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LARVAL DEVELOPMENT OF *GOBIESOX RHESSODON* (GOBIESOCIDAE) WITH NOTES ON THE LARVA OF *RIMICOLA MUSCARUM*

Seven species of clingfishes of the genera *Gobiesox* and *Rimicola* occupy the rocky inter- and subtidal areas along the California coast. Extreme modification of the pelvic fins into a suction disc enables them to cling to rock and algal substrates. Although all clingfish species are listed as being uncommon to rare in California by Miller and Lea (1972), clingfish larvae are collected on a regular basis (although in low numbers) by monitoring programs dealing with fish larvae (Brewer,[1] McGowen,[2] and White[3]). Of the seven species recorded in southern California, adults of only two, *G. rhessodon* and *R. muscarum*, are usually encountered (pers. obs.).

Knowledge of larval stages of eastern Pacific (especially Californian) fishes is largely limited to pelagic species of those coastal species with protracted pelagic larval periods (Ahlstrom 1965; Moser et al. 1977). Larvae of many nearshore, coastal fishes are undescribed. Recent concern over the affects of harbor development and thermal discharge and entrainment from power plants on fish populations has intensified the need for proper identification of fish eggs and larvae.

The principal systematic work to date on the adults of eastern Pacific clingfishes was carried out by Briggs (1955). No previous works on the larvae of eastern Pacific clingfishes have been carried out, although the eggs and larvae of an Atlantic clingfish, *G. strumosus*, are well known (Runyan 1961; Dovel 1963).

Descriptions of a larval series of *G. rhessodon* and early larvae of *R. muscarum* are presented here as taxonomic aids to larval fish investigators working in the California coastal region.

Methods and Materials

Eggs and adults of *G. rhessodon* and *R. muscarum* were collected in June 1977 from the intertidal zone at low tide at Catalina Harbor and Little Harbor, Santa Catalina Island, Calif. Adults with their eggs were transported to the Catalina Marine Science Center (CMSC) operated by the University of Southern California and maintained in tanks with running seawater. The failure of hatched larvae to feed (probably due to lack of suitable food) precluded culturing past 2 days (4.0 mm). Additional specimens of *G. rhessodon* utilized in the series were obtained by vertical plankton tow under a night-light at the CMSC dock in Big Fisherman's Cove (4.7 mm) in June 1977; by horizontal tow in King Harbor, Redondo

[1]Gary D. Brewer, Institute for Marine and Coastal Studies, University of Southern California, Los Angeles, CA 90007. Pers. commun. June 1977.

[2]Gerald E. McGowen, Southern California Edison (Occidental College), Redondo Beach, Calif. Pers. commun. June 1977.

[3]Wayne S. White, U.S. Fish and Wildlife Service, Laguna Niguel, Calif. Pers. commun. August 1977.

Beach, Calif. (7.5 mm), in 1977; by otter trawl in Marina del Ray, Calif. (12.0 mm), in June 1977; and from the larval fish collection of the Harbors Environmental Projects (University of Southern California) taken by horizontal plankton tows in Los Angeles Harbor (specimens collected in 1972-73). A total of 32 larvae from 2.6 to 7.5 mm of *G. rhessodon* were examined for larval characteristics. An additional 311 larvae of *G. rhessodon* (2.9-7.5 mm) from King Harbor were checked specifically for the presence of melanophores on the head. Larvae were examined and drawn using a Wild[4] stereomicroscope fitted with a camera lucida. Standard length (SL) was measured from the tip of the snout to the tip of the notochord until completion of notochord flexion and then to the posterior margin of the hypural plate.

Results and Discussion

Gobiesox rhessodon

The most distinctive character of *G. rhessodon* larvae was the presence of 8-17 (mean 12) stellate melanophores, which ran laterally in two or three rows from the pectoral fin region to just posterior to the anus (Table 1, Figures 1-3). The dorsum of the gut was also heavily pigmented with stellate melanophores (not included in the lateral melanophore counts). The gut pigmentation often obscured the well-developed swim bladder. Myomere counts ranged from 24 to 29 (mean 27) but were difficult to count, especially in early stages. All specimens up to 6.9 mm had four to seven regularly spaced melanophores along the ventral portion of the tail region. The length of the gut averaged approximately 35% of body length in all specimens examined. Head length ranged from 19 to 25% SL in most specimens <6.5 mm. Individuals ≥6.5 mm had a much larger head of about 33% of SL. All specimens had a stellate melanophore at the base of each pectoral fin which was covered by the opercular flap in later stages (>6.9 mm). The larvae from Catalina and Los Angeles Harbor possessed from zero to four spots on the dorsal portion of the head. Forty-two percent (mean 24, range 2.6-6.9 mm) of the larvae had head pigmentation in the form of spots. Of the larvae examined from King Harbor, 79% (mean 311) lacked this head pigmentation. The larvae with and without head spots were very similar in every other respect.

The larvae of *G. rhessodon* hatched at about 4.0 mm (three specimens ranged from 3.9 to 4.1 mm) from attached, monolayered eggs laid under rocks and cobble in the intertidal zone at Catalina Island. Nest guarding adults have been found from spring to early summer by Lavenberg.[5] The relatively advanced larvae possessed well-developed jaws and pectoral fins at hatching and a laterally bilobed yolk, which was absorbed within the first 24 h. The gut had two or three constrictions giving it the appearance of being looped. The constrictions were characteristic of the larvae up to 6.9 mm. Notochord flexion occurred between 5.5 and 6.9 mm, and caudal fin rays started to develop just prior to flexion. Dorsal and anal fin ray development began around 6.2 mm and the fins were developed sufficiently for positive identification at about 6.9 mm. The development of the pelvic fins began at 5.5 mm and the characteristic suction disc was formed at about 7.0 mm. Transformation and settling probably occur between 8 and 12 mm as evidenced by an 8-mm planktonic specimen from King Harbor that possessed juvenile pigmentation (McGowen see footnote 2) and the 12-mm juvenile (Figure 3) which was collected by benthic otter trawl. This latter specimen exhibited the ability to cling to surfaces after capture.

Larvae of *G. rhessodon* appear to be the most common *Gobiesox* encountered in several nearshore plankton sampling programs in southern California (Brewer see footnote 1; McGowen see footnote 2; White see footnote 3). This is to be expected in that previous species lists of adult/

[4]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

TABLE 1.—Summary of larval measurements and adult counts for *Gobiesox rhessodon* and *Rimicola muscarum* (Miller and Lea 1972 and present study).

Item	*Gobiesox rhessodon*	*Rimicola muscarum*
Larvae:		
No. lateral melanophores	8-17 ($\bar{x}$ = 12) in 2-3 rows	40-50 in 4 rows
Myomere count	24-29 ($\bar{x}$ = 27)	(1)
No. ventral tail melanophores	4-7	Absent
Size (mm) at onset of pelvic fin development	5.5	?
Adults:		
No. visible dorsal fin rays	10-12	6-8
No. visible anal fin rays	9-10	6-8
No. pectoral fin rays	19-21	14-17
No. vertebrae	[2]28-29	[2]35-36

[1]Lateral melanophores obscurred myomeres so that accurate counts could not be taken.
[2]Counts from Los Angeles County Museum specimen X-rays—*G. rhessodon* (LACM 1998), four specimens; *R. muscarum* (LACM W70-16), six specimens.

[5]Robert J. Lavenberg, Curator of Fishes, Los Angeles County Museum of Natural History, Los Angeles, CA 90007. Pers. commun. June 1977.

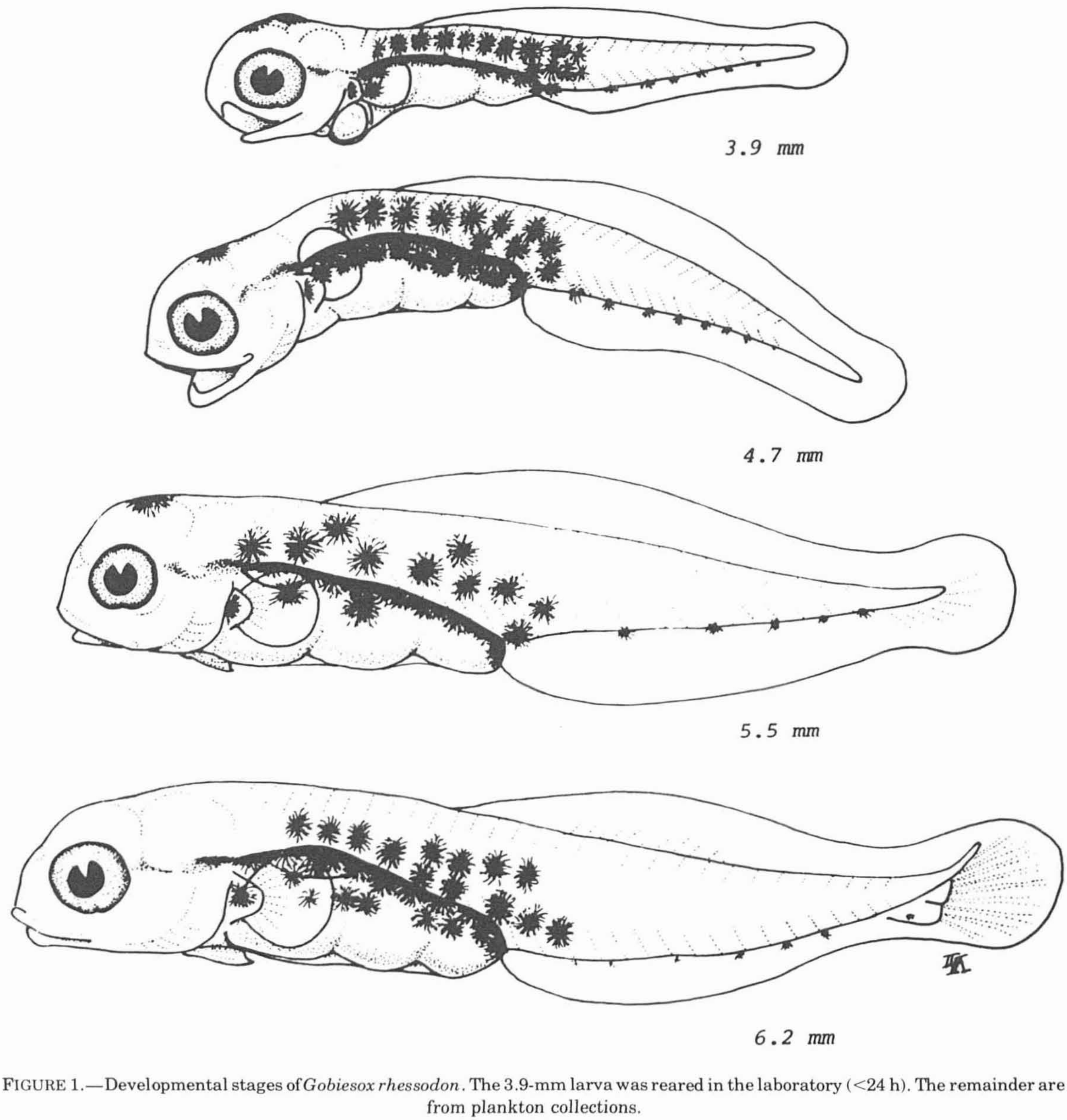

FIGURE 1.—Developmental stages of *Gobiesox rhessodon*. The 3.9-mm larva was reared in the laboratory (<24 h). The remainder are from plankton collections.

juvenile fishes in southern California coastal areas have included *G. rhessodon* exclusively (Horn and Allen 1976).

Rimicola muscarum

Yolk-sac larvae of *R. muscarum* (Figure 4), shortly after hatching, can be distinguished from *G. rhessodon* larvae at this stage by the greater number of lateral, stellate melanophores (40-50) in four rows that continue to the sixth or seventh postanal myomere, and the absence of pigmentation on the ventral tail region (Table 1). Yolk-sac larvae do not have head pigment. Adult counts are also markedly different from *G. rhessodon* (Table 1).

Comparison

Three species of *Gobiesox*, in addition to *G. rhessodon*, have been reported in southern California: *G. maendricus*, *G. papillifer*, and *G. eugrammus*.

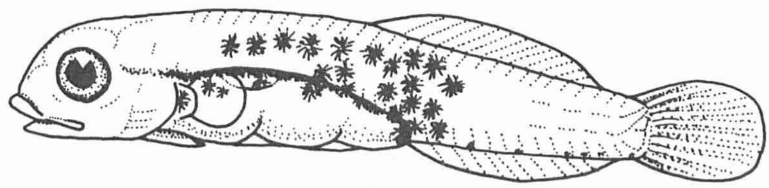

FIGURE 2.—Pelagic larvae of *Gobiesox rhessodon*.

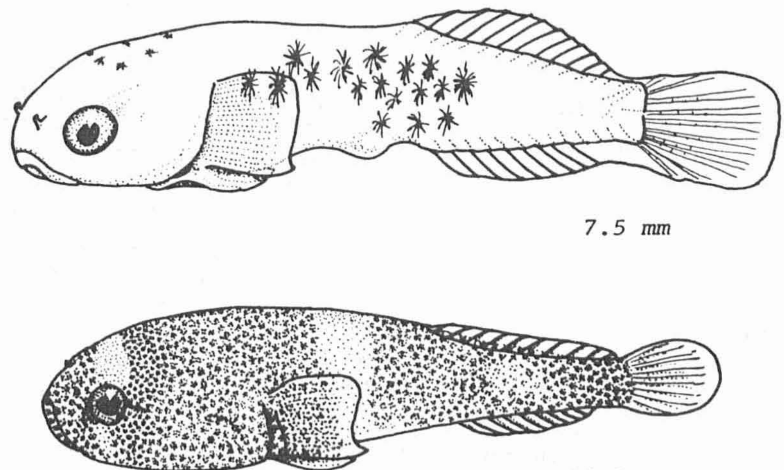

FIGURE 3.—Late pelagic larva (upper) and benthic juvenile (lower) of *Gobiesox rhessodon*.

The larval stages of *G. maeandricus* have recently been described by Marliave (1976). Based on Marliave's description and data from Richardson,[6] *G. maeandricus* larvae differ from *G. rhessodon* mainly in that *G. maeandricus* lack lateral melanophores and possess more myomeres (31-33). In addition, adults of *G. maeandricus* are rare south of Point Conception, Calif. (Miller and Lea 1972). *Gobiesox papillifer* and *G. eugrammus* are also rare in southern California. *Gobiesox papillifer* has been reported only once in southern California, and *G. eugrammus* only ranges as far north as San Diego County (Miller and Lea 1972). The larvae of these two species of *Gobiesox* have not been described, however, it is unlikely that any of these forms were among the specimens examined considering the distributions of the adults.

The Atlantic species of *Gobiesox*, *G. strumosus*, studied by Runyan (1961) and Dovel (1963) was similar in appearance to *G. rhessodon*, but does differ in that the Atlantic species had 10-15 saddle melanophores (as opposed to lateral) and displayed no ventral midline pigment in the early stages (<3.9 mm). Later larvae of *G. strumosus* also appeared to be more heavily pigmented on the trunk portion of the body (4.73-8.78 mm).

The presence or absence of head pigmentation has been used by some investigators to separate *Gobiesox* larvae collected in southern California into two types. This character is variable in *G.*

[6]Sally L. Richardson, School of Oceanography, Oregon State University, Corvallis, OR 97331. Pers. commun. May 1978.

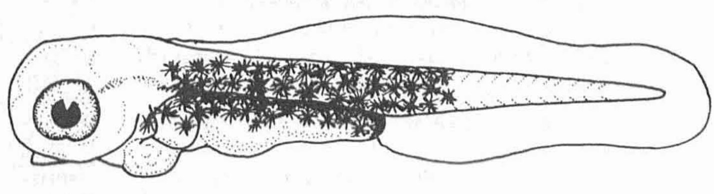

FIGURE 4.—Yolk stage larva of *Rimicola muscarum*.

rhessodon and, therefore, is not useful in distinguishing it from other species.

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SPRING AND SUMMER FOODS OF WALLEYE POLLOCK, *THERAGRA CHALCOGRAMMA*, IN THE EASTERN BERING SEA

The walleye (Alaska) pollock, *Theragra chalcogramma* (Pallas 1811), is the most abundant commercial fish species in the eastern Bering Sea (Pereyra et al.[1]) and plays an important role in ecosystem trophodynamics of the region. To obtain better knowledge of the role of the pollock as a predator, we have studied the stomach contents of pollock from the eastern Bering Sea collected on U.S. research vessels in the summer of 1974 and on Soviet and Japanese fishing vessels in the spring of 1977.

Results from this study contribute to our understanding of feeding habits; information on seasonal and size-dependent changes in feeding behavior are used to model interactions between species (trophodynamics), and to predict the influence of commercial fisheries on the abundance of populations in the eastern Bering Sea (Laevastu and Favorite[2,3]).

Methods

Pollock stomachs were collected by U.S. fisheries observers, on an opportunistic basis, aboard Soviet and Japanese motherships in the eastern Bering Sea. Samples were collected in the region of the continental shelf break in April and May 1977 (Figure 1, Table 1). The stomachs were removed, tied in cheesecloth, and preserved in dilute Formalin[4] (ca. 5%) and sent to the Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, Wash., for analysis. Identifiable matter was separated by major taxa. Wet weight for each taxa was determined after blotting with paper towels. Uniden-

[1]Pereyra, W. T., J. E. Reeves, and R. G. Bakkala. 1976. Demersal fish and shellfish resources of the eastern Bering Sea in the baseline year 1975. Unpubl. manuscr., vol. 1, 619 p. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112.

[2]Laevastu, T., and F. Favorite. 1976. Evaluation of standing stocks of marine resources in the eastern Bering Sea. Unpubl. manuscr., 35 p. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112.

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