

Spawning Behavior of the Cottid Fish *Clinocottus recalvus* (Greeley)

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CLINOCOTTUS RECALVUS (Greeley) 1899 is a small tide-pool cottid found along the coast of California and Lower California. This paper reports briefly on the spawning activities of individuals confined in a laboratory aquarium. Dr. Rolf L. Bolin has kindly furnished information concerning the anatomy and biology of this and related species.

Two females and one male were collected from tide pools at Pacific Grove, California, on February 5, 1951. They were placed in an aquarium, which had wooden ends and bottom and glass sides and was supplied with running water. They were fed regularly on chopped sea mussels. A decided preference was shown for the mussel gonads; the mantle edges were somewhat less acceptable, and the gills were seldom eaten.

The aquarium contained two small granite rocks. It was intended that these would provide a suitable place for the deposition of eggs. Grooves, about 0.5 cm. wide and 1.5 cm. deep, routed along the bottom and ends of the aquarium and in which the glass sides were set, also provided places for the deposition of eggs.

Periodic examination of the aquarium disclosed the deposition of egg clusters on or about the following dates: February 27, March 3, 17, 19, 23, and 27, April 9 and 21, and May 6, 1951. Each of the clusters was removed shortly after its discovery, as I soon learned that prolonged contact with the wood

of the tank resulted in the death of the embryos.

Of the nine clusters of eggs deposited, five were laid in the vertical grooves of the ends of the aquarium; two were laid beneath one of the stones, one was laid in the vertical crack between the two stones, and one was laid in one of the grooves of the bottom. Each of the clusters fitted closely the place where it was deposited, indicating that they were laid in a very fluid state.

The first five clusters were of a deep vinaceous color. The sixth was of the same color, but of lesser intensity. The last three clusters were bright orange, very closely matching the color of the mussel gonads upon which the adults had fed.

Prior to the deposition of each of the last four clusters of eggs, the female concerned showed a marked ventrally directed protrusion around the anus (Fig. 1*a*). The profile of the bulge became progressively more acute up to the time the eggs were spawned. This was not observed preceding the earlier spawnings, but could have been overlooked.

It was not possible to determine which female produced the first four egg clusters, since no differences in appearance were noted. However, it was possible to determine which female deposited each of the last five clusters, since their abdominal regions were quite collapsed immediately following spawning. The two females spawned alternately over the period March 23 to May 6.

On three occasions spawning took place

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during daylight hours, at about 8:00 A.M., 2:00 P.M., and 5:00 P.M. The time at which the other spawnings occurred is not known.

Copulation was observed on two occasions. A different female was involved each time. The behavior pattern was almost identical in both cases.

One of the females deposited a cluster of eggs at about 2:00 P.M. on March 23. These eggs were spawned in a groove at one end of the tank, against the glass of the side and about 6 inches above the bottom. Immediately after spawning, the female dropped down to the bottom of the tank. At this time, the male came alongside the female and seized the female by the left pectoral fin as shown in Figure 1*b*. It appeared that the male was trying to induce the female to return to the site of the egg cluster. The male persisted in dragging the female across the aquarium by the pectoral fin. After this struggle had gone on for perhaps 5 minutes, the female did return to a position over the egg cluster, clinging to the side and end of the tank, with head uppermost. The male then moved up against the left side of the female and held this position for only a moment and then turned and passed over the back of the female, as in Figure 1*c*. This was repeated several times, the female being rolled slightly to the right side on each occasion. On about the sixth such attempt, copulation was achieved while the male was across the female at right angles (Fig. 1*d*). The vigor of the male's thrust, which lasted for perhaps 3 seconds, carried the two away from their position and into mid-water. Immediately thereafter, the male dropped to the bottom of the tank and the female returned to the previous position over the egg cluster. The female clung there for about 5 minutes, during which time a large quantity of milt poured from the region of the genital opening and created a dense cloud in the immediate vicinity. After that, the female too dropped down to the bottom of the aquarium.

Copulation with the second female oc-

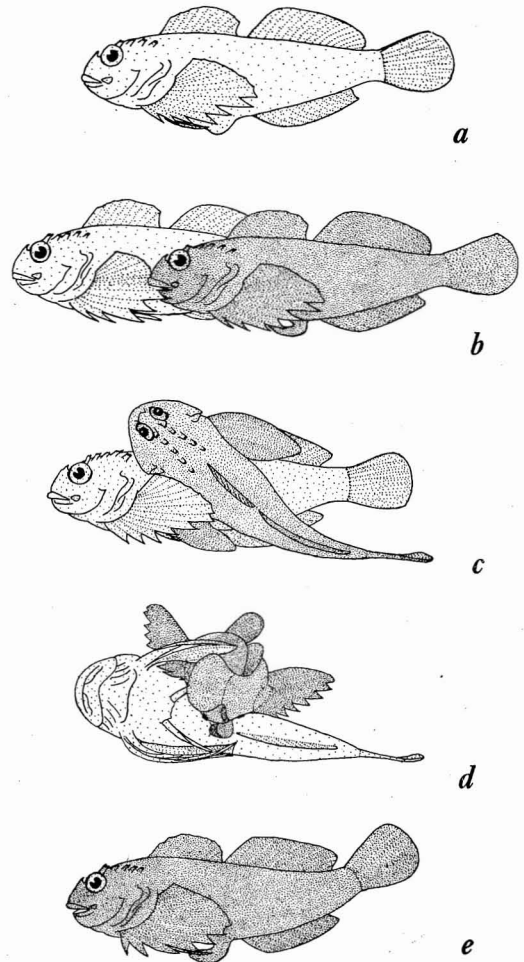


FIG. 1. *Clinocottus recalvus*. *a*, Female with abdominal protrusion, indicating readiness to spawn; *b*, position at the start of mating activities (the male in this and subsequent figures is represented by the darkly stippled individual); *c*, the male moving over the body of the female; *d*, position at copulation; *e*, position of the male after copulation.

curred shortly after deposition of an egg cluster at about 8:00 A.M. on March 27. The behavior of the male and female was almost identical with that previously observed. This cluster of eggs was deposited in a vertical crack between the two stones. These stones gave a much better substrate to which the fish could cling. In consequence, they were not swept from the site during the copulatory thrust, but remained in a fixed position. After

copulation the male dropped to the bottom, but did not lie there quietly as before. Instead, the tail was arched high away from the substrate and the mouth held open (Fig. 1e). Convulsive movements persisted for about 10 minutes, subsiding gradually.

On April 5, the male was removed from the aquarium. The female which had spawned and copulated on March 23, spawned again on April 9 and again on May 6. Both clusters deposited after removal of the male proved fertile and developed normally. The female that had spawned and copulated on March 27, spawned again on April 21. Only about one half of the eggs of the spawning of April 21 developed. The remainder appeared to be infertile. The subsequent history of the eggs and the development of the larvae have already been described (Morris, 1951).

The two females measured 85 and 98 mm. in total length. During the period of February 27 to May 6, it is estimated that the total number of eggs laid by both was between 8,000 and 9,000. This estimate is based on the

sizes of the clusters and on a count previously made on an egg cluster of the same species.

CONCLUSIONS

On both occasions of observed copulation, spawning preceded copulation by several minutes. The females continued to lay fertile eggs for several weeks after copulation. These two characteristics are reminiscent of the breeding behavior of some of the ovoviviparous fresh-water aquarium fishes.

The sharp difference observed in egg color suggests that this character is dictated by environmental conditions and possibly to a great extent by the nature of the food.

The fecundity of this species and the ease with which it is kept in aquaria indicates that it would be a very convenient subject for laboratory studies.

REFERENCE

- MORRIS, ROBERT W. 1951. Early development of the cottid fish, *Clinocottus recalvus* (Greeley). *Calif. Fish and Game* 37 (3): 281-300, 28 figs.