AN EXPLORATORY ATTEMPT TO REAR LARGEMOUTH BLACK BASS FINGERLINGS IN A CONTROLLED ENVIRONMENT

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ABSTRACT

An experiment on the rearing of largemouth black bass fingerlings in troughs is described. Negative results were obtained in inducing ½, and ¾-inch fry to feed on a diet of ground fish. Sizes of 1½, 2 and 3-inch fish accepted this form of food after a training period of 3-5 days.

Bass fingerlings were successfully reared from a size of 1½ inches to one of 3 inches on a diet of ground fish over a period of 116 days. Growth was slow, but the average weight of the fish increased from 417 milligrams at the start of the period to one of 4.2 grams at the end, a tenfold increase. Mortality was high for the first four weeks of the feeding period but later was reduced to an insignificant level as the fish learned to feed and diseases were controlled.

Although the number of fish reared was small, the experiment indicates that this species can be reared under artificial conditions. Rearing techniques employed would have to be improved considerably to make the procedure economically feasible.

INTRODUCTION

The possibility of rearing the largemouth black bass, *Micropterus salmoides,* Raf., on artificial food in a controlled environment has intrigued bass culturists for many years. While many fish culturists have attempted to rear largemouth bass on artificial food in tanks, troughs or ponds, only token success has been reported. Undoubtedly many other attempts resulted in negative results which went unreported.

Hayford (1927) described feeding small bass on a prepared diet artificially produced that was composed principally of *Daphnia magna.* After the fish reached a size of two inches, chopped sheep hearts were substituted. Langlois (1931) fed both large and smallmouth black bass in ponds. Daphnia were supplied for four weeks initially, followed with fresh, finely ground goldfish. Food was supplied at the water inlet. As soon as the bass were taking fresh fish readily, the diet was changed to frozen fish. Langlois found that frozen goldfish, suckers and herring were satisfactory food but canned carp and the salt-water species were unsatisfactory.

Little is known about the nutritional requirements of small bass. Turner and Kraatz (1920) made an excellent study of the food habits of small bass collected from natural waters. Marcus (1932) studied the effect of temperature on the rate of digestion of 4.5-9.0 inch largemouth black bass, and Sarbahi (1951) investigated the enzymes in the digestive tract of this species.

Thompson (1941) gave data on the rate of food conversion of largemouth bass using live minnows as a diet. Later, Prather (1951) conducted a study on the efficiency of largemouth bass in converting minnows to bass flesh. Except for a few other scattered and fragmentary reports, this covers the work that has been reported to date on nutrition of our most important fresh water game fish. Considering the paucity of information on the subject, it is understandable that trial and error experimentation has thus far failed to develop a workable technique of rearing the species on artificial food.

Where largemouth black bass are stocked in a favorable environment, fingerlings of small size give adequate survival to produce a balanced fish population (Smith and Swingle, 1943). Growth is rapid under these conditions, being much better than it would be under optimum hatchery conditions. Since this is the case there appears to be no beneficial results from rearing bass to be stocked in new

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or renovated farm ponds to a size larger than 1-1½ inches in the hatchery. However, with the development of management practices for the correction of unbalanced established fish populations, a bass considerably larger than 1½ inches is sometimes needed. If larger bass were available, much of an existing fish population could be utilized instead of being eliminated for a replacement stocking. It would appear then that practical methods for producing large bass fingerlings of a size of 4-8 inches would allow the fish culturist to supply management biologists with another tool for improving fishing in waters where crowded forage fish populations occur.

EXPERIMENTAL PROCEDURE

An experiment was conducted at the Marion, Alabama National Fish Hatchery to explore the practicability of rearing largemouth black bass on artificial food in troughs and in holding tanks. Eight aluminum troughs 14 inches wide, 8 inches deep and 8 feet long were employed for the experiment along with several concrete fish holding tanks which were 8 feet long, 2 feet wide and 20 inches deep. Water was supplied from a well, being pumped into a reservoir and moving from there by gravity to the troughs. The flow per trough was from 1-2 gallons per minute. Water temperatures ranged from 75-82° F. in the rearing units.

Small bass of ½, ¾, 1½, 2 and 3-inch sizes were transferred from spawning-rearing ponds to the rearing troughs for experimental feeding. Prior to introduction in the troughs the fish were graded to a relatively uniform size. A count and a total weight of the fish stocked was obtained. Feeding efforts were commenced on the day following stocking the fish. Finely ground liver was used initially as the diet, but proved to be unsatisfactory as the small bass could not be induced to feed up on it. Ground bluegill and goldfish were then tried and proved to be acceptable to the bass. Preparation consisted of removing scales, head and viscera of the fish and then griding the remainder to a fine consistency with a household food chopper. At feeding enough water was mixed with the meat to make a thick paste. It was then introduced into the water near the small bass with a wooden paddle. Some fish began to feed by the second day food was offered. Initially the small fish were fed six times daily at two-hour intervals during daylight hours. Later, as they increased in size, the number of feedings per day was reduced to four.

Each experimental lot of fish was counted and weighed periodically to determine survival and gain. Mortality was recorded daily. Suspected or diagnosed diseases were treated by use of a 2 p.p.m. pyridylmercuric acetate treatment for one hour, formalin at a rate of 1:4,000 for one-half hour or potassium permanganate at a rate of 10 p.p.m. for 30-60 minutes.

Most mortality was caused by cannibalism, disease, disease treatments or starvation. A significant number of fish in all of the experimental lots failed to learn to take the artificial food. These fish would succumb to disease, to the disease-prevention treatments, or to apparent starvation after 2-3 weeks. Symptoms of nutritional deficiencies were observed in several individuals with the most common one being a deformed vertebral column which shaped the fish in a rough facsimile of a flat "S" curve.

Some of the fish remaining at the termination of the experiment were grouped together in a concrete holding tank and fed for about eighteen months on two other types of feeds. The first was a commercial meat type trout food which was used for about a year. The fish were then fed a pelleted form of the dry meal mixture of the Cortland No. 6 formulation. With only routine care, this lot of fish survived and made slow growth. Several specimens that were transferred to a larger concrete holding pool grew to a size of 0.5-1.0 pound the following year. These fish learned to take ¼-inch pellets readily and maintained themselves for several months in good condition on a pellet diet.

After a technique of feeding the small bass had been established, some data were secured on food conversion, with several experimental lots being fed a measured amount of food. When growth ceased because of crowding, the lots were graded and divided into new lots for further feeding and observation.

RESULTS OF THE EXPERIMENT

The results obtained from eleven of the lots are given in Table I. The length of the feeding periods varied from 13 to 63 days. Eight of the eleven lots of fish showed an increase in weight during the experiment. Considering the amount of mortality which took place, this fact indicates that substantial growth took place among the survivors. The rate of food conversion was calculated, although again the high rate of mortality obscures the degree to which the healthy feeding fish made use of the food supplied. A conversion of about 10:1 is indicated for these experimental conditions based on the results obtained in Lots 1-B, 1-C, 1-D, 2-B and 2-C. No adjustment was made for the loss in lot weight caused by the death of the individual fish and the dead fish were not weighed.

TABLE I

RESULTS OF FEEDING LARGEMOUTH BLACK BASS FINGERLINGS A DIET OF GROUND FISH

Lot No.	*Days Fed*	*No. in Lot*	*% Mortality*	*Daily Gain in Wt. as % of Starting Wt.**	*Food Conversion*
1-A	14	499	23.0	2.5	Not determined
1-B	48	317	63.7	2.4	10.6
1-C	28	240	3.8	1.5	10.0
1-D	14	231	0.4	0.7	10.9
2-A	14	498	37.6	–2.5	Not determined
2-B	63	386	5.7	3.7	6.0 **
2-C	42	241	7.1	1.0	13.4
5	63	531	50.5	0.4	20.9 †
6	13	202	51.5	–2.5	Not determined‡
7	47	604	63.2	–0.2	Not determined
8	47	576	59.7	0.06	193.3

* Obtained by dividing net gain by the initial weight, multiplying the result by 100 and dividing by number of days in feeding period.

** Only determined for last six days in feeding period.

† First 21 days of period not included.

‡ During one 14-day feeding period when mortality was 20.2 precent this lot showed a gain of 1.6 percent of their starting weight and a food conversion of 12.2.

Table II shows the detailed record of mortality, growth and food utilization for a group of 1,000 fish that was started on May 8 as 1¾-inch fingerlings numbering 1,100 per pound. This is the approximate size at which the fish would change from a zooplankton diet to one of insects and fish according to Turner and Kraatz (*op. cit.*). After a period of adjustment to the changed environmental conditions, the lot made appreciable growth increases until the experiment was terminated 116 days later. Mortality was high for the first four weeks but decreased to an insignificant level after the fish learned to feed.

TABLE II

FEEDING SURVIVAL AND GROWTH OF 1000 FISH * FED A DIET OF GROUND FISH

Date Weighed	5/8	5/22	6/4	6/19	7/2	7/17	7/23	8/6	8/20	9/3
Number of Fish	997	703	500	492	485	482	481	476	468	454
Total Wt. (gms.)	416	414	608	785	1009	1164	1250	1470	1734	1907
Avg. Wt. Per Fish (gms.)	0.417	0.589	1.216	1.594	2.080	2.414	2.599	3.088	3.705	4.200
Mortality (No.) Since Previous Weighing	...	293	203	8	7	3	1	5	8	14
Cumulative % Mortality	...	29.4	49.8	50.6	51.3	51.6	51.7	52.2	53.0	54.4
Gain in Wt. (gms.)	...	–2	194	178	224	155	86	120	264	173
% Wt. Gain (from Previous Weighing)	...	...	46.9	29.3	28.5	15.4	7.4	9.6	18.0	10.0
Daily % Wt. Gain	...	...	3.6	2.0	2.2	1.0	1.2	0.7	1.3	0.7
Food Supplied (gms.)	...	...	...	...	...	...	600	2062	2141	2071
Food Conversion	...	...	...	...	...	...	7.0	17.2	8.1	12.0

* Consolidated data for lots 1A and 2A which were started on 5/8, combined on 5/22 for grading into more evenly sized lots 1B and 2B. The latter groups were combined and graded again on 7/23 into lots 1C and 2C.

Losses from cannibalism were surprisingly low. A small number of bass were consumed by cannibals, but since the number of fish in each lot was low, the cannibals could be detected and were removed as soon as noted. The fact that the fish were graded initially and were regraded in some cases undoubtedly reduced the cannibalistic tendencies of the experimental fish. After the bass learned to take the food supplied, they made no effort to prey on their neighbors.

Feeding bass fry of a size of ½-inch was unsuccessful. Three lots were included but could not be induced to take either ground fish or fish roe. Success of feeding ¾-inch fry was not much better. A loss of more than 90 percent occurred over a three-week period in two lots of 500 fish each of this size. Roe from the female fish being ground for food was the only material that this size could be induced to take with any degree of success during the early part of the feeding period. However, the survivors later learned to take ground fish. One lot of 3-inch bass was included. These fish were more cannibalistic than the smaller sizes but with the exception of the worst cannibals, learned to eat the prepared food. There was more evidence of nutritional deficiency in this lot than in the smaller fish studied.

Lots 1-C and 2-C were held in the holding tanks instead of a rearing trough. More space was available per fish but the growth rate here was about the same as that in the troughs. The water temperature was several degrees colder and probably neutralized the influence of increasing the space per fish. Space did seem to be an important factor in the well-being of the bass however. After an initial period of rapid growth within a lot, the rate of growth would decrease along with the food intake. It was observed that regrading and dividing the fish in the trough would result in a temporary increase in the food intake that would be followed by an increase in growth.

Under the conditions of this experiment, bass 1½ inches in length adjusted to an artificial environment more readily than did ½-inch, ¾-inch or 3-inch fish. After an acclimation period where losses were high, mortality remained at an insignificant level for periods of up to seven weeks provided that disease was controlled. Control of disease was not always obtained with the methods employed in this experiment, but is not an insurmountable obstacle with modern disease control techniques.

The rate of growth observed in troughs and tanks was much lower than that normally obtained in ponds. Appreciable and sustained growth was demonstrated by several of the experimental lots however. Lot 2-B showed a daily gain of 5 percent for one 14-day feeding period, while most of the other lots showed an average daily gain of from 1-2½ percent. The fish started on May 8 as 1½-inch fingerlings averaged about 3 inches in length by September 3, although a few of the fastest growing individuals were approaching 4 inches in size.

Data on food utilization were not obtained initially since only a feeding technique was being developed. However, during the latter part of the experiment, it was possible to measure the effectiveness of ground fish in producing bass flesh. Food conversion values for a one- or two-week feeding period, ranged from a low of 6.0 in lot 2-B for a six-day period, to 19.1 in Lot 2-C for a 13-day period. Where higher values were obtained, mortality appeared to be the influencing factor. A conversion of 10 seemed most typical for the fish diet under these conditions.

The feeding rate for this experiment varied from 8 to 14 percent of the body weight of the lot per day. Since the fish would not eat any appreciable quantity of food that was not moving, some of the food supplied was uneaten. Also in this preliminary study, efforts were aimed at inducing as many fish to live and grow as possible so over-feeding was normally practiced. Probably the conversion obtained here could be greatly improved with use of improved feeding techniques.

It appears from this study that the rearing of largemouth black bass under controlled conditions on an artificial diet is feasible. Considerable improvement would be required in the rearing facilities, feeds and cultural techniques before such a practice would be economical, but it does not appear to be an impossible undertaking.

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ESTIMATED SIZES OF VARIOUS FORAGE FISHES CHAIN PICKEREL CAN SWALLOW

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The chain pickerel, *Esox niger,* has been reported to be a voracious feeder on other fish. In the evaluation of fish populations, it is necessary to know the sizes of various forage fishes that piscivorous fishes can swallow. Without such information, it is impossible to determine accurately such population values as I_F, S_F and the Y/C ratio. This paper presents, in tabular form, a preliminary estimate of the sizes of gizzard shad, *Dorosoma cepedianum,* bluegills, *Lepomis macrochirus,* golden shiner, *Notemigonus crysoleucas,* and green sunfish, *Lepomis cyanellus,* that various sizes of chain pickerel can swallow.

The basic steps underlying such a tabulated estimate of sizes of forage fish a given piscivorous species can swallow were given by Lawrence.* The length-depth relationships of bluegills, golden shiners, and green sunfish from that publication, and additional calculations on the body depth-total length relationships of gizzard shad are included in this report. The equations for the body depth-length relationship of gizzard shad are as follows:

Total Length Interval, MM.	*Equation*
55-99	$L = 31.0 + 2.381\ D$
100-199	$L = 15.2 + 3.351\ D$
200-299	$L = 81.9 + 2.452\ D$
300-399	$L = 147.3 + 1.869\ D$

Exactly how the chain pickerel catches and orients its prey for swallowing is unknown, but the anatomical structures limiting the size of prey a given chain pickerel can swallow have been investigated. This fish does not possess the semirigid pair of cleithrum bones surrounding the anterior portion of the esophagus as do the Centrachid basses. Rather, there is a series of slim, pliable

* Lawrence, J. M., Estimated sizes of various forage fishes largemouth bass can swallow. Proc. S. E. Assoc. Game and Fish Comm., 11:220-225. 1957.