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Embryonic and larval development of the giant goby *Gobius cobitis* (Pisces: Gobiidae)

M. F. GIL†, E. J. GONÇALVES‡*, C. FARIA‡, V. C. ALMADA‡, C. BAPTISTA‡ and H. CARREIRO‡

†Aquário Vasco da Gama, R. Direita, Dafundo, P-1495 Lisboa, Portugal
‡Unidade de Investigação em Eco-Etologia, Instituto Superior de Psicologia Aplicada, R. Jardim do Tabaco 44, P-1100 Lisboa, Portugal

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Data are presented on the embryonic and larval development of *Gobius cobitis* (Pisces: Gobiidae). Embryonic development lasts from 15 days at 15°C to 17 days at 18°C. Larval development takes 37–44 days. Larvae begin to settle on the bottom at 1·3–1·4 cm total length. After five and a half months juveniles are about 5·5 cm total length.

KEYWORDS: *Gobius cobitis*, Pisces, early ontogeny.

Introduction

Gobius cobitis Pallas, 1811 is a very common inshore fish in the north-eastern Atlantic and in the Mediterranean (Miller, 1986). This giant goby has been the subject of several studies concerning its ecology, growth and feeding (Gibson, 1969; Wheeler, 1969; Gibson, 1970, 1972). Despite its abundance, reproduction of this species is poorly known. A description of the eggs was provided by Le Danois (1913) and Spartà (1950), who also described the early larvae. Gibson (1970) described the breeding habitat of this species in Brittany (West coast of France) and studied the relationship between fecundity and body size in females. Based on oocyte diameters he concluded that each female probably spawns at least twice in each breeding season. Faria and Almada (1995) described the breeding season and habitat of this species in Portugal, and provided notes on the total number of eggs guarded by each male.

In this paper, we present data on the embryonic and larval development of *G. cobitis*.

Materials and methods

Eggs and larvae were obtained from a captive pair of *G. cobitis* (male: 25 cm total length (TL); female: 18 cm TL) maintained for several years at a public aquarium (Aquário Vasco da Gama, Lisbon). Fishes were fed with fish meat and shrimp. The tank was illuminated with fluorescent light (60 W) from 09:00 h to 19:00 h, throughout the year. The bottom of the tank was covered with a layer of sand and several large stones were provided.

The sequence of embryonic development is based on a spawning that occurred on 15

*Author to whom correspondence should be addressed

February 1993 (temperature range: 12–16°C) on a vertical stone. A sample of eggs was removed daily from the stone by aspiration with a long pipette. They were observed under a Nikon stereomicroscope, photographed by a Nikon Fx-35DX camera and preserved in buffered 4% formalin.

Upon hatching, larvae were collected by aspiration and were reared in glass 17 l tanks. These tanks were subjected to a natural photoperiod with a supplement of fluorescent light (15 W) 24 h day^{-1}, and a constant flow of sea water was maintained. Larvae were fed twice a day with cultured *Brachionus* sp., which were mixed and subsequently replaced by *Artemia* sp. nauplii eight days after hatching.

The descriptions of larval development are based on eggs hatched at 10 February 1993 (temperature range: 13·5–17·5°C). Larvae were collected daily, and were subjected to the same procedure described for the eggs. Larval and juvenile survival was good, and several fishes reached sexual maturity and spawned in the aquarium.

Results

Embryonic development

The eggs correspond to the descriptions of Spartà (1950) and Gibson (1970). They are fusiform (length: mean = 3·59 mm, standard deviation (s.d.) = 0·07, range = 3·44–3·74 mm; width: mean = 1·18 mm, s.d. = 0·03, range = 1·11–1·26 mm; $n = 50$), pointed and yellowish, and are attached to the substratum by filaments.

Figure 1 presents the ontogenetic events of embryonic development. In Fig. 2 embryos collected at different developmental stages are shown.

Hatching occurred through a three day period (22–24 days after spawning) at 12–16°C. Another egg mass incubated between 14 and 31 March 1993 at a higher temperature (15–18°C), took only between 15 and 17 days to hatch. Hatching took about eight seconds (Fig. 2E). After sideways movements of the head, the egg capsules was ruptured at its apex. The larva adopted an 'S' posture and, with movements of the trunk, pushed itself out. When only the tail was left inside the egg, was this process assisted by pectoral fin movements.

Larval development

The newly hatched larvae measured *ca* 5·5 mm. The mouth and anus were open, the eyes were fully pigmented, the gas bladder was formed but was not full and the yolk was

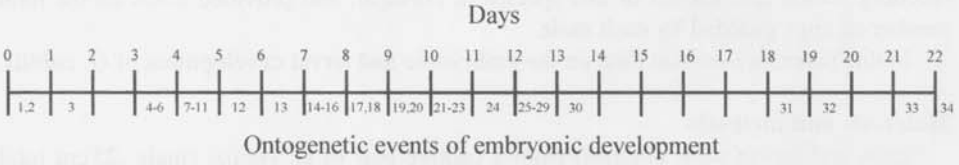

FIG. 1. Ontogenetic events of embryonic development of *Gobius cobitis* in order of first appearance: (1) cleavage process completed; (2) embryo recognizable; (3) cephalic and caudal dilatation; (4) embryo reaches the margin of the yolk; (5) optic vesicles; (6) brain; (7) eye lens; (8) tail bud free of the yolk; (9) gut; (10) somites; (11) notochord; (12) anus visible but closed; (13) embryo movements; (14) pigmented eyes; (15) heart beating; (16) anus open; (17) auditory vesicles and otholitis; (18) median finfold; (19) median finfold constriction near the tail; (20) pectoral fin buds; (21) embryo as long as egg major axis; (22) mouth differentiation; (23) gas bladder, (24) embryo longer than egg major axis (25) opercular differentiation; (26) mouth open; (27) jaws; (28) hatching glands; (29) liver; (30) opercular aperture open; (31) peristalsis; (32) eye movements; (33) hypurals rudiments; (34) hatching.

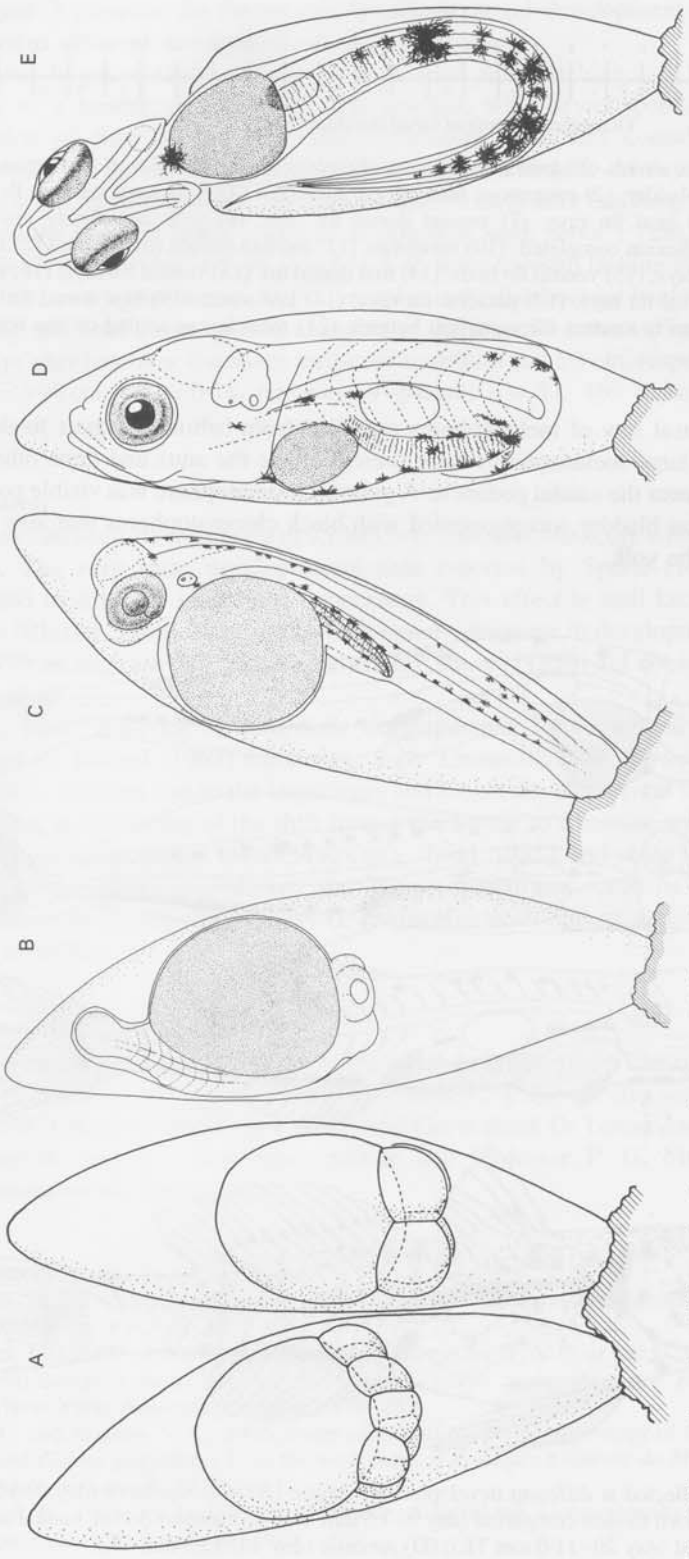

FIG 2. Eggs collected at different developmental stages: (A) four and eight cell stages (day 0); (B) embryo with tail bud free of the yolk (day 4); (C) embryo as long as major axis (day 10); (D) embryo prior to hatching (day 21); (E) hatching process (day 22).

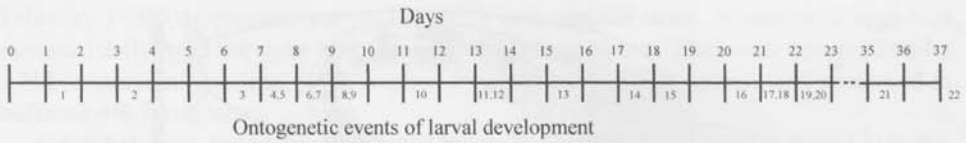

FIG. 3. Ontogenetic events of larval development of *Gobius cobitis* in order of first appearance: (1) filled gas bladder; (2) exogenous feeding; (3) hypurals; (4) notochord starts to flex; (5) gill arches; (6) anal fin rays; (7) second dorsal fin rays; (8) yolk completely resorbed; (9) notochord flexion completed; (10) vertebrae; (11) median finfold resorption; (12) segmented caudal fin rays; (13) ventral fin buds; (14) first dorsal fin; (15) ventral fin rays; (16) segmented second dorsal fin rays; (17) pectoral fin rays; (18) jaw teeth; (19) first dorsal fin rays; (20) larvae begun to contact the aquarium bottom; (21) most larvae settled on the bottom; (22) pelvic disc.

reduced. A ventral row of melanophores extended from behind the anus to the caudal peduncle. Two large melanophores were present above the anus and three others at the dorsal midline, near the caudal peduncle. A yellow chromatophore was visible posterior to the yolk. The gas bladder was pigmented with black chromatophores that also occurred scattered over the yolk.

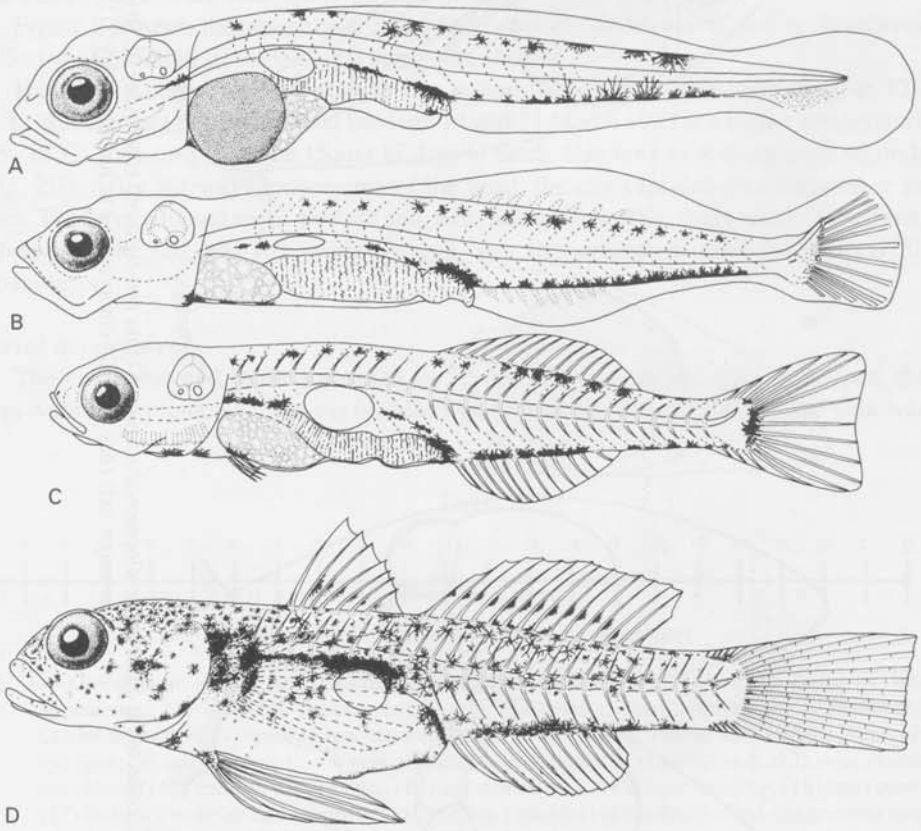

FIG. 4. Larvae collected at different developmental stages: (A) yolk-sac larva (day 0–5·5 mm TL); (B) notochord flexion completed (day 9–7·5 mm TL); (C) second dorsal, caudal and anal fin rays formed (day 20–11·0 mm TL); (D) juvenile (day 44–13·9 mm TL).

Figure 3 presents the ontogenetic events of larval development. In Fig. 4 larvae collected at different developmental stages are shown.

Larvae began to settle on the bottom 22 days after hatching at 1·3–1·4 cm TL. The change to a benthic mode of life was gradual, with larvae spending an increasing proportion of time on the substratum. Although there was considerable individual variation in the timing of metamorphosis, which occurred 37–44 days after hatching at *ca* 1·8 cm TL, most individuals became benthic 35 days after hatching. It is interesting to note that the smallest fishes collected in tidepools were about 1·7 cm (mean = 1·68 cm, s.d. = 0·17, range = 1·3–1·9 cm, $n = 64$), with some fish still lacking the juvenile general body shape and pigmentation. At metamorphosis the fish became heavily pigmented with the body and head shape quickly changing to the juvenile pattern (Fig. 4D). At 108 and 169 days after hatching, the fishes measured *ca* 4·0 cm and 5·5 cm, respectively (108 days: mean = 3·98 cm, s.d. = 0·78, range = 2·9–6·0 cm; $n = 37$; 169 days: mean = 5·45 cm, s.d. = 1·16, range = 3·2–8·1 cm, $n = 31$).

Discussion

The embryonic development described here contrasts markedly with the data of Spartà (1950). The very short developmental time reported by Spartà (10 days) could be explained by a higher incubation temperature. This effect is well known for many fish species (Blaxter, 1969). Here, we also observed a decrease in development time of seven days with an increase of 2·5°C. Unfortunately, Spartà (1950) did not indicate incubation temperature.

The basic sequence of embryonic developmental events agreed largely with that provided by Ballard (1969) for *Gobius niger* Linnaeus, 1758. However, the timing of events was different due to the larger eggs and longer developmental times of *G. cobitis*. Variability in the timing of the shift from a planktonic to a benthic way of life has been reported for many marine invertebrates (e.g. Todd, 1985), and some benthic fishes (e.g. *Ophioblennius atlanticus*, Nursall and Turner, 1985) and could be of great adaptive significance for benthic species like *G. cobitis* that must find an adequate substratum on which to settle.

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