1971

Nutrition Studies of the Brindled Madtom, Noturus miurus Jordan, Based on Stomach Content Analysis

Randall Stephen Madding
Eastern Illinois University

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NUTRITION STUDIES OF THE BRINDLED MADTOM, NOTURUS MIURUS JORDAN, BASED ON STOMACH CONTENT ANALYSIS

(TITLE)

BY

Randall Stephen Madding

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

Master of Science

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

1971
YEAR

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NUTRITION STUDIES OF THE BRINDLED MADTOM, *NOTURUS MIURUS* JORDAN, BASED ON STOMACH CONTENT ANALYSIS

BY

RANDALL STEPHEN MADDING

B. S. in Ed., Eastern Illinois University, 1966

ABSTRACT OF A THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Science at the Graduate School
of Eastern Illinois University

CHARLESTON, ILLINOIS

1971

ABSTRACT

Brindled madtoms and small channel catfish (140 mm or less) were examined to determine their food habits and the possibility of competition for food organisms between the two species when collected from the same area.

Two hundred twenty-three brindled madtoms were collected from Polecat Creek (study area I) 3 miles southwest of Ashmore, Coles County, Illinois. The study in Polecat Creek was conducted from July 10, 1967 to June 5, 1968, collections being made approximately every month. Two hundred forty-five brindled madtoms and 140 channel catfish were collected from the Embarras River (study area II) 2 miles south of Charleston, Coles County, Illinois. Madtoms and small channel catfish were collected from the Embarras River during the months of July through October, 1970.

All specimens used in the study were collected by seining at night. Madtoms were easier to collect at this time and food organisms had undergone little digestion, which aided in their identification. Specimens collected by day seining either had empty stomachs or food organisms were in an advanced state of digestion, making identification difficult.

Chironomidae larvae were the most important food item of madtoms in both study areas. Chironomidae pupae, Trichoptera larvae, and Ephemeroptera nymphs, along with Chironomidae larvae make up the major portion of the food of brindled

madtoms. Seasonal variations in items eaten appeared to coincide with the availability of the particular organisms.

Chironomidae larvae and pupae, and Trichoptera larvae were the most common organisms eaten by small channel catfish. The important food items of brindled madtoms from study area II were nearly identical to those fed on by small channel catfish. This competition for food could possibly limit the populations of both species when found in the same habitat.

During the study it was discovered that brindled madtoms could be collected by pouring the contents of tin cans found in the water into a small net. Several madtoms were collected in this manner. Fifty tin cans were randomly placed in study area I. These were checked weekly during the summer of 1970. Each time one to 3 madtoms were collected from the 50 tin cans. Tin cans make up a minor artificial habitat for the brindled madtom.

ACKNOWLEDGMENTS

I would like to thank my advisor, Dr. Leonard Durham, whose guidance and criticism were essential in the preparation of this thesis.

I am grateful to Ron DeHollander, George Hubert, Mike Sliva, Bob Platt, Steve Platt, John Dion, Dale Fruendt, Randy Cooley, and Mike Carter who assisted in the collecting.

Thanks are extended to Drs. Riegel and Goodrich who aided in the identification of insect fragments during analysis of stomach contents.

Thanks to Drs. Peterka, Goodrich, and Riegel for their critical review of this paper.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The brindled madtom, Noturus miurus Jordan, is a freshwater fish ranging in size from 23 - 97 mm total length. Because of its size, it must provide a food source for larger fish, and, as such, must be an important link in food chains in ecosystems such as Polecat Creek and the Embarras River where it is easily found. The purpose of this study is to define at least one more link in this food chain by attempting to determine the nutritional habits of the brindled madtom by analysis of its stomach contents.

A survey of the literature shows that the life history of the brindled madtom is well documented (Andrews, 1963). However, little information is available on the food habits of this fish.

Although the major portion of this paper concerns itself with the food habits of the brindled madtom, notes on the food habits of small channel catfish Ictalurus punctatus (Rafinesque), are included since the possibility of competition between the two is suspected.

MATERIALS AND METHODS

I. AREAS OF STUDY

Polecat Creek (study area I) is located 3 miles southwest of Ashmore, Illinois (Coles County, N. E. ¼ of Sect. 10, T. 12N.-R10E.). The study area is approximately 200 yards long, extending east from the iron bridge to a sharp north bend in the creek. The creek is bordered to the north by a hilly wooded area, and to the south by rolling farmland.

The creek fluctuates greatly in size. In the spring it consists of pools 18-20 feet wide and average 12 inches in depth. Each pool is connected by narrow shallow riffles. In the fall the pools are 10-12 feet wide and average 6 inches in depth.

Most of the pools and riffles have sand and gravel bottoms. In some parts the creek flows over bedrock outcroppings, and there are large sandstone rocks in these areas. The creek is generally free of debris except in the fall when leaf litter accumulates in the pools. Siltation is very light, and the water is usually very clear.

Embarras River (study area II) is located 2 miles south of Charleston, Illinois (Coles County, N. E. ¼ of Sect. 25, T. 12N.-R. 9E). The study area is approximately 200 yards long, extending west from an old concrete bridge to a large deep pool. The river is bordered on both sides by a narrow strip of large trees.

The river fluctuates greatly in size. In the spring the pools are 60 feet wide and average 3 feet in depth. In the fall the pools are 50 feet wide and average 1½ feet in depth. Most of the pools and riffles have sand and gravel bottoms. There are many large rocks and boulders throughout the study area. The river is turbid most of the year due to heavy siltation from surrounding farmland.

II. COLLECTING METHODS

Fish were collected by seining, electroshocking, rotenone application, and by examining tin cans found in the water. Because the stomach contents of the fish collected during the daylight hours were always in an advanced state of digestion and often unidentifiable, fish used in food analysis were collected at night.

Seining was successful through shallow pools above and below riffles. The fish used in this study were selected at random, and many were released to avoid depleting the madtom population. Those selected were preserved in 10 percent formalin.

Because madtoms were observed in empty cans in the water, fifty tin beer cans were randomly placed throughout study area I. These cans were checked weekly during the summer of 1970, by pouring their contents into a small net.

In study area II, 140 small channel catfish of approximately the same size as madtoms were collected and preserved in 10 percent formalin. Their stomach contents were examined to determine if competition for food occurred with the brindled madtom.

III. STOMACH ANALYSIS

The stomachs were removed from the specimens and placed in small dissecting bowls. The stomachs were then cut open and the contents were flushed out and examined under a binocular microscope. Because of the size of the food items and the varying states of digestion, only the frequency of occurrence for recording material identified could be used with any degree of accuracy.

Stomach contents were analyzed separately for each collection date.

Identification of food organisms was made using the following texts and keys: Fresh-water Invertebrates of the United States by Robert Pennak (1953), An Introduction to the Study of Insects by Donald Borror and Dwight Delong (1963), and Fresh-water Biology by W. T. Edmondson (1963).

RESULTS

I. HABITAT

Brindled madtoms were usually found in shallow pools adjacent to riffle areas with a current velocity of one foot per second or less. The bottom was usually covered with sand, gravel, and large fist-sized rocks. Madtoms generally were found hidden under debris and rocks during the day. On November 1, 1967, 9 madtoms were observed swimming in or near a mat of loosely packed leaves in Pole-cat Creek. Madtoms were collected from the Embarras River in tin cans whose contents were poured into a small net.

On August 8, 1966, several fish were collected from tin cans and one clam shell. One male, 2 females, and 26 eggs were found in one can. One female with 13 young were found inside a dead clam shell. Two females were found in one can 2 feet away from a can containing a freckled madtom, Noturus nocturnus Jordan and Gilbert. All fish collected on this day were in 12-18 inches of water with a sand and gravel bottom.

II. COLLECTING RESULTS

Night seining was the most successful method of collecting specimens. On October 31, 1966, between 7:00 and 8:00 P. M., 12 seine hauls were made in the Polecat Creek collecting 66 madtoms. Other attempts were made between 11:00 and 12:00 P. M. and 3:30 and 4:30 A. M. with similar degrees of success. On November 6, 1966, between 7:30 and 8:30 P. M. 129 madtoms were collected in the Embarras River in 7 seine hauls. The following evening 150 madtoms were collected in 6 seine hauls between 8:00 and 9:00 P. M.

Each time the 50 tin beer cans were examined, one to three madtoms were collected.

III. STOMACH ANALYSIS

Four hundred sixty-eight madtoms and 140 channel catfish were collected by night seining. The types of food eaten, seasonal changes in feeding habits, and differences in food preferences between small and large madtoms were noted.

Organic material was listed in tables when food items were too well digested to be identified. Inorganic debris consisted of small pieces of sand found in the stomachs of several fish.

Most madtoms were less than 75 with an average of 48 mm.

Chironomidae larvae were the most important food item of madtoms in both study areas. Chironomidae pupae, Trichoptera larvae, and Ephemeroptera nymphs, along with Chironomidae larvae made up the major portion of the food of brindled madtoms (Tables 1, 2, and 3).

During February and March madtoms fed mainly on Chironomidae larvae. Chironomidae larvae accounted for 100 percent of food material in three collections made during these months. Throughout the year, Chironomidae larvae occurred in at least 70 percent of the madtom stomachs (Table 2).

New organisms were added to the diet as they became available in the spring. Chironomidae pupae became more abundant from March to October. Trichoptera larvae were more numerous from July to November. Ephemeroptera nymphs were very common food items from July to November (Table 2).

Four fish (23-27mm) contained one or 2 Trichoptera larvae (10-12mm) that completely filled their stomachs.

Channel catfish ranged in size from 35-140 mm total length. Most were less than 90 mm with an average length of 57 mm.

Chironomidae larvae and pupae, and Trichoptera larvae were the most common organisms eaten by channel catfish (Table 4).

Table 1. Stomach Contents of Brindled Madtoms in Polecat Creek and Embarras River by Frequency of Occurrence. (Figures in parenthesis represent numbers of stomachs containing item.)

Classification	Polecat Creek Oct. 31, 1966 50 specimens percent	Embarras River Nov. 6, 1966 50 specimens percent
Chironomidae larvae	96.0 (48)	68.0 (34)
Chironomidae pupae	12.0 (6)	
Simuliidae larvae		36.0 (18)
Ephemeroptera nymphs	30.0 (15)	4.0 (2)
Copepoda	68.0 (34)	18.0 (9)
Cladocera	14.0 (7)	10.0 (5)
Amphipoda	10.0 (5)	
Trichoptera larvae	26.0 (13)	10.0 (5)
Trichoptera pupae	2.0 (1)	2.0 (1)
Lepidoptera larvae	4.0 (2)	2.0 (1)
Odonata nymph	2.0 (1)	
Coleoptera adult	2.0 (1)	
Homoptera adult	2.0 (1)	
Neuroptera larva	2.0 (1)	
Collembola	6.0 (3)	
Hemiptera adult		2.0 (1)
Gastropoda	2.0 (1)	
Nematoda	4.0 (2)	2.0 (1)
Arachnida	4.0 (2)	
Cyprinidae	2.0 (1)	
Algae	6.0 (3)	20.0 (10)
Inorganic debris	14.0 (7)	20.0 (10)
Stomach empty	2.0 (1)	18.0 (9)

Table 2. Stomach Contents of Brindled Madtoms in Polecat Creek by Frequency of Occurrence. (Figures in parentheses represent numbers of stomachs containing item.)

Classification	July 10, 1967 20 specimens percent	August 7, 1967 20 specimens percent	September 8, 1967 20 specimens percent
Chironomidae larvae	95.0 (19)	85.0 (17)	75.0 (15)
Chironomidae pupae	85.0 (17)	40.0 (8)	65.0 (13)
Simuliidae larva	5.0 (1)		
Trichoptera larvae	20.0 (4)	15.0 (3)	15.0 (3)
Ephemeroptera nymphs	60.0 (12)	70.0 (14)	35.0 (7)
Cyprinidae	5.0 (1)		
Fish scale	5.0 (1)		
Decapoda	5.0 (1)		
Coleoptera adults	5.0 (1)	5.0 (1)	
Amphipoda	10.0 (2)		
Amphibian larva	5.0 (1)		
Ceratopogonidae larvae		5.0 (1)	5.0 (1)
Tipulidae larva		5.0 (1)	
Algae	15.0 (3)		
Inorganic debris	70.0 (14)	65.0 (13)	55.0 (11)
Stomach empty	5.0 (1)	5.0 (1)	10.0 (2)

Table 2. (continued)

Classification	October 1, 1967 20 specimens percent	November 7, 1967 20 specimens percent	December, 1967* ---
Chironomidae larvae	70.0 (14)	70.0 (14)	
Chironomidae pupae	30.0 (6)		
Simuliidae larva	5.0 (1)		
Trichoptera larvae	10.0 (2)		
Ephemeroptera nymphs	45.0 (9)	10.0 (2)	
Ceratopogonidae larvae	15.0 (3)	15.0 (3)	
Nematomorpha	5.0 (1)		
Copepoda		5.0 (1)	
Amphipoda		5.0 (1)	
Arachnida		5.0 (1)	
Alga	5.0 (1)		
Organic material		5.0 (1)	
Inorganic debris	55.0 (11)	60.0 (12)	
Stomachs empty	10.0 (2)	10.0 (2)	

* No collection due to high water.

Table 2. (continued)

Classification	January, 1968* ---	February 4, 1968 8 specimens percent	March 5, 1968 5 specimens percent
Chironomidae larvae		100.0 (8)	100.0 (5)
Simuliidae larvae		12.5 (1)	
Annelida		12.5 (1)	
Alga			20.0 (1)
Inorganic debris			20.0 (1)

* No collection due to creek being frozen.

Table 2. (continued)

Classification	March 30, 1968 20 specimens percent	May 1, 1968 20 specimens percent	June 5, 1968 20 specimens percent
Chironomidae larvae	100.0 (20)	100.0 (20)	90.0 (18)
Chironomidae pupae	100.0 (20)	85.0 (17)	30.0 (6)
Simuliidae larvae	10.0 (2)	15.0 (3)	10.0 (2)
Trichoptera larva		5.0 (1)	
Ephemeroptera nymphs	5.0 (1)	30.0 (6)	5.0 (1)
Lepidoptera larva	5.0 (1)		
Plecoptera nymphs		15.0 (3)	
Nematoda		10.0 (2)	10.0 (2)
Collembola		5.0 (1)	
Decapoda			5.0 (1)
Amphipoda			5.0 (1)
Algae	10.0 (2)		5.0 (1)
Inorganic debris	80.0 (16)	70.0 (14)	80.0 (16)
Stomach empty			5.0 (1)

Table 3. Stomach Contents of Brindled Madtoms in Embarras River by Frequency of Occurrence. (Figures in parenthesis represent numbers of stomachs containing items.)

Classification	July 19, 1970 24 specimens percent	July 26, 1970 34 specimens percent	August 3, 1970 24 specimens percent
Chironomidae larvae	45.8 (11)	94.1 (32)	75.0 (18)
Chironomidae pupae	12.5 (3)	58.8 (20)	37.5 (9)
Trichoptera larvae	45.8 (11)	61.8 (21)	50.0 (12)
Trichoptera adults			12.5 (3)
Ephemeroptera nymphs		8.8 (3)	4.2 (1)
Ceratopogonidae larva		2.9 (1)	
Decapoda		2.9 (1)	4.2 (1)
Fish scale		2.9 (1)	4.2 (1)
Alga			4.2 (1)
Organic material		8.8 (3)	4.2 (1)
Inorganic debris	41.7 (10)	29.4 (10)	41.7 (10)
Stomachs empty	37.5 (9)		

Table 3. (continued)

Classification	August 27, 1970 43 specimens percent	September 20, 1970 30 specimens percent	October 22, 1970 40 specimens percent
Chironomidae larvae	90.7 (39)	86.7 (26)	77.5 (31)
Chironomidae pupae	25.6 (11)		2.5 (1)
Trichoptera larvae	60.5 (26)	53.3 (16)	42.5 (17)
Ephemeroptera nymphs	20.9 (9)	3.3 (1)	7.5 (3)
Simuliidae larvae			5.0 (2)
Corixidae adults	11.6 (5)		
Ostracoda	2.3 (1)		
Organic material	4.7 (2)		5.0 (2)
Inorganic debris	32.6 (14)	43.3 (13)	42.5 (17)
Stomachs empty	2.3 (1)	10.0 (3)	10.0 (4)

Table 4. Stomach Contents of Channel Catfish in the Embarras River by Frequency of Occurrence. (Figures in parenthesis represent numbers of stomachs containing item.)

Classification	July 19, 1970 44 specimens percent	July 26, 1970 49 specimens percent	August 3, 1970 25 specimens percent
Chironomidae larvae	86.4 (38)	75.5 (37)	96.0 (24)
Chironomidae pupae	34.1 (15)	24.5 (12)	24.0 (6)
Simuliidae larva	2.3 (1)		
Trichoptera larvae	86.4 (38)	93.9 (46)	88.0 (22)
Ephemeroptera nymphs	6.8 (3)		8.0 (2)
Decapoda		2.0 (1)	
Nematoda			4.0 (1)
Organic material	2.3 (1)	10.2 (5)	4.0 (1)
Inorganic debris	11.4 (5)	6.1 (3)	
Stomachs empty	4.5 (2)		

Table 4. (continued)

Classification	August 27, 1970 21 specimens percent	September 20, 1970 16 specimens percent	October 22, 1970 5 specimens percent
Chironomidae larvae	90.5 (19)	93.8 (15)	100.0 (5)
Chironomidae pupae	42.9 (9)		
Trichoptera larvae	95.2 (20)	56.3 (9)	60.0 (3)
Trichoptera adults	14.3 (3)		
Ephemeroptera nymphs	9.5 (2)		

Table 5. Summary of Stomach Contents of Brindled Madtoms in Polecat Creek, and Brindled Madtoms and Channel Catfish in Embarras River by Frequency of Occurrence (Tables 1, 2, 3, and 4). (Figures in parenthesis represent numbers of stomachs containing item.)

Classification	Brindled madtom Polecat Creek 223 specimens 1966 and 1967-68 percent	Brindled madtom Embarras River 245 specimens 1966 and 1970 percent	Channel catfish Embarras River 140 specimens 1970 percent
Chironomidae larvae	88.8 (198)	78.0 (191)	98.6 (138)
Trichoptera larvae	11.7 (26)	44.1 (108)	98.6 (138)
Chironomidae pupae	41.7 (93)	18.0 (44)	30.0 (42)
Ephemeroptera nymphs	30.0 (67)	7.8 (19)	5.0 (7)
Copepoda	15.7 (35)	3.7 (9)	
Simuliidae larvae	4.5 (10)	8.2 (20)	0.7 (1)
Algae	4.9 (11)	4.5 (11)	
Cladocera	3.1 (7)	2.0 (5)	
Amphipoda	4.0 (9)		
Ceratopogonidae larvae	4.0 (9)		
Nematoda	2.7 (6)	0.4 (1)	0.7 (1)
Trichoptera adults		1.2 (3)	2.1 (3)
Corixidae adults		2.0 (5)	
Decopoda	0.4 (1)	0.8 (2)	0.7 (1)
Collembola	1.8 (4)		
Arachnida	1.3 (3)		
Fish scale	0.4 (1)	0.8 (2)	
Coleoptera adults	1.3 (3)		
Plecoptera nymphs	1.3 (3)		
Trichoptera pupae	0.4 (1)	0.4 (1)	
Cyprinidae	0.9 (2)		
Lepidoptera larva	0.4 (1)		
Odonata nymph	0.4 (1)		
Homoptera adult	0.4 (1)		
Hemiptera adult		0.4 (1)	

Table 5. (continued)

Classification	Brindled madtom Polecat Creek 223 specimens 1966 and 1967-68 percent		Brindled madtom Embarras River 245 specimens 1966 and 1970 percent		Channel catfish Embarras River 140 specimens 1970 percent	
Neuroptera larva	0.4	(1)				
Gastropoda	0.4	(1)				
Amphibian larva	0.4	(1)				
Tipulidae larva	0.4	(1)				
Nematomorpha	0.4	(1)				
Annelida	0.4	(1)	0.4	(1)		
Ostracoda						
Organic material	0.4	(1)	3.3	(8)	5.0	(7)
Inorganic debris	51.6	(115)	34.2	(84)	5.7	(8)
Stomach empty	4.5	(10)	10.6	(26)	1.4	(2)

DISCUSSION

Forbes and Richardson (1920) mention that habitat of Noturus flavus Rafinesque closely resembles that of the brindled madtom, being separated mainly by their distribution. At this time they had little information on the habitat of the freckled madtom. Andrews (1963) later collected freckled madtoms in habitats very similar to that preferred by the brindled madtom and considers them to be ecological equivalents.

Chironomidae larvae are the most important food item of madtoms collected. Andrews (1963) found Ephemeroptera nymphs to be the main food of brindled madtoms. Diptera and Trichoptera larvae were also important food organisms.

Although very small madtoms (20 mm or less) probably feed on plankton, they quickly grow large enough to feed on organisms eaten by adults. Small madtoms (23-27 mm) ate items of surprisingly large size.

The main factors influencing items eaten by madtoms appears to be the size and their availability.

Bowman (1932) found the marginal madtom, Rabida insignis (Richardson), to be nocturnal in its food habits. This is also probably true of the brindled madtom judging from the number of empty stomachs or the advanced state of digestion of food items from fish collected during the day. Specimens collected at night often had full stomachs and most food organisms were entire.

Chironomidae larvae were the most common food items

eaten by small channel catfish from study area II. Turner (1966) examined 203 channel catfish less than 200 mm, and found their main food to be an amphipod. Chironomidae larvae and mysid shrimp were also eaten, but were of much lesser importance.

Andrews collected young-of-the-year channel and flathead catfish along with freckled madtoms. He indicated the possibility of competition for food between these small catfish that could live in areas where madtoms occurred in abundance.

It was found that important food items of brindled madtoms were nearly identical to those fed on by small channel catfish. This competition for food would likely limit the number of both fish in an area where both occurred.

Inorganic debris found in madtom stomachs was possibly due to their feeding habits. Sand was accidently taken in while ingesting their food which is usually found in or near riffle areas where sand is abundant. The major portion of their food consists of benthic organisms. Some sand could possibly be taken in as the madtoms eat Trichoptera larvae with cases constructed of sand.

Tin cans that had been dumped or thrown into the Embarras River were picked up and their contents poured into a small net. Several madtoms were collected in this manner. Tin cans placed in study area I were also examined and found to contain madtoms. They possibly hide in the cans during the day or use the cans to raise and protect their young from predators. Tin cans make up a minor artificial habitat for the brindled madtom

and possibly for other species of madtoms and catfish.

SUMMARY

Chironomidae larvae and pupae, Trichoptera larvae, and Ephemeroptera nymphs were the most common food items of brindled madtoms. Chironomidae larvae were important food organisms for madtoms in Polecat Creek throughout the year. Chironomidae larvae and pupae, and Trichoptera larvae were the most common organisms eaten by channel catfish. The most important food items of madtoms was nearly identical to those fed on by small channel catfish. This competition for food would likely limit the number of both species when found together, unless the population of food organisms was large enough to support both fish populations.

The brindled madtom appears to be nocturnal since they were easier to collect at night. Stomachs of specimens collected at night were often full of undigested organisms.

Tin cans play a minor role as an artificial habitat for the brindled madtom.

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