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LINEFISH LARVAE AND THE AGULHAS CURRENT

L.E. Beckley
Oceanographic Research Institute

INTRODUCTION

Biological studies on several linefish species have revealed annual northward spawning migrations of adult fish from Cape to Natal waters. Juveniles of these species are encountered in inshore nursery areas in the Cape and in several papers spanning nearly two decades it has been suggested that the Agulhas Current is the mechanism responsible for the southward dispersal of the early life history stages of these species (van der Elst 1976, Heydorn *et al.* 1978, van der Elst 1981, Joubert 1981, Smale 1984, Griffiths 1988, Garratt 1988, van der Elst & Adkin 1991). In 1990 a SEFREF funded project commenced to study the ichthyoplankton along the east coast with the objective of testing the hypothesis that linefish larvae drift south in the Agulhas Current.

The Agulhas current is a western boundary current that forms part of the anticyclonic Indian Ocean gyre. Other western boundary currents include the Gulf Stream in the North Atlantic, the Kiroshio Current in the North Pacific, the Brazil Current in the South Atlantic and the East Australian Current in the South Pacific. The Agulhas Current flows along the east coast of South Africa following the edge of the continental shelf and getting further from the coast as the shelf widens over the Agulhas Bank until it retroflects at about 20°E and heads eastwards (Schumann 1987). The Agulhas Current generally becomes established between 25° and 30°S and the upper layers of the current are a mixture of both Tropical Surface Water and Subtropical Surface Water (Pearce 1977, Saetre & da Silva 1984). The average speed of the current is 1 - 2 ms^{-1} and about 60 million m^3 of water are transported each second which is about a quarter of a million times the flow of the Orange River (Shannon 1989). At Durban the core of the current is about 50 km offshore, at Port Edward the core is generally 30 km offshore, at East London about 50 km offshore and off Algoa Bay about 70km offshore (Grundlingh 1983).

OCEANOGRAPHY

The Sea Fisheries Research Institute Research Ship *Sardinops* was used for the east coast surveys and because of its small size and limited speed the sampling programme had to be designed accordingly. A grid of 36 stations along nine station lines extending from Algoa Bay in the south to Tugela River in the north was established. Each station line had four stations, two on the continental shelf in 50 m and 100 m of water and two off the shelf in 500 m and 2000 m of water (Fig. 1). The outer station on the Tugela line was, however, in 1000 m of water as the 2000 m contour is over 200 km offshore and Grundlingh (1983) had shown the core to be over the 1000 m isobath. From north to south the grid covered some 800 km with the widest station line being that off Algoa Bay which extended 100 km offshore. This grid of stations was occupied during three research cruises in May/June 1990, October 1990 and February 1991. All inshore stations were sampled on the northward leg of the cruise whilst the offshore stations were done on the southbound journey.

At each station a Seacat CTD profiler or temperature/salinity bridge was used to take oceanographic measurements of how temperature and conductivity or salinity varied with depth. Compilation of vertical profiles into transverse sections along all station lines clearly indicated warm Agulhas Current water at all offshore stations, some surface intrusions of Agulhas water onto the shelf, several strong thermoclines and some upwelling of cold deeper water onto the shelf (Fig. 2).

ICHTHOYPLANKTON

Fish larvae were sampled with standard 57 cm diameter SFRI Bongo frames fitted with 500 µm mesh zooplankton nets and General Oceanics mechanical flowmeters. Double oblique plankton tows to a depth of 80 m were made at all the stations except of course the 50 m inshore stations where tows were only made to 40m for obvious reasons. Tows were generally of 10 minutes duration and filtered approximately 200 m^3 of water per net.

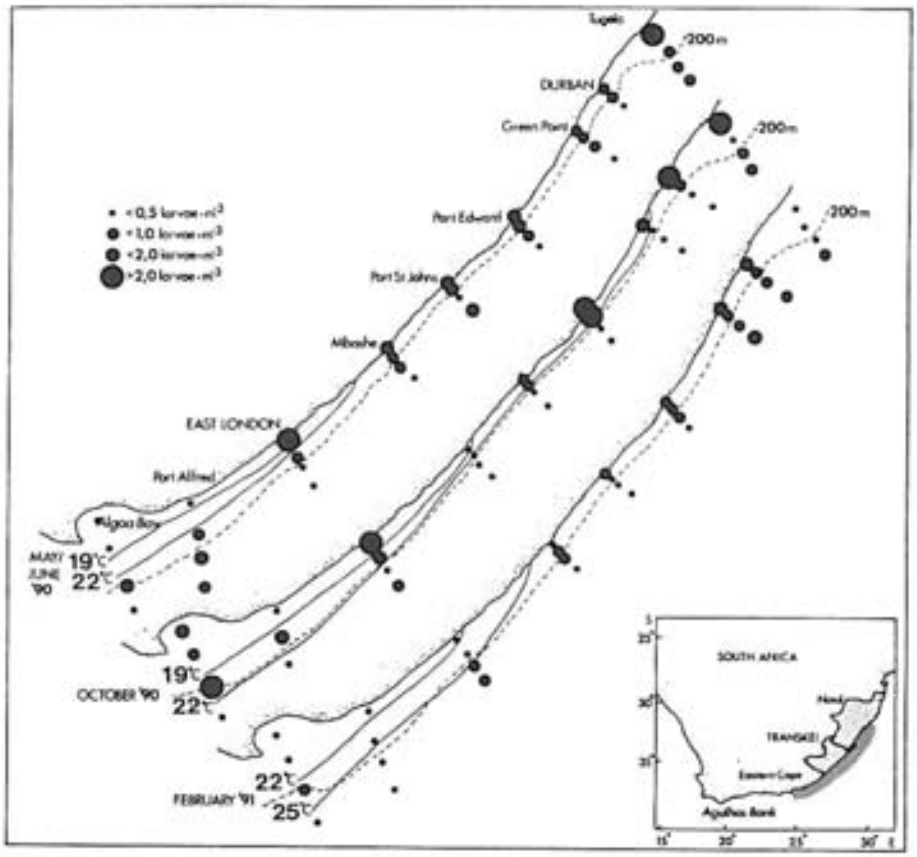

Fig. 1. The study area along the east coast of South Africa, showing the oceanographic and ichthyoplankton sampling stations. The 200 m isobath, sea surface isotherms and mean concentrations of fish larvae recorded from oblique Bongo net tows during the three cruises are given.

Over $30x10^3$ larvae were extracted from the 212 samples with 45% collected during the October 1990 cruise. Mean concentration per sample was 0.8053 larvae m^{-3} (SE 0.055). About 1% of these larvae remain unidentified and most of these are small yolk sac larvae or specimens damaged beyond recognition. Larvae of 139 families have been distinguished representing 58% of all families in Smith & Heemstra (1986). Larvae of 62 out of the total of 94 perciform families in southern African waters were recorded.

Overall composition of the ichthyoplankton caught during the three cruises is shown in Figure 3. Myctophids and clupeiforms constituted over half the larvae, perciforms comprised some 25% and others (e.g. stomiiforms, aulopiforms, gadiforms, scorpaeniforms, pleuronectiforms) about 20%. The rest of this paper will focus on the perciforms, in particular, those families which are important in the linefishery.

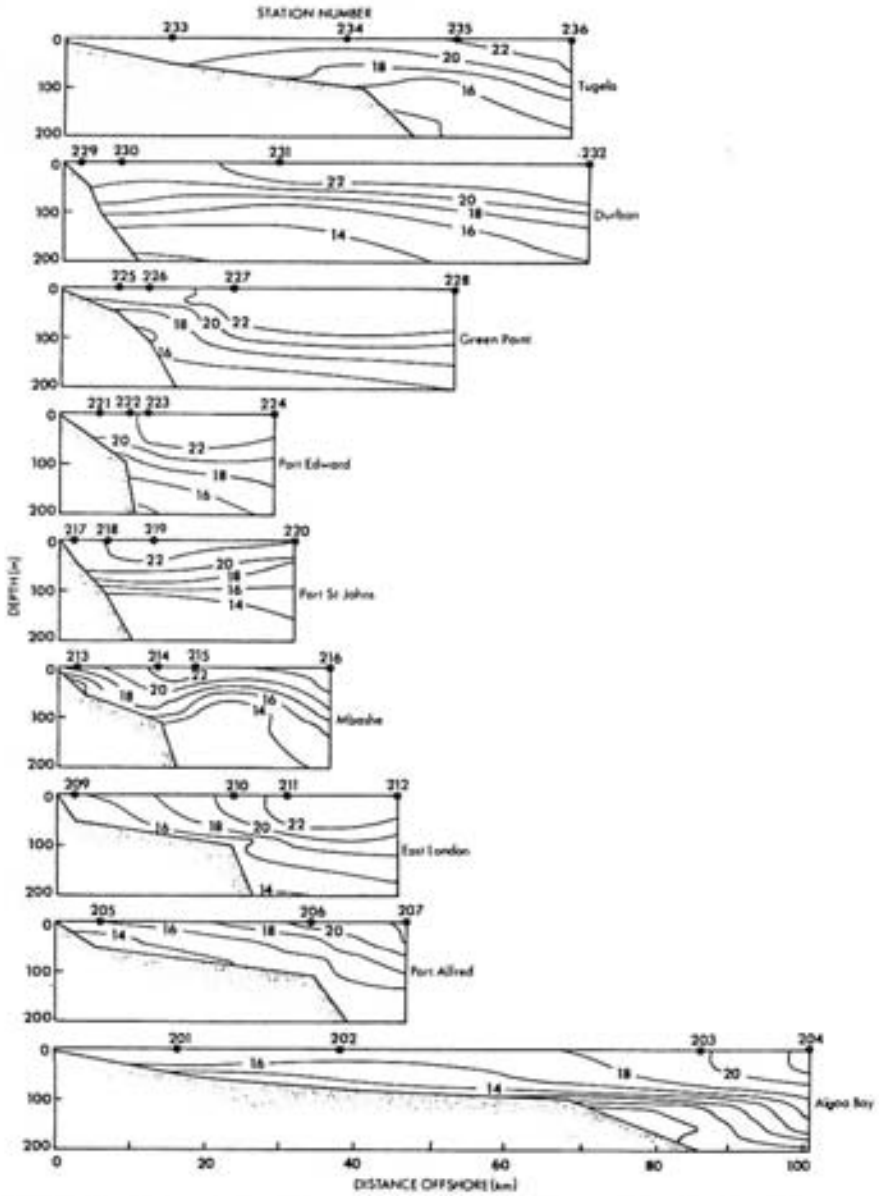

Fig. 2. Transverse sea temperature (°C) sections along the east coast of South Africa (October 1990).

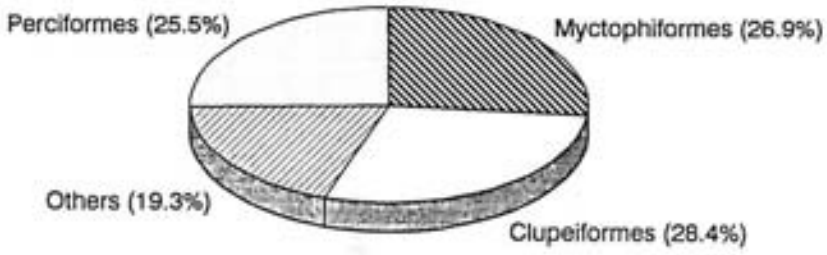

Fig. 3. Composition of ichthyoplankton in 1990/91 east coast survey samples.

Shad (*Pomatomus saltatrix*) is extremely important in the Natal rock and surf fishery. A total of 10 shad larvae were collected during the east coast surveys - five in October 1990 and five in February 1991 but all were on the shelf at the inshore stations in 50 m or 100 m of water along the Natal coast (Fig. 4). Shad eggs are regularly recorded off Park Rynie south of Durban in about 30m - 60m of water in the months of October to March (Alan Connell, pers. comm.). Research on larval distibution of *Pomatomus saltatrix* on the east coast of the United States has shown spawning to occur shoreward of the Gulf Stream in the South Atlantic Bight (Florida to Cape Hatteras) during spring, and larvae are carried northward to spread out over the continental shelf in the Middle Atlantic Bight (Cape Hatteras to Cape Cod) during the summer months (Kendall & Walford 1979). Similarly, work off the East Australian coast has shown that larvae of *P.saltatrix* occur on the shelf inshore of the East Australian Current between Brisbane and Sydney (Anthony Miskiewicz, pers. comm.).

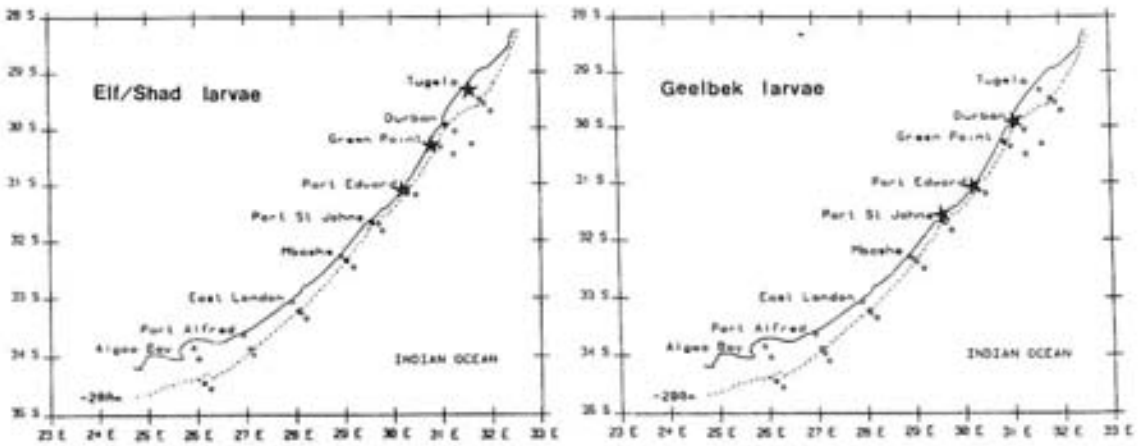

Fig. 4: Localities where elf/shad (*P. saltatrix*) and geelbek (*A. aequidens*) larvae were collected during 1990/91 east coast surveys.

Figure 5 shows the total number of sciaenid (kob) larvae caught in the different depths of water along the east coast. There was a complete absence of sciaenid larvae offshore in the core of the Agulhas current. The few larvae caught in 500 m were from off Algoa Bay and the remaining 93% were all caught on the shelf. Geelbek, *Atractoscion aequidens*, larvae can be distinguished from other sciaenid larvae by the presence of pigment on the pectoral fin and a total of nine geelbek larvae were recorded - three in each survey and all inshore on the shelf in water of 50 m or 100 m between Durban and Port St Johns and none offshore in the current (Fig. 4). Geelbek eggs have been recorded off Park Rynie during the months of July to March (Alan Connell, pers. comm.).

There are over 50 species of carangids in South African waters and many are important linefish. Larvae of the maasbanker (*Trachurus capensis*) and tropical scads (*Decapterus* sp.) were numerically dominant (Fig. 5). *Caranx* larvae were mainly offshore in the current at the northern stations in February 1991. A single ?*Lichia amia* (leervis) larva was recorded in February 1991 in 50 m of water off Port Edward and two ?*Seriola lalandii* (yellowtail) larvae were recorded - one in May 1990 in 100 m of water off East London and one in 100 m of water off Port Edward in February 1991.

Sparid larvae were clearly shelf-associated with sand soldier, *Pagellus bellotti natalensis*, the most common single species (Fig. 5). Haemulid larvae were also largely shelf-associated and samples were dominated by the pinky *Pomadasys olivaceum* (Fig. 5). Serranid larvae were dominated by Anthiine larvae (Fig. 5). These occurred both on the shelf (mainly the northern stations) and offshore in the current indicative of the more tropical distibution pattern of the adults. Larvae of Epinephaline rockcods were restricted to the shelf.

Tuna larvae were almost exclusively caught during the February cruise with frigate tuna (*Auxis thazard*) and Eastern little tuna (*Euthynnus affinis*) apparently spawning off Natal and larger larvae extending in a plume along the shelf edge all the way down to Algoa Bay (Fig. 6). Skipjack (*Katsuwonus pelamis*) larvae occurred chiefly offshore in the Agulhas Current and yellowfin and longfin larvae were restricted to offshore stations in the north. These *Thunnus* larvae were associated with Tropical Surface Water entrained in the Agulhas Current during the summer months (Beckley & van Ballegooyen 1992) and probably represent specimens advected from the central Indian Ocean spawing area (Shannon, van der Elst & Crawford 1989). Similarly, the relatively few other percIform larvae found offshore in the Agulhas Current were Indo-Pacific species that had been swept out of their normal distribution range (e.g. Acanthuridae, Chaetodontidae, Labridae).

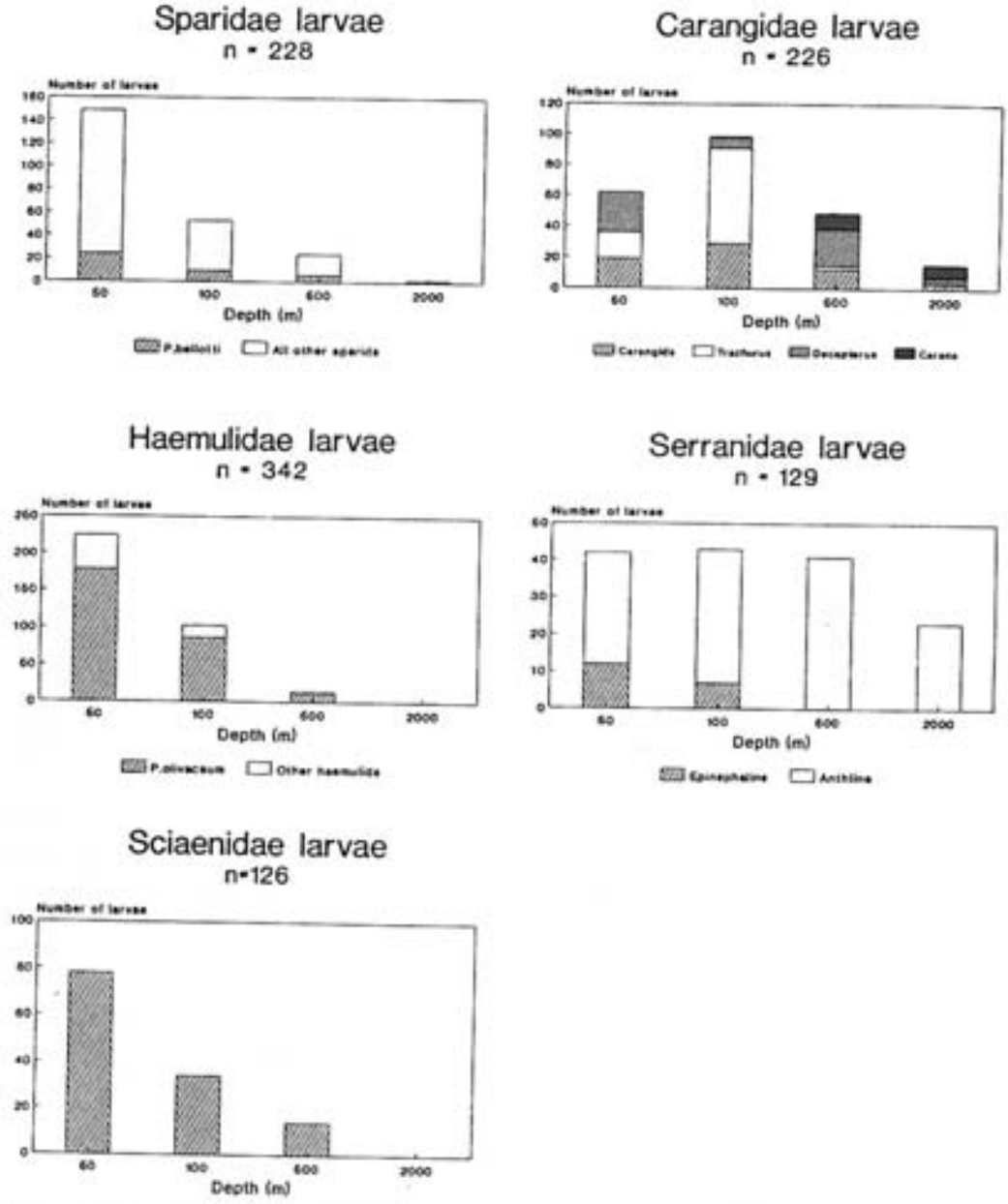

Fig. 5. Larval abundance of linefish families in relation to depth of water in 1990/91 east coast surveys.

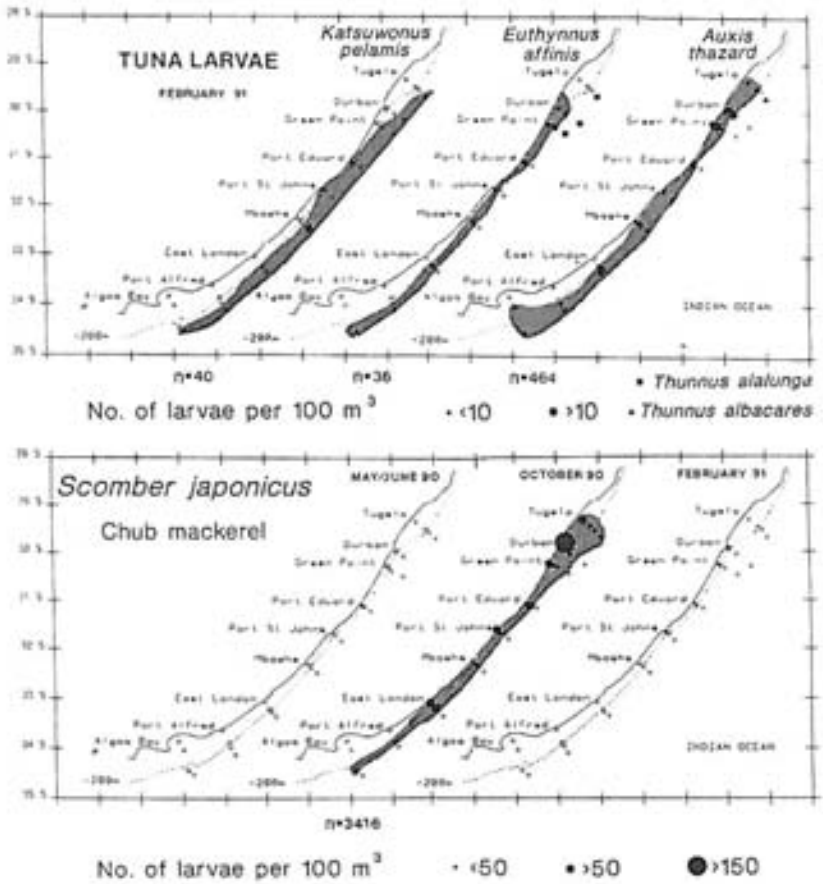

Fig. 6. Distribution and abundance of scombrid larvae along the east coast of South Africa during the 1990/91 cruises.

CONCLUSIONS

Based on the results of the east coast ichthyoplankton surveys it does not appear that inshore linefish species spawn in the Agulhas Current or use the Agulhas Current *per se* to transport larvae southwards - a simple calculation of 800 km at 3 knots (i.e. 120 km per day) would passively transport a larva from 30km offshore of Durban to 100 km offshore of Port Elizabeth in only six days. Rather, it appears that oceanographic features associated with the shoreward edge of the current are involved in retaining linefish larvae on the shelf for southward dispersal to nursery areas. These oceanographic phenomena such as surface intrusions of Agulhas water onto the shelf, upwelling of cold central water from under the current onto the shelf, downwelling on the inside edge of the current, the Natal Pulse and cyclonic eddies are only now being studied by oceanographers (e.g. SFRI Agulhas Current Boundary Processes cruise in January 1992). Detailed oceanographic studies on the shelf will assist in elucidating retention and dispersal of linefish larvae in shelf waters along the east coast.

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