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BRIEF COMMUNICATIONS

Larvae of *Crystallodytes pauciradiatus* (Perciformes: Creediidae) from Easter Island, South Pacific

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Larvae of *Crystallodytes pauciradiatus* (Creediidae) are described from 47 individuals (2·9–21·3 mm). They are elongate, slender, lightly pigmented, have prominent preopercular spines and unique small spines on the lower jaw. Early stages are restricted to the nearshore water around Easter Island, South Pacific.

Key words: *Crystallodytes pauciradiatus*; Easter Island; larvae; South Pacific.

Members of the family Creediidae are small, elongate and nearly transparent, burrowing marine fishes found in coastal waters of tropical to temperate regions of the Indian and Pacific Oceans (Randall *et al*., 1997; Reader & Neira, 1998; Reader *et al*., 2000). They have a fleshy projecting snout, and long, spineless dorsal and anal fins (Randall *et al*., 1997). The family contains seven genera and 16 species (Nelson, 1985; Nelson & Randall, 1985). Most species live in the nearshore waters of continents or large land masses, such as Africa, Australia, Japan and New Zealand, whereas a few live in distant oceanic islands such as Hawaii and Easter Island (Nelson, 1978; Yoshino *et al*., 1999).

The reproduction and development of creediids have been studied in only a few species. The two species from Hawaii, *Limnichthys donaldsoni* Schultz and *Crystallodytes cookei* Fowler have been reported to be protandrous hermaphrodites that spawn pelagic eggs over an extended spawning season (R.C. Langston, pers. comm.). The eggs of the same two species are pelagic, measuring 0·78 and 1·03 mm in diameter, respectively, and have several oil globules, smooth chorion, unsegmented yolk and narrow perivitelline space (Leis, 1982). Creediid larvae, known from five species (Leis & Rennis, 1983; Reader & Neira, 1998; Reader *et al*., 2000), are elongate and laterally compressed, have a relatively moderate

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to long intestine with striations, and a preanal distance ranging from 45 to 60% of body length (BL). Following Neira *et al.* (1998) BL corresponds to notochord length (L_N) in preflexion and flexion larvae and to standard length (L_S) in postflexion larvae. A larval specialization is the presence of unique preopercular spination that is lost during development. They also show an elongate snout that flattens by the end of the flexion stage. The larvae develop small villiform teeth along both jaws (Leis, 1982; Reader *et al.*, 2000).

The genus *Crystallodytes* comprises two nominal species, *Crystallodytes pauciradiatus* Nelson & Randall, endemic to Easter Island, and *Crystallodytes cookei*; the latter includes the subspecies *Crystallodytes cookei cookei* Fowler from Hawaii and *Crystallodytes cookei enderburyensis* Shultz from Enderbury Island (Phoenix Islands) and Tau Island (American Samoa) in the South Pacific (Nelson & Randall, 1985).

In this paper, the larvae and distribution of *C. pauciradiatus* are described using specimens collected around Easter Island. The larval characters are compared with those present in *C. cookei*, from Hawaii, and in other creediids.

A total of 47 larvae were obtained during an oceanographic expedition (CIMAR-5) to Easter Island (27°10′ S; 109°20′ W), on November 1999. Samples were collected onboard the Chilean Navy vessel AGOR Vidal Gormaz using a bongo net (0·6 m diameter, 3 m long, 350 μm mesh) equipped with OSK flowmeters. A total of 10 stations located 1852 m (1 nautical mile) from the shore were sampled during day and night. The samples were taken in oblique tows from 400 m depth, or from close to the bottom in shallow stations. Additionally, four transects perpendicular to the island with four stations each, were sampled at 3, 7, 12 and 20 nm from the shore (Castro & Landaeta, 2002). Samples were preserved in 10% formalin. The abundance of larvae was expressed as individuals per 1000 m^3. The terminology used for morphometric measurements follows Neira *et al.* (1998). Measurements were made to the nearest 0·1 mm using a dissecting microscope. Measurements of body depth (BD), head length (HL), and preanal length (PAL) were converted to percentage (%) of BL (Table I); ranges and means ± S.D. are also given.

The positive identification of late postflexion larvae of *C. pauciradiatus* was confirmed by using data of fin meristics of adults available in the literature, whose combination is found only in this species in Easter Island (D 30–32; A 34–36; C 8 branched; P_2 I, 5; Nelson, 1985).

The larvae of *C. pauciradiatus* [Fig. 1(a)–(e)] are elongate throughout development (BD 7·6–8·5% BL, Table I), becoming gradually more compressed during and after inflexion (BD >8·4% BL). The head is relatively small initially (HL 16–20% BL), but increases during flexion stage (Table I) when the snout flattens and elongates (from *c.* 8% HL at 2·9 mm to 37% HL at 20 mm BL). Teeth appear toward late preflexion stages, at *c.* 6·5 mm BL. Eyes are round and pigmented in the smallest larva examined (2·9 mm). The gut is moderate to long (PAL 48–58% BL), straight and tubular. During postflexion, the gut develops striations [Fig. 1(c)]. In larger individuals, usually >19 mm L_S, the first anal rays may become displaced to the right side of the posterior end of the intestine. The smallest and largest larvae undergoing inflexion measured 9·5 and 10·7 mm, respectively, whereas the smallest postflexion larva measured 11·9 mm BL (Table I). An inflated gas bladder was noticeable in larvae >10 mm BL, especially

TABLE I. Range of body length (notocord length in preflexion and flexion larvae, and standard length in postflexion larvae) and range and mean ± S.D. of body proportions (as a percentage of body length) of *Crystallodytes pauciradiatus* larvae. *n*, sample size

	Preflexion ($n=8$)	Flexion ($n=4$)	Postflexion ($n=35$)
Body length (BL) (mm)	2·9–6·8	9·5–10·7	11·9–21·3
Head length (HL) (%BL)	10·0–23·2	19·0–22·5	14·1–23·6
	16·8 ± 4·9	20·8 ± 1·5	19·5 ± 2·0
Eye diameter (%HL)	23·1–36·4	19·1–21·1	13·2–19·2
	29·4 ± 4·7	19·8 ± 0·9	16·3 ± 1·4
Snout length (%HL)	7·7–28·6	31·7–36·8	26·3–39·3
	18·1 ± 7·3	34·0 ± 2·1	33·4 ± 2·6
Body depth (%BL)	5·4–8·9	7·0–9·3	5·5–9·5
	7·6 ± 1·2	8·5 ± 1·0	8·4 ± 0·8
Preanal length (%BL)	46·2–57·1	56·0–61·5	38·5–56·0
	53·6 ± 3·6	57·8 ± 2·6	48·2 ± 3·7

in those that were caught at night. Scales on the lateral line were absent in the largest larva examined (21·3 mm BL).

Vertebral counts range from 50 to 53 in *C. pauciradiatus* (Nelson, 1985); approximately similar counts were found in larval myomeres; 18–22 preanal and 28–32 postanal, 49–54 total.

Between 13 and 15 small spines develop on the posterior and ventral margins of the preopercular bone in the smallest specimens examined; they increase to 19–20 at inflexion [Fig. 1(a)–(d)]. The dorsal-most two spines are longer than the rest and extend from a common posterior projection of the preopercular bone. In the advanced postflexion stages (*i.e.* >17 mm BL), these spines begin to disappear, first from the posterior edge (usually >18 mm BL) and later from the postero-ventral margin of the preoperculum (after 19 mm BL); the last ones to disappear (>20 mm BL) are the two larger on the posterior projection of the preopercular bone and those in the antero-ventral margin [Fig. 1(d)–(e)]. This loss does not occur at the same size in all individuals.

A series of ventrally oriented villiform spines develop during preflexion stages on the inferior margin of the lower jaw, on the dentary bone [Fig. 1(b)–(d)]; these are lost during development in postflexion stages at >15 mm BL. As these structures disappear completely, they do not seem to be related to the cirri of the lower jaw reported for adults (Nelson & Randall, 1985).

Pectoral fin show signs of late development as rays have not yet formed by 21 mm BL. Caudal-fin rays begin to form by 9 mm, prior to notochord flexion. Caudal formula of 6 + 5 principal rays is defined by 11 mm BL. The dorsal and anal fin anlagen appear during inflexion (*c.* 9 mm BL); dorsal and anal rays begin to develop from the middle of the fin in both directions, and are fully developed at *c.* 13 mm. The first anal rays may become displaced to the right side of the posterior end of the intestine in larger specimens, as it occurs in the congeneric *C. cookei* (Leis, 1982). This displacement is not recorded in all large specimens; when it occurs, however, it is observed in the size range between 17

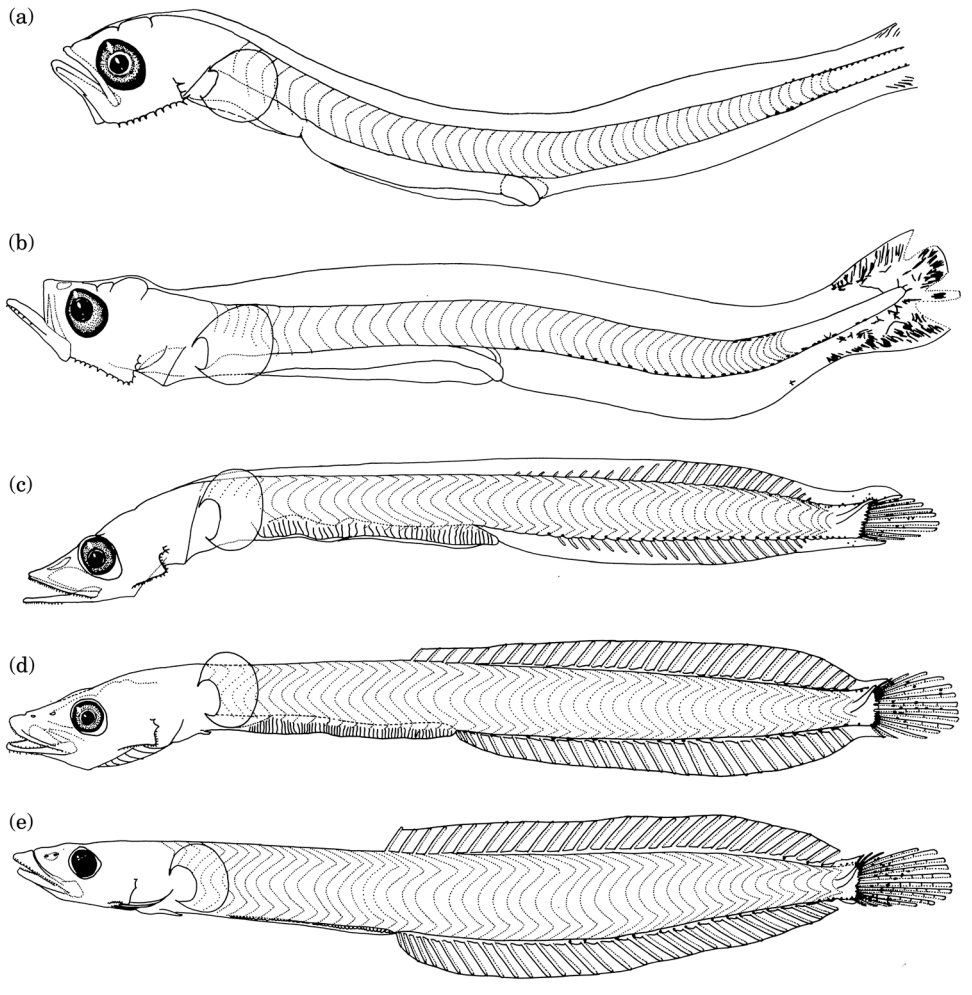

FIG. 1. Larvae of *Crystallodytes pauciradiatus* from Easter Island: (a) damaged early preflexion larva (3·3 mm L_N, to the point where the tail is cut), (b) preflexion larva (5·4 mm L_N), (c) early postflexion larva (9·8 mm L_S), (d) postflexion larva (13·7 mm L_S) and (e) postflexion larva (18·9 mm L_S).

and 21 mm BL. Minute pelvic fins buds appear at 12 mm; pelvic fins remain small in all larvae and no rays are observed in all specimens.

Pigmentation is initially limited to the posterior portion of the caudal fin fold. During preflexion small melanophores develop dorsally and ventrally along the posterior tail and caudal peduncle. At *c.* 5 mm BL, a series of 20–30 melanophores develop ventrally along the margin of the tail, beginning at myomeres 20–25. After inflexion, pigmentation becomes restricted to the ventral margin of the tail between the pterygiophores of the anal fin, one or two melanophores on the dorsal or ventral margin of the caudal peduncle, and a few melanophores scattered between the caudal fin rays.

The average abundance of *C. pauciradiatus* larvae around Easter Island was 16 individuals per 1000 m^3, ranging from 3 to 43 individuals per 1000 m^3 in

positive stations. Almost all larvae were found in the stations at 1852 m from shore; the only exception was a single individual collected at a station located 3 nm from shore in the southern area (Fig. 2). This pattern has been observed in other larval creediids (Leis, 1982) and in most coastal shallow water species from Easter Island (Castro & Landaeta, 2002; Landaeta *et al.*, 2002, 2003). There were no differences between the larval abundance on the leeward (south-east) and windward sides of the island, nor in larval abundance from day and night catches (Kruskal–Wallis test, $P > 0{\cdot}05$). Also, there were no significant differences in larval sizes from samples collected during day or night (Kolgomorov–Smirnov test, $P > 0{\cdot}05$).

Among the species that occur in Easter Island, the larvae of *C. pauciradiatus* are most likely to be confused with those of the percophids *Dactylopsaron dimorphicum* Parin & Belyanina and *Osopsaron karlik* Parin, and the schindlerid *Schindleria praematura* (Schindler) (Castro & Landaeta, 2002), especially in early stages. The larvae of these species share a similar elongate body shape with little or no pigment. Both percophids, however possess fewer myomeres (32–35), elongated pelvic fins and, in the case of *D. dimorphicum*, digitiform opercular processes (Landaeta *et al.*, 2003). Larval *S. praematura* have 13

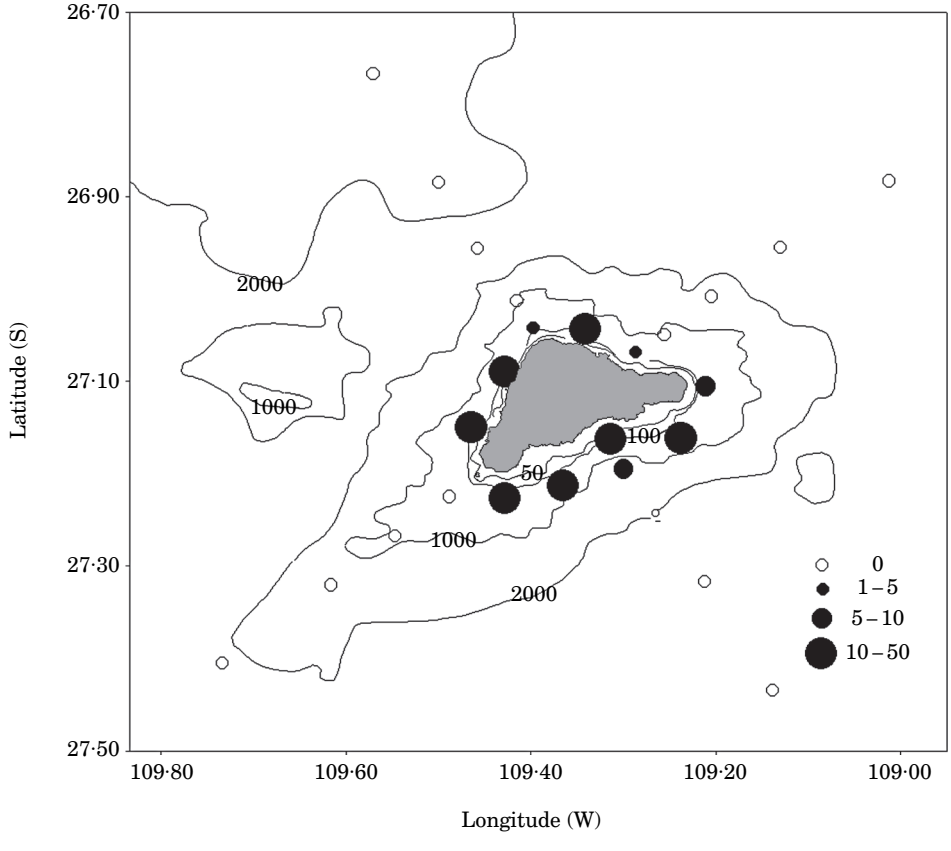

FIG. 2. Horizontal distribution of *Crystallodytes pauciradiatus* larvae around Easter Island during November 1999. Larval density expressed as individuals per 1000 m^3.

segmented caudal rays and inflexion occurs at a very small size (*c.* 3·5 mm) (Leis & Trnski, 1989; Landaeta *et al.*, 2002).

The larvae of *C. pauciradiatus* show some of the main characters observed in those of other creediid genera, such as an elongate body, long dorsal and anal fins, long striated gut, and prominent preopercular spination. Besides these, they show a series of unique features. They develop spines on the lower jaw in preflexion stages, which disappear during late postflexion stages. Furthermore, they show preopercular spines throughout most of the development; they lose them at larger sizes compared to species of the genera *Creedia*, *Schizochirus* and *Limnichthys* (Reader *et al.*, 2000).

There are developmental features shared by the two species of *Crystallodytes* that may be related to larval duration and pelagic dispersal potential, features that are absent in other creediid larvae. First, both species have larvae that reach remarkably large sizes; their maximum sizes recorded are 21·3 mm L_S in *C. pauciradiatus* and 14·8 mm L_S in *C. cookei* (Leis, 1982; a maximum size for larval *C. cookei* was not given). Second, at these sizes, scales have still not developed in both species, whereas in other creediid larvae they form (and reached the transformation stage) between 8 and 10 mm BL, as it is recorded in species of *Creedia*, *Limnichthys* and *Schizochirus* (Reader *et al.*, 2000). Although there are no data about actual age of the larvae, the differences in size and scale formation are so remarkable that suggest differences in larval duration. This feature needs to be confirmed using an age estimation method, such as daily increment counts in otoliths.

The features outlined are consistent with a prolonged larval life and may be related to their presence in distant oceanic islands such as Easter Island (*C. pauciradiatus*), Hawaii (*C. cookei cookei*), Phoenix Islands and American Samoa (*C. cookei enderburyensis*). Although the larvae of these species have not been recorded from open ocean waters, the presence of large (and probably long-lived) larvae still represents as an attribute with potential for pelagic dispersal.

Certainly one of the most remarkable features in the ontogeny of *C. pauciradiatus* relates to its adult and larval sizes. As adults, creediids reach lengths of 50–75 mm L_S, whereas their larvae rarely exceed 10–12 mm. In contrast, adults of *C. pauciradiatus* are comparatively smaller, *i.e.* 27–35 mm L_S (Nelson & Randall, 1985), whereas their larvae can reach >21 mm BL.

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