

Early Life History of *Pomatomus saltatrix* off the East Coast of South Africa

Lynnath E. Beckley^A and Allan D. Connell^B

^AOceanographic Research Institute, PO Box 10712, Marine Parade, Durban 4056, South Africa.

^BCSIR Catchment and Coastal Environmental Programme, PO Box 17001, Congella, Durban 4013, South Africa.

Abstract. Several authors have stated that southward transport of the early life-history stages of *Pomatomus saltatrix* occurs by passive drift in the Agulhas Current, a strong western boundary current which flows southwards following the edge of the continental shelf of eastern South Africa. However, an extensive study of the ichthyoplankton occurring in shelf and Agulhas Current waters from 29°S to 34°S located *P. saltatrix* larvae only in the shelf waters off KwaZulu-Natal. Sampling of fish eggs in the inshore shelf waters 60 km south of Durban on a regular basis has confirmed spawning of *P. saltatrix* to occur in this region. The data thus suggest that larval dispersal might occur in shelf waters where, although strongly influenced by the Agulhas Current, southward transport is not as rapid.

Introduction

The cosmopolitan fish *Pomatomus saltatrix*, known in South Africa as the elf or shad, is a major constituent of the catches of shore anglers along the east coast of South Africa (Joubert 1981; van der Elst 1989). The biology of this species, including migrations and the reproductive cycle, has been investigated in the KwaZulu-Natal province along the east coast (van der Elst 1976). Studies of ichthyofauna in South African estuaries have indicated that estuaries do not serve as important nursery areas for this species (Wallace *et al.* 1984a). However, shallow-water trawling surveys established that large marine bays on the south coast of the continent, particularly those in the Eastern Cape province, serve as nursery areas for 0+ juveniles (Smale 1984; Wallace *et al.* 1984b). A study of the ichthyoplankton of the nearshore waters of Algoa Bay in the Eastern Cape province did not reveal any larval *P. saltatrix* (Beckley 1986).

During autumn, *P. saltatrix* undertakes annual northward migrations from the south coast and in winter reaches the waters of KwaZulu-Natal where the species is taken by rock and surf anglers (van der Elst 1981). Reproductive activity occurs in spring and early summer (van der Elst 1976). It has been suggested that *P. saltatrix* spawns in offshore waters and that the larvae drift south in the Agulhas Current, the fast-flowing western boundary current that follows the edge of the continental shelf off the east coast of South Africa (van der Elst 1976, 1981; Heydorn *et al.* 1978).

This larval dispersal hypothesis has also been proposed for several other coastal fish species (Heydorn *et al.* 1978; Joubert 1981; van der Elst 1981; Garratt 1988; Griffiths 1988) and to examine this an extensive ichthyoplankton survey covering the waters of both the shelf and Agulhas Current was conducted off the east coast of South Africa in 1990–91 (Beckley and van Ballegooyen 1992). The results of this survey with respect to larvae of *Pomatomus saltatrix*

are presented here. In addition, samples of live fish eggs collected from shelf waters in KwaZulu-Natal during 1987–95, were analysed for the presence of *P. saltatrix* eggs.

Materials and Methods

Ichthyoplankton Survey

Three cruises were conducted with the RS *Sardinops* along the east coast of South Africa in May–June 1990, October 1990 and February 1991. The cruises covered a grid of stations extending from Algoa Bay (34°S) to Tugela (29°S), a longshore distance of some 800 km (Fig. 1). Nine station lines perpendicular to the coast were occupied. Each line had two stations located on the shelf in depths of 50 m and 100 m and two stations in the Agulhas Current offshore of the shelf break in depths of 500 m (slope) and 2000 m (oceanic). The offshore extent of the grid varied from 30 km to 100 km depending on the width of the continental shelf and adjacent bathymetry. The outer station on the Tugela line was restricted to 1000 m depth because Grundlingh (1983) had shown that the mean position of the core of the Agulhas Current was inshore of the 1000 m isobath along this part of the coast. The 2000 m stations on the Durban and Port Alfred lines could not be sampled during June 1990 and October 1990, respectively, because of severe gales.

Oceanographic conditions were recorded during the three cruises; the methodology and results have been described in detail by Beckley and van Ballegooyen (1992). Ichthyoplankton samples were collected with standard bongo nets of 57-cm mouth diameter and 500- μ m mesh equipped with mechanical flowmeters and a recording diving depth gauge. Stepped oblique tows were conducted in the upper 80 m of the water column at all stations except at the inshore 50-m depth stations where only the upper 40 m was sampled. All tows were of 10 min duration, and mean volume of water filtered per net was 197 m³ (s.e. 2.5 m³). This methodology, with a slower net retrieval rate for the inshore 50-m depth stations, can result in some bias towards these stations if particular larvae occur only in the upper part of the water column. Samples were preserved in 5% v/v formalin in sea-water. Fish larvae were separated from the zooplankton under a dissecting microscope and *P. saltatrix* larvae identified on the basis of the descriptions of Norcross *et al.* (1974) and Fahay (1983).

Egg Sampling

Surface plankton samples were taken opportunistically with a semi-circular plankton net (40-cm diameter and 300- μ m mesh) trailed passively behind an anchored boat supporting diving operations. Samples

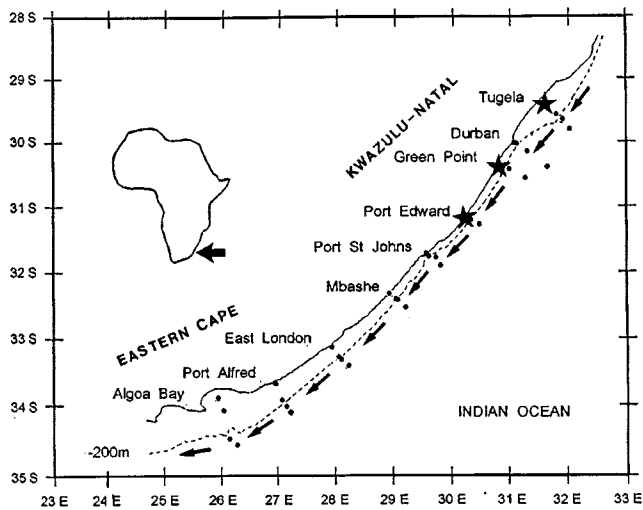


Fig. 1. Map of the east coast of South Africa indicating sampling sites during the 1990-91 ichthyoplankton survey. Large stars indicate areas where *Pomatomus saltatrix* larvae were collected and arrows indicate the path of the Agulhas Current. The provinces of KwaZulu-Natal and Eastern Cape, respectively, extend north and south from Port Edward.

were collected in water of 30 to 60 m depth in an area 4 to 5 km offshore of Park Rynie on the KwaZulu-Natal coast (60 km south of Durban) during the period January 1987 to April 1995; 398 samples were taken at approximately weekly intervals. Volumes of water filtered were measured for only 48 of the samples and ranged from 23 to 108 m³ with a mean of 53 m³.

Eggs were transported in sealed 25-L plastic buckets to the laboratory, where they were separated from the plankton, sorted to species level under a dissecting microscope and placed in clean sea-water in 500-mL glass containers for hatching. The unique ratio of egg size to oil globule size and the posterior position of the oil globule in the newly hatched larvae (Deuel *et al.* 1966; Fahay 1983) made them clearly distinguishable from the early life-history stages of other fish species found in the area. On two occasions batches of larvae were reared to 30-day juveniles in 50-L glass tanks for confirmation of identification as *P. saltatrix* by diagnostic fin counts. The larvae were fed on the rotifer *Brachionus plicatilis* supplemented by newly hatched *Artemia salina* and copepods from plankton hauls.

Results

Ichthyoplankton Survey

During all three cruises the warm Sub-Tropical Surface Water of the Agulhas Current was clearly evident at the oceanic 2000 m stations. In general, similar Agulhas Current water characteristics were recorded at the 500 m slope stations although the isothermal surface layer was shallower than that further offshore.

Warm surface water >22°C was found at many of the northern shelf stations, but a persistent wedge of cooler water occurred on the continental shelf south of Mbashe and East London. In October 1990, at the end of the austral winter, cooler water <22°C extended along the coast from Algoa Bay in the south to Green Point in the north. The water characteristics at many of the shelf stations frequently indicated shallow surface intrusions of warm Agulhas water

which were of varying depth and frequently masked underlying colder water.

Over half of the 3×10^4 larvae extracted from the ichthyoplankton samples were myctophid and clupeoid larvae (Beckley and Hewitson 1994; Olivar and Beckley 1994). Perciform larvae representing 62 families (including Pomatomidae) made up 25% of the total number of larvae collected.

Only ten *P. saltatrix* larvae, ranging from 2.8 to 9.8 mm standard length (SL; $x = 4.35$ mm) were collected during the survey. The larvae were found in KwaZulu-Natal shelf waters at the Port Edward 50-m, Port Edward 100-m, Green Point 100-m and Tugela 50-m stations during the October 1990 cruise and at the Port Edward 50-m, Port Edward 100-m, Green Point 50-m and Green Point 100-m stations during the February 1991 cruise (Fig. 1).

Egg Samples

In total, 2026 *P. saltatrix* eggs were found in 94 of the 398 samples taken off Park Rynie. From the mean number of *P. saltatrix* eggs collected per month during the study period a clear spawning season over the spring and summer months (October to March) was apparent (Fig. 2). A peak in egg abundance occurred in December.

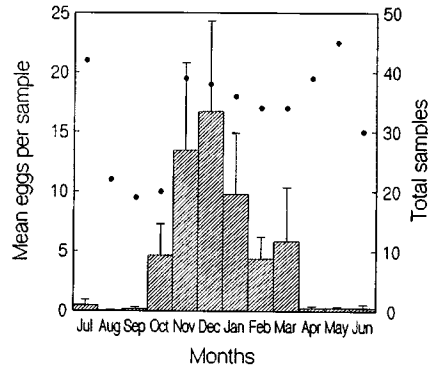


Fig. 2. Mean monthly number (shaded columns) of *Pomatomus saltatrix* eggs captured per surface haul (+ 1 s.e.) offshore of Park Rynie on the KwaZulu-Natal coast during the period January 1987 to April 1995. Total number of hauls (•) completed per month over the study period is indicated on the secondary y-axis.

Discussion

The eggs and larvae of *P. saltatrix* examined in this study were collected from shelf waters off KwaZulu-Natal. Their seasonal occurrence supports the reproductive biology study of van der Elst (1976), who found the gonad index of both males and females to peak in the period October to January.

The absence of larvae at the slope and oceanic stations in the present study suggests that *Pomatomus saltatrix* does

not spawn in the Agulhas Current or use the Agulhas Current *per se* to transport larvae southwards. A simple calculation of passive drift in the Agulhas Current at 1.5–2.0 m s⁻¹ (Schumann 1987, 1988) or 130 to 170 km per day would result in transport of early life-history stages from 30 km offshore of Durban to 100 km offshore of Algoa Bay in only five or six days. A similar problem of rapid transport far from the shelf by the Gulf Stream has been described by Nyman and Conover (1988) and McBride and Conover (1991) from an investigation of the relationship between spawning season and recruitment of young-of-the-year *P. saltatrix* on the east coast of the USA.

Other studies in the USA have indicated that spawning of *P. saltatrix* occurs on the continental shelf on the westward side of the Gulf Stream (Norcross *et al.* 1974; Kendall and Walford 1979; Collins and Stender 1987). Recently, Hare and Cowen (1993) proposed a transport model incorporating the Gulf Stream, cross-slope currents and the along-shelf current of the mid-Atlantic Bight. From studies in the Gulf of Mexico, Ditty and Shaw (1995) suggested that spawning of *P. saltatrix* occurs over the continental shelf particularly around hydrographically dynamic areas such as riverine/oceanic frontal zones. In the Mediterranean, off the southern coast of Spain, the larvae of *P. saltatrix* have also been found to be distributed over the continental shelf (Sabatés and Martin 1993).

The continental shelf off the east coast of South Africa is generally narrow and, although shelf waters are strongly influenced by the Agulhas Current, coastal wind events do also have a marked effect on water movements (Schumann 1987). Progressive vector diagrams published by Schumann (1988) of current measurements taken in about 30 m depth off Port Edward clearly indicated south-westward flow attaining 0.5 m s⁻¹. Further south, current measurements taken at moorings located off East London in depths of 31 and 78 m also indicated that flow was predominantly south-westward along the isobaths, although some reversals to a north-eastward flow did take place during strong south-westerly wind events (Schumann 1987). In general, currents on the shelf, although slower, would thus also favour southward dispersal of *P. saltatrix* larvae spawned off Kwazulu-Natal. It is estimated that, using shelf currents, they could reach their nursery areas in the marine embayments along the south coast in three to four weeks.

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