

Further data on the reproduction and larval development of *Knipowitschia caucasica* (Gobiidae)

A. N. ECONOMOU, C. DAOULAS, T. PSARRAS AND R. BARBIERI-TSELIKI
National Centre for Marine Research, Ag. Kosmas, Hellenikon, 16604 Athens, Greece

(Received 28 September 1993, Accepted 6 November 1993)

The counting, spawning and parental care behaviours of *Knipowitschia caucasica* (Kawrajsky) in an aquarium are described, and the earliest stages of ontogenetic development are illustrated.

Key words: *Knipowitschia caucasica*; spawning behaviour; eggs; larvae; Greece.

In a previous article (Daoulas *et al.*, 1993), we described field-caught larvae of *Knipowitschia caucasica* (Kawrajsky), 5 mm s.l. and larger, from Lake Trichonis (Greece). In this article, additional material on the breeding behaviour and earliest stages of development of this gobiid species is presented.

Three adult *K. caucasica* (one male and two females) were fished from Lake Trichonis on 4 December 1992 and reared in a 80-l tank capacity along with *Economidichthys pygmaeus* (Holly) and *E. trichonis* Economidis & Miller. Pieces of reed on the bottom of the tank served as nests. Each reed was torn longitudinally in two pieces fastened together by an elastic band, which allowed them to be opened from time to time for sampling and observation of the developing embryos. Rearing procedures are described by Daoulas *et al.* (1993).

In March 1993, the male assumed breeding pigments and established a territory in the inner cavity of a reed. The pigments consisted of a bright blue spot on the first dorsal fin, dark pigment on the pelvic fins and a silver hue on the anal fin, and were maintained up to the death of the fish. Only one female was in reproductive condition. One to two days before spawning the female assumed breeding colourations, consisting of two intensely pigmented black areas on the first dorsal fin, a black spot on the lower jaw, two rows of

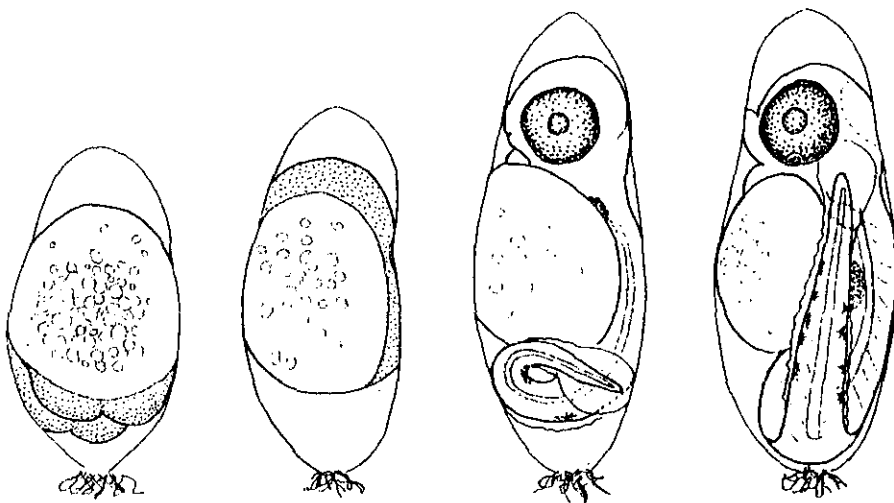


FIG. 1. Eggs of *K. caucasica* in various developmental stages.

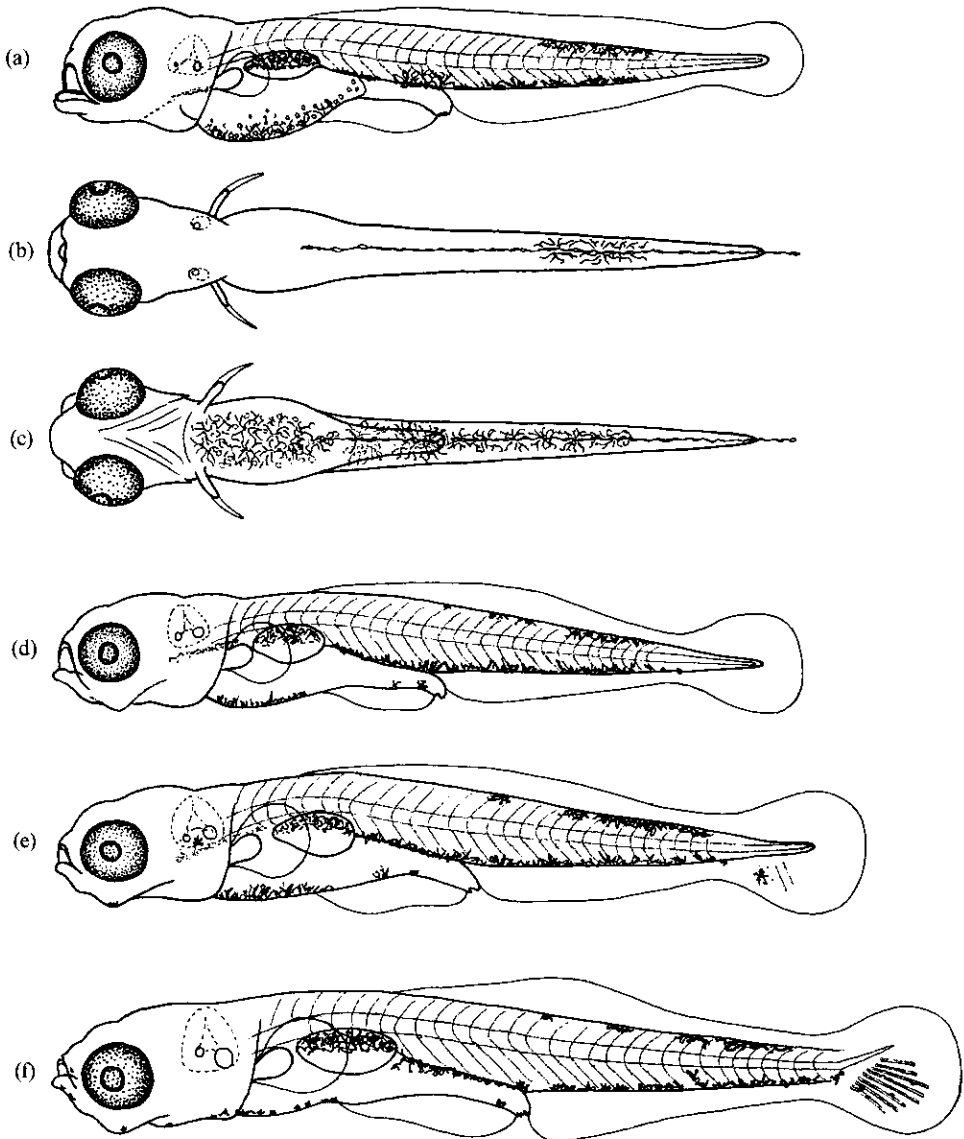


FIG. 2. Morphological development of *K. caucasica* larvae. (a), (b) and (c) lateral, dorsal and ventral view of an embryo 4.3 mm, day 1 from hatching; (d) larva 4.3 mm, day 3; (e) larva 4.7 mm, day 5; (f) larva 5.1 mm, day 9.

melanophores running obliquely from the eyes to the upper jaw and yellow pigment covering the abdominal region. The female died on 30 May and the male a few days later.

The male performed frequent exits to invite the female for spawning. Typically, he approached the female from below, touched with its snout the lower jaw of the female, and then returned to the reed, usually followed by the female. However, in only a few cases did the female enter the reed, remaining inside for no more than 3 s. This courting behaviour was repeated numerous times for intervals lasting from several hours to more than 1 day. Finally, the female stayed inside the reed and initiated spawning in an inverted position, the eggs being attached to the 'ceiling' of the reed.

During spawning, the female moved slowly along a line from the inner to the outer side of the reed. While the female deposited the eggs, the male lay with its back on the back of the female. After spawning was completed, the female remained for a while near the outer side of the reed waiting for the male to run alone along the same line, ventral side of the body upwards, presumably in order to fertilize the eggs. Then the female, accompanied by the male, moved back again to resume spawning along another line. Spawning took about 1.5 h, during which time the female breeding colours lost their brightness. Within 1 day, almost all the female breeding pigments had disappeared.

Over a period of about 35 days the two fish mated four times. The first spawning probably occurred on 28 March, the second on 6 April, the third on 14 April and the fourth on 2 May. The male ate the eggs of the second and third spawnings, and for this reason, the male was taken away from the nest 2 days after the last spawning. However, fungus soon developed, which ultimately killed the embryos before they hatched. After each spawning, the male remained inside the reed aerating the eggs and defending the nest, chasing all other gobies approaching the site. At irregular intervals (8–60 min), the male performed short exits, lasting 1–5 min, during which time he remained near the reed, and occasionally fed, never moving away from the nest.

Each spawning batch consisted of about 80–100 eggs. The eggs were cylindrical, 2.3×0.9 mm, shaped like those of *E. pygmaeus*, but the embryos were differently pigmented (Fig. 1). Only 50 eggs of the first spawning were successfully hatched after 6 days of incubation at 18°C. The morphological development of larvae is shown in Fig. 2. At hatching, the larvae measured about 4.1 mm and had large branched melanophores on the yolk, on the dorsal side of the swimbladder, on the preanal region, and postanally along a row. They were clearly distinct from *E. pygmaeus* larvae (Daoulas *et al.*, 1993) from the absence of head and dorsal pigment except a single, large, branched melanophore dorsally near the tail. However, there were traces of dorsal melanophores on the second half of the body, which became more prominent during the next 2 days of development, gradually forming a short dorsal row.

The swimbladder filled within 1 day and the yolk sac was absorbed within 3 days. On day 5, first ray development in the hypoural region was observed in a larva 4.7 mm long. The first sign of the upward upturning of the end of the notochord was noted on day 8, at about 4.9 mm. Flexion was well under way on day 10 (5.2 mm), and in at least one larva, it was completed on day 12 at 5.4 mm. Thickening of the primordial fin in the anal region and development of interspinous anal fin rays was noted on day 11 (5.3–5.5 mm). Subsequent stages of development, as well as characters differentiating the *K. caucasica* from the *E. trichonis* larvae, have been discussed by Daoulas *et al.* (1993).

Reference

- Daoulas, Ch., Economou, A. N., Psarras, Th. & Barbieri-Tseliki, R. (1993). Reproductive strategies and early development of three freshwater gobies. *Journal of Fish Biology* **42**, 749–776.