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WHEN DO TROUT AND GRAYLING FRY BEGIN TO TAKE FOOD?<sup>1</sup>

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There is a considerable difference of opinion among fish-culturists as to the time when trout and grayling fry should receive their initial feeding. The most common practice is to offer food when the fry first "swim up," i.e., at the time when the fish have absorbed sufficient yolk to enable them to rise from the bottom of the hatchery trough and remain up in the water, at least for a limited time.

Henshall (1904, 1907) fed trout and grayling fry before the yolk sac was entirely absorbed. Leach (1923a) reports that brook trout begin to feed as soon as the yolk sac diminished sufficiently to allow the fish to rise and that grayling fry (1923b) began a search for food about one week after hatching. He indicates that rainbow fry should receive food at the time when the umbilical sac is absorbed. Steuert (1901) found that brown trout first ingested food 31 days after hatching and that by the 35th day almost 100% of the fish were feeding.

The interesting experiments of Atkins (1905) showed a greater mortality in brook trout fed early than in those deprived of food for five days. Fasting beyond the fifth day increased the rate of mortality in brook and lake trout but not in silver salmon. He questions the practice of very early feeding even though the fry are capable of taking food.

Some experiments designed to secure definite information on the time of initial feeding in trout and grayling were undertaken at the Bozeman Station of the U. S. Bureau of Fisheries. During the spawning seasons of 1937 and 1938 observations were made on the feeding time for the following species: brown trout (Salmo trutta), rainbow trout (Salmo gairdnerii irideus), cutthroat trout (Salmo lewisi), brook trout (Salvelinus fontinalis), and Montana grayling (Thymallus montanus).

We are indebted to Mr. Fred J. Foster, Regional Director of the U. S. Bureau of Fisheries, who made the facilities of the hatchery available for these experiments, and to Superintendent Charles Fuqua and Mr. Hubert Toppie for assistance in the experiments.

#### Methods

The trout and grayling eggs were hatched and the resulting fry were held in standard hatchery troughs. The water supply for all experiments came from the same two springs (temperature 47-52°F.). This water contained practically no organisms which might have been utilized as food.

The experimental fry were fed on the more or less standard ration used in starting young fish. This consisted of beef liver and, in one or two cases, beef heart and salmon carcass meal. The food was prepared and fed in the usual manner except that it was ground more finely and introduced into the water with special care.

Feeding was initiated several days before the trout fry became active and the day after hatching in the case of the grayling.

Thirty to sixty minutes after each feeding 15-25 fry were preserved, and later examined for stomach and intestinal contents.

Feeding Experiments

Brown Trout Fry - Fig. 1.

Brown trout eggs taken November 19 from Madison River (Montana) hatched December 28. The first food (consisting of finely ground beef liver) was offered January 21, twenty-five days after hatching, just as the fry made their initial effort to "swim up." Sixteen fish were examined, 30-45 minutes after the morning feeding each day.

The first evidence of stomach contents appeared 27 days after hatching. By the 31st day practically all fish had stomach contents. This agrees almost identically with the results of Steuert (1901).

The water temperature remained at 52° F. throughout our experiment.

Rainbow Trout - Fig. 2.

Rainbow trout eggs were collected from Madison River fish. These hatched on May 23-27, 1937 and the first food (finely ground beef liver and salmon carcass meal) was offered June 8, just 14 days after the mean hatching period. Fifteen fry were examined for stomach contents, 45 minutes after each morning feeding. The first stomach contents were observed on the 16th day after hatching and the majority were feeding by the 20th day. A week later all of the fish examined had stomach contents.

The water temperature varied between 47 and 52°F. during the course of the experiment.

Cutthroat Trout - Fig. 3.

Cutthroat trout eggs shipped from the Saratoga, Wyoming station of the U. S. Bureau of Fisheries hatched May 7-10, 1937. Food, consisting of finely ground beef liver and salmon carcass meal, was offered 12 days later. Fifteen fry were examined 35-60 minutes after feeding. The first evidence of food in the digestive tracts of these fry appeared two days

later or 14 days after the average hatching time. By the 23d day, 100% of the fry were taking food. The water temperature varied between 47-51°F. during the experiment.

Brook Trout - Fig. 4.

The brook trout eggs were secured from the Creed, Colorado station of the U. S. Bureau of Fisheries. They hatched January 8, 1938 and the resulting fry were given their first feeding, consisting of beef liver, 21 days later. This was about one week ahead of the usual hatchery starting time. On the 23d day one of the 16 fish examined had stomach contents. All had food in their digestive tracts by the 35th day.

The water temperature remained almost constant at 52°F. during the experiment.

Grayling - Fig. 5.

The Montana grayling eggs from Grebe Lake, Yellowstone National Park, hatched June 29. Twenty-five fry were examined 30-45 minutes after the first feeding each day. Food consisting of finely ground beef hearts was presented for the first time on June 30, just one day after the peak of the hatching period. The first evidence of feeding was observed four days after hatching and all fish examined had stomach contents on the 8th day. This is in agreement with a previous experiment by Brown (1938) in which the first evidence of feeding occurred on the 5th day. The water temperature varied between 50 and 52°F. during the course of the above experiment.

The trout fry studied showed very little uniformity between species in their initial feeding time. Rainbow fry began to feed first (20 days after hatching) and brook trout fed last (35 days after hatching). The grayling, of course, fed much earlier than any of the trout species (eight days after hatching). The interval between the time when a few fry started

to feed and when all were feeding is also variable between some of the species. In the brown trout, rainbow trout and grayling, this interval was four days, in the outthroat trout 10 days, and in the brook trout 12 days.

The Relation of the Size of the Yolk Sac to the Feeding Period

Since the size or disappearance of the yolk sac has been used as an indicator for the initiation of feeding, measurements were made on the yolk sacs of rainbow trout and grayling fry of different ages.

The rainbow fry had reached an average total length of 22 mm. at the time when the majority were ingesting food (Fig. 6). At the same period the yolk sac had decreased in length from 6.5 mm. to 4.3 mm. and in width from 3.7 mm. to 2.8 mm. There was no marked change in the yolk sac which could be attributed to the first feeding, but simply the normal reduction in size. Although no measurements were made, the brook trout showed a greater variation in yolk mass during the experiment than any of the other species. In all of the fry studied it was a matter of 1-3 weeks before all trace of the yolk mass was gone.

The complete reduction of yolk in grayling fry is much more rapid, due to its smaller quantity and the early activity of the fry. Within one week after hatching or at the time when all fry were ingesting food the average size of the yolk sac had decreased from 8.6 mm. in length to 0.8 mm. and in width from 4.3 mm. to 2.0 mm. At the end of the second week, the yolk of many of the fry had completely disappeared and in the remainder it was present only as one or two small oil droplets.

It is safe to conclude that the size or presence of the yolk sac shows no correlation with the initial feeding time. The size varies greatly during the early feeding period between species and also between individuals of the same species.

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Captions for Figures

- Fig. 1. Showing the time when brown trout fry (Salmo trutta) began to ingest food.
- Fig. 2. Showing the time when rainbow trout fry (Salmo gairdnerii irideus) began to ingest food.
- Fig. 3. Showing the time when cutthroat trout fry (Salmo lewisi) began to ingest food.
- Fig. 4. Showing the time when brook trout fry (Salvelinus fontinalis) began to ingest food.
- Fig. 5. Showing the time when grayling fry (Thymallus montanus) began to ingest food.
- Fig. 6. Showing the comparative measurements between the average length and width of the yolk sac and the average total length of rainbow fry of different ages. The cross line represents the first date at which the majority of fry were taking food.