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Early development of the red mouthed goby, *Gobius cruentatus* (Pisces: Gobiidae)

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The full developmental embryonic sequence of *Gobius cruentatus* is described for the first time. Embryonic development lasted 13 days (14.0–15.0°C). The newly hatched larvae (3.3 mm total length) presented pigmented eyes, the yolk is fully absorbed, and the mouth and anus were opened allowing the onset of exogenous feeding almost after hatching.

INTRODUCTION

Gobius cruentatus Gmelin (1789) is an eastern Atlantic goby, occurring from south-west Ireland to Senegal and in the Mediterranean (Miller, 1986). It is found inshore on rocky habitats, sand and sea grass meadows (Wilkins & Myers, 1992). Although abundant throughout its distributional range, the reproductive biology of this species is virtually unknown. The existing information is concerned mainly with distributional patterns and the use of space (e.g. Miller, 1986, 1990; Minchin, 1987; Wheeler, 1992; Wilkins & Myers, 1992, 1993, 1995).

MATERIALS AND METHODS

Eggs and larvae were obtained from a pair of captive fish maintained since May 1998 at a public aquarium (Aquário Vasco da Gama, Lisbon). The gobies were fed daily with fish and shrimp. The tank was illuminated with fluorescent light (60W) from 0900 to 1900. The bottom of the tank was covered with a layer of sand and several large flat stones. Eggs were removed from the spawning stone daily by aspiration with a tube and were observed under a Nikon stereomicroscope, photographed by a Nikon Fx-35DX camera and preserved in buffered 5% formalin.

RESULTS

The complete sequence of embryonic development (temperature: 14–15°C) was based on a spawning that occurred on 8 December 1998. The breeding male presented a dark coloration with bright red lips. Parental care included fanning and rubbing the eggs with the dorsal fin or the posterior end of the body as described for other species of the genus *Gobius* (see e.g. Gil et al., 1997; Faria et al., 1998).

The eggs were transparent and fusiform (length= 2.04 mm, range 1.90–2.10 mm, SD=0.08; width=0.56 mm, range 0.50–0.60 mm, SD=0.05; N=50) and were attached to the underneath of a horizontal rock by filaments. They were distributed in a single layer within a total area of 121 cm^2 with a density of 176 eggs cm^{-2}. In Figure 1 eggs in different developmental stages and the newly hatched larva are presented. The main ontogenetic events of embryonic development are shown in Figure 2.

Hatching occurred 13 days after fertilization and the egg capsule was disrupted by the lower jaw of the larvae, where hatching glands were visible. The head was the first to emerge after rapid movements of the body. Newly hatched larvae measured 3.30 mm total length (range 3.24–3.34 mm; SD=0.03; N=7). The mouth and anus were open, with formed lips and differentiated jaws. The yolk was fully absorbed. The liver was developed, the eyes were fully pigmented and the gas bladder was filled. The pectoral fins were differentiated and the inner ear already presented the sagittae and lapilli otoliths. The opercules were open and the branchial arches were differentiated.

The larvae presented seven to nine pre-anal melanophores ventrally and one above the anus (Figure 1). There was a continuous row of post-anal melanophores with several large and ramified in the middle of this row. Dorsally, there was a melanophore between the brain and the trunk, and a row of ramified melanophores in the direction of the ventral patch. Internally, the dorsal membrane of the gas bladder was fully pigmented and there were one or two ramified melanophores above the gut. There were also yellow pigments along the entire body, being more concentrated in the regions that contained melanophores.

DISCUSSION

The sequence of embryonic development described for *Gobius cruentatus* largely agrees with the known descriptions for other species of the genus *Gobius* (e.g. *Gobius cobitis* Pallas, 1811 (Gil et al., 1997); *Gobius niger* Linnaeus, 1758 (Ballard, 1969); *Gobius paganellus* Linnaeus, 1758 (unpublished data)). However the incubation periods observed varies between species: *G. niger* also hatch 13 days after spawning, but at a lower temperature—13°C (Ballard, 1969); *G. paganellus* hatch 11 days after spawning at 15.5–16.5°C (unpublished data); *G. cobitis* present the longer

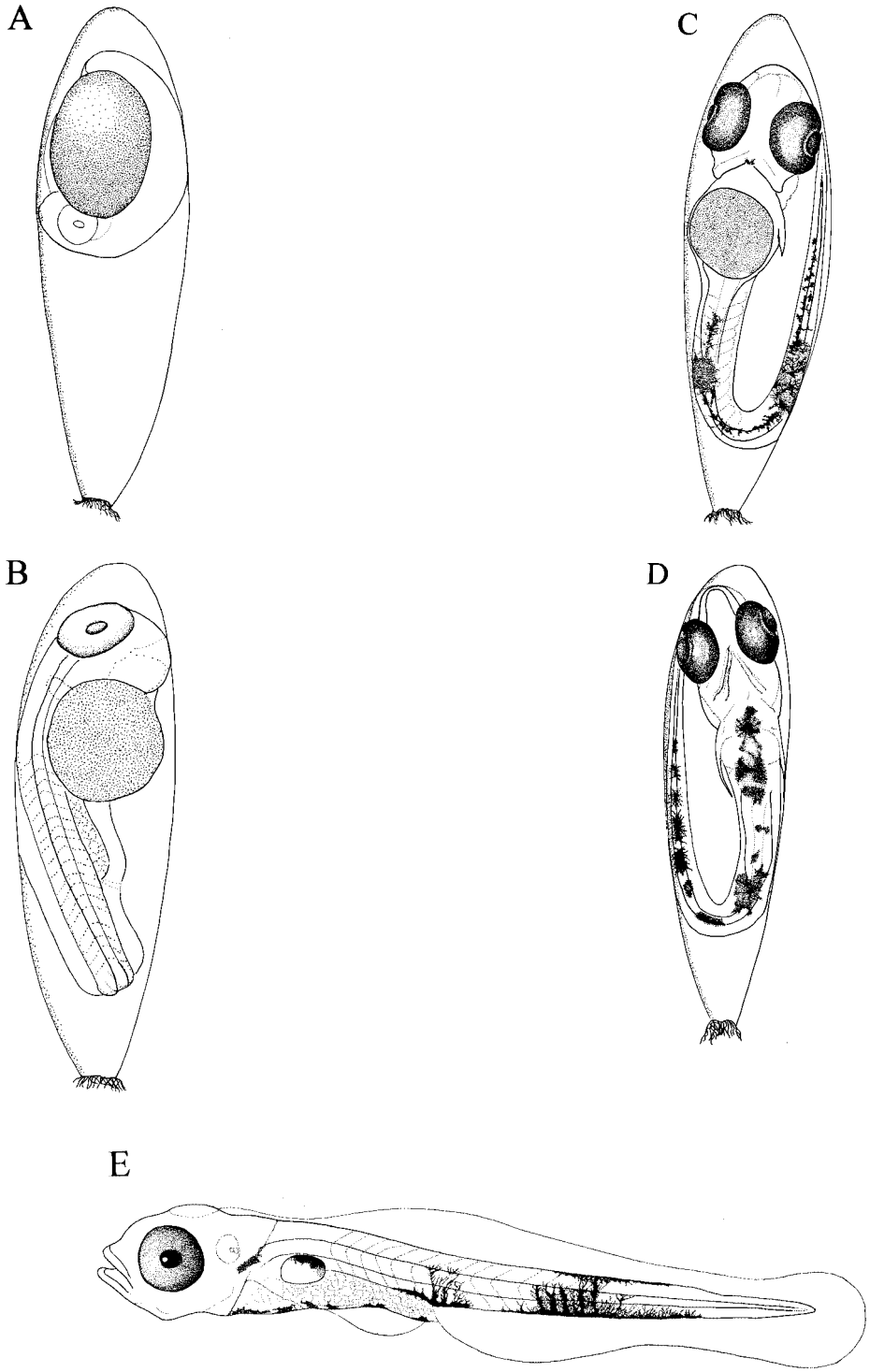

Figure 1. Eggs collected at different developmental stages: (A) day 1; (B) day 4; (C) day 8; (D) day 10; (E) newly hatched larva (3.3 mm total length).

incubation period, 22–24 days at 12–16°C (Gil et al., 1997). These differences are probably related to the size of the newly hatched larvae: 2.5 mm in *G. niger* (Ballard, 1969), 3.3 mm in *G. cruentatus*, 3.5 mm in *G. paganellus* (unpublished data), and 5.5 mm in *G. cobitis* (Gil et al., 1997). Additionally, the shorter developmental time described for *G. paganellus* is probably related to the higher incubation temperature, since the decrease of developmental time with higher temperatures is known for many fish species (Blaxter, 1969). This effect could also explain the similar incubation periods observed for *G. cruentatus* and *G. niger* in spite of the differences in size of the newly hatched larvae. These two factors, size at hatching and incubation temperature, should be clearly differentiated when comparing the early ontogeny of related species.

The area and density of the egg batches are related to species size, since smaller fish tend to have smaller and denser batches (Miller, 1984; Thresher, 1984). This situation was described by Faria & Almada (1995) for *G. paganellus* and *G. cobitis*, with the smaller *G. paganellus*

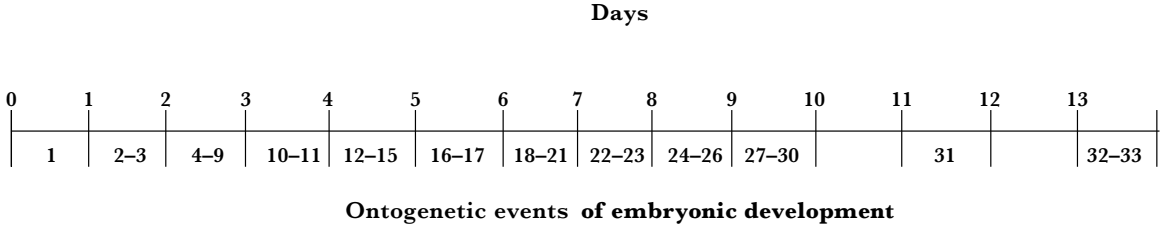

Figure 2. Ontogenetic events of embryonic development of *Gobius cruentatus* in order of first appearance: (1) embryo recognizable; (2) cephalic and caudal dilatation; (3) embryo reaches the margin of the yolk; (4) eye lens; (5) brain; (6) notochord differentiation; (7) tail bud free of the yolk; (8) myomeres; (9) gut differentiation; (10) brain lobes; (11) embryo movements; (12) auditory vesicles; (13) median fin fold; (14) embryo longer than egg major axis; (15) heart beating; (16) notochord; (17) mouth differentiation; (18) anus visible but closed; (19) pigmented eyes; (20) otoliths; (21) pectoral fin buds; (22) gas bladder; (23) mouth visible but closed; (24) anus opened; (25) hatching glands; (26) opercules visible but closed; (27) mouth opened; (28) liver differentiation; (29) opercules opened; (30) mandibles differentiation; (31) gut movements; (32) eye movements; (33) hatching.

presenting smaller eggs in a higher density. *Gobius cruentatus*, which is smaller than *G. cobitis* but larger than *G. paganellus* presented intermediate egg densities (85 eggs cm^{-2} for *G. cobitis*, 176 eggs cm^{-2} for *G. cruentatus* and 208 eggs cm^{-2} for *G. paganellus*).

Like other coastal species with demersal eggs, the newly hatched larvae of *G. cruentatus* showed the typical pattern of development of marine fish with male parental care (Thresher, 1984). The eyes and pectoral fins were fully developed at hatching with the larvae immediately swimming in an active way. The mouth and anus were opened, allowing the onset of exogenous feeding almost after hatching.

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