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The description of *Austroglossus pectoralis* (Teleostei: Soleidae) larvae from the South-east coast of South Africa*

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SUMMARY: Preflexion and flexion larval stages of the East coast sole *Austroglossus pectoralis* are described. Larval morphology was consistent with that of other soleids. The yolk-sac was evident in larvae up to 2.9 mm BL. Flexion is evident in some 3.5 mm BL larvae and in all larvae > 3.8 mm BL. Larvae have 50 to 58 (8-10 + 40-49) myomeres and a large protruding gut. The head profile is rounded initially and becomes convex after flexion. Teeth are present at 4.0 mm BL and are initially robust, becoming elongate and incisor-shaped after flexion. Pectoral fins are present but no rays have developed in the largest specimen. The sequence of fin anlagen development is caudal, dorsal and anal. Eye migration is not evident in the largest (8.8 mm BL) specimen examined. Pigment is evident over the fore- and mid-brain, snout and lower jaw, and along the ventral and dorsal midline of the trunk and tail. The ventral and lateral walls of the gut also bear melanophores. The larvae of *A. pectoralis* are compared with previously described soleid species which are found in southern African waters, including its congeneric *A. microlepis*.

Key words: Soleidae, *Austroglossus pectoralis*, larval development and description, morphology, morphometrics, pigment.

INTRODUCTION

The family Soleidae comprises two subfamilies, the Achirinae and Soleinae (Ahlstrom *et al*., 1984), with the majority of described larvae world wide belonging to the Soleinae. In southern African waters, the family Soleidae comprises twelve genera and sixteen species (Heemstra and Gon, 1986) all within the subfamily Soleinae. The genus *Austroglossus* is represented by only two species, *A. microlepis* and *A. pectoralis*, both of which are endemic to southern Africa and of some importance to the commercial trawl fishery. The eggs and larvae of *A. microlepis* have been described in detail (O'Toole, 1977; Brownell, 1979), but the early stages of *A. pectoralis* have not yet received attention. Between 1993 and 1996 along the south-east coast of South Africa, spring appeared to be the peak season for larval abundance, followed by summer and autumn (Wood, 1998). Unpublished data from Marine and Coastal Management (MCM) in Cape Town has shown that peak reproductive activity is between April and October (Frances Le Clus, MCM, pers. comm.). Evidence from captive specimens pointed to a year round spawning capability (Le Clus *et al*., 1994) which supported earlier field observations by Zoutendyk (1974), Hecht (1976) and Payne (1986 in Le Clus *et al*., 1994). While

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adults are found in waters between 10 and 120 metres (Heemstra and Gon 1986), they appear to spawn between Cape Agulhas and Port Alfred in waters between 50 and 108 metres over a mud or sandy seabed (Le Clus *et al*., 1994). Eggs are probably released off the bottom above the nepheloid layer which covers mud patches.

Six other soleid species which are found in southern African waters have had aspects of their early life histories published. These are *A. microlepis* (O'Toole, 1977; Brownell, 1979), *Dicologlossa cuneata* (Lagardère and Aboussouan, 1981), *Heteromycteris capensis* (Brownell, 1979), *Monochirus luteus* (Nichols, 1976 in Olivar and Fortuño, 1991), *M. ocellatus* (Palomera and Rubiès, 1977 in Olivar and Fortuño, 1991), *Pegusa lascaris* (Clarke, 1914 in Ahlstrom *et al*., 1984; Russell, 1976) and *Synapturichthys kleini* (Brownell, 1979). This paper provides a description of the preflexion and flexion larval stages of *A. pectoralis* which were sampled from the Tsitsikamma National Park along the south-east coast of South Africa.

MATERIAL AND METHODS

The Tsitsikamma National Park is a Marine Protected Area along South Africa's south-east coast and extends from Oubosstrand (34º03'S, 24º11'E) in the east to Grootbank (34º00'S, 23º30'E) in the west. The larval description is based on 22 larvae (1.6-8.8 mm BL) identified from samples collected in this area using bongo nets and an RMT1x6 multiple level sampler between August 1993 and October 1996. Specimens were fixed in 5% buffered formalin in sea water then transferred to 70% ethanol after two weeks. Eight larvae that were cleared and stained for morphological features were stored in 95% ethanol before being processed according to the methods of Pothoff (1984). Larvae were drawn facing right with the aid of a *camera lucida* attached to a dissecting microscope. Larval measurements to the nearest 0.01 mm were performed using a dissecting microscope and an ocular micrometer. Terminology follows that of Leis and Trnski (1989). The following body measurements were made, body depth (BD), body length (BL), eye diameter (ED), head length (HL), pre-anal length (PAL), pre-dorsal fin length (PDL), and snouth length (SnL).

All specimens used for this description have been accessioned into the collection at the J.L.B. Smith Institute of Ichthyology in Grahamstown, South Africa (RUSI numbers 57400-57444).

RESULTS

Description is based on nine larvae ranging in size from 1.6 mm to 8.8 mm BL (Fig. 1). Larvae are moderately elongate, laterally compressed and bilaterally symmetrical (due to the absence of eye migration) They are moderately deep bodied (BD ranges from 0.32 to 051% BL - Table 1), the gut however, is massive and protrudes well below the ventral margin of the body. The smallest larva (1.6 mm BL) possessed a yolk-sac with a single pigmented oil globule, with those < 2.9 mm BL still displaying remnants of yolk. The coiled gut extends to 52% BL in preflexion larvae and 42% BL in flexion larvae (Table 1). A gas bladder was only visible in one of the preflexion specimens measuring 4.0 mm BL. The head is moderately large, ranging from 0.18 to 0.41% BL in preflexion larvae and 0.24 to 0.28% BL in flexion larvae (Table 1), with a steep profile during initial stages and a more gradual convex profile in later stages. In preflexion larvae the mouth does not reach the anterior margin of the eye, but it becomes relatively larger during flexion, eventually reaching the posterior margin of the eye in the largest specimens. Small, robust teeth are visible in larvae from 4.0 mm BL, with those in the lower jaw becoming elongate and incisor-shaped in flexion larvae >5.4 mm BL. The eye is small and round ranging in size from 0.02 to 0.05% BL (Table 1), and there was no evidence of eye migration in the largest (8.8 mm BL) specimen examined. Pectoral fins are visible from the yolk-sac stages (<2.9 mm BL) but no rays develop even in the largest specimen. The caudal fin anlage is the fist to appear, followed by the dorsal and anal anlagen. Large flexion larvae had a percentage of fully developed caudal fin rays, and while ossification was not yet complete an 8.67 mm BL larva has a fin count of D92 and A86 which is in agreement with the meristic values for for adult fish. A translucent zone develops ventrally and dorsally

TABLE 1. – Morphometrics for *Austroglossus pectoralis* larvae sampled from the Tsitsikamma coast, measured as a percentage of body length.

	Preflexion (n = 8)	Flexion (n = 14)
PAL	0.38 - 0.52	0.40 - 0.42
PDL	0.09 - 0.21	0.05 - 0.11
HL	0.18 - 0.41	0.24 - 0.28
SnL	0.05 - 0.11	0.09 - 0.13
ED	0.04 - 0.08	0.02 - 0.05
BD	0.33 - 0.51	0.32 - 0.41

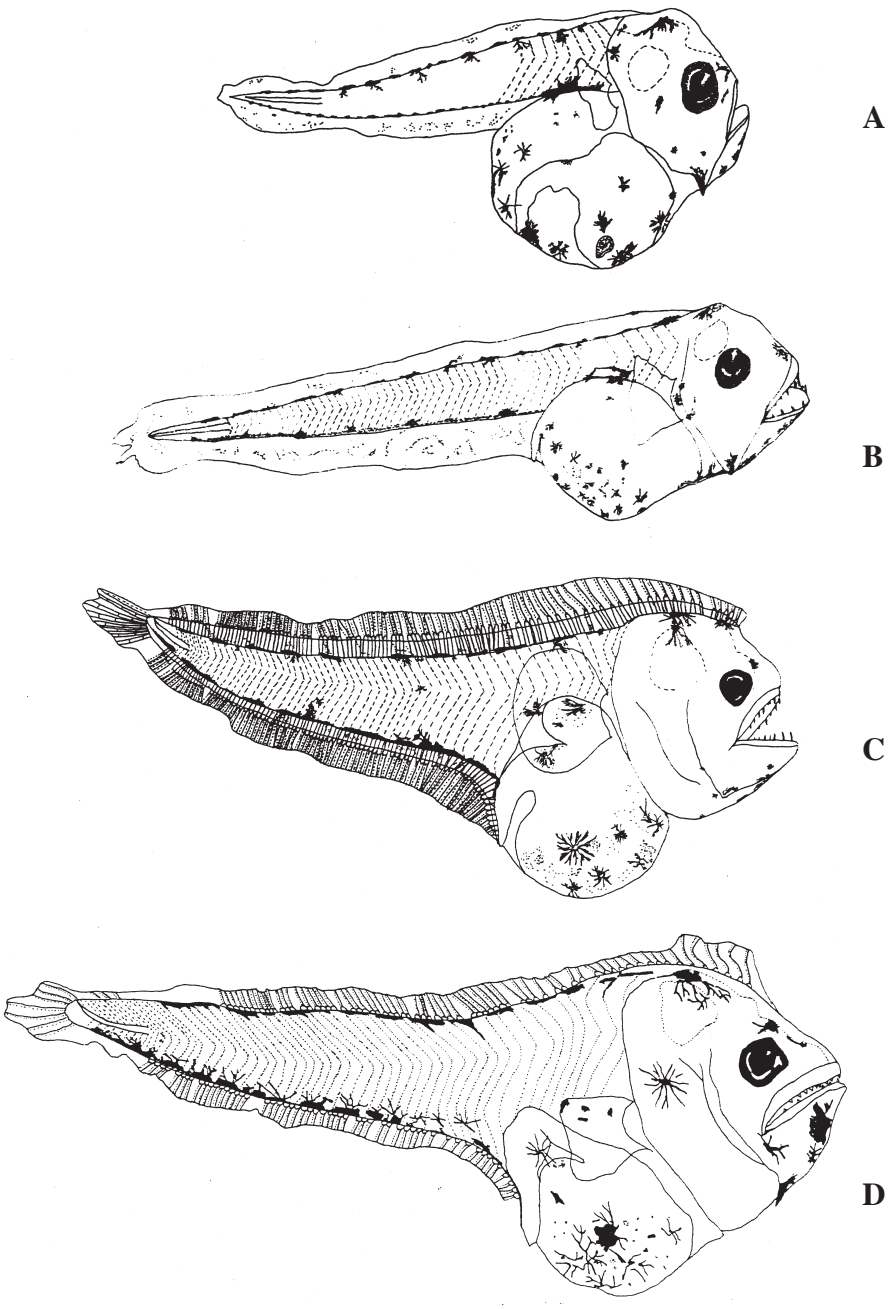

FIG. 1. – Larvae of the soleid, *Austroglossus pectoralis* (Kaup, 1858), from the Tsitsikamma coast of South Africa. A: Stage - preflexion (yolk-sac); BL - 2.90 mm; myomeres - not distinct. B: Stage - preflexion; BL - 4.0 mm; myomeres - 50 (9 + 41). C: Stage - flexion; BL - 4.91 mm; myomeres - 57-58 (8-9 + 49). D: Stage - flexion; BL - 8.67 mm; myomeres - 56-58 (8-10 + 48). Myomeres at the yolk-sac stage were not distinct and only pre-anal elements have been illustrated. Similarly, vertebrae have not been illustrated but numbers do appear in Table 2.

to the body musculature in late flexion larvae and houses the elongate pterygiophores.

Vertebrae and myomere counts were not possible for the smaller preflexion larvae examined, with only eight preanal myomeres visible in some. By 4.0 mm BL, however, a total of 50 myomeres (10 + 40) and 52 vertebrae were visible. In flexion specimens, the full compliment of 58 vertebrae were visible, and myomeres ranged from 56 to 58 (8-9 + 47-49) in flexion specimens. Flexion in this species is evident in some 3.5 mm BL larvae, and in all those >3.8 mm BL.

Pigment (Fig. 1). All developmental stages are moderately pigmented. Large patches are visible over the midbrain and on the snout in front of the eye throughout development, although the snout

pigmentation was somewhat reduced in the larger specimens. Preflexion larvae also posses some internal coverage over the hindbrain region. The angle of the lower jaw is heavily marked during all stages while the region beneath the lower jaw bears fine pigment in preflexion stages which develop into larger melanophores during flexion. Isolated patches are evident on the subopercular and opercular surfaces, and a few small pigment clusters are visible at the base of the pectoral fin bud at 4.0 mm BL. During all stages, the ventral and lateral surfaces of the gut are extensively covered by large stellate melanophores interspersed with numerous clusters of small spots. The oil globule situated on the ventral gut surface in yolk-sac larvae is covered by small pigment spots. Scattered internal pigment is visible over the dorsal gut region in preflexion stages in the vicinity of the gas bladder, while flexion larvae bear a few large stellar melanophores in this region. The ventral midline of the tail in yolk-sac larvae bears 18 large melanophores packed closely together in a longitudinal series which extends to just short of the notochord tip. Arising from some of these melanophores are branches of pigment which intrude onto the lateral surface of the tail. Large preflexion specimens still have extensive ventral tail pigment, although only seven large patches were evident with the rest of the surface covered by closely packed spots. Between 15 and 17 large melanophores mark the ventral line of the tail during flexion stages, some of which have branches stretching onto the ventro-lateral surface. Eleven large melanophores mark the dorsal midline of the trunk and tail in yolk-sac larvae, with some overlapping onto the finfold and some sending out branches onto the lateral surface. Three smaller melanophores are arranged over the notochord tip. Larger preflexion specimens bear 14 evenly spaced melanophores and flexion stages posses twelve to fourteen medium to large melanophores which straddle the dorsal midline of the trunk and tail, with the spacing between them increasing with larval size so that they extend almost to the notochord tip in late flexion larvae. Some of these melanophores overlap onto the dorsal translucent zone and the dorso-ventral surface. The small melanophores near the notochord tip in preflexion specimens have been lost by the time notochord flexion is initiated. A single medium-sized stellar melanophore is situated medio-laterally on the 11th postanal myoseptum in larger flexion stages. The dorsal and ventral primordial finfolds in preflexion stages are extensively covered by numerous small pigment spots which persist during flexion stages and are manifested on the fin membranes and over the translucent zones which house the pterygiophores.

DISCUSSION

According to Leis and Trnski (1989) the suite of characters which is used to describe soleid larvae is unique amongst the flatfishes, and as such they are not susceptible to misidentification as belonging to one of the other pleuronectiform families. Amongst these characters are the absence of elongate fin rays, a convex head profile, no head spination, large gut, small eyes, a pectoral fin which is not paddle-shaped and which is retained through metamorphosis, and paired pelvic fins. The development of *A. pectoralis* is similar to that of other members of the Soleinae in certain aspects, where for example the size at hatching and size of yolk-sac larvae range from 1.3 mm BL for *D. cuneata* (Lagardère and Aboussouan, 1981) to 4.1 mm BL for *Aesopia cornuta* (Mito, 1963). This study revealed yolk-sac larvae measured between 1.6 and 2.9 mm BL. It is difficult to compare other aspects of development such as flexion, as the size at which this occurs amongst the Soleinae is highly variable. Flexion occurs in *A. microlepis* and *D. cuneata* between 5.2 and 5.5 mm BL and 6.3 and 6.5 mm BL respectively (O'Toole, 1977; Lagardère and Aboussouan, 1981) compared with the small size of 3.5 mm BL observed for *A. pectoralis* (Table 2).

The most obvious differences between *A. pectoralis* larvae and those of the seven other soleid species from southern African waters which have been described appear in Table 2. These encompass vertebral and myomere counts, size at flexion and pigment patterns. The most closely related species, *A. microlepis*, not only possesses different morphological and pigmentation patterns but its distribution is restricted along the west coast and as far as False Bay (Heemstra and Gon 1986), whereas *A. pectoralis* is distributed from the Cape all along the east coast to Natal. According to Heemstra and Gon (1986) there are 16 soleid species found in southern African waters, but of these only five are found on the south-east coast within the vicinity of the study area. The remainder are restricted either to the west coat or the KwaZulu-Natal coast in the north. Three of the species which are found in the study region and whose larvae have not been described, namely

TABLE 2. – A summary of the common descriptive features for larvae of the eight soleid species which have been described and which are found in southern African waters (* denotes size at completion of flexion, the rest are size at commencement of flexion).

Species	Myomeres - range for preflexion and flexion	Vertebrae	Size at flexion	Pigment	Reference
Austroglossus microlepis	56 - 58	55 - 57	5.2 - 5.5	Dorsal and ventral midline; gut; lower jaw; behind eyes; pectoral fins	O'Toole, 1977; Brownell, 1979
Austroglossus pectoralis	50 - 58 (8-10 + 40-49)	58	3.5 - 3.8	Dorsal and ventral midline; fore- and hind-brain; snout; lower jaw; ventral and lateral gut; small spots on finfold	This paper
Dicologlossa cuneata	44 - 47 (9 + 35 - 38)	43 - 45	6.3 - 6.5	Dorsal and ventral midline, midbrain; hindbrain; finfold; swim bladder, gut; head	Lagardère and Aboussouan, 1981
Heteromycteris capensis	39 - 41 (10 + 29 - 31)	40 - 43	6.2*	Midline body contour; finfold; ventral gut wall; lower jaw, behind eyes; lower pectoral fin margin	Brownell, 1979
Monochirus luteus	36 - 38	36 - 40	5.5	Dorsal and ventral midline; midbrain; posterior tail (early); finfold; ventral abdominal wall	Nichols 1976 in Olivar and Fortuño, 1991
Monochirus ocellatus	34 - 37 (8-9 + 26-28)	37 - 38	4	Three dorsal and two ventral concentrations of small spots on finfold; caudal tip; dorsal and ventral body contour; head, lower jaw; gut wall; swim bladder; pectoral fins	Palomera and Rubies, 1971 in Olivar and Fortuño, 1991
Pegusa lascaris	47 (9 + 38)	42 - 47	5.3	Many small melanophores scattered over head, body and fins. Heaviest concentrations over lateral and ventral gut surface and laterally on the tail.	Clarke, 1914 in Ahlstrom *et al*., 1984; Russell, 1976
Synapturichthys kleini	42 - 45 (9-10 + 33-35)	46 - 47	6.5*	Densely packed stellate melanophores scattered over all body surfaces and finfold.	Brownell, 1979

Solea bleekeri, Solea fulvomarginata and *Synaptura marginata*, could not be confused with *A. pectoralis* as they possess 32-37, 41-43 and 46 vertebrae resprectively (Heemstra and Gon, 1986) as opposed to the 58 for *A. pectoralis*.

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