THE FOOD OF THE GOLDEN SHINER,

Notemigonus crysoleucas (Mitchill)

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By

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Bachelor of Science

Oklahoma Agricultural and Mechanical College

Stillwater, Oklahoma

1947

Submitted to the Department of Zoology

Oklahoma Agricultural and Mechanical College

In Partial Fulfillment of the Requirements

for the Degree of

MASTER OF SCIENCE

1949

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ACKNOWLEDGEMENT

The writer wishes to express his appreciation to Dr. W. H. Irwin, Professor of Zoology of Oklahoma Agricultural and Mechanical College, for encouragements and criticisms during this work and to Victor Graham, Superintendent of Holdenville State Fish Hatchery, for the young of the year.

INTRODUCTION

The objective of this study was to learn the types of food consumed and the proportional amounts required by the golden shiner, Notemigonus crysoleucas (Mitchill).

Recently increasing interest has been shown by icthyologists and fish culturists in the food requirements of our minnows. The interest is due to a demand for minnows to serve as forage for game fish in hatcheries and for commercial bait. Increased fishing in Oklahoma due to more impoundments has created an additional demand for bait minnows. Many dealers have started minnow propagation in private waters and others are considering the enterprise.

Notemigonus crysoleucas inhabits most waters of the state from clear cool streams to extremely turbid water of farm ponds. A size suitable for bait can be obtained in the summer of the first year, Aldrich (1946). The fish is resistant to many kinds of parasitic infestations, and in the southwest it has a long spawning season extending from April into August. The eggs are deposited on rooted aquatic plants, sticks, and other organic debris, making spawning possible in almost any type of habitat in Oklahoma, Aldrich (1946). Because of the foregoing statements it appears to be a good prospect for a commercial bait minnow.

Collections of the golden shiner from both large and small impoundments which varied from clear to turbid water were made at intervals during 1947. One hundred specimens were collected, examined, and the results recorded.

The writer has found no article in the literature dealing specifically with the food of the golden shiner in the southwest, and only

fragmentary reports for other regions. Forbes (1878), according to Kraatz (1928), summarized the food studies of Illinois minnows and reported them "full of dirt with fragments of indigenous vegetation, confervoid algae and many diatoms". Dobie, Meehean, and Washburn (1948) reported that the golden shiner young in general feed upon "algae and entomostracans, while the adults have been known to feed on young fishes, insects, plankton, crustaceans, protozoans, algae, diatoms, and mollusks". Pearse (1918) gives the following figures based on the examination of 59 fish. From lakes near Madison, Wisconsin: Insect larvae (4.9 per cent), adult insects (2.2 per cent), insect pupae (5.7 per cent), entomostracans (76.1 per cent), amphipods (2.2 per cent), mites (0.4 per cent), rotifer and protozoans (1.0 per cent), algae (1.5 per cent), other plant material (3.1 per cent).

METHOD

The golden shiners were collected, during varying hours from dawn to twilight, by short small-meshed seines. Immediately after collection, these were preserved in 10 per cent formalin and kept for further analysis.

Records were made of the specimens as to the date of collection, place, time of day, collector, and total length in millimeters. Apparent condition of the fish were recorded as fat, average, or thin. Water conditions were noted as clear, turbid, warm, or cool. Each specimen was weighed in grams by means of a chainomatic torsion balance. Age was determined by removing scales from the sides below the dorsal fin and the annuli counted under a 16 mm objective. Gonads were removed and placed under a 16 mm lens to determine the sex.

One incision was made from the anus forward to the isthmus and another dorsad from the first incision, thus allowing the body wall to be folded away from the abdominal cavity and the digestive tract removed. The contents of the alimentry tract were removed by squeezing and scraping them onto a previously weighed cover slip. The food and cover slip were placed on a chainomatic torsian balance and weighed in grams. From 1 to 30 cc of water, depending upon the amount of food, was placed in a bottle and thoroughly agitated. Identification and enumeration were executed by means of a specially constructed counting cell completely filled with the sample material over which a cover slip was inserted. The special counting cell was constructed to permit the use of a 4 mm objective and a 10x ocular for identification and to provide a depth of liquid sufficiently shallow that a 16 mm lens inserted for counting would clearly show all organisms from top to bottom of the cell without refocusing. Ten ocular units were selected at random and the conversions were made as in standard methods of plankton analysis, Whipple (1927).

Individual cell counts were used for all types of algae while animals were enumerated as single units. If several fragments of Cladocerans or Copepods were present, representing different structures, they were counted as one organism. No attempt was made to compensate for the difference in size between plant and animal food. The estimated percentage was based upon the number of individuals, (Table 1).

FOOD ANALYSIS

The food of these fishes was principally plankton or the same organisms acting as periphyton. The average number of organisms eaten by an individual fish was 180,550 of which 7,969 were animals and 172,281 were

plant units. Plant individuals were consumed in large numbers (95.5 per cent) while the animal individuals comprised the remainder (4.5 per cent). Most of the animal food were Copepods (32.5 per cent), Cladecera (27.5 per cent), and miscellaneous (26.1 per cent). Those of lesser numbers were found to be Rotifera (7.9 per cent), Insecta (3.5 per cent), Ostracoda (2.0 per cent), and Protozoans (0.5 per cent), (Table 1).

TABLE 1 AVERAGE ALIMENTARY CONTENT OF 100 GOLDEN SHINERS

	Animal Food	Average Number of Organisms per fish
Protozoans	.5%	34
Ostracoda	2.0%	158
Insecta	3.5%	278
Cladecera	27.5%	2186
Copepoda	32.5%	2591
Rotifera	7.9%	637
Miscellaneous[1]	26.1%	2085
Algae		172,581

[1]includes eggs of all types, trematodes, amphipods, and other organic remains.

Thirty species of algae were identified, ten were filamentous and twenty non-filamentous forms. Only nine species of animal organisms were identified, four being Cladocerans, three Protozoans, and two insect larvae. Species of questionable identity were not listed. (Table 2)

TABLE 2 GENERA OF FOOD ORGANISMS OF 100 GOLDEN SHINERS

FILAMENTOUS	NON-FILAMENTOUS		PROTOZOA	CLADOCERA
Spirogyra	Cosmarium	Staurastrum	Diffugia	Bosmina
Anabaena	Pleodorina	Navicula	Euglena	Chydorus
Mougeotia	Closterium	Microcystis	Phacus	Pleuroxus
Bumilleria	Characium	Volvox		Daphnia
Oedgonium	Marsoniella	Ceratium		
Rhizoclonium	Pediastrum	Glenodinium		

TABLE 2 GENERA OF FOOD ORGANISMS OF 100 GOLDEN SHINERS
CONTINUED

FILAMENTOUS	NON-FILAMENTOUS		PROTOZOA	CLADOCERA
Ulothrix	Characiopsis	Gonyaulax		INSECT LARVAE
Nostoc	Coelosphaerium	Cocystis		
Zygnema	Pondorina	Peridinium		Eristalis
Lyngbya	Merismopedia	Onychonema		Chironomus

Plant and animal food organisms are available and utilized by golden shiners during various months as follows: Diatoms and Desmids were present during all seasons; filamentous algae were absent during February; filamentous fungus were predominate during June: Cladecerans were extremely abundant during February; Rotifers were consumed in large number during May but scarcely taken throughout other months. Animal food was predominate only during February and May. (Table 3)

TABLE 3 ABUNDANCE OF ORGANISMS DURING MONTHLY FEEDING

Month of Collection	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct
Plant Food Consumed	A	S	A	A	A	A	A	A	A	A
Animal Food Consumed	S	A	C	S	A	S	C	C	S	S

A——abundant
C——common or average
S——scarce

From 100 specimens examined, 16, mostly obtained during February and March, lacked food in the alimentry tract. Considering this the food weight was 1.6 per cent of the body weight. The food content in percentage varied with the season of the year and the size of the specimen. During July the proportion of food to total body weight made up 4.8 per cent compared to February with 0.9 per cent (only those specimens with food in the alimentry tract were considered). (Table 4)

TABLE 4. NUMBER OF FULL AND EMPTY STOMACHS, LENGTH, AND FOOD WEIGHT IN COMPARISON TO BODY WEIGHT OF 100 GOLDEN SHINERS

Month of Collection	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct
Mean Total Length in MM	47	107	105	87	38	52	68	88	95	112
Range of Total Length in MM	47	70 to 128	51 to 124	60 to 136	27 to 70	32 to 78	61 to 78	75 to 103	85 to 105	75 to 153
Number of Fish with Food	1	9	3	14	9	18	8	9	8	5
Number of Fish without Food	0	6	5	2	0	1	0	1	1	0
Food wt. in Comparison to Body Weight	1.5%	0.9%	1.4%	1.9%	1.2%	2.9%	4.8%	2.7%	2.7%	1.8%

No apparent difference was noted between the food of the males and females or to the type of organism consumed in relationship to age.

DISCUSSION

The fish examined in this study fed almost entirely upon plankton. These organisms may have been free floating or attached to the substratum as periphyton. Since some purely bottom dwelling forms such as Ostracods were found it seems likely that these minnows did obtain a portion of their food from the bottom. Golden shiners apparently require such a large number of food organisms that they feed by mouthing and scraping the exterior of sticks, stones, aquatic plants, and other organic debris to obtain large quantities at a time. Periphyton is probably one of their most abundant food sources.

Breathing movements at times have been associated with the consumption of food but of the few specimens examined 1/6 lacked food in the alimentry tract, because of this the writer assumed that feeding was deliberate.

The proportion of organisms in the diet varied somewhat with the season indicating that the golden shiner consumes foods as they become available by increased abundance. A large number of Rotifera were found in the alimentry tract during May and were very scarce throughout the other months. Filamentous fungus was taken in specimens only during June. These two examples offer evidence that they take advantage of food abundances as found during "blooms".

Certain seasons of the year seem to have a direct correlation between food weight and body weight. June, July, August, and September were the months in which large amounts were eaten, and the period in which the ratio of food to body weight was at its peak. During the summer months algal blooms are more abundant and probably provide an increased food supply.

Undoubtedly more species of organisms were eaten than could be found or identified in the alimentry tract. The non-loricate rotifers, non-shelled protozoa, etc., were probably eaten as food but because of their thin body membranes disintegrated quickly in the digestive juices. Evidence of the action of the digestive juices was definitely noticed on the filamentous algae since Spirogyra was often still green showing identification characteristics plainly, while in other specimens only the cell walls were present with the chlorophyll and other soft parts faded or absent. The number of animals found was probably incorrect since fragments were at times counted as entire units. This method did supply data concerning the number of individuals but the weight method surely is more accurate in the measurement of food consumed.

The specimens examined in this study fed upon small plants and animals and only seldom were the larvae of insects eaten. Dobie, Meehean,

and Washburn (1948) reported other large particles such as young fish and large amounts of insects. In support of these writers golden shiners are occasionally caught by fishermen on flies, worms, and other assorted baits but these caught are usually much larger sized specimens than those examined in this study.

The prospects of raising golden shiners as bait minnows in Oklahoma are promising. Plant or animal organisms are generally available in pond saters or can be produced in large numbers. Notemigonus crysoleucas will consume almost any type of food that is of small enough size to be ingested. "Blooms" arising during different seasons enable the fish to substain themselves under normal conditions and numbers. When heavy population in encouraged, fertilization of the water causes an increase in "blooms" (Dobie, Meehean, and Washburn, 1948).

SUMMARY

1. In this paper are presented the results of an investigation of the food of 100 golden shiners.
2. Notemigonus crysoleucas may be well considered as belonging to the plankton and periphyton eating group of minnows. It is probably both a top and bottom feeder consuming plant and animal organisms along with small amounts of organic remains.
3. Animal food was proportionately less abundant than plant food.
4. The food weight in proportion to the body weight was 1.6 per cent in spite of the fact that 1/6 were without food in the alimentry tract.
5. Thirty species of algae and nine species of animal organisms were identified from the food contents.
6. As the food can be obtained in almost any type of water the golden shiner meets the requirements of a forage and bait minnow.

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