flows S into W-central Hancock County. It is joined by Bayou Bacon to form the Jourdan River (Fig. 1, stations 9-12) which empties into St. Louis Bay. Stream gradients reach as high as 3.8-4.8 m/km in the headwaters and are less than 0.1 m/km in the lower sections of streams in the drainage.

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The mean annual temperature is about 20 C. Mean temperature in January is 13 C and in July, 28 C. Average annual precipitation in the area, about 154.2 cm, is one of the highest levels in the United

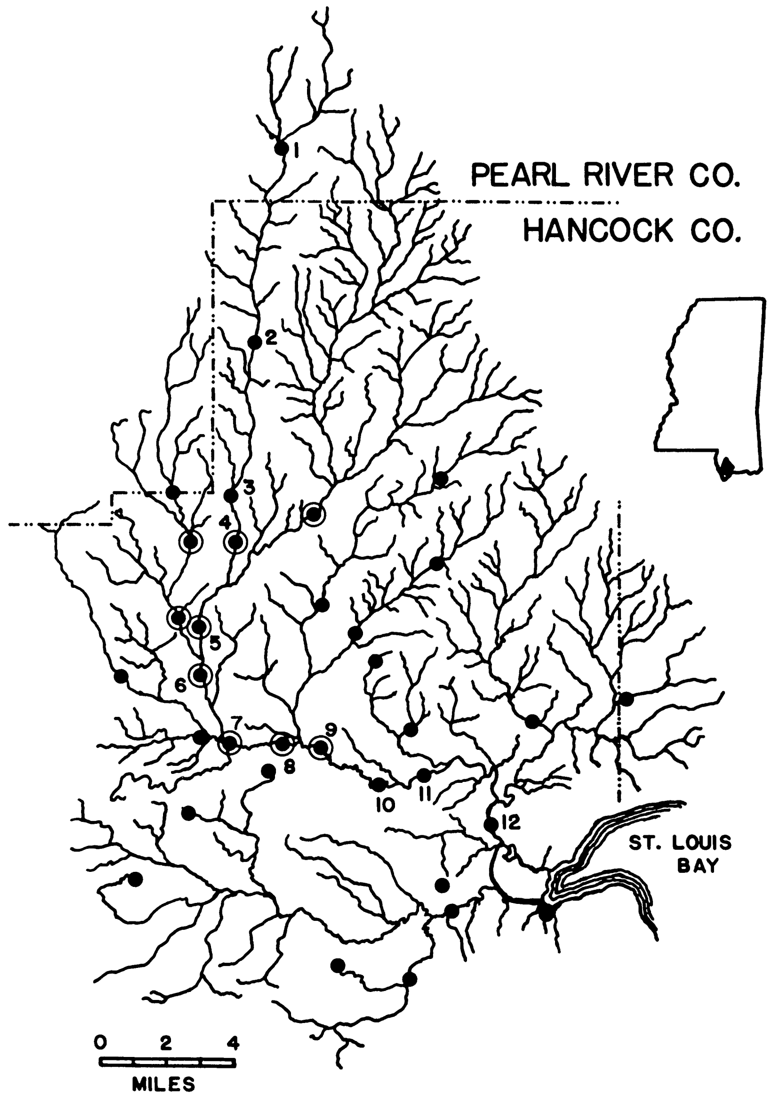

Fig. 1.—Map of the Jourdan River drainage system, showing collection localities (dots). Localities in Catahoula Creek and the Jourdan River are numbered and localities from which *N. longirostris* was taken are circled. The insert shows the location of the drainage system in southern Mississippi

States (Environmental Data Service, 1968). The average annual runoff of 50.8-76.2 cm is also relatively high (Miller *et al.*, 1963).

Following heavy rains, creeks in the drainage are subject to a rapid increase in flow rate and water depth but return to a more normal seasonal flow within a few days. Rapid flows through the area often produce major shifts in the sandy stream beds.

MATERIALS AND METHODS

A primary study area was located in Catahoula Creek and included the mouth of Dead Tiger Creek (Fig. 1, station 7). Specimens were taken from this area for the life history study. Day and night collections were taken monthly or bimonthly from May 1970 through May 1972. A 3-m-long, 4.8-mm-mesh seine was used throughout the period; and in addition, a 3.2-mm-mesh seine was used from May 1971 through May 1972. Collections were also taken from other locations throughout the Jourdan River drainage system to obtain distributional and ecological data. Fishes were preserved in 10% formalin and stored in 43% isopropyl alcohol. Specimens are deposited in the Mississippi State University Collection.

Physical characteristics of the stream including width, average depth seined, current, bottom type, bank slope, bank vegetation, gradient and temperature were noted for each collection. These data, along with information on species occurrence, were used in computing chi-square tests of independence, using two-way contingency analyses, to determine those factors significantly related to the presence or absence of *N. longirostris*. Although 103 collections were made within the drainage system, only one collection was made at about two-thirds of our localities. Multiple collections were made at other localities, with the majority from station 7. For this reason, only one collection from each station was used in the analysis of distribution to prevent biasing the results. For those localities where more than one collection was available, collections used were randomly selected. Distributional and ecological data from the other collections are in general agreement with those used in the analysis. Only data for those factors significantly related to occurrence are given.

Measurements of dissolved oxygen, free carbon dioxide, *p*H, alkalinity, and total hardness were made in the field at station 7 with a Hach Water Test Kit. Water samples taken from the primary study area were transported to the laboratory for measurement of color and turbidity. True color of water samples was determined with a Hellige Aqua Tester. Turbidity was measured in Jackson Turbidity Units with a Bausch and Lomb Spectronic 20 according to procedures outlined by Hach Chemical Company (1970).

Digestive tracts were removed from specimens taken in February, May, August and November 1971. Contents were removed from the first third of the tract, the esophagus to the first 180° turn, and examined under dissecting and compound microscopes. The amount of each food type was estimated as a percentage of the total volume.

Low numbers of small items such as diatoms or copepods were arbitrarily estimated at 0.5 or 1.0% depending on relative volumes. The food was then placed in a Wintrobe Hematocrit Tube with isopropyl alcohol and centrifuged before measuring total volume. Volume was determined for each food type by using total volume and estimated percent total volume. Due to maceration of the food, stomachs often contained large amounts of unidentifiable and digested material. Individuals containing more than 50% unidentifiable material or less than 2.0 mm^3 of food were excluded from analyses to minimize overestimation of food items not easily macerated or digested.

Diel feeding activity was determined by collections taken at intervals of about 4 hr on 30-31 May 1971. Digestive tracts were removed from 15 specimens in each collection, contents were analyzed, and total food volume was determined. Volumes were determined for a number of supplemental specimens with full stomachs to establish a relationship between standard length and maximum stomach fullness by regression analysis (Fig. 2). An estimate of percent maximum fullness was obtained when food volume was compared to the value for maximum fullness. Average percent maximum fullness was plotted for fish in each collection to determine feeding activity patterns.

Only specimens longer than 25 mm were used for seasonal and diel feeding analyses. However, specimens 15-24 mm long were exam-

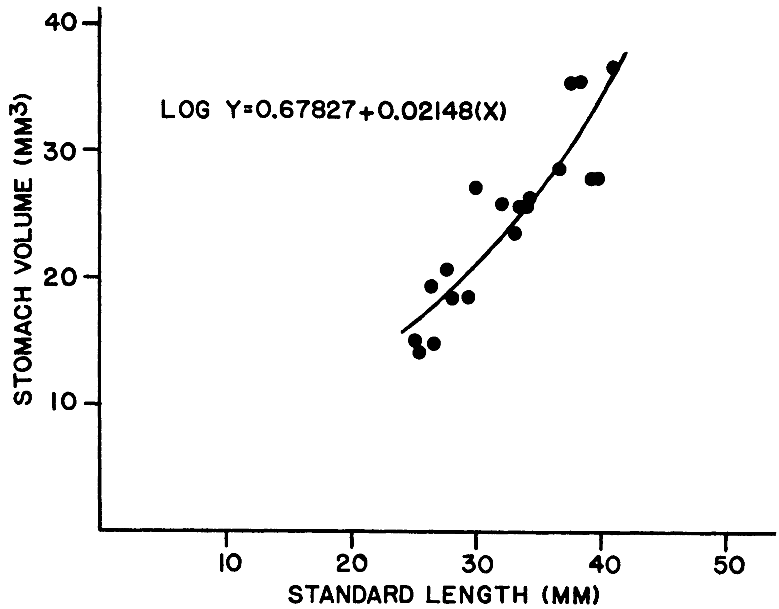

Fig. 2.—Relationship between maximum stomach fullness and standard length for *N. longirostris* collected in Catahoula Creek, Mississippi, 30-31 May 1971 ($r^2 = 0.81$)

ined from 7 and 30 May 1971 collections to determine the foods of smaller individuals.

RESULTS AND DISCUSSION

Habitat and distribution.—*N. longirostris* selects a relatively well-defined habitat. It was usually taken over clean, white, open sand bottoms to depths of about 0.6 m along the edges of open sandbars where flow was low to moderate and the bank gradually sloped into the creek. *N. longirostris* was most abundant along the lower ends of these sandbars where there is reduced flow and suspended detritus tends to settle out. Lack of a strongly swept bottom allows benthic invertebrates to inhabit those areas. Occasionally, *N. longirostris* was also taken in relatively large numbers in stream sections with wooded banks and sandy bottoms. Shoals were often exposed in these areas due to the low water at the time of collection. *N. longirostris* was taken from similar habitats throughout the drainage system (Fig. 1).

Of those factors tested, shore vegetation, bottom type, width, gradient and current were significantly related to the presence or absence of *N. longirostris* (Table 1). In the extreme areas of the distribution the open sandbars are reduced in size, whereas they often make up 50% or more of the total shoreline in intermediate stream sections. Above the areas of its distribution, the banks are commonly covered by wooded or brushy vegetation and are often steep. Below these areas they may also be composed of marsh grasses. Above the uppermost areas of distribution, bottoms change from clean, white sand, occasionally with some slight silt or gravel, to sand with gravel or mud and some vegetation. Below the lowest areas bottoms are of mud with some sand. The main channel also deepens considerably. A significant ($P < 0.05$) relationship between average depth seined and occurrence of *N. longirostris* was indicated only when collections were grouped into those taken at depths greater or less than 0.9 m. This may indicate a trend associated with the widening and deepening of stream courses in their lower sections. Stream widths at locations where *N. longirostris* was taken varied from ca. 6.1-30.5 m; gradient ranged from less than ca. 0.1 to 1.58 m/km and was usually 0.46-0.76 m/km. Current was moderate.

In Catahoula Creek, areas of continuously high gradients (> 1.35-1.46 m/km) occurred above the uppermost point of distribution. There was an isolated section of 1.73 m/km within the extremes of the distribution. Occurrence of *N. longirostris* in this and similar areas in the drainage system can only be inferred, assuming a continuous distribution.

Early sampling at station 7 indicated that *N. longirostris* did not occur in the mouth or immediate discharge of Dead Tiger Creek. Physicochemical measurements taken in Dead Tiger Creek and in Catahoula Creek are compared in Table 2. Oxygen levels were usually 8 ppm or more in Catahoula Creek. Free carbon dioxide was usually 7-14 ppm. Dissolved oxygen was significantly lower in Dead Tiger

TABLE 1.—Results of two-way contingency analyses of the presence or absence of *N. longirostris* in relation to shore vegetation, bottom type, width, gradient and current. Percent of total number of *N. longirostris* taken under each condition of the above environmental components is given in parentheses after the number of collections

	Shore vegetation				Bottom type		
	Wood	Brush	Sand-bar	Pasture or marsh grass	Sand, sand w/some silt or gravel	Sand, gravel & mud or clay	Mud
N. longirostris							
Present	4(42)	1(24)	4(34)	0(0)	8(94)	1(6)	0(0)
Absent	7	11	0	6	4	4	16
Chi-square				15.55			15.52
Probability				<0.005			<0.005

	Width (m)			Gradient (m/km)			Current		
	0-7.8	7.9-30.5	>30.5	0-0.38	0.39-1.14	1.15-3.8	None	Slow	Moderate
N. longirostris									
Present	2(23)	7(77)	0(0)	2(20)	5(58)	2(22)	0(0)	1(16)	8(84)
Absent	12	7	5	10	3	11	7	10	7
Chi-square			6.71			6.61			9.59
Probability			<0.05			<0.05			<0.01

Creek while free carbon dioxide was significantly higher. The *p*H in both creeks was slightly acidic; the water was soft and not well-buffered. Phenolphthalein alkalinity was always zero. Methyl orange alkalinity and hardness were never greater than 34 ppm. Water in Catahoula Creek was usually light brown and clear; in Dead Tiger Creek it was dark brown and clear. Turbidity was significantly greater in Catahoula Creek; color was significantly less. The low levels of dissolved oxygen, high levels of CO_2, presence of steep, wooded and brush covered banks are major differences thought to be important in determining local distribution.

Species associates.—*Notropis longirostris* was the most abundant species in the primary study area (particularly characterized by large, open sandbars) as it often was in similar areas. In 1 year (February 1971-March 1972) 5513 specimens were taken from station 7. *Notropis venustus,* the second most abundant species (4599 specimens), was most commonly taken with *N. longirostris* at station 7. However, *Ammocrypta beani,* the third most abundant species (1326 specimens), was most closely associated with *N. longirostris.* Both were taken from the same habitat over the open sand bottoms. *A. beani* was occasionally taken in low numbers at station 3, but was otherwise restricted to the same distribution as *N. longirostris.* Analysis of joint

TABLE 2.—Means and ranges of physicochemical measurements taken in the primary study area, Catahoula Creek, Mississippi, February 1971-February 1972. Numbers in parentheses indicate the number of observations on the mean if different from the number of samples listed. Tests of significant differences between means are two-tailed tests of t values at $(n_1\text{-}1) + (n_2\text{-}1)$ df, * = significant at the .05 level, ** = significant at the .01 level, ns = no significant difference

Station	Number of samples	Dissolved oxygen (ppm)	CO_2 (ppm)	*p*H	Methyl orange alkalinity (mg/1)
Catahoula Creek	13	9.0**	10.4**	6.0^{ns}	$22.8(11)^{ns}$
		7-10	5-20	5.0-7.0	10-34
Dead Tiger Creek	7	3.7**	25.7**	5.4^{ns}	23.2^{ns}
		2-5	15-30	4.0-6.0	10-34

TABLE 2.—(continued)

Station	Total hardness (mg/1)	Color units	Turbidity units	Water temp (°C)
Catahoula Creek	$21.1(12)^{ns}$	71.7(9)**	55.5(10)*	21.2^{ns}
	17-34	22-140	25-100	14-29
Dead Tiger Creek	18.3^{ns}	192.9**	34.3*	21.7^{ns}
	17-25	130-240	24-45	13-25

occurrence of *N. longirostris* with *N. venustus* and *A. beani* for collections taken throughout the drainage (Table 3) indicates a significant positive association with these two species. Bailey *et al.* (1954) noted a common association between *N. longirostris, A. beani* and *Ericymba buccata.* Hubbs and Walker (1942) also noted the common association between *N. longirostris* and *E. buccata.* The latter was not taken from the drainage system. Other species taken in the primary study area were not commonly taken or closely associated with *N. longirostris* due to low abundance or preference for other habitats. These species are as follows (number of specimens in parentheses): Lepisosteidae, *Lepisosteus oculatus* (1); Anguillidae, *Anguilla rostrata* (1); Esocidae, *Esox niger* (15), *E. americanus* (8); Cyprinidae, *Notropis texanus* (707), *Opsopoeodus emiliae* (70), *Hybopsis winchelli* (20), *Notropis roseipinnis* (16), *N. welaka* (13), *Notemigonus crysoleucas* (7); Catostomidae, *Moxostoma poecilurum* (44), *Erimyzon tenuis* (24), *Hypentelium nigricans* (1); Ictaluridae, *Noturus leptacanthus* (25), *N. miurus* (5), *Ictalurus punctatus* (1); Aphredoderidae, *Aphredoderus sayanus* (53); Cyprinodontidae, *Fundulus olivaceus* (313), *F. notti* (2), *F. chrysotus* (1); Poeciliidae, *Gambusia affinis* (610); Atherinidae, *Labidesthes sicculus* (299); Centrarchidae, *Lepomis megalotis* (387), *L. macrochirus* (165), *Micropterus punctulatus* (162), *M. salmoides* (19), *Chaenobryttus gulosus* (12), *Lepomis cyanellus* (12), *Ambloplites ariommus* (4), *Centrarchus macropterus* (2), *Lepomis humilis* (1), *L. marginatus* (1); Percidae, *Percina nigrofasciata* (544), *Etheostoma stigmaeum* (13), *E. histrio* (3), *E. swaini* (2), *E. fusiforme* (1); Gobiidae, *Gobionellus shufeldti* (13); Soleidae, *Trinectes maculatus* (13).

Change of food with season and fish size.—*N. longirostris* primarily ate dipteran larvae, emerging or newly emerged dipterans, and other aquatic insects (Table 4). Generally dipterans were present in large volumes, but in August there was a noticeable decrease in the amount of dipterans and an increase in the volume of other aquatic insects. Tendipedids made up most of the dipteran larvae in May, August and November. Dolichopid larvae, present only in February, made up somewhat more of the total volume of dipteran larvae than tendipedid larvae. Ceratopogonid larvae were occasionally present in small numbers. Seeds of various sedges (family Cyperaceae) were present in

TABLE 3.—Results of 2X2 contingency analyses of joint occurrence of *N. longirostris* with *N. venustus* and *A. beani.* Neither collection containing *A. beani* at station 3 was selected for inclusion in the analysis

	Notropis venustus		*Ammocrypta beani*	
	Present	Absent	Present	Absent
N. longirostris				
Present	9	0	7	2
Absent	5	19	0	24
Chi-square		16.80		23.69
Probability		<0.005		<0.005

May and were major food items of larger fish in August. Other food items generally occurred in smaller volumes but may have occurred relatively often. The only terrestrial insects consumed were ants. Crustaceans used as food items were primarily copepods but also included cladocerans and an occasional ostracod. Microscopic plants included diatoms, desmids, filamentous algae and aquatic fungi. Diatoms were present in large volumes in all months except November when filamentous algae made up the greatest volume of the microscopic plants. Sand occurred frequently, though in small amounts, and indicated bottom feeding habits for *N. longirostris*. Individuals observed in laboratory aquaria were seen to dig or jab at the bottom in search of food. Miscellaneous items occurring infrequently in small amounts included trichopterans, nematodes and egg cases. Unidentified material primarily included macerated and digested foods along with detritus. Detritus was noted in a few stomachs, but positive identification could not be made after digestion had begun.

Change in foods with size of fish was primarily marked by an increased variety of food items. Small fish (15-24 mm) fed almost exclusively on dipteran larvae (primarily tendipedids) and emerging or newly emerged dipterans (Table 5). Crustaceans and microscopic plants were relatively frequent food items but only made up a small portion of the total volume. Fish in the two larger groups (25-34 mm and 35-44 mm) also fed heavily on dipteran larvae but less so on emerging dipterans. Various other aquatic insects were ingested in addition to the dipterans. Besides ephemeropterans, which were not

TABLE 4.—Percent total volume (%T.V.) and percent frequency of occurrence (%F.O.) of food items in stomachs of *N. longirostris* collected seasonally from Catahoula Creek, Mississippi, during 1971

	Month							
Food	February (n=12)		May (n=28)		August (n=15)		November (n=13)	
item	%T.V.	%F.O.	%T.V.	%F.O.	%T.V.	%F.O.	%T.V.	%F.O.
Dipteran larvae	15.7	91.7	34.9	89.3	7.3	80.0	25.8	92.3
Emerging or newly emerged dipterans	17.3	33.3	10.6	35.7	4.0	13.3	23.3	76.9
Coleoptera	6.3	16.7	4.5	10.7	4.7	13.3	0.4	7.7
Ephemeroptera	7.9	16.7	2.5	10.7	....	....	....	....
Odonata	....	....	2.4	10.7	....	....	....	....
Unidentified insects	16.7	75.0	5.5	32.1	34.9	73.3	3.1	7.7
Terrestrial insects	5.3	33.3	....	....	....	....	....	....
Crustacea	0.6	33.3	0.4	35.7	0.4	26.7	5.3	76.9
Microscopic plants	0.4	41.7	0.3	35.7	0.9	26.7	9.3	76.9
Cyperaceae	....	....	9.4	14.3	22.1	33.3	....	....
Sand	1.1	41.7	2.0	89.3	2.3	53.3	3.5	84.6
Miscellaneous	0.7	8.3	0.1	3.6	0.1	6.7	0.4	7.7
Unidentified	28.1	91.7	27.5	92.9	23.4	73.3	28.9	100.0

found in stomachs of smaller fish, some fish in the largest group ingested relatively large seeds of various sedges.

Selection of a particular food item is dependent on properties of both the feeding animals and the food organisms (Ivlev, 1961). Food selection was not included in this study; however, examination of bottom samples taken in May indicated that the most abundant food organisms (dipteran larvae) were those primarily eaten by *N. longirostris*. Therefore, availability may have been important in the change of foods with season. Size is probably an important factor in the change of foods among growing individuals. Larger individuals were probably better able to use larger and, in most cases, harder food items. This is a general phenomenon noted for many fishes (Hynes, 1970).

Diel feeding activity.—Stomachs examined from collections taken 30-31 May 1971 indicated marked periodicity in feeding activity of *N. longirostris* (Fig. 3). Average percent maximum volume decreased from 32% at 1615 hr to 1% at 0330 hr. An increase to 12% maximum stomach volume in the 0800 hr sample indicated feeding had begun earlier in the morning. Feeding rapidly increased throughout the rest of the morning and early afternoon until maximum volume averaged 47% at about 1300 hr. Empty stomachs were found primarily in the 2400 and 0330 hr collections and were most numerous in the 0330 collection.

The adaptive aspects of specific life history characteristics of *N. longirostris* will be considered in a later paper on reproduction, age and growth.

Acknowledgments.—We thank Jim Bennett and Doug Minchew for their help in the field. Ben Gabriel, Jerry Clonts, Dr. Sidney McDaniel and Dr. Howard Chambers assisted with identification of food organisms. We also thank

TABLE 5.—Percent total volume (%T.V.) and percent frequency of occurrence (%F.O.) of food items in stomachs of different size groups of *N. longirostris* collected from Catahoula Creek, Mississippi, May 1971

Food item	Size group 15-24 mm (n=10) %T.V.	%F.O.	25-34 mm (n=12) %T.V.	%F.O.	35-44 mm (n=16) %T.V.	%F.O.
Dipteran larvae	58.7	100.0	40.3	91.7	30.8	87.5
Emerging or newly emerged dipterans	23.1	90.0	12.7	33.3	9.4	43.8
Coleoptera	....	....	4.6	16.7	4.4	6.3
Ephemeroptera	....	....	....	....	3.7	12.5
Odonata	....	....	1.1	16.7	3.3	6.3
Unidentified insects	0.3	10.0	7.4	50.0	4.1	18.8
Crustacea	0.8	50.0	0.4	41.7	0.4	31.3
Microscopic plants	0.3	40.0	0.4	41.7	0.2	31.3
Cyperaceae	....	....	....	....	15.6	25.0
Sand	1.2	60.0	2.5	91.7	1.7	87.5
Miscellaneous	0.9	20.0	0.2	8.3	....	....
Unidentified	14.9	100.0	30.3	100.0	26.5	87.5

Gerri Heins for her assistance with field sampling and laboratory analyses. Dr. Gerald Gunning reviewed the manuscript and offered helpful comments. Dr. William Dunlap helped with statistical analyses. This study was supported by NASA Grant No. NGL 25001-0040 to the junior author.

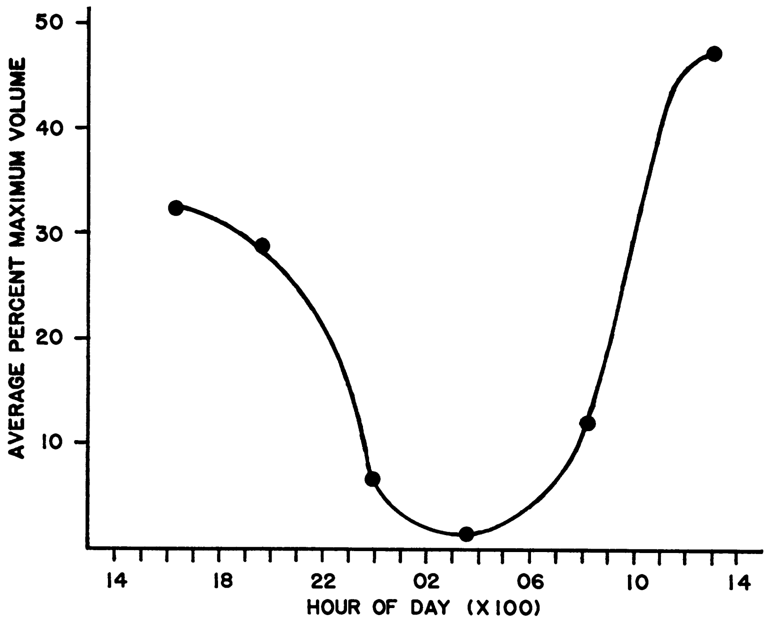

Fig. 3.—Average percent maximum stomach fullness for *N. longirostris* collected periodically in Catahoula Creek, Mississippi, 30-31 May 1971. All samples included 15 fish except the 2400 hr sample which included 13

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SUBMITTED 21 MARCH 1974 ACCEPTED 15 JULY 1974