A description of the early life history stages of the kob, *Argyrosomus hololepidotus* (Pisces: Sciaenidae), from southern Africa

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The larval development of the kob, *Argyrosomus hololepidotus* is described and illustrated from a series of specimens collected in Algoa Bay, South Africa. Larvae are moderately deep bodied (BD = 30% BL) with a convex dorsal profile and trunk tapering to a narrow caudal peduncle. The head is large, increasing from 22% BL in preflexion larvae to 35% BL in juveniles. Pre-anal length increases from 37% BL in preflexion larvae to >60% in juveniles. Notochord flexion occurs at 5–6 mm BL. *Argyrosomus hololepidotus* larvae are characterized by melanophores behind the head, at the anal fin base, on the caudal fin, on the abdomen, in the angle of the jaw and at the jaw isthmus. Medio-lateral pigmentation increases markedly in early juveniles. Osteological development is described from a series of cleared and stained specimens. By 14 mm BL all fins have the adult complement of spines and rays. The larvae of *A. hololepidotus* are briefly compared with those of other Atlantic and Indo-Pacific sciaenids.

Die larwale ontwikkeling van die kabeljou, *Argyrosomus hololepidotus*, word beskryf vanaf monsters wat in Algoabaai, Suid-Afrika versamel is. Larwes het 'n ronde dorsale profiel en die liggaam is spitslopend na die stert. Die verhouding van liggaamsdiepte tot liggaamslengte is ongeveer 30% en die verhouding van koplengte tot liggaamslengte neem toe vanaf 22% in prefleksie-larwes tot by 35% in jong vissies. Fleksie vind plaas tussen 5–6 mm liggaamslengte. Kabeljoularwes word gekenmerk deur pigmentkolle agter die kop, by die anale en stertvinne, in die hoek van die kakebeen en op die maag. Alle vinne is teen 14 mm liggaamslengte ontwikkel. Osteologiese ontwikkeling van die skedel en ruggraat word beskryf en kabeljoularwes word met dié van ander Sciaenidae vergelyk.

In southern Africa the teleost family Sciaenidae is represented by nine species (Smith & Heemstra 1986). One of these, the kob, *Argyrosomus hololepidotus* (Lacepede), is widely distributed, occurring off the coasts of Angola, Namibia, South Africa and Mozambique as well as Madagascar, Mauritius, India and Australia (Trewavas 1977; Smith & Heemstra 1986).

Argyrosomus hololepidotus is an important commercial linefish and trawl species in South African coastal waters. About 1200 tons of kob are landed annually and, after snoek (*Thyristes atun*), kob is the second most valuable species in the commercial linefishery (A.J. Penney, Sea Fisheries Research Institute, pers. comm.). Kob is also sought after by recreational anglers (van der Elst 1981) and is the major target species of ski-boat fishermen in the Eastern Cape (Smale & Buxton 1985).

The general biology of the kob has been examined in Natal and the Eastern Cape (Wallace & Schleyer 1979; Smale 1984; Smale 1985). This species has a prolonged breeding season with a peak from August to December (spring and summer) and the shallow (0–9 m) soft substratum regions of Algoa Bay have been identified as a major nursery area for juveniles.

Though larvae of kob have been recorded from the nearshore waters of Algoa Bay (Beckley 1986), little is known about the early life history stages of this species. Gilchrist (1916) reported on unfertilized *A. hololepidotus* eggs from the Cape of Good Hope and Melville-Smith (1978) illustrated 3,3 mm and 15,9 mm *A. hololepidotus* specimens collected in the Swartkops estuary on the south east coast.

The larvae of several northern hemisphere sciaenids, particularly those of commercial importance on the Atlantic coast of the United States, have been described (see Johnson 1978 and Ditty 1989 for reviews). Moser, Ambrose, Busby, Butler, Sandknop, Sumida & Stevens (1983) described the early stages of *Atractoscion nobilis* from the Pacific coast of the United States. In the Indo-Pacific region, Yamuda (1973) described the postlarvae and juveniles of two *Pseudosciaena* species from the East China Sea, Takita (1974) the early life history stages of *Nibea albiflora* and *Pennahia argentata* from Ariake Sound, Kinoshita & Fujita (1988) the larvae of *Nibea mitsukurii* from Tosa Bay and Leis & Trnski (1989) larvae of unidentified sciaenids from the Great Barrier Reef and North Australia.

In this paper the early life history stages of *Argyrosomus hololepidotus* are described and illustrated from a series of specimens collected in Algoa Bay (34°S/26°E) during 1980–1982.

Materials and Methods

Larvae were collected in ichthyoplankton tows from the nearshore region of Algoa Bay (see Beckley 1986) and juvenile specimens were trawled in Algoa Bay off the mouth of the Swartkops estuary (see Beckley 1984). Larvae and juveniles were fixed and stored in 5% formalin.

Larvae were measured to the nearest 0,1 mm using a dissecting microscope fitted with an ocular micrometer and juveniles were measured to the nearest 0,1 mm using a pair of calipers. Terminology and measurements follow Leis & Rennis (1983) and Leis & Trnski (1989) and description of pigmentation follows Russell (1976). Body length (BL) refers to notochord length in preflexion and flexion larvae and standard length in postflexion larvae and juveniles. Drawings were done with the aid of a camera lucida. Fin counts were obtained by staining specimens with alizarin red. For dorsal and anal fins each element with a separate

base was counted. Myomere and paired fin counts were made on the left-hand side of the body. Vertebral counts and sequence of bone ossification in *A. hololepidotus* were determined from a series of 30 specimens (ranging from 2,2–10,2 mm BL) cleared and double stained with alcian blue and alizarin red for cartilage and bone following the techniques of Taylor (1967) and Potthoff (1984). All material is deposited in the J.L.B. Smith Institute of Ichthyology in Grahamstown, South Africa (RUSI 27005, 27006).

Identification

Larvae were identified as sciaenids by virtue of their deep robust heads, short gut, number of myomeres and body shape. Specimens were assembled into a series using body pigmentation and sequence of fin development. Fin counts from the larger specimens confirmed the series to be *A. hololepidotus*. Meristic characteristics of adult *A. hololepidotus* are D X+I 26–29; A II 7; P 17; LL 48–54; GR (3–5)+(9–11); depth 2,9–4,0 (Smith & Heemstra 1986).

Description of larval developmemnt

Morphology

The smallest larva in the series (2,2 mm BL) has a differentiated mouth, pigmented eyes, pectoral buds, dorsal and anal fin folds (Figure 1A). In developing preflexion larvae (Figure 1B) both head length and preanal length increase relative to body length (Table 1). Notochord flexion occurs at 5–6 mm BL and by this stage the larvae have the characteristic sciaenid form of a large head with well-developed jaws, a convex dorsal profile and a moderately deep trunk that tapers to a narrow caudal peduncle (Figure 1C). After flexion (Figures 1D–G) relative headlength increases further to about 35% BL in 20-mm juveniles. Pre-anal length also increases and is around 58% BL in 20-mm juveniles (Table 1). As a proportion of BL, snout length, eye diameter and body depth stay approximately constant during larval development (Table 1). Pre-anal fin length as a proportion of BL increases gradually, whereas pre-dorsal fin length as a proportion of BL decreases as the full complement of dorsal spines is attained (Table 1). The gap between the anus and anal fin origin decreases from about 15% BL in postflexion larvae to < 4% in juveniles > 20 mm (Table 1).

Pigmentation

Small *A. hololepidotus* larvae < 3 mm BL are characterized by a group of dorsal melanophores behind the head in the shoulder region and a cluster of ventral melanophores midway between the anus and tip of the notochord (Figure 1A). From the latter, a row of small, punctate melanophores extends both posteriorly and anteriorly along the mid-ventral body contour. There is a melanophore immediately anterior to the anus and in the lateral abdominal region three external melanophores occur. There is an external melanophore behind the pectoral fin bud and another in the lower jaw angle. Internal peritoneal pigmentation occurs, particularly dorsally and anteriorly to the gut.

In larvae from 3–5 mm BL (Figure 1B) the number of punctate mid-ventral melanophores decreases and a large branched melanophore replaces the cluster of mid-ventral

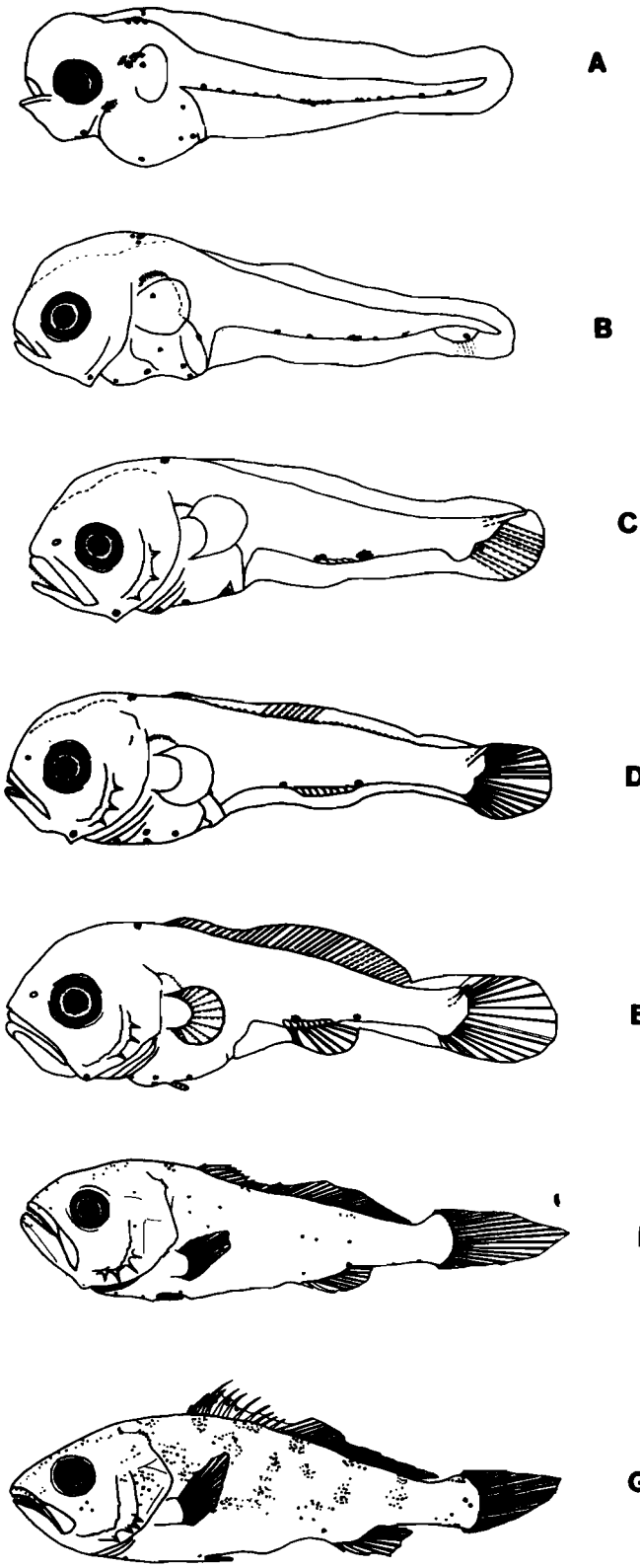

Figure 1. Development of *Argyrosomus hololepidotus*. A — 2,2 mm BL; B — 4,3 mm BL; C — 5,5 mm BL; D — 6,8 mm BL; E — 9,1 mm BL; F — 14,0 mm BL; G — 24,8 mm BL.

melanophores. An internal melanophore develops posterior to the gut and a melanophore develops at the throat isthmus. The abdominal melanophores vary in number from 4–7 and a single melanophore occurs on the caudal fin anlage.

In larvae >5 mm (Figure 1C–E) the large branched ventral melanophore is situated posterior to the developing

Table 1 Morphometrics of *Argyrosomus hololepidotus* larvae and juveniles. Measurements are given as percentages of body length with upper figure representing the mean and lower figure the standard deviation for each size class of larvae. BL = Body Length; n = number of specimens; HL = Head Length; SnL = Snout Length; ED = Eye Diameter; BD = Body Depth; PAL = Pre-anal Length; PGBL = Pre-gas Bladder Length; PAFL = Pre-anal Fin Length; PDFL = Pre-dorsal Fin Length

BL(mm)	n	HL	SnL	ED	BD	PAL	PGBL	PAFL	PDFL
2–2,9	18	22,6	6,2	9,8	29,4	37,0	26,7		
		1,9	1,2	0,7	2,8	2,7	1,5		
3–3,9	10	26,6	7,7	9,3	31,7	40,0	27,6		
		1,9	0,9	1,5	2,2	1,9	2,1		
4–4,9	5	28,8	8,1	9,6	29,7	40,1	29,5		
		1,7	1,6	0,5	2,1	2,1	2,4		
5–5,9	6	27,9	7,9	9,0	29,1	38,9	27,3		
		1,8	0,9	0,6	1,2	1,6	1,5		
6–6,9	3	28,6	8,2	9,0	29,5	43,5	31,0		
		4,7	0,8	0,6	1,5	2,3	1,8		
7–7,9	6	32,0	9,5	9,0	30,7	47,6	30,9	62,2	38,4
		1,5	1,5	1,4	0,8	1,7	2,5	2,3	1,2
8–8,9	8	32,6	9,7	8,6	31,4	48,5	30,7	62,8	35,9
		1,2	1,1	0,5	1,9	1,6	1,6	2,7	2,2
9–9,9	3	33,6	10,3	9,0	30,9	48,7	31,1	60,6	33,9
		1,9	1,0	0,9	3,9	1,4	1,2	2,3	1,4
10–19,9	6	35,5	9,6	9,1	32,7	57,8	34,4	66,1	35,9
		1,1	1,4	0,5	1,2	3,6	0,4	2,0	4,3
20–39,9	5	34,5	8,6	8,5	31,2	62,4		65,9	35,5
		1,5	0,9	0,5	1,6	0,6		1,0	0,9
40–79,9	5	32,8	7,2	8,4	29,0	62,4		66,0	34,8
		0,5	0,5	0,6	1,4	1,5		2,7	2,1

anal fin and the only remaining mid-ventral body contour melanophore is located near the anterior insertion of the anal fin. The abdominal pigmentation becomes more ventrally located and the lower jaw angle, jaw isthmus, caudal fin and head melanophores are still evident.

Larvae > 10 mm (Figure 1F) develop additional melanophores around the base of the caudal fin. Several melanophores develop in the occipital region and on the upper and lower jaws. Lateral melanophores develop from the pectoral fin towards the group of melanophores behind the head in the shoulder region. Dorso-lateral melanophores develop around the bases of the 8–9th dorsal spines and the 14–17th dorsal rays. Medio-lateral melanophores develop dorsal to the anal fin and isolated melanophores develop on the operculum.

Juveniles > 20 mm (Figure 1G) are characterized by increased pigmentation in the occipital, snout, preopercular and opercular regions as well as on both the upper and lower jaws. Focal areas for dorso-lateral pigment are at the shoulder and around the bases of the 2nd–4th and 7–10th dorsal spines and at the bases of the 3rd–5th, 14–17th and 23rd–26th dorsal rays. Medio-lateral pigment develops ventral to the dorso-lateral pigment focal areas and juveniles > 20 mm appear to have six lateral pigment bars. Melanophores along the ventral and dorsal surfaces of the caudal peduncle are also evident. Melanophores also occur on the dorsal fin between the first six dorsal spines.

Skeletal development and ossification

From 30 cleared and stained specimens (2,2–10,2 mm BL) the following sequence in skull development was determined. The cleithrum stains for cartilage in the smallest specimen in the series and is ossified by 4,1 mm. The jaw bones are the next components to stain for cartilage and by 4,1 mm the premaxilla, dentary, articular and mandibular are ossified. At 4,0 mm BL, four cartilagenous branchiostegals are evident and these increase to seven ossified ones by 4,8 mm. Ossification of the preopercle is evident from 4,2 mm and series of small and moderate preopercular spines develop. These spines ossify and increase in number so that by 10,2 mm BL there are up to eight small and four moderate preopercular spines.

Small curved teeth are evident on the premaxilla at 4,0 mm, and by 4,3 mm teeth develop on the dentary as well. Gill arches stain for cartilage at 4,0 mm and are ossified at 5,9 mm. Post-temporal spines develop at 8,3 mm with three evident by 10,2 mm. These spines increase in number and are clearly obvious in larger larvae and juveniles (Figures 1F–G).

Differentiation of vertebrae is apparent by 4,8 mm with the first five vertebrae partly ossified at this stage. By 5,4 mm the first 14 vertebrae are ossified and the full complement of 24 vertebrae and urostyle are ossified by 8,3 mm (Table 2). Neural spines are evident prior to differentiation of the vertebrae, with the first two spines staining for cartilage at 4,1 mm. The first four neural spines are ossified at 5,2 mm and by 8,3 mm all 24 neural spines are ossified. Haemal spines develop on vertebrae 6–24 and ossify at 6,8 mm. Ribs attached to vertebrae 1–5 are evident in a 10,2 mm specimen.

Fin formation and meristics

Fin meristics for *A. hololepidotus* larvae are given in Table 2 and details of fin development are as follows. The anlage of the caudal fin is evident from 4,5 mm and the principal elements stain for cartilage from 5,3 mm. By 6,8 mm the adult complement of 9+8 principal elements has ossified. Procurrent caudal elements develop at 8,3 mm and gradually increase to 8/7 by 14,5 mm. In larvae and juveniles > 9 mm the caudal fin becomes characteristically rounded to sinuate (Figures 1E–G). Two hypurals staining for cartilage are apparent at 5,9 mm, five hypurals at 8,8 mm and by 8,7 mm these are all ossified. Pectoral buds were present in the smallest larvae examined but pectoral fins only become differentiated with elements staining for cartilage from 8,3 mm. At 10,2 mm, 15 pectoral elements are ossified and the full complement of 17–18 elements is reached by 13,5 mm. The coracoids and pterygoids are differentiated and stain for cartilage by 10,2 mm. The pelvic fin anlage is evident at 8,3 mm, elements become differentiated by 8,7 mm and by 10,5 mm the five rays and single spine are ossified. The elements of the dorsal fin first become differentiated from 6,6 mm with 12 dorsal fin elements evident at 6,8 mm. At 8,7 mm there are 32 ossified elements and by 10,2 m four dorsal

Table 2 Meristics of 41 *Argyrosomus hololepidotus* larvae and juveniles. Specimens >10,2 mm were only stained with Alizarin Red and not cleared with trypsin. BL = Body Length; P1 = Pectoral Fin; C1 = Principal Caudal Fin; C2 = Procurrent Caudal Fin (Dorsal/Ventral); D = Dorsal; A = Anal; P2 = Pelvic Fin; Bran = Branchiostegals; Vert = Vertebrae

BL	P1	C1	C2	D	A	P2	Bran	Vert
4,0	bud						4	
4,1	bud						6	
4,3	bud						6	
4,3	bud						6	
4,3	bud						6	
4,3	bud						6	
4,5	bud	anlage					6	
4,5	bud	anlage					6	
4,5	bud	anlage					7	
4,8	bud	anlage					7	5
5,1	bud	anlage					7	12
5,2	bud	anlage					7	12
5,3	bud	5+4	0/0				7	9
5,4	bud	6+5	0/0				7	14
5,9	bud	5+5	0/0				7	20
6,1	bud	7+6	0/0				7	20
6,6	bud	7+6	0/0				7	20
6,8	bud	9+8	0/0	12			6	21+1[a]
7,2	bud	9+8	0/0	11	2		7	22+1
7,9	bud	9+8	0/0	15	6		7	22+1
8,3	6	9+8	0/1	30	6	anlage	7	24+1
8,5	9	9+8	1/1	33	8	anlage	7	24+1
8,7	8	9+8	2/1	32	8	4	7	24+1
8,8	12	9+7	2/1	32	8	3	7	24+1
10,2	15	9+8	5/5	IV32	II6	6	7	24+1
10,5	16	9+8	6/6	X+I26	II7	I 5	*	*
13,5	18	9+8	6/5	X+I19[b]	II7	I 5	*	*
14,0	17	9+8	8/6	X+I27	II7	I 5	*	*
14,5	17	9+8	8/7	X+I26	II7	I 5	*	*
14,5	17	9+8	8/7	X+I26	II7	I 5	*	*
18,5	17	9+8	8/8	X+I28	II7	I 5	*	*
20,5	18	9+8	8/8	X+I27	II7	I 5	*	*
23,9	18	9+8	8/7	X+I26	II7	I 5	*	*
24,8	17	9+8	8/7	X+I28	II7	I 5	*	*
28,8	18	9+8	8/8	X+I28	II7	I 5	*	*
33,3	18	9+8	8/7	X+I27	II7	I 5	*	*
43,7	17	9+8	8/7	X+I26	II7	I 5	*	*
46,6	18	9+8	8/7	X+I26	II7	I 5	*	*
58,5	17	9+8	8/7	X+I26	II7	I 5	*	*
64,0	17	9+8	8/7	X+I27	II7	I 5	*	*
80,0	17	9+8	8/7	X+I28	II7	I 5	*	*

[a] +1 indicates ossified urostyle;

[b] dorsal fin damaged.

spines are ossified and dorsal pterygiophores are evident. By 10,5 m the full dorsal complement of 11 spines and 26–28 rays is ossified. Two anal fin elements are present at 7,2 mm and by 10,5 mm the full complement of two spines and seven rays is ossified. Although pectoral buds are apparent in the smallest larvae in the series, the sequence of fin ossification is caudal, dorsal, anal, pectoral and finally, pelvic.

Discussion

Six of the other eight sciaenid species recorded from South Africa are only found along the east coast, north of Algoa Bay (Smith & Heemstra 1986) and their larvae are thus unlikely to occur in the study area. The baardman, *Umbrina canariensis* and the geelbek, *Atractoscion aequidens* do, however, co-occur with *A. hololepidotus* in Algoa Bay. The larvae of *U. canariensis* can readily be distinguished from those of *A. hololepidotus* by a prominent dorso-ventral pigment band across the gut and shoulder region, pigmented pelvic fins and smaller size at flexion (Beckley, unpublished data). The larvae of *A. aequidens* are still unknown, though Meyer-Rochow (1972) tentatively identified some sciaenid eggs and yolk sac stages obtained off Luderitz (Namibia) as belonging to this species. *A. aequidens* does, however, differ from *A. hololepidotus* in having higher dorsal and anal fin ray counts, which would allow late postflexion larvae of the two species to be distinguished. The kob larvae described above differ markedly from the early stages of the Californian *Atractoscion* species (*A. nobilis*) which have a solid pigment sheath of melanophores that initially covers the head and trunk but later expands to cover the body completely.

Trewavas (1977) ascribed four of the 65 known Indo-Pacific sciaenid species to the genus *Argyrosomus (A. hololepidotus, A. japonicus, A. muiiy* and *A. amoyensis).* She did not, however, include the square-tailed kob, *Argyrosomus thorpei,* described from Natal by Smith (1977), rather allocating this species to the genus *Afroscion.* Although the larvae of *A. thorpei* are unknown they may be similar to those of *A. hololepidotus* as, in Natal, where the two species co-occur, the adults are often confused. The early stages of the other three Indo-Pacific *Argyrosomus* species are also still undescribed though Taniguchi & Okada (1984) have recorded morphological changes with growth in juvenile *A. japonicus.* In *A. hololepidotus* larvae, changes in body proportions with growth (e.g. head length and pre-anal length in Table 1) are also clearly evident and are similar to those described for the larvae of *Sciaena occellata* (Holt, Johnson, Arnold, Fable & Williams 1981) and *Atractoscion nobilis* (Moser *et al.* 1983).

This description of the early life history stages of *A. hololepidotus* is thus the first of the family Sciaenidae from southern Africa. As the other eight indigenous sciaenid species (particularly, the geelbek, *A. aequidens* and square-tailed kob, *A. thorpei*) are of importance to the linefishery, full descriptions of the larvae of these species are also desirable. Ichthyoplankton sampling in progress along the Natal coast (Marine Linefish Research Programme) and rearing of larvae hatched from collected eggs (A. Connell pers. comm.) will, hopefully, provide material to enable the larvae of these species to be distinguished.

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