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The Breeding Habits of the Silvery Minnow, *Hybognathus regius* Girard

Edward C. Raney

Little has been recorded concerning the breeding habits of the Silvery Minnow, *Hybognathus regius* Girard. Bean (1903, p. 118) wrote that it spawns in early spring. Wright and Allen (1913, p. 4) have given April 25 to June as the breeding time and quiet water and riffles as the breeding place. Adams and Hankinson (1928, p. 366) concluded that the eggs were probably laid in the spring after finding schools of young about an inch long in July in Oneida Lake, New York.

Studies carried on for the past several years at the south end of Cayuga Lake near Ithaca, New York, have shown that the Silvery Minnow is one of the earliest of our northeastern cyprinids to spawn. The more pertinent notes on breeding behavior are here recorded. Considerable additional data on the economics of this species based on studies still in progress at the Cornell Experimental Hatchery will be reported in a subsequent paper. However, it should be mentioned at this time that it shows considerable promise as a bait and forage fish which may be easily raised in small ponds. In the Finger Lakes Region of New York the males and, to a lesser extent, the females are a very important spring bait minnow for the Pike, *Esox lucius*, and the Pickerel, *Esox niger*.

MIGRATION

Near the middle of March large numbers of the Silvery Minnow migrate into the small coves (Fig. 1.) which lead off from the sluggish portion of lower Fall Creek just before it enters Cayuga Lake near Ithaca. Although an occasional specimen may move in over the spawning grounds in October and November, no large schools have been seen in the fall. The spring migration reaches its climax during the last week in April. Some idea of the immense numbers which may occur was obtained by observing the activities of commercial bait fishermen. On April 24, 1938, by hauling a 50 foot bag seine through a small cove 75 feet wide and 200 feet long, they captured approximately 4,000 adults. Repeated hauls on the same and succeeding days were rewarded with slightly smaller catches. Although the numbers dwindled gradually after the middle of May the Silvery Minnow was still the most abundant species of minnow of bait fish size taken throughout May. It appears that the collection of these unspawned fish in such great numbers over a period of years is rather poor conservation practice. The great spring concentration of this species has also been noted by Smith (1907, p. 86) who

1 Taken by the New York State Biological Survey.

observes that in April, 1902, in Pasquotank River, this species was numerous "probably surpassing in abundance any other fish of the family."

The males come into the coves earlier and stay later than the females. There are at all times more males on the spawning grounds. Of 319 unselected adults taken over the breeding areas at various times during late April and May, 1938, there were 61 females and 258 males. It is likely that the females may move out of the area after spawning while individual males may stay for longer periods. Evidence that males are not more abundant at all seasons is indicated by a fairly large collection taken September 1, 1931 in Lake Ontario at Montario which contained 36 males and 52 females.

By June 1 only males were to be found in the cove where spawning was observed. After the middle of June adults were rarely taken and had apparently gone out into the lake.

The common associates in the quiet coves where spawning occurs are *Catostomus commersonnii commersonnii*, *Cyprinus carpio*, *Notropis bifrenatus*, *Notropis heterolepis heterolepis*, *Notemigonus crysoleucas crysoleucas*, *Hyborhynchus notatus*, *Ameiurus nebulosus nebulosus*, *Schilbeodes gyrinus*, *Esox niger*, *Esox lucius*, *Boleosoma nigrum olmstedii*, *Micro pterus dolomieu*, *Huro*



Fig. 1. Cove off Fall Creek near Cayuga Lake, Ithaca, New York. Spawning was observed April 26-28, 1938 near the border of the grass shown in the foreground.

salmoides and *Lepomis g:bbosus*. Less often *Pomolobus pseudoharengus*, *Notropis hudsonius hudsonius* and *Notropis spilopterus* are found on the spawning grounds. It appears that the juvenile *Hypognathus* might serve as an important forage fish for both the juvenile Pickerel, *Esox niger*, and Pike, *Esox lucius*. These two predacious species have just spawned several weeks to a month before.

SEXUAL DIMORPHISM

At the spawning season adult males and females differ in coloration, location and abundance of breeding tubercles and size. The males are light yellow along the sides, from the eye posteriorly over the operculum to the base of the tail. The mid-line of the belly is silvery. All the fins of the male are a faint yellow, the color being least pronounced in the dorsal. The females are silvery as are the males other than during the spawning period. The males are much darker than the females, especially when viewed from above. The differences in coloration are so striking that the local bait fishermen believe they are separate species and designate them by different common names.

The breeding males have small light colored breeding tubercles scattered densely over the top and sides of the head, on the chin, cheeks, opercles and on the apical edge of the scales, of the back and sides. The tubercles are more abundant on the more anterior scales. Both sides of all the fins of the males have tubercles but they are better developed on the upper sides of the pectoral and ventral fins. The ripe females have a few minute tubercles scattered over the top of the head and on the pectoral and ventral fins.

The females attain a larger size than the males. This character, as well as the swollen abdomen of the female, was useful in distinguishing the sexes during spawning. The largest male examined was 83 mm. standard length; the largest female was 100 mm. Of 61 adult females taken during late April and May 1938, 19 or 31 per cent were longer than the largest male. While Fowler (1909, p. 522) reports that this species "is said to reach 9 inches in length" Adams and Hankinson (1928, p. 364) took "none more than four inches" in Oneida Lake. Smith (1907, p. 86) gives the maximum length as 6 to 7 inches, with an average length of 4 inches. Among several thousand specimens examined from New York State the largest was 120 mm. (4.8 inches) in total length.

SPAWNING

Unlike any of our other northeastern minnows whose breeding habits are known, the Silvery Minnow lays its non-adhesive eggs on the bottom ooze in the quiet water of coves. (Fig. 1) The bottom is partly covered with the decaying vegetable material of the previous year as leaves, small branches and grass. A few weeks later these same coves are choked with vegetation as the mat forming water clover, *Marsilia quadrifolia*, several species of pond weed, *Potamogeton*, and spatterdock, *Nymphozanthus advena*, and are utilized by spawning Carp, *Cyprinus carpio*; the Golden Shiner, *Notemigonus crysoleucas crysoleucas*; the Common Bullhead, *Ameiurus nebulosus nebulosus*; the Tad-

period. Still later small schools may combine to form large groups of several hundreds of individuals which occasionally may be seen at the surface but which more often feed on the bottom ooze as do the juveniles and adults.

Juvenile *Hybognathus* taken July 1 from the lagoon where spawning had been observed were almost an inch in total length, 20 mm. in standard length. By July 15 they were about 1.5 inches in total length, 30 mm. in standard length. At this time a number of young had found their way to the lake shore where they were observed in shallow water. On August 5 the total length was very close to 2 inches, the standard length 40 mm. Some females apparently reach maturity and spawn when a year old and but 50 to 55 mm. in standard length. The slower growing males probably do not spawn until they are two years old.

The drawings of the larvae shown in figures 2 and 3 were drawn from preserved specimens by Mr. Dwight A. Webster.

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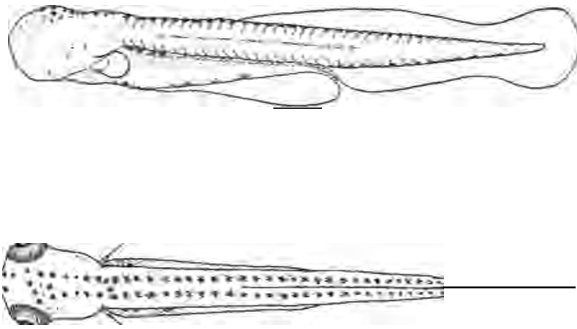


Fig. 2. Newly hatched larva, 5.7 mm. in total length, taken on May 2, 1938 in a cove off Lower Fall Creek near Ithaca, New York.

The eggs are matured during the late fall. A large female taken in the Hudson River the last week in November was considerably swollen with well developed eggs.

Newly hatched larvae (Fig. 2) were recovered on May 2. They averaged 5.5 mm. in standard length, 6 mm. in total length. The characters of the larger larvae are portrayed in Fig. 3.

The larvae remain for a time near the bottom but as the yolk sac is used up they rise and may be found singly in the surface layer. Approximately two weeks after hatching they may be seen in small schools near shore usually among the emergent vegetation. The individuals in a school vary considerably in size even at this time and this, also, is indicative of an extended spawning

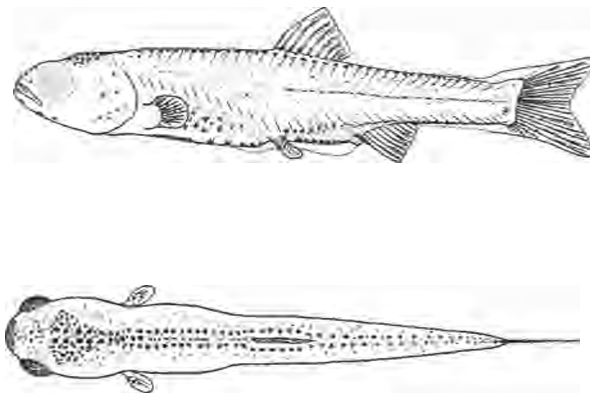


Fig. 3. Larva 12 mm. in standard length, 14 mm. in total length, taken June 4, 1938 from Pond E at the Cornell Experimental Hatchery, Ithaca, New York.

Breeding is usually accomplished with a male close on either side of a female, near the base of newly sprouted grass in from 2 to 6 inches of water. The eggs are apparently laid as the three vibrate rapidly for a second or two. The breeding vibration although momentary is violent enough to disturb the bottom ooze making the water slightly turbid. When spawning occurs quite close to shore the grass could be seen waving considerably. At times one male appeared to spawn by crowding a female against a clump of vegetation. On other occasions a single female would be accompanied by from 4 to 10 males when spawning took place. However, it appears that only the two males close along side the female are effective. Because of the ooze which is stirred up it was impossible to *see* details at the moment of spawning.

After spawning the female returns to the deeper waters in the center of the cove. The males again take up their movements near the shore looking for other females. Upon a number of occasions a male would almost immediately spawn again with a different female. It was not determined how soon a female would spawn again nor how many eggs were laid at one spawning although the number is likely quite small.

Some males will take food during spawning activities but the alimentary tracts of females seldom contained anything. The food consists largely of the microscopic material which is found in the bottom ooze. Various diatoms as well as other types of algae appear to be the most voluminous item in the diet. They are remarkably well adapted to digest this microscopic plant food as they possess very long coiled intestines.

EGGS AND YOUNG

Just after several spawning acts eggs were observed and recovered. They were scattered over the decaying vegetation and ooze on the bottom. Some eggs may be buried under a few millimeters of ooze. The majority of the eggs were non-adhesive at this time although in a number of cases eggs were observed attached to bits of bottom debris. Perhaps the eggs are adhesive when freshly laid but lose this adhesiveness when water hardened although this did not appear to be the case in a few females which were stripped.

The freshly laid eggs were slightly milky in color and were one mm. in diameter. An attempt to determine the incubation period was made by collecting eggs from the bottom, just after a spawning group had left the spot, and placing them in a small submerged screen box. The eggs hatched in from six to seven days. The water temperature during the day varied from 13.3 to 20.5° C. during this period. Although it appeared several times as if male *Hybognathus* were eating their own eggs this observation is unconfirmed by stomach analysis. No other species were seen feeding upon the eggs.

The number of eggs laid depends upon the size of the fish. There were 6600 developed eggs in the ovaries of large females, 90 mm in standard length. Females from 68 to 70 mm. had 3000 eggs while those of 60 mm. standard length had 2000. The eggs of ripe fish are about equally developed.

pole Cat, *Schilbeodes gyrimus* and the Large-mouthed Black Bass, *Huro salmoides*. However, at the spawning time of the Silvery Minnow only the stalks of the water clover are to be seen in the deeper areas. Close to and on shore occurs an abundance of reed canary grass, *Phalaris arundinacea*. This grass gives considerable shelter to which these minnows retire when frightened. Here also most spawning takes place usually in water up to one foot in depth.

The following spawning observations were made April 26, 27 and 28, 1938. During the day the air varied from 20° C. to 28° C.; the water from 13° C. to 20.5° C. A change in weather resulting in a sudden drop in water temperature brought a temporary halt to spawning on April 30. No other spawning activity was observed but it undoubtedly continued at least to the middle of May as ripe males and females were taken together several times up until this date.

Spawning activities started in the morning about 10 a.m. and continued until about 4 p.m. Activity reached its greatest height from 12 noon to 2 p.m. No spawning takes place at night. After dark the Silvery Minnows may be seen lying quietly at the bottom. They are always more concentrated in the newly sprouted grass near the shore.

As one approached the breeding grounds the *Hybognathus* would quickly take shelter either under a nearby log or in the grass along shore. After a short time however they returned to their former activities and would not scare except when quick movements were made. Spawning groups were studied often at a distance of from 2 to 3 feet from my observation post at the side of the cove. At one time a group spawned within a few inches of my foot.

At the spawning time the general setup is quite similar throughout the length of the cove which is several hundred yards long but only 10 to 20 feet wide. Many females may be seen lying quietly or moving slowly about in the central waters where the depth varies from 1 to 2.5 feet. The males are very active but are usually confined to the grassy borders where the actual spawning takes place. However, it was found that successful spawning may take place where there is no vegetation in small ponds at the Cornell Experimental Hatchery. No territory is held and no fighting was observed among the males. Individuals of both sexes were occasionally seen coming to the surface to gulp air.

When ready to spawn a female will move slowly toward the shallow water at the side of the cove. From one to ten males will move at once toward her. The first two to get to her swim slightly underneath on opposite sides and nose her slightly in the region in front of and about the anus. The other males will attempt to squeeze out the two males which first reached her. If they fail to replace the lower males they swim along close to the female's back and sides. The female followed by her retinue of males may at times move quickly in a curved path which usually ends in the center of the cove among the rest of the non active females. When pursued in this manner a female would often jump out of the water a few inches and travel as much as three feet while in the air. Usually, however, she continues toward the grassy area and spawning occurs.