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INSTITUTE FOR FISHERIES RESEARCH
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Report 269

EXPERIMENTAL FEEDING OF BASS FRY (*MICROPTERUS DOLOMIEU*) TO BLUNTNOSE MINNOWS
(*HYBORHYNCHUS NOTATUS*) AND TO GOLDEN SHINERS (*NOTEMIGONUS CRYSOLEUCAS*
AURATUS).

Bluntnose Minnows and Golden Shiners are used to some extent in hatchery ponds as bass food. One method is to put the adult minnows in the bass-rearing ponds early in the spring. Bass fry are taken from the fry traps, a few days after rising from the nest, and put in the rearing ponds containing the forage minnows. Both of these minnows have a long spawning season throughout the summer, and the continual source of minnow fry offers good forage for the young bass. The experience of several fish-culturists in using Golden Shiners in bass ponds has definitely indicated that this minnow will eat bass fry. It has been assumed that the Bluntnose Minnow (and likewise the Fathead Minnow, *Pimephales p. promelas*) will not eat the young bass. The following experiments have been carried on to obtain further information on the predatory relationships between these forage minnows and bass fry. The experiments were conducted in the Experimental Aquarium of the Institute for Fisheries Research, at the University of Michigan in the spring of 1934. The bass fry were obtained from the hatchery at Northville, Michigan, by the courtesy of E. R. Widmyer. The minnows were obtained from the Huron River at Ypsilanti.

Bluntnose Minnows

EXPERIMENT NO. 1.—May 21, 1934. Twenty-nine Bluntnose Minnows, 48 to 75 mm. in standard length, $2 \frac{3}{8}$ to $3 \frac{7}{16}$ inches in total length, were obtained on May 19. These fish were kept in a 10-gallon aquarium until May 21, during which time they were fed daily a cooked mixture of bran, shrimp and oatmeal. On May 21, 97 bass fry were obtained from the Northville hatchery. These fry had risen from the nest one or two days prior to the 21st and were still in the fry trap. These fry were 8 millimeters

long and were still lightly pigmented; their yolk sac was only partially absorbed, having a diameter slightly larger than the diameter of the head of the fry. The following feeding experiment was carried on from 9:30 P.M. to 10:30 P.M. on May 21. The water temperature in the aquarium was 20°C. Prior to this experiment the aquarium room had been dark for over one hour and, when the lights were turned on, the Bluntnose Minnows were found lying quite inactive at the bottom of the aquarium. A light hung about 6" directly over this aquarium during the experiment. Bass fry were introduced into the aquarium in groups of two or three. As these fry swam slowly toward the bottom, the minnows darted upward to eat them, rarely missing their prey. The minnows, swimming actively near the bottom, often darted up as much as 8 inches for the fry. 39 fry in small lots, were fed to the minnows over the course of 45 minutes. Finally the 58 remaining fry were dumped into the aquarium and they all disappeared within 5 minutes. The smaller minnows appeared to eat the fry as readily as did the larger minnows.

EXPERIMENT No. 2.—May 26, 1934. The 29 Bluntnose Minnows, used in the first experiment, were kept in the same aquarium until May 26. During this interval they were fed daily with the bran, shrimp and oatmeal preparation. This daily feeding was liberal so that there was generally an excess of food at the bottom of the aquarium. In this, as well as the first experiment, the minnows were fed on the prepared food on the morning of the day in which the experiment was made. A light hung over the aquarium during the experiment. The aquarium water was 21°C. The bass fry used in the experiment were approximately 10.5 millimeters long and were heavily pigmented (nearly black). At 10:00 A.M., 20 fry were introduced; at 10:10 A.M., 20 more were introduced; and at 10:15 A.M., 20 more. In each trial the entire 20 fry were eaten within 2 minutes after they were introduced. During the feeding, I observed that certain of the minnows were more predaceous than others on the fry. Selecting these more predaceous individuals, stomach examinations were made with the following results:

- (1) A maturing male Bluntnose Minnow, 55 mm. in standard length and 2 1/2" in

total length, contained 12 bass fry.

- (2) An adult male with tubercles well developed, 67 mm. and 3 1/8", contained 13 bass fry.
- (3) A gravid female, 49 mm. and 2 3/8", contained 3 fry.
- (4) A maturing male, 60 mm. and 2 3/4", contained 6 fry.
- (5) An adult male with tubercles well developed, 72 mm. and 3 3/8", contained the remains of 6 fry. The examination of this specimen was made at 11:15 A.M., one hour after the last introduction of fry into the aquarium. The remains of the fry, recovered from this specimen, indicated that digestion was already partially completed. A diffuse mass of pigmented flesh represented the remains of each fry. This would probably not have been recognized as fish, certainly not as bass fry, in a wild-caught minnow.
- (6) An adult male with breeding tubercles, 72 mm. and 3 1/4", was examined after 25 other bass fry were introduced into the aquarium at 11:25 A.M. (Most of these were eaten immediately). This minnow contained 2 bass fry which were digested almost beyond recognition, and 4 fry which were intact.

Of the last group of fry introduced, 7 of the largest ones remained at the top of the aquarium for several minutes, apparently being attracted by the light. The minnows remained near the bottom of the aquarium, occasionally darting to the top for the fry (a distance of 1 foot), missing their prey on about one-third of the attempts. Upon sinking to the bottom the fry were immediately eaten. The bass fry, removed from the stomachs of the minnows, showed that very little mutilation occurred during the process of eating or swallowing. Those taken from the stomachs immediately after they had been eaten were intact.

EXPERIMENT NO. 3.—May 30, 1934. The 23 remaining specimens of Bluntnose Minnows, used in experiments 1 and 2, were kept in the aquarium until May 30, receiving, during this time, the same daily feeding of the bran, shrimp and oatmeal preparation. These minnows 48 to 75 millimeters in standard length, were still apparently healthy, had no fungus infection, and had been fed well. On May 30, 21 bass fry, 13 to 17 milli-

meters in total length, were introduced into the aquarium. Four fry were eaten, these being the smallest ones, less than 15 millimeters long. The minnows were observed striking at the remaining fry but were unable to eat them. Either the fry were too large or they were too elusive for the minnows. This experiment seems to indicate that the maximum size of bass fry, which the blunt-nose minnow is able to catch and eat, is slightly less than 15 millimeters (9/16 inch)

Pond A at the Northville hatchery was used during the summer of 1934 as a bass-rearing pond. Early in the spring a brood stock of Bluntnose Minnows was introduced, and the first minnow nests appeared coincident with the first hatching of the bass fry in other ponds. Approximately 50,000 bass fry were put in Pond A during the month of May. On May 30 the pond contained a large number of fry that were less than 10 days old, as well as many older ones. The smallest of the fry were about 12 to 15 millimeters in total length, but most of them were larger. At 5 P.M. on May 30, 15 adult Bluntnose Minnows were seined from Pond A. The minnows ranged from 41 to 55 millimeters in standard length or 1 7/8 to 2 5/8 inches in total length. These minnows had been seen swimming about in the shallow part of the pond where large numbers of bass fry were seen dispersed throughout the open water. Examination of the stomachs of these 15 minnows revealed no bass fry. The minnows had recently fed on algae, plant debris and insect larvae but no remains of fry could be found. Actual proof that the adult Bluntnose Minnows feed on bass fry in rearing ponds is therefore still forthcoming.

Golden Shiners

Experiment No. 4. May 18, 1934. On April 27, 1934 a stock of golden shiners was obtained. These fish were kept in an aquarium holding about 40 gallons of water. They were fed daily as described for the Blunt-nose Minnows. By May 18, this stock of minnows had been reduced, by death due to fungus, to 11 specimens. These fish were fed well at 9 A.M. on May 18. The bass fry were obtained from a fry trap on May 18 and, according to the hatchery men, they had risen from the nest earlier this same day. The fry were sparsely pigmented and were 9 millimeters in total length.

Fry were introduced into the golden shiner aquarium as follows: 100 fry at 4:30 P.M., 100 fry at 5:00 P.M., and 100 fry at 5:30 P.M. The last fry disappeared at 6 P.M., all being eaten by the Golden Shiners. Four of the Golden Shiners were examined between 6 and 6:15 P.M. for stomach contents. Pigmented fragments of the skin and retina were the only recognizable remains of the fry. The four specimens examined were 108, 113, 115 and 116 mm. in standard length or 5 to 5 5/8 inches in total length. The other seven specimens were 86 to 110 mm. in standard length of 4 1/8 to 5 1/4 inches in total length. The stomach examinations indicated that while the fry were being swallowed, they were greatly mutilated by the pharyngeal teeth of the golden shiners. In this respect the contrast was quite sharp between the Golden Shiners and the Blunt-nose Minnows. This observation should have significance in interpreting the results of stomach examinations made on these minnows, for remains of small fry will be very difficult to detect in the stomachs of Golden Shiner.

EXPERIMENT NO. 5.—May 26, 1934. The Golden Shiners used in this experiment were obtained on May 19. By May 26, many of the original stock were heavily fungused and had died. Many of the remaining fish had small patches of fungus infection. The aquarium held about 25 gallons of water. The water temperature was 21°C. The bass fry were 10.5 mm. in total length and were heavily pigmented. At 12 noon 97 fry were introduced into the aquarium. At 1:30 P.M. there was no perceptible decrease in the number of fry and none had been seen to be eaten. At 3 P.M. all the fry were recovered. It is my belief that the fungus infection on these minnows interfered with their normal feeding.

EXPERIMENT NO. 6.—May 26, 1934. At 3 P.M., May 26, 22 adult shiners were obtained from the Huron River. These shiners were put in an aquarium at 4:00 P.M. and immediately 57 of the bass fry (10.5 mm. long), recovered from Experiment No. 5, were introduced. The aquarium contained about 25 gallons of water. During the first half hour of the experiment, I observed that many of the fry were eaten. By 4:30 P.M. I was able to count only 28 of the fry and, at this time, 7 of the shiners were removed from the aquarium. These 7 shiners were preserved and later examined for stomach con-

tents. They were 88 to 104 mm. in standard length or 4 1/4 to 5 inches in total length. Stomach examinations of the 7 fish indicated that 6 specimens had not eaten any fry, while one specimen (92 mm. standard length) had eaten 22 fry. The remains of these 22 fry indicated that they were greatly mutilated during the swallowing process. The aquarium was last observed at 5 P.M., May 26, when it contained 15 shiners and 28 bass fry. At 8 A.M. on May 28, the shiners were all in good condition and the bass fry had disappeared, the inference being that they were eaten. In interpreting the results of this experiment, it is of considerable importance to note that the fry were put in the aquarium immediately after the shiners were introduced, and that one shiner at least began eating the bass fry immediately after the introduction of the fry, and ~~that~~ approximately one hour after the shiners had been seined from the Huron River. There was no chance for the shiners to become accustomed to the aquarium conditions, nor is it likely that they were more pressed by hunger than they would have been in natural waters. Five shiners, collected at the same time as the 22 fish used in this experiment, and preserved 1/2 hour later, were examined for stomach contents. The stomachs of three were empty while the stomachs of two contained some food.

EXPERIMENT NO. 7.—May 30, 1934. Of the shiners used in Experiment No. 6, 13 specimens were held in the same aquarium until May 30. By this time they were all somewhat fungused. They ranged in size from 81 to 118 mm. in standard length or 4 to 5 3/4 inches in total length. The bass fry used were 13 to 17 millimeters (approximately 1/2 to 3/4 of an inch) in total length. On the afternoon of May 30, 21 bass fry were introduced into the aquarium. There were no immediate results. At 8 A.M. on May 31, only one fry could be seen in the aquarium. Three more fry were than added. At noon on May 31, the fry were gone. The inference here is that the fry were eaten by the shiners.

EXPERIMENT NO. 8.—June 8-9, 1934. Seven Golden Shiners were obtained from the Huron River at 11 A.M. on June 8. These specimens were 84 to 118 mm. in standard length or 4 1/4 to 5 3/4 inches in total length. They were put in a 10-gallon aquarium at noon on June 8. 35 bass fry were put in the aquarium at 5 P.M. June 8.

The aquarium was observed for the following 1/2 hour during which time no fry were eaten. Occasionally a shiner attempted to catch one of the fry but the latter appeared too elusive. At 3:30 P.M. on June 9, the 7 shiners and 32 of the fry were removed from the aquarium and preserved. Upon examining the alimentary tracts of the shiners, one specimen (adult female, standard length 116 millimeters) contained the remains of two fry, 15 and 17 mm. in total length. The 32 recovered fry were of the following sizes given in total length in millimeters:

Total length of fry, mm.	17	18	19	20	21	22	23	24	25	26	27	28
No. of fry of each length	1	-	4	2	3	5	3	1	4	3	2	4

One fry was not accounted for. The two fry, which were eaten, were the smallest ones of the group. This experiment probably indicates the approximate maximum size of bass fry that are eaten by Golden Shiners of the sizes here used.

SUMMARY

The minnows held in an aquarium for any considerable length of time were fed a liberal amount of prepared food. Thus it is unlikely that any of the minnows were abnormally pressed for food before the beginning of the experiments.

Under experimental conditions, adult Bluntnose Minnows readily devoured bass fry 8 millimeters long, 10.5 millimeters long, and 13 to 15 millimeters long, failing to capture fry over 15 millimeters long. It appeared that fry above 15 mm. (about 5/8") were either too large for the minnows to eat or too elusive for them to catch, even in a small aquarium.

There was some evidence that, in a rich hatchery pond, adult Bluntnose Minnows do not eat fry over 12 millimeters long.

Under experimental conditions, adult Golden Shiners, approximately 4 to 5 inches in total length, readily ate bass fry 9 mm. long, 10.5 mm. long, and 13 to 17 mm. long. Fry longer than 17 mm. (3/4" long) were not taken by the shiners.

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APPENDIX TO REPORT 269

Certain fish culturists have found Golden Shiners guilty of eating small bass fry placed in rearing ponds. There has been no previous evidence that Bluntnosed Minnows are guilty of the same practice. The experiments in Report 269 indicate that this minnow might also be suspected. It is not at all unreasonable to expect that small and rather feeble, newly-hatched bass fry, concentrated in small ponds along with large numbers of adult forage minnows, would, under certain conditions, be easy prey to almost any minnow species. Forage minnows should have a definite role in bass production, in spite of their possible predatory habits on the fry.

The value of a forage minnow in bass production was illustrated at the Northville Federal Hatchery during the summer of 1934. Bluntnosed Minnows were used in the four rearing ponds. These four ponds gave an average production of 19,100 fingerling bass per acre; the average for the three best ponds was 24,400 per acre; the best pond, 34,500 per acre. The Northville fish culturists (Mr. L. A. O'Neal and Mr. E. R. Widmyer) attribute their success, in a large part, to the use of the forage species.

The writer is convinced that many forage species, adapted to pond life, could be used successfully, if the bass fry were reared to a size of $3/4$ " to 1" before placing them in the large rearing ponds containing the forage species. This could be done by placing the fry in small ponds containing rich cultures of Daphnia, for a short period; possibly the cement daphnia ponds could be used advantageously. It might not be feasible or practical to rear the fry to a $3/4$ " size in these small ponds-- a $1/2$ " size, or a week's growth in a rich daphnia pond, would eliminate most, if not all, of the loss which might be incurred by introducing the newly-hatched fry into ponds containing forage minnows. Perhaps a portion of the fry could be left in the fry traps and fed there for a short period.

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