Icosteoidei: Development and Relationships

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THE suborder, Icosteoidei, consists of one family, Icosteidae, with a monotypic species *Icosteus aenigmaticus* (Nelson, 1976). Adults inhabit the epi- and bathypelagic areas of the North Pacific Ocean from southern California to Japan. Adults may exceed 2 m in length and have dark flaccid bodies; a characteristic implied in the common name of the species, ragfish (Hart, 1973).

The systematic position of this group and its designation as an order or suborder is not well established. Greenwood et al. (1966) consider it a suborder of Perciformes while Gosline (1971) elevates it to an order, Icosteiformes, a probable perciform derivative.

DEVELOPMENT

The only early life history data previously published is a brief description of the egg (Allen, 1968). *Icosteus aenigmaticus* eggs are commonly collected in ichthyoplankton surveys off the Pacific coast of North America [California Cooperative Oceanic Fisheries Investigations (CalCOFI) and Northwest and Alaska Fisheries Center (NWAFC)], but larvae (mostly preflexion) are infrequently found and a complete size series from hatching to transformation is not presently available. Larvae may move offshore or into deeper waters. The first published description and illustration of the larvae from pre- to postflexion stages are provided here, based on National Marine Fisheries Service (NMFS) collections. Although *I. aenigmaticus* juveniles undergo a marked transformation to the adult stage, little information is available concerning this change (Hart, 1973).

Eggs

The pelagic egg of *I. aenigmaticus* ranges in diameter from 2.8 to 3.1 mm (Fig. 305). A large, sometimes irregular, oil globule with a diameter of 0.42 to 0.60 mm is present. The oil globule usually decreases in size with development. The chorion is smooth, sometimes amber or rose colored. Early stage egg yolks are frequently opaque, although later stages have a clear, unsegmented yolk. During the middle stage of development, embryos have pigment along the dorsal body as well as on the yolk and oil globule. Late stage embryos have functional mouths, pectoral buds, and very wide finfolds. Scattered pigment occurs on the eyes, snout, jaws, and dorsal head. The dorsal surface of the gut is pigmented. Along the dorsal and anal finfolds, three or four clusters of melanophores appear at each distal edge. Melanophores also appear above and below the tail in the caudal finfold. An irregular double row of melanophores extends the length of the dorsal body margin. A few mediolateral spots appear anteriorly. Occasionally, pigment occurs along the ventral body margin.

Larvae

Morphology.—Newly hatched larvae of *I. aenigmaticus* are 6.5 mm NL; yolk material may persist until larvae are 10 mm. Flexion begins at about 11 mm and is complete at about 17 mm SL. The size at transformation is not known, but fin development is almost complete by 28 mm. The body, surrounded by a wide finfold, is very soft. Preflexion larvae have small heads with rounded snouts and long tapering bodies (Fig. 306). Dorsal and ventral finfolds are wider than the body. During flexion the body thickens and becomes more robust, especially anteriorly. Postflexion larvae have a robust head and gut and a tapering trunk (Fig. 306). Preanal length is less than 50% body length. A series of preopercular spines appears during late flexion.

Pigment.—Newly hatched larvae of *I. aenigmaticus* display essentially the same eye, head, gut, body, and finfold pigment as the embryos. With increasing size the head and gut usually become increasingly covered with discrete spots. Dorsal body margin pigment is present throughout larval development, while the amount of lateral and ventral body margin pigment varies and is relatively sparse. The characteristic embryonic caudal pigment persists in the developing larvae, becoming less prominent but remaining as scattered melanophores on the hypural margin and fin ray bases. In general, postflexion larvae are less pigmented except on the head. Pelvic and pectoral fin bases and pelvic rays acquire melanophores during postflexion.

Meristics.—*Icosteus aenigmaticus* larvae have the following vertebral and fin ray counts: Vert. 66–68; D 55; A 39; Pec. 21; Pel. I,4; and C 9 + 8 = 17 (NWAFC files). These counts conform

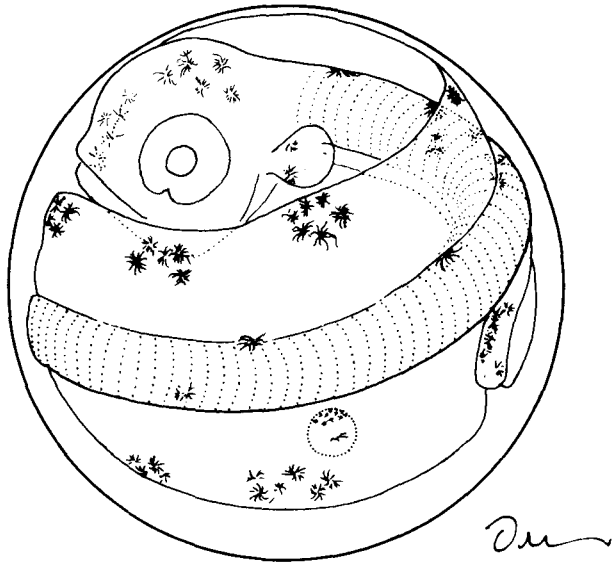

Fig. 305. Egg of *Icosteus aenigmaticus*: 2.8 mm, drawn by H. Orr.

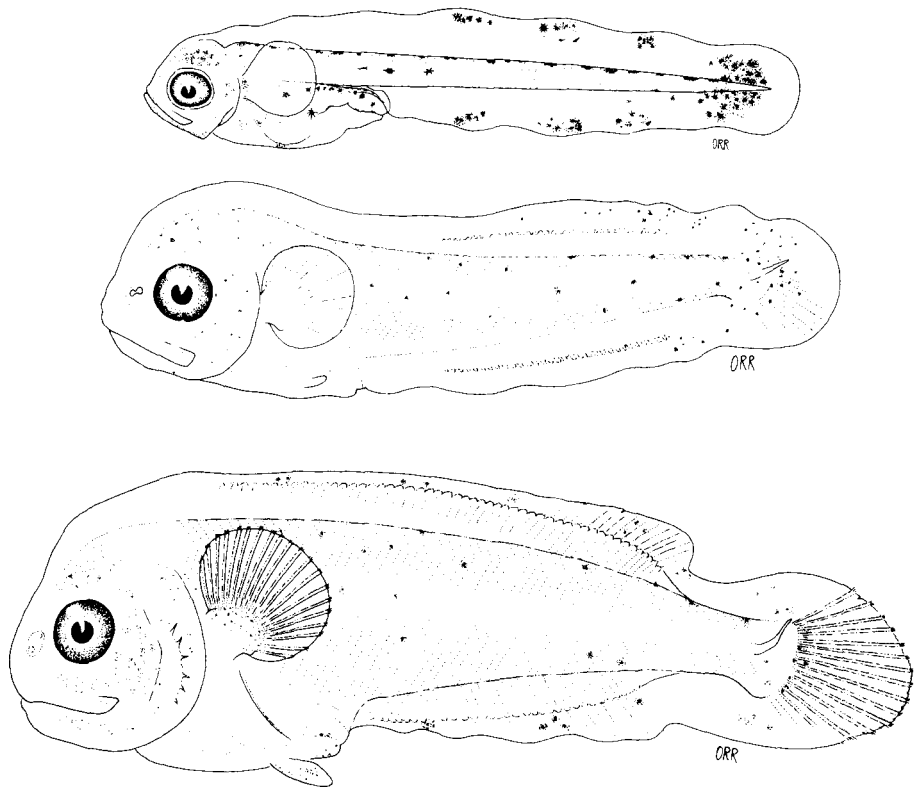

Fig. 306. Larvae of *Icosteus aenigmaticus* from top to bottom: 9.5 mm SL; 10.2 mm; and 28.5 mm SL, drawn by H. Orr.

to those for the adults except adults lack a pelvic fin (Abe, 1954; Miller and Lea, 1972; Hart, 1973). The caudal fin contains the perciform number of principal rays, 17, with 6–9 procurrent rays on each side. Pectoral fin blades are present at hatching and rays form during flexion. Pelvic fin rays begin development during flexion and are complete in postflexion larvae. At what size the pelvic fins disappear is not known. The last fin rays to form are the dorsal and anal, with their anlagen appearing in the middle of the posterior half of the finfolds at about mid-flexion. Formation of these fins proceeds forward and toward the body margin (Fig. 306). The largest larva available, 28.5 mm, has the complete fin ray complement.

Relationships

The foregoing brief description of the eggs and larvae of *I. aenigmaticus* provides some additional information toward the understanding of the life history of this unique but poorly understood fish. Characters discussed here (e.g., sequence of fin formation and meristics) help support its position among perciform relatives. Sequence of fin formation and reduced number of pelvic fin rays are blennioid-like characters, and 17 principal caudal fin rays are the typical percoid number. Eggs, larvae, and early juveniles superficially resemble stromateoid fishes but additional data are needed before a precise relationship can be determined. To understand this family more fully, we need information regarding the critical juvenile phase as well as a complete osteological examination from preflexion larvae to adults.

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