

13. First record of larvae of *Arnoglossus imperialis* (Rafinesque, 1810) (Bothidae, Pisces) Atlantic species from the Indian Ocean.

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ABSTRACT

Larvae ranging from 7.7 mm NL to 12.2 mm SL were found in zooplankton from the Agulhas Bank. The long leaf-like larval body, the presence of spiny discoid scutes distributed along the bases of median fin rays, cleithra, urohyal, posterior basipterygial processes, and in other parts of the body are characteristic features of the species.

The larvae were found in the Agulhas Bank only during January 1963, February 1964 and March/April 1965. All three stages, preflexion, flexion, and postflexion were found. The adults and larvae of this species are reported only from the Atlantic coast of Europe and Africa from northern Scotland to Angola and the western parts of the Mediterranean. The mixture of Atlantic water and of Agulhas current water at the periphery of the bank may act as seeders of different populations to bank water. The presence of this species in the samples from coastal waters in all three years almost at the same time and their absence at other stations suggest that the species is not a new recruit but an established species in the area.

INTRODUCTION

The Ocean around the southern end of Africa has many peculiar features since it is a meeting place of two great oceans, the Atlantic and the Indian Ocean. The present study is part of a major effort towards the understanding of the oceans off South Africa. The samples were taken as a grid of fixed stations on the Agulhas Bank visited at regular intervals by R.S. Africana II and R.S. Natal

MATERIAL AND METHODS

Plankton samples collected during the

cruises of R.S. Africana in the Agulhas Bank area during the International Indian Ocean Expedition using the Indian Ocean standard net were studied. The area of study is limited by 20°E and 22°E, by the land mass to the north and roughly by 37°50'S to the south (Chandrika & Panampunnayil, 1972). The samples were collected monthly from January 1964 to June 1965. During the cruises of Natal also zooplankton samples were collected from this area from 1962 to 1963. The flat fish larvae were sorted out from the zooplankton samples and were identified to the specific level. The drawings were made using Projectina Optik. The number of larvae were calculated for 1000 m³ water.

Larvae ranging from 7.7 mm NL to 12.2 mm SL are present in the collections taken from the Agulhas Bank. Preflexion, flexion, and postflexion stages were present in the collections (Tables 1 & 2).

MORPHOLOGY

The larval body is thin, transparent, laterally compressed, long and leaf-like with black and symmetrical eyes. The mouth is small and terminal, the lower jaw is prominent, projecting beyond the upper with five pairs of teeth on the upper and three pairs on the lower jaw in the early stages. The alimentary canal runs parallel to the vertebral column up to the level of the sixth myotome and then runs down obliquely and coils. The single elliptical coil has a straight rectal portion lying vertically down and the anus opens on the 10th myotome in 7.7 mm NL. In 12.2 mm

Table 1. Morphometrics in mm of larvae of *Arnoglossus imperialis*.

STN	BL	RE	NC	SA	HL	SL	EW	EH	DPB	DAN	DCP	CPL	SPF
A-2877	7.7	SY	STR	3.00	1.70	0.56	0.37	0.40	2.80	2.60	-	-	1.20
A-3497	8.5	SY	MF	3.40	1.90	0.55	0.47	0.55	3.50	3.40	-	-	1.50
A-3546	10.3	SY	PTF	3.80	2.50	0.66	0.55	0.58	4.70	4.70	0.87	0.55	1.30
A-2866	12.2	SY	PTF	4.20	2.90	0.84	0.52	0.55	5.80	5.90	1.42	0.58	1.50

ST = Station, BL = Body length, RE = Right eye, NC = Notochord, SA = Snout to anus, HL = Head length, SL = Snout length, EW = Eye width, EH = Eye height, DPB = Body depth at pectoral fin base, DAN = Body depth at anus, DCP = Caudal peduncle depth, CPL = Caudal peduncle length; SPF = Snout to origin of pelvic fin; SYM = Symmetrical, STR = Straight, MF = Midflexion, PTF = Postflexion.

Table 2. Meristics of larvae of *Arnoglossus imperialis*.

Station	Size (mm)	Stage	N	RE	Fin ray			Vertebrae		PCL	CL	Total
					DL	AL	CL	LP	CL			
A-2877	7.7 NL	PF	STR	SYM	ca.87	ca.59	0	0				
A-3497	8.5 NL	MF	FL	SYM	ca.92	ca.67	11	0				
A-3546	10.3 SL	PTF	FLD	SYM	98	76	17	2+4	10	32	42	
A-2866	12.2 SL	PTF	FLD	SYM	101	79	17	2+4	10	32	42	

N = Notochord, RE = Right eye, DL = Dorsal, AL = Anal, CL = Caudal, LP = Left pelvic, PCL = Precaudal, PF = Preflexion, STR = Straight, SYM = Symmetrical, MF = Midflexion, FL = Flexing, PTF = Post flexion FLD = Flexed

SL larvae (Fig. 1b) the rectal portion is seen pushed forwards and the anus opens at the level of the eighth vertebral segment. A swim bladder is present and lies below the sixth and eighth myotome in early stages but pushes backward to lie between the eighth and ninth vertebral segments in 12.2 mm SL. The liver is well developed and its dorso-ventral axis is about twice the antero-posterior axis.

No spines are found on the urohyal cleithra or on the posterior basipterygial processes. But discoid scutes with a circlet of nine spines are seen in between the distal ends of the pterygiophores and in different parts of the body. These spiny scutes are concentrated more on the ventral aspect of the abdomen along the posterior basipterygial processes, pelvic fin radial, cleithra and sides of the abdomen, as well as a few on rays. These scutes with spines are different from the spines on the cleithra, urohyal or on the basipterygial processes of *Engyproson* and related groups and wherever present the margins of the structure itself are drawn out

into spines.

In 8.5 mm NL larvae pigments are seen on the swim bladder as dark blotch with a central white dot. Brownish black spots are also found beneath the intestine and along the dorsal body wall in patches, dorsal aspect of the vertebral column beneath the spinal cord and also on the median fins at the posterior caudal portion. In some larval forms the pigments are not clearly seen.

The relative head length, depth at pectoral fin base, and depth across the anus increases from preflexion to postflexion stages. (Table 1). The relative snout length on the other hand decreases. The snout to anus length, eye width and eye height, and length between snout and pelvic fin base increase from preflexion to flexion stages and thereafter decreases to values less than preflexion stages.

Fin and supporting structures

The median fin folds are continuous and confluent with the caudal in 7.7 mm NL larvae. An elongated dorsal ray

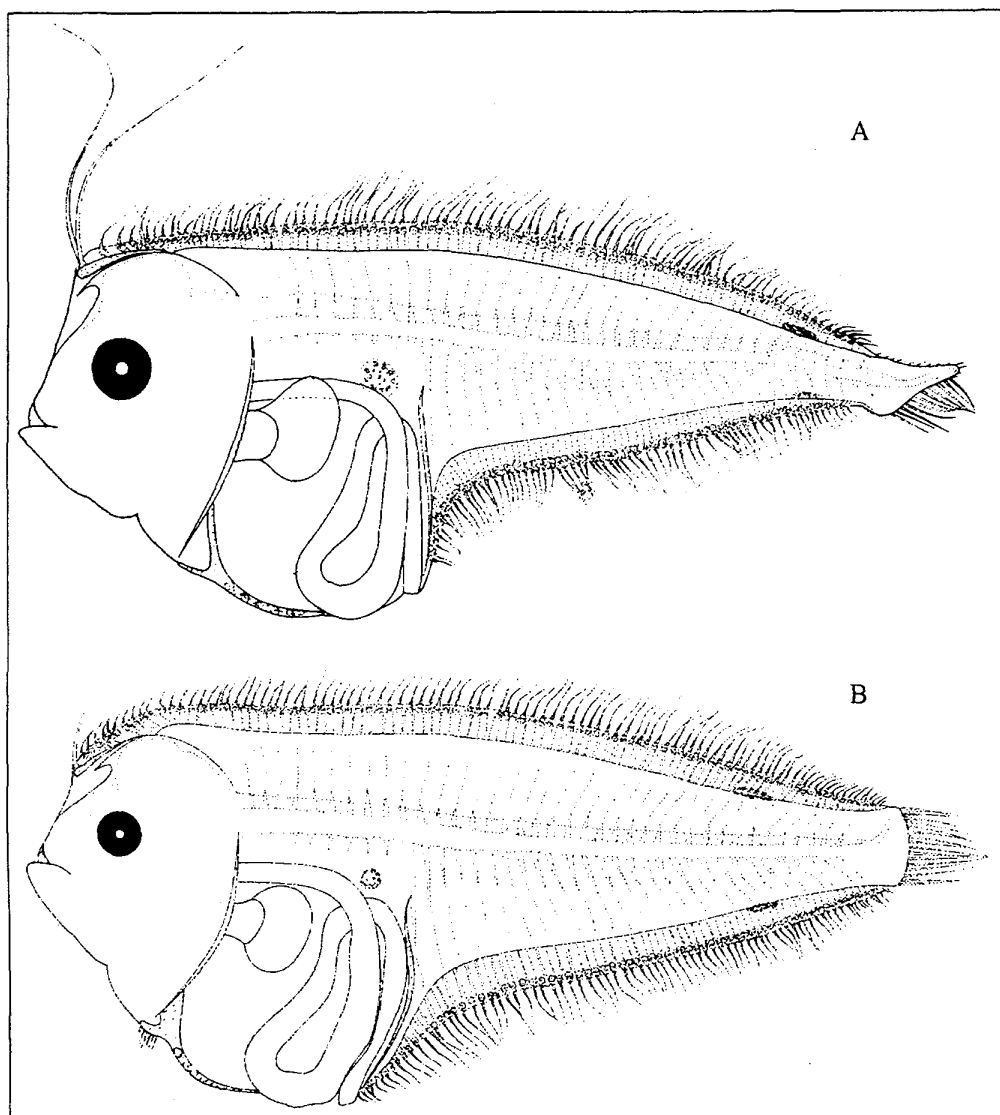


Fig. 1. A: *Amoglossus imperialis*, 8.5 mm flexion stage larva. B: *A. imperialis*, 12.2 mm post flexion stage larva.

followed by six to seven short rays are seen in the anterior end of the dorsal fin fold. In the middle caudal portion of the dorsal and anal fin folds fin rays are also well differentiated but not in the remaining anterior and posterior portions in 7.7 mm NL. In 8.5 mm NL the rays are developed in the remaining anterior portions (Fig. 1A) and in 10.3 mm SL all rays except the tiny first dorsal ray, the differentiation of which is indicated in 12.2 mm SL, the largest specimen in the collections (Fig. 1B). There are 101 dorsal and 79 anal rays. The forward extension of the first dor-

sal pterygiophore which is to support the first tiny dorsal ray is differentiated in 7 mm NL larvae

In 7.7 mm larvae the inferior hypural lower, middle, superior hypural middle, as well as epural plates are differentiated. Caudal rays are not traceable. The notochord however, is seen in 8.5 mm NL larvae in which two rays are seen articulated to inferior hypural lower, four to the middle and five rays to the superior hypural middle. Full complement of 17 rays are seen in 10.3 mm SL larvae along flexion of the notochord.

Among the paired fins the pectoral fin remains in the embryonic stage. In 7.7 mm NL the pelvic fin radial rudiment is seen. The posterior basipterygial processes do not reach up to the level of the intestinal loop. The pelvic fin radial (anterior basipterygial processes) are differentiated in 8.5 mm NL (Fig 1A), and in 10.3 mm SL two rays of the left pelvic fin are seen lying in advance of the right fin. The pelvic fin radial of the left side grows forwards and reaches a little in front of the tip of the cleithra in 12.2 mm SL (Fig 1B).

Axial skeleton

The notochord remains vacuolated and straight in 7.7 mm NL larvae. Nine neural processes, one arch and six haemal processes preceded by two arches are clearly differentiated in the precaudal region in 10.3 mm SL. The first neural arch is cartilaginous. In the caudal region 29 neural and haemal processes and two arches at the posterior end are seen in 10.3 mm SL. The segmentation of the notochord is also complete in 10.3 mm SL. There are 10 precaudal and 32 caudal vertebrae including urostyle (Table 2).

DISTRIBUTION

The area of sampling was restricted to a narrow strip in the Agulhas Bank and also a few samples off the shelf region. The whole area of the cruise is north of the subtropical convergence and mostly north of the warm waters of the Agulhas current that flows in a south-westerly direction. Water over the bank was fairly stable during the sampling period with an isothermal and isohaline

surface layer during winter that was heated up in summer to temperatures as high as 21.6°C. The surface temperature in the winter was as low as 14.7°C. The water below the thermocline which was found at 30-50 m depth or at 50-70 m, was Indian Ocean Central Water formed by sinking at the subtropical convergence or Atlantic Ocean Central Water upwelling over the shelf. Throughout the year surface layer salinity is above 35.2‰ while Indian Ocean Central water was found to have salinities lower than 35.0‰, and a slightly higher temperature of 10-12°C. Agulhas Current water has slightly higher salinity above 35.35‰ (Chandrika & Panampunnayil, 1972). The pattern of surface currents over the bank is mixed, usually not very strong westerly or easterly drifts may occur with patterns changing in the different seasons and eddies are often formed. The upwelling of cold deep water over the bank is the main feature of the area. (De Decker, 1964).

The larvae were available only in four 'Africana' samples and one sample of 'Natal' but they are found in the collections of different years (Table 3). The maximum number of 29 larvae.1000 m⁻³ was found in the near shore station (Fig. 2). The temperature of the stations from where the larvae were collected ranged between 12-20°C. The salinity was around 35‰ and the oxygen value ranged between 4.6 to 5.4 ml.l⁻¹.

REMARKS

The larvae possess bothid characters. In the absence of spines on cleithra, uro-

Table 3. Records of *A. imperialis* larvae.1000 m⁻³ in the Agulhas Bank region.

Sta. No.	Lat.(S)	Long.(E)	Date	Time (hrs)	larvae.1000m ⁻³
Na -17	34°59'00"	21°32'00"	27-1-63	0530	10
A-2866	34°55'00"	21°05'00"	8-2-64	0941	29
A-2877	35°50'00"	20°11'00"	10-2-64	1039	7
A-3497	36°10'00"	20°10'00"	5-4-65	1410	13
A-3546	35°00'00"	20°34'00"	4-3-65	1438	22

Na = Natal, A= Africana

hyal, and posterior basipterygial processes, these larvae can be placed under the genus *Arnoglossus* or *Bothus*. The long leaf-like larval body, the posterior basipterygial processes not extending to the anus, are characters helpful in placing the present larval forms along with *Arnoglossus* spp. The presence of spiny discoid scutes distributed along the bases of the median fin rays, cleithra, urohyal, posterior basipterygial processes, and also in other parts of the body, are characteristic features of the species. Kyle (1913) has observed these spiny discs in *A. imperialis* from 7.0 mm to 29.0 mm and not afterwards. He has stated that "with one exception all known genera of the family Rhombidae have spines in one form or another in the postlarval stages but none have such a well developed system of spines as we find in *Arnoglossus*". His statement might have led many workers to confuse between the spines on the urohyal, cleithra, and posterior basipterygial processes, and the spiny discoid scutes and guided them to place such larvae under *Arnoglossus* spp. Another peculiarity of the present larvae is that the caudal rays are differentiated much after the differentiation of hypural plates and that the urostyle remains straight even after the development of hypural plates. The number of fin rays and vertebrae tally with the adults of *Arnoglossus imperialis*. The adults are reported from the Atlantic coasts of Europe and Africa from northern Scotland to Angola, and from the western part of the Mediterranean (Norman, 1934). Larvae from Atlantic waters have been described and reported by Kyle (1913). Larval forms described in the present report have been collected only from stations around the Agulhas Bank. De Decker (1973) has reported that different groups of zooplankton like Thaliacea, Appendicularia, Chaetognatha, Euphausiacea, Amphipoda, Cladocera, and Copepoda have species of Atlantic origin flourish on the Agulhas Bank. The larvae of *A. imperialis* are reported from the Indian Ocean for the first time. Adults are not yet reported from Indian waters. The fact that the larvae of *A. imperialis* have been collected from the Agulhas Bank only gives

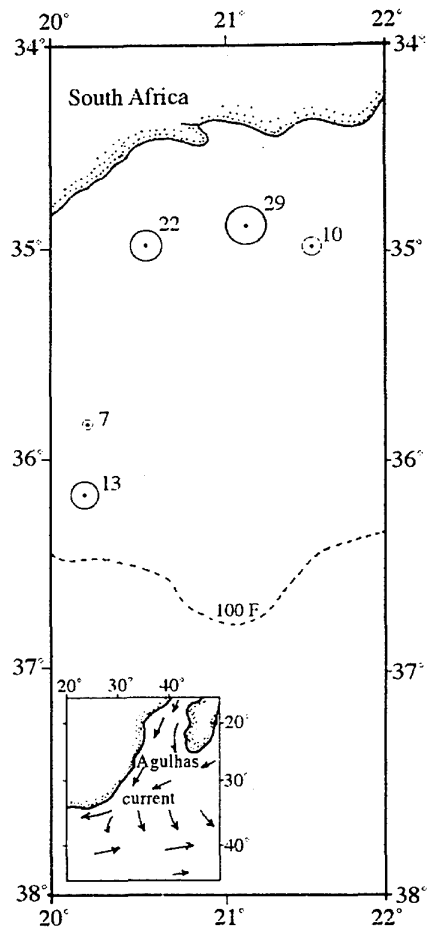


Fig.2. Distribution of larvae of *A. imperialis* (ind. 1000 m⁻³) in the Agulhas Bank.

strength to the statement made by De Decker (1964). The larvae of *A. imperialis* also can thrive well on the Agulhas Bank as has been reported for several other Atlantic species by De Decker (1973).

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