BULLETIN OF MARINE SCIENCE, 77(2): 201–207, 2005

FIRST DESCRIPTION OF LARVAE OF *BATHYLAGICHTHYS PARINI* (PISCES, BATHYLAGIDAE) FROM THE SOUTHEASTERN PACIFIC

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ABSTRACT

The early stages of development of *Bathylagichthys parini* Kobyliansky, 1990 are described for the first time on the basis of 69 larvae collected in the fjords of Chilean Patagonia. Morphometric and meristic data were obtained from a series of larvae between 5.3 and 25.4 mm in body length. Data are presented on the development of pigmentation patterns and the sequence of fin formation. The total number of vertebrae, fin rays, and branchiostegal rays in the more developed larvae coincided with those observed in adults of *B. parini* described for the Pacific Ocean bordering Chile, and *Bathylagichthys australis* Kobyliansky, 1990 from the south central Pacific and Indian oceans. Comparative details of the development of the supraorbital bone in relation to the orbit are useful in separating both species, as this characteristic in the transforming specimen described here is consistent with *B. parini*. Larvae of *B. parini* are differentiated from other species of Bathylagidae in the region by having elliptical eyes with ventral choroid tissue in the form of a teardrop and three branchiostegal rays instead of two. Also, they develop non-pedunculate eyes. Adults of *B. parini* have been recorded from the SE Pacific at 42°59´S, 80°15´W and also from fjords of southern Chile.

Two species of *Bathylagichthys*, *Bathylagichthys parini* Kobyliansky, 1990 and *Bathylagichthys australis* Kobyliansky, 1990, have been added to the list of Bathylagidae species that occur in the SE Pacific Ocean bordering Chile and in the south central Pacific and Indian oceans, respectively (Pequeño 1989, 1997; Kobyliansky, 1990). This genus was created on the basis of a phenetic analysis (Kobyliansky, 1990). While some authors ascribe *Bathylagichthys* to the genus *Bathylagus* (Olivar et al., 1993), Eschmeyer (2005) recognized *Bathylagichthys* as a valid genus.

Early developmental stages are known for most of the bathylagid species recorded from the Pacific Ocean (Ahlstrom et al., 1984; Moser and Ahlstrom, 1996); however, the early stages of the more recently recorded *Bathylagichthys* species have not been described. The objectives of the present study are to describe the larvae of *B. parini*, and to identify the characteristics that differentiate these larvae from those of other bathylagid species found off the coast of Chile.

Materials and Methods

Larvae were obtained from plankton samples collected in October and November 1995 and 1996 at stations located from Reloncavi Sound (41°32´S, 72°57´W) to Smyth Channel (52°45.10´S, 73°48.5´W) in southern Chile. Collections were made using a 60 cm diameter Bongo net, with a mesh opening of 0.35 mm. Oblique hauls were made from 200 m to the surface, or off-bottom to the surface at shoaler stations. Samples were fixed in 5% neutralized seawater formalin upon collection.

Observations and measurements of the specimens were carried out using a stereoscopic microscope fitted with an eyepiece micrometer. Drawings were made with the aid of a camera lucida. Body parts and measurements mentioned here are defined in Moser (1996). Larvae representative of successive stages in early larval development were selected from a total of

69 larvae measuring 5.3–25.4 mm in body length (BL). A group of 33 larvae was stained with alizarin red-S following the method of Hollister (1934) to obtain meristic data and observe cephalic osteology. Body parts and measurements were related to BL and head length (HL) using linear regression analysis. Present allocation of species of Bathylagidae is based on Eschmeyer (2005).

Results

Morphology and Morphometrics.—The larvae were characterized by having peculiar choroid tissue, situated below the eye as a teardrop-shaped projection; this regressed after the larvae reached 21 mm BL. The eyes were elliptical in larvae < 21 mm BL, later assuming a rounded shape (Fig. 1). The eyes never displayed elongated peduncles typical of some bathylagid species. The larvae were elongated with a long gut (85% BL). Transverse rugae were observed in the hindgut of larvae from 10.7 to 20 mm BL. They were in the preflexion stage between 5.3 and 12.9 mm BL, flexion stage from 13.0 to 18.6 mm, and postflexion > 19.4 mm. The staining process permitted distinguishing the supraorbital bone in individuals beginning at 17.5 mm BL. This extended from the level of the anterior edge to slightly behind the level of the posterior edge of the orbit (Fig. 2).

Ranges for morphometric data (Table 1) are: snout length 20.3%–36.9% HL; eye diameter 13.2%–30.5% HL; eye depth 12.2%–36.6% HL; head length 16.4%–28.6% BL; predorsal distance 44.8%–52.9% BL; prepelvic distance 48.9%–59.8% BL; body depth 6.1%–16.1% BL; preanus length 70.4%–93.1% BL. Percentages of snout length, head length, preanus length, predorsal distance, and prepelvic distance did not show any tendency with larval development. Percentage of eye depth decreased with larval development. Percentages of eye diameter were higher in the smaller and larger larvae. Percentage of body depth increased with larval growth.

Regression analysis showed that most of the larval structures in relation to HL or BL had an acceptable fit to a simple linear model ($r^2 > 0.81$). Larvae between 21.5 and 25.4 mm showed a slight deviation from linearity with higher positive residuals in the case of eye depth, eye width, head length, and body depth, and higher negative residuals in the case of preanus length.

Pigmentation.—Melanophores were punctate or stellate, with some located in the same relative position throughout the entire larval period. Dorsal head pigment was observed mainly in 21.4–25.4 mm BL larvae. Some larvae had pigment spots around the eye. Beginning at 9.3 mm BL, all larvae had pigment on the maxillae, and on the lower jaw in some cases. Between 5.5 and 8.8 mm BL the choroid tissue had one or two pigment spots, and at 10 mm BL it became entirely pigmented. Beginning at 9.3 mm BL, melanophores were observed in the opercular-preopercular region. Pigmentation on the isthmus was observed in some larvae at 8.8 mm BL, and was present in all larvae over 10 mm BL, arranged in two irregular rows of 12–14 spots.

Larvae between 6.2 and 20.4 mm BL had melanophores on the ventral region below the heart, while in more developed larvae and juveniles, a dense, dark coloration appeared in this region. Beginning at 6.2 mm BL, pigmentation was observed on the sides of the body, evenly distributed from the level of the pectoral fin, or from mid-body, to the caudal region. In a transforming larva (25.4 mm BL) dorsal pigment extended from the hindbrain to below the dorsal fin base. In small larvae gut pigmentation was sparse and irregularly distributed, but in larvae > 7.8 mm BL a continuous lateral row of widely spaced melanophores was present. At 21 mm BL,

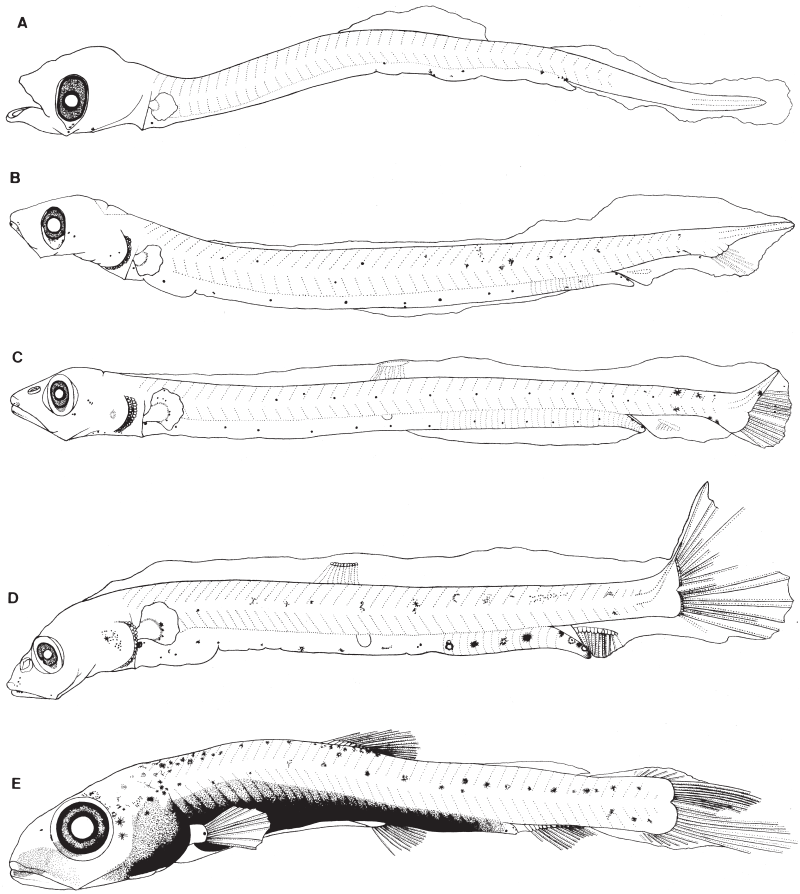

Figure 1. Larval stages of *Bathylagichthys parini*. (A) 5.5 mm BL; (B) 10.7 mm BL; (C) 15.0 mm BL; (D) 19.4 mm BL; and (E) 25.4 mm BL transforming specimen.

initiation of juvenile pigmentation was observed in the gut. All the larvae had a few spots below the base of the pectoral fin; pigmentation on the fin blade was variable in larvae of 9.7–15 mm BL, but was consistently present in larger specimens. Some larvae had pigment spots at the base of the caudal fin and between the caudal fin rays, but not between the rays of the pelvic, dorsal, or anal fins.

Formation of Fins, and Meristic Characters.—Pectoral fins were present in all larvae, but rays were formed only in larvae > 21 mm BL. At 21.5 mm BL, all 10 pectoral-fin rays were completely formed. Of the remaining fins, the first to appear was the caudal: the hypural complex was distinguishable at 7.8 mm BL, with initial ray formation at 9.3 mm BL. All principal rays (10 + 9) were forming at 14.3 mm BL, and these were completely formed at 16.2 mm BL. At 22.5 mm BL, 7 + 7 procurrent rays were visible. At 10.4 mm BL, the anlage of the anal fin was observed at a small distance from the ventral contour of the body in the median finfold, at myomere 40. This fin was completely developed at 21.5 mm BL, had 12 rays, and originated at myomeres 33–34. The anlage of the dorsal fin in the median finfold was visible at 14.2 mm BL, connected to the trunk by hyaline strands, and originated at myomere 18. The dorsal fin was completely formed at 21.6 mm BL with 14 rays, at the level of

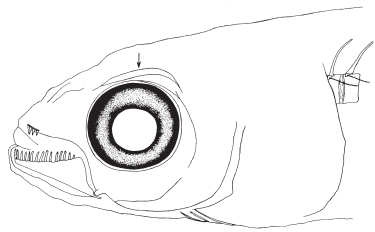

Figure 2. Supraorbital bone in a 25.4 mm BL transforming specimen of *Bathylagichthys parini* (arrow).

myomere 16. The pelvic fin was the last to form, at 12.5 mm BL, as small buds located just between the trunk and the upper part of the gut at the level of myomeres 19 and 21 (Fig. 1C). At 21.6 mm BL this fin had 10 rays and developed at myomere 18.

The total number of vertebrae, 47 in the most developed larvae, is the number observed in adults (Table 2). The lower number of vertebrae in larvae < 11 mm BL reflected lack of staining of the postanal vertebrae. The number of preanal vertebrae decreased after 20.3 mm BL and the number of postanal vertebrae increased during larval growth due to migration of the anus. Three branchiostegal rays could be counted in specimens 16.2 mm BL (Fig 2).

Table 1. Morphometric data (mm) on selected larvae of *Bathylagichthys parini*.

Stage	Body length	Snout length	Eye width	Eye depth	Head length	Predorsal length	Preanus length	Prepelvic length	Body depth
Preflexion	5.3	0.4	0.3	0.4	1.1	-	4.3	-	0.5
	6.2	0.4	0.3	0.4	1.2	-	5.6	-	0.5
	7.2	0.3	0.3	0.4	1.2	-	5.9	-	0.5
	7.8	0.3	0.3	0.4	1.3	-	6.0	-	0.5
	8.3	0.5	0.4	0.5	1.8	-	6.7	-	0.7
	8.9	0.6	0.4	0.5	1.9	-	7.9	-	0.9
	9.4	0.6	0.4	0.5	2.0	-	8.1	-	0.8
	10.6	0.5	0.4	0.5	2.0	-	9.1	-	0.9
	11.0	0.8	0.5	0.6	2.5	-	9.7	-	1.2
	11.9	0.7	0.4	0.6	2.4	-	10.8	-	1.1
	12.5	0.8	0.4	0.6	2.4	-	11.2	6.7	1.1
Flexion	12.9	0.5	0.4	0.5	2.2	-	11.4	7.3	0.9
	13.3	0.8	0.4	0.5	2.5	-	11.2	7.1	1.1
	14.3	0.9	0.6	0.7	3.1	7.3	12.9	8.0	1.7
	15.5	0.9	0.5	0.6	2.9	7.6	13.6	8.5	1.4
	16.8	1.0	0.5	0.7	3.1	8.7	15.2	8.9	1.8
	17.7	1.2	0.6	0.8	3.4	8.8	16.2	9.7	1.7
	18.6	1.2	0.8	1.0	4.0	9.5	16.3	10.3	2.3
Postflexion	19.4	1.2	0.6	0.8	3.5	8.7	17.1	9.9	2.2
	20.4	1.0	0.6	0.8	3.6	9.9	17.4	10.6	1.8
	21.5	1.2	1.4	1.3	5.1	10.1	17.0	11.7	2.9
	22.5	1.2	1.4	1.3	5.3	11.6	18.0	11.3	2.9
	25.4	1.9	2.2	2.1	7.3	12.9	21.0	14.3	4.1

Table 2. Meristic data of selected larvae and adults of *Bathylagichthys parini*. Principal and procurrent caudal fin rays grouped in brackets. Vertebrae (preanus + postanus).

Body length (mm)	Fin rays					Branchiostegal rays	Vertebrae
	Caudal	Pelvic	Pectoral	Dorsal	Anal		
5.5							40 + 2
6.2							38 + 5
7.8							40 + 2
9.4	(3 + 2) (0 + 0)						40 + 3
9.7	(3 + 2) (0 + 0)						40 + 5
10.0	(4 + 2) (0 + 0)						40 + 5
10.3	(4 + 3) (0 + 0)						39 + 4
11.0	(6 + 5) (0 + 0)						40 + 6
11.8	(6 + 5) (0 + 0)						40 + 5
12.5	(5 + 5) (0 + 0)						40 + 5
12.9	(9 + 8) (0 + 0)						40 + 6
13.3	(9 + 8) (0 + 0)						40 + 5
13.8	(9 + 7) (0 + 0)						40 + 5
14.1	(9 + 9) (0 + 0)						39 + 6
14.3	(10 + 9) (0 + 0)						40 + 5
16.2	(10 + 9) (0 + 0)				6	3	38 + 6
17.4	(10 + 9) (0 + 1)				6	3	39 + 6
19.4	(10 + 9) (0 + 1)				9	3	39 + 7
20.0	(10 + 9) (1 + 2)				10	3	40 + 6
20.3	(10 + 9) (2 + 3)				11	Damaged	40 + 7
21.5	(10 + 9) (3 + 5)	8	10	13	12	3	31 + 16
22.5	(10 + 9) (7 + 7)	9	10	14	12	3	32 + 15
25.4	(10 + 9) (7 + 7)	10	10	14	12	3	31 + 16
Adult*		9–10	10	12–14	11–12	3	47
Adult**		10	11	12–13	11	3	

*Kobyliansky (1990)
**Pequeño and Matallanas (2003)

Discussion

The meristic characters of the larvae coincide with those of *B. parini* recorded from the SE Pacific and *B. australis* from the south central Pacific and Indian oceans. There are no differences between the meristic characters of these two species, except in the broader range in numbers of vertebrae in *B. australis* (47–50) in comparison with the 47 of *B. parini* (Kobyliansky, 1990). The two species differ in the length of the supraorbital bone (Kobyliansky, 1990): in *B. australis* this structure terminates before the level of the middle of the orbit, while in *B. parini* it extends past the posterior edge of the orbit as in larvae of 17.5 mm BL. The description of the genus *Bathylagichthys* was based on a comparative study of the osteology of bathylagid species (Kobyliansky, 1986). The characters distinguishing *Bathylagichthys* from other genera of the family are "the system of dermal trunk canals, the multicusped teeth on the dentary, the presence of a mesocoracoid and a tripartite postcleithrum in the pectoral girdle, and of a urodermal in the supporting skeleton of the caudal fin" (Kobyliansky, 1990).

The most important character for differentiating larval *B. parini* from early larvae of *Bathylagus antarcticus* Günther, 1878, *Bathylagus nigrigenys* Parr, 1931, *Bathylagus stilbius* (Gilbert, 1890), and *Melanolagus bericoides* (Borodin, 1929) from the SE Pacific is the presence of elliptical eyes, not pedunculated, with ventral choroid tissue in the form of a teardrop. *Bathylagus antarcticus* and *M. bericoides* have pedunculate eyes, while *B. nigrigenys*, and *B. stilbius* have round eyes (Ahlstrom et al., 1984; Moser and Ahlstrom, 1996). The choroid tissue is visible in larvae of *B. parini* of < 21 mm BL, the size at which the eye changes from elliptical to round. In late larvae, the presence of three, instead of two, branchiostegal rays (Ahlstrom et al., 1984; Kobyliansky, 1990; Pequeño and Matallanas, 2003), as observed in *B. parini* larvae of 16.2 mm BL, is also a morphological character not observed in the larvae of the other bathylagid species that occur off the coast of Chile. Bathylagid larvae from the region have more than 14 anal rays, except *B. stilbius*, which has 10–14. In larvae of *B. parini* 12 anal rays were counted, while the adults have 11–12 (Ahlstrom et al., 1984; Kobyliansky, 1990; Moser and Ahlstrom, 1996; Pequeño and Matallanas, 2003).

Other larvae known to have elongated choroid tissue belong to an as yet unidentified species of *Bathylagus* described from the Benguela Current (Olivar et al., 1993). Some characters of this species (type B) coincide with those of *B. parini* described here, such as the size at flexion of the notochord, the elliptical shape of the eye, elongated choroidal tissue, preanus length, and the number of anal fin rays. Some of the differences between these two species include the later formation of dorsal, anal, and pelvic fin rays, and the presence of pedunculate eyes in the larvae of *Bathylagus* type B. Descriptions of larvae of other species of *Bathylagichthys* are not known, so the presence of the particular larval character represented by the elongated choroidal tissue cannot yet be utilized for diagnosis of the genus.

The holotype and paratypes of *B. parini* were captured in the SE Pacific Ocean (42°59´S, 85°15´W), at depths of 20–70 m (Kobyliansky, 1990). The larvae here described were obtained in fjords of southern Chile at approximately the same latitude, but about 170 nmi east of the type location. The distribution of the larvae extends from 41°30´S to 54°53´S, from Reloncavi Sound to the Beagle Channel (Bernal and Balbontin, 1999, 2003); initially identified as Bathylagidae (Balbontin and Bernal, 1997). During oceanographic cruises carried out between 43°40´S and 46°30´S, the frequency of occurrence of these larvae in spring 1998 was 50%, whereas in the summer of 1999 it was only 3%. The average abundance in the spring was 13.4 larvae 10 m^{-2} of sea surface, whereas in the summer it was 0.3 larvae 10 m^{-2} (Balbontin and Bernal, in press), suggesting that this species reproduces seasonally in the austral channels between the gulfs of Corcovado and Elefantes. Three adults of the species were also caught in these channels (Pequeño and Matallanas, 2003), thus expanding the species' range southward and placing it within the influence of the Antarctic Circumpolar Current (Orsi et al., 1995).

Acknowledgements

We thank S. Palma for collection of the ichthyoplankton samples during the cruises. We also thank G. Moser for critically reading an earlier version of the manuscript. The comments of three anonymous reviewers are also acknowledged. This work was partially funded by the Cimar Fjord 1 and Cimar Fjord 2 Grants of the National Oceanographic Committee of Chile (CONA).

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Date Submitted: 28 September, 2004. Date Accepted: 24 February, 2005.

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