Factors influencing the recruitment of juvenile fishes into the Mhlanga estuary

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The migration of juvenile fishes (<5 cm) into the temporarily open Mhlanga estuary was monitored to determine the effects of different opening periods on immigration. The estuary opened at the end of January 1978 following a nine month closed phase. Only two marine species were recorded entering the estuary in February, compared to 11 species in November 1978. The estuary was closed between April and September. The large November recruitment may be attributed to the abundance of juvenile fishes in the sea adjacent to the estuary, whereas by February very few juveniles were present in Natal inshore waters. Estuarine and freshwater fish species were found to breed inside the estuary during the closed phase when environmental conditions were relatively stable. Mechanisms employed by these species to prevent eggs and larvae from being swept out to sea are discussed, as are strategies used by marine species to ensure recruitment during the very short open phase of the estuary.
S. Afr. J. Zool. 1980, 15: 166 – 169

Die migrasie van jong visse (<5 cm) in die tydelike oop Mhlanga estuarium is gemonitor om die invloed van verskillende oop periodes op immigrasie te bepaal. Die estuarium het teen die einde van Januarie 1978 oopgegaan na 'n geslote tydperk van nege maande. Slegs twee mariene spesies is aangeteken wat die estuarium in Februarie binnegekom het, in vergelyking met 11 spesies in November 1978. Die estuarium was tussen April en September gesluit. Die groot Novemberaanwas mag te wyte wees aan die volopheid van jong visse in die aangrensende see terwyl daar in Februarie min in die Natalse waters was. Dit is gevind dat estuariese- en varswatervisspesies broei gedurende die geslote fase in die estuarium as omgewingstoestande relatief stabiel is. Meganismes wat aangewend word om te verhoed dat eiers en larwes meegevoer word na die see sowel as strategieë wat deur mariene spesies gebruik word om hervestiging gedurende die baie kort oop-fase van die estuarium te verseker word bespreek.
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The estuarine fish fauna of the Natal coast comprises 116 stenohaline, 113 euryhaline and three freshwater species (Wallace 1975a). The main feature of the life cycles of most euryhaline species is the division into a juvenile phase which is largely estuarine and an adult phase which is primarily marine. Additionally most species breed at sea (Wallace 1975b) with only a few species having adapted their entire life cycle to the varying physical conditions of estuaries. Juveniles of 29 of the marine species are considered common in Natal estuaries. These species enter estuaries between 1–6 cm in length although most species have completed their most active recruitment phase by the time a length of 5 cm is attained (Wallace & van der Elst 1975).

Material and Methods

Study area

The Mhlanga estuary (29°42'S; 31°06'E) is fed by a river 28 km in length with a catchment area of approximately 124 km² (Chew & Bowen 1971). The mean annual rainfall within the catchment is about 100 cm, 70% of which falls during summer (October – March) (Brand, Kemp, Pretorius & Schoonbee 1967). The estuary remains closed to the sea for most of the year because the inflow of fresh water from the river is insufficient to counteract the effect of longshore drift maintaining the sand bar across the mouth. Heavy rains in the catchment area result in a flooding of the estuary lagoon and breaching of the sand bar. The estuary was artificially opened in January and September because water levels began to back up into sugar cane which had been planted on the floodplain. The strong outflow of turbid water decreases after a few days thus allowing tidal penetration of the estuary. Salinities during 1978 fluctuated between 0–34 ‰ but were normally less than 10 ‰ (Whitfield 1980b). Salinities were highest prior to closure of the estuary and decreased steadily during the closed phase due to seepage of saline water through the sand bar into the sea and the inflow of fresh water from the river. The deepest portion of the estuary was in the middle reaches where a depth of 3,2 m was recorded. The water level dropped approximately 1 m when the estuary opened but rose rapidly following closure. Water temperatures attained a maximum of 30 °C in January ($\bar{x}$ = 28 °C) a minimum of 14 °C in July ($\bar{x}$ = 16 °C).

Fish less than 5 cm standard length (S.L.) were sampled in January, February, March, May, July, September and November 1978. The following gear was used: a small seine

net (10 m × 1,5 m × 4 mm bar mesh), fry seine net (3 m × 1 m × 1,5 mm bar mesh) and a cast net (4 m diameter, 12 mm bar mesh). Fish were measured to standard length and preserved in 4% formaldehyde for identification in the laboratory.

Results

The catch composition of juvenile fishes at Mhlanga is shown in Table 1. Thirteen marine, three estuarine and one freshwater species were recorded. The estuary opened at the end of January, following a nine month closed phase. The juveniles of only two marine species were recorded entering the estuary in February, three species in March and two species in May (entered April), compared to 11 species in November after the estuary had opened in September (Fig. 1).

The relationship between recruitment of juvenile fishes into Natal estuaries and records of juveniles of the same species entering the Mhlanga estuary are shown in Fig. 2. No data were available on the spawning and recruitment periods of *Gerres rappi, Crenimugil crenilabis, Monodactylus falciformis* and *Ambassis commersoni* in Natal estuaries. *G. rappi* entered the Mhlanga system in March and *C. crenilabis, M. falciformis* and *A. commersoni* in November. *A. commersoni* juveniles may have been the product of an estuarine spawning since Wallace (1975b) found that the closely related *Ambassis natalensis* spawns in estuaries. Evidence of estuarine spawning by *Glossogobius giuris, Solea bleekeri* and *Gilchristella aestuarius* was the presence of juveniles (<2 cm S.L.) captured in July, more than two months after the estuary had closed. The freshwater cichlid *Sarotherodon mossambicus* was also recorded spawning in the estuary in September and juveniles (<1,5 cm S.L.) were captured during November, January, February and March.

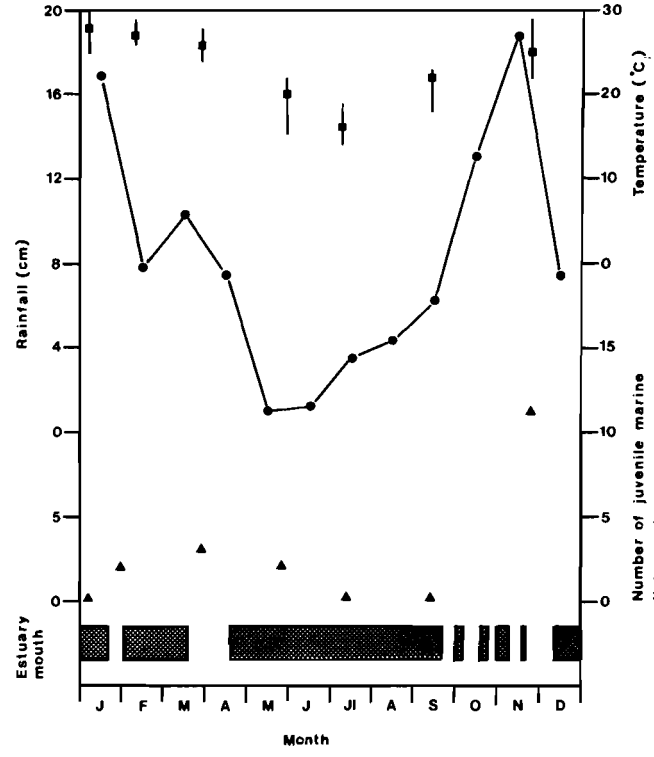

Fig. 1 Recruitment of juvenile marine fish species into the Mhlanga estuary in relation to physical conditions recorded at the estuary. Water temperatures (ϕ), rainfall in the catchment area (—) and mouth closure (stippled) are indicated.

Discussion

Most southern African estuarine fish species spawn at sea, despite the fact that they are adapted to the varying environmental conditions of estuaries. Wallace (1975b) suggested that this is because the relatively stable marine environment is more suitable for the survival of egg and larval stages. The spawning season of dominant estuarine species in Natal is during late autumn, winter and spring (May – November) with many species having an extended spawning period lasting 4 – 8 months (Wallace 1975b). This prolongs the period of juvenile recruitment into estuaries and has a buffering action against failure of recruitment as a result of adverse marine or estuarine conditions. The extended spawning season strategy enabled juveniles to enter the Mhlanga estuary which was closed in

Table 1 Juvenile fishes (<5 cm S.L.) captured at the Mhlanga estuary during 1978 (P = present, C = common, A = abundant)

Species	Common name	Relative abundance	Length range when first sampled (mm)	Marine	Estuarine	Freshwater
Acanthopagrus berda	Riverbream	P	34	+		
Ambassis commersoni	Banded glassy	P	16–18	+?		
Crenimugil crenilabis	Fringelip mullet	P	49–50	+		
Gerres rappi	Evenfin pursemouth	P	16–30	+		
Gilchristella aestuarius	Estuarine roundherring	A	17–24		+	
Glossogobius giuris	Tank goby	C	12–21		+	
Leiognathus equulus	Slimy	P	25–35	+		
Liza macrolepis	Largescale mullet	C	15–37	+		
Monodactylus falciformis	Cape moony	P	43	+		
Mugil cephalus	Flathead mullet	C	25–40	+		
Myxus capensis	Freshwater mullet	A	12–29	+		
Pomadasys commersonni	Spotted grunter	P	33–35	+		
Rhabdosargsus holubi	Cape stumpnose	C	21–28	+		
Sarotherodon mossambicus	Mozambique tilapia	A	10–29			+
Solea bleekeri	Blackhand sole	P	16–17		+	
Terapon jarbua	Thornfish	A	11–24	+		
Valamugil cunnesius	Longarm mullet	A	11–41	+		

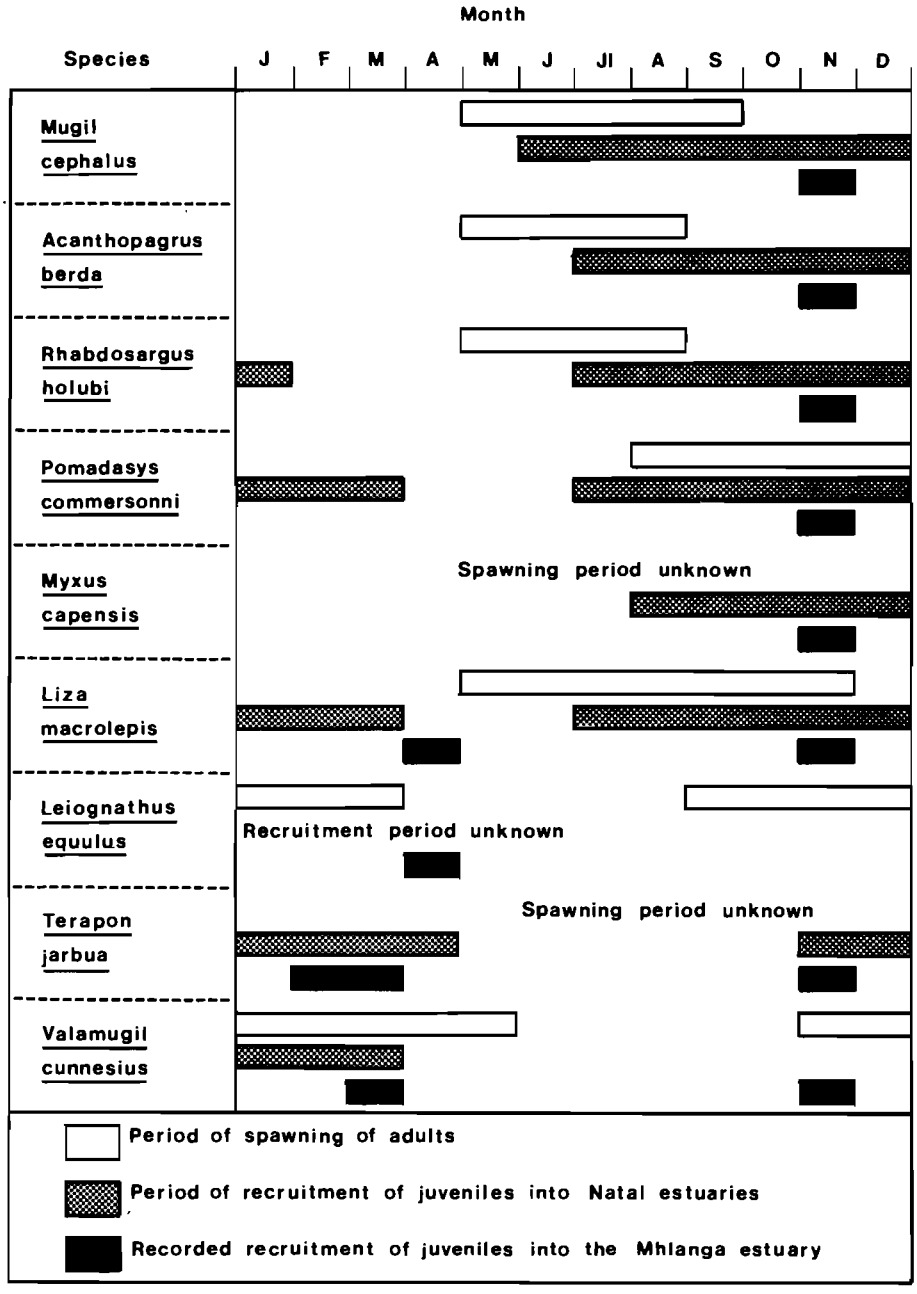

Fig. 2 Months of spawning of adult marine fishes (after Wallace 1975b), periods of migration of juveniles into estuaries (after Wallace & van der Elst 1975) and occurrence of juveniles (<5 cm S.L.) in the Mhlanga estuary.

winter and opened in spring (Fig. 1). Wallace and van der Elst (1975) found that maximum immigration into Natal estuaries occurs from September to November and therefore those blind estuaries which do not open during this period will have decreased recruitment. This occurred at Mhlanga when the estuary remained closed from April 1977 to January 1978 and only two species were recorded entering the estuary after it opened (Fig. 1). In contrast 11 species were captured in November 1978, which is a peak period for migration of juveniles into Natal estuaries (Wallace & van der Elst 1975).

The duration of the open phase of blind estuaries is important since fry require sufficient time to enter the estuary before it closes. Normally the Mhlanga estuary closes within 10 days of opening, which leaves a short period for recruitment. Wallace and van der Elst (1975) suggested that egg and larval stages of fishes spawned along the Natal coast would be retained in inshore waters because of current systems in the area. This, combined with evidence that the spawning grounds of estuarine species are in the vicinity of estuary mouths or marine inshore environments (Wallace 1975b), leads to the conclusion that reproductive strategy is to reduce the distance between breeding and nursery areas. Maximum recruitment is thereby ensured for the more than 50 seasonally closed estuaries along the Natal coast.

The biology of *G. aestuarius* in an estuarine system has been described by Blaber (1979) who found that spawning occurred throughout the year with an early summer peak. This prolonged breeding season is especially important to fish species resident in blind estuaries since breaching of the sand bar due to sudden thunderstorms, and resultant fluctuating physical conditions, can occur at any time of the year. Breeding by *G. aestuarius* at Mhlanga during the closed phase of the estuary enabled the fry to utilize the winter peak of zooplankton (Whitfield 1980a). *G. giuris* and *S. bleekeri* also bred during the stable closed phase whereas *S. mossambicus* were recorded carrying eggs and fry during the open phase. *S. mossambicus* had however completed nesting activities before the estuary opened.

Fish species which spawn in blind estuaries have to ensure that the eggs and fry are not lost to the marine environment when the estuary opens. The eggs of *G. aestuarius* are sticky and presumably attached to the substrate or aquatic macrophytes (Blaber 1979). The eggs of *G. giuris* at Mhlanga are also slightly sticky and Breder and Rosen (1966) found that specializations in gobiid breeding biology include adhesive eggs which are laid in the substrate, under stones and amongst algal filaments. *G. aestuarius, G. giuris* and *S. bleekeri* are all small species and the fry could utilize eddies present along the margin of an open estuary to avoid being swept out to sea. *S. mossambicus* exhibits parental care during egg and larval phases (Crass 1964) and release the fry after a length of 5 mm has been attained, by which stage they are able to maintain their position in the estuary. Therefore most species present in the Mhlanga estuary have reproductive strategies which ensure that they are able to enter or remain in the estuary during the open phase.

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