Juveniles, food and the surf zone habitat: implications for teleost nursery areas

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The length composition, abundance patterns and feeding habits of juvenile *Diplodus sargus capensis*, *Lithognathus mormyrus*, *Pomadasys olivaceum*, *Rhabdosargus globiceps*, *Sarpa salpa* and *Trachurus trachurus* are given. Zooplankton, in the form of copepods, chaetognaths, crustacean larvae and mysids, constituted a major component of the diet of these fish. The swimming prawn, *Macropetasma africanus*, was also a major prey item consumed by *D. sargus*, *P. olivaceum* and *R. globiceps*. The use of King's Beach as a nursery area is discussed in relation to food availability and shelter from predators.

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Die lengtesamestelling, getalpatrone en eetgewoontes van jong *Diplodus sargus capensis*, *Lithognathus mormyrus*, *Pomadasys olivaceum*, *Rhabdosargus globiceps*, *Sarpa salpa* en *Trachurus trachurus* word gegee. Zooplankton, wat uit Copepoda, Chaetognatha, die larwes van Crustacea en Mysidacea bestaan, het die grootste deel van die dieet van die visse uitgemaak. Die garnaal, *Macropetasma africanus*, was 'n belangrike prooi-item vir *D. sargus*, *P. olivaceum* en *R. globiceps*. Die gebruik van King's Beach as 'n grootwordgebied in terme van die beskikbaarheid van kos en beskerming teen roofdiere word bespreek.

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Recent work has indicated the importance of inshore waters as nursery areas for marine teleosts (Lasiak 1981; Berry, van der Elst, Hanekom, Joubert & Smale 1982; Lenanton 1982; Buxton, Smale, Wallace & Cockcroft 1984; Smale 1984; Robertson & Lenanton 1984; Wallace, Kok & Beckley 1984; Beckley 1985). The geographical extent of these nurseries has yet to be established and little is known of the abiotic and biotic factors that characterize these areas.

Data are presented here on the occurrence and diet of the juveniles of six teleost species, namely *Diplodus sargus capensis*, *Lithognathus mormyrus*, *Pomadasys olivaceum*, *Rhabdosargus globiceps*, *Sarpa salpa* and *Trachurus trachurus*. Although some 23 species of juvenile teleosts were recorded off King's Beach only the aforementioned species were caught in significant numbers throughout the study (Lasiak 1981, 1984a). The recruitment and early growth of these fish have been described previously (Lasiak 1983).

Methods

Sampling was carried out monthly between October 1979 and October 1980 by seine netting within the surf zone off King's Beach. Details of the study area, fishing gear and sampling procedure are given in Lasiak (1983 & 1984a). The numbers of *D. sargus capensis*, *L. mormyrus*, *P. olivaceum*, *R. globiceps*, *S. salpa* and *T. trachurus* individuals caught per month were noted. The total wet mass and total length were recorded for each fish. The latter measurement was used to summarize the length composition of the population throughout the study period.

A subsample of fish were retained each month for stomach contents analysis. Two methods were adopted, frequency of occurrence and gravimetry, as described in Lasiak (1984b). Problems were encountered in determining the mass of prey items in the smaller fish so food items from individuals comprising a monthly subsample were pooled.

Results

Diplodus sargus capensis

The blacktail, *Diplodus sargus capensis* is primarily an inshore species favouring turbulent seas and rocky shores but is also found in small shoals over deeper reefs (van der Elst 1981). Juveniles frequent the lower vegetated reaches of estuaries (Winter 1979; Beckley 1983), the surf zone (Lasiak 1981; Berry *et al.* 1982), subtidal reefs (Wallace *et al.* 1984) and tidal pools (Christensen 1978; Beckley 1985).

Fish caught off King's Beach ranged in length between 22 and 360 mm with juveniles within the 40–90 mm TL range predominating (Figure 1). Fry of ≤ 50 mm were recorded

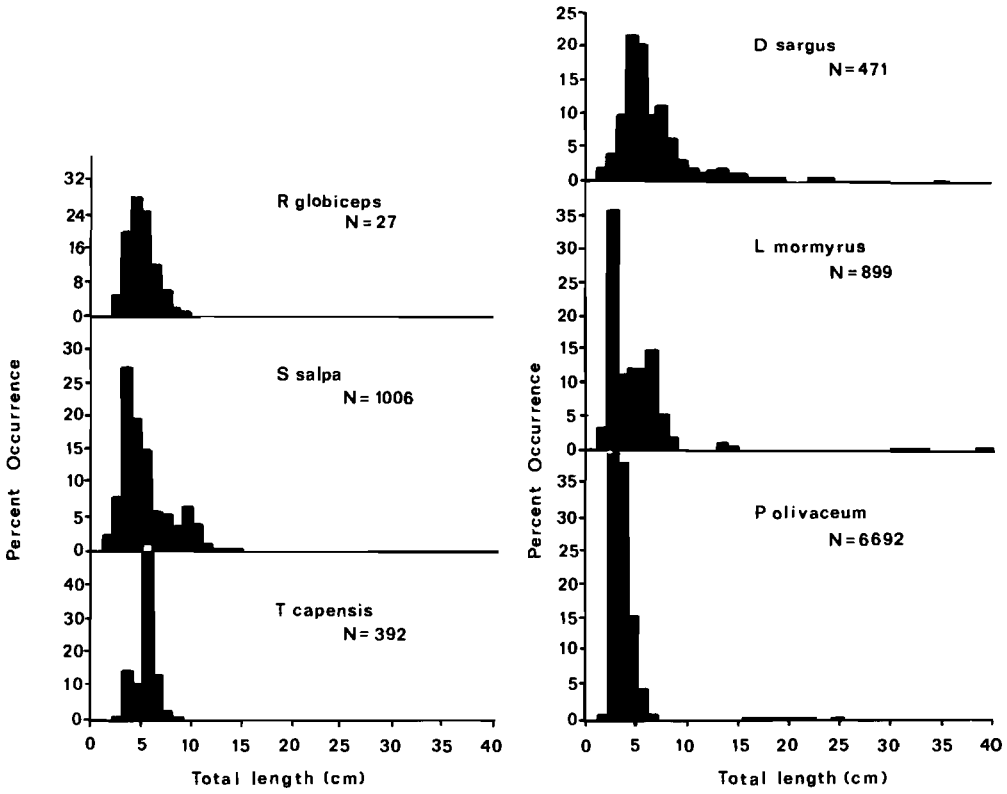


Figure 1 Length composition of six teleosts from fine-meshed seine hauls at King's Beach.

throughout the year indicating a prolonged recruitment, although two major peaks in recruitment were noted (February–April, July–August) (Lasiak 1983). The number of fish caught increased to a peak in February followed thereafter by a steady decline in numbers (Figure 2).

A total of 149 stomachs from juvenile *D. sargus* of ≤ 10 g total mass (9 cm TL) were analysed. The prey items occurring most frequently were copepods (47%), algae (26,2%), the swimming prawn *Macropetasma africanus* (19,5%) and ostracods (14,8%) (Table 1). On a gravimetric basis *M. africanus* and copepods dominated the diet. No seasonal trends were discernible with regard to the occurrence of prey items in the stomachs. Christensen (1978) found that the diet of juveniles associated with tidal pools consisted essentially of harpacticoid copepods, algae, isopods, polychaetes and ostracods.

Lithognathus mormyrus

With the exception of the tropical East African coast, the sand steenbras *Lithognathus mormyrus*, is found all around the African continent (Bauchot & Hureau 1981). It is a shallow-water species which prefers sandy beaches but also makes limited use of estuaries (Talbot 1955; Winter 1979; van der Elst 1981).

Fish caught off King's Beach varied in length from 21 to 291 mm, a large proportion of the catch being juveniles between 30 and 80 mm TL (Figure 1). Juveniles were caught throughout the year which suggests that King's Beach and its surrounding waters may constitute a nursery area for this species. The major recruitment period was February to May (Lasiak 1983). *L. mormyrus* was well represented in trawl catches between Mossel Bay and Plettenberg Bay with the majority of fish caught above 120 mm TL (Buxton *et al.* 1984). No fish of 0-age group (below 72 mm) were caught in the latter trawl survey. The number of sand steenbras caught off King's Beach was highly variable (Figure 2).

The stomachs of 217 juvenile sand steenbras of ≤ 10 g total mass (9,5 cm TL) were examined. In terms of frequency of occurrence the most prevalent items found in the stomachs were copepods, chaetognaths, ostracods and crustacean larvae (Table 1). Copepods (28,3%), chaetognaths (27,0%), fish (7,8%) and mysids (6,8%) comprised the major food items on a gravimetric basis. Copepods and crustacean larvae were found throughout the year, ostracods were present in the diet from November to July, and the mysid *Mesopodopsis slabberi* was found in stomachs between February and April. Juvenile *L. mormyrus* are thus planktivores whereas the sub-adults and adults are benthic feeders (Lasiak 1984b; Buxton *et al.* 1984). Ontogenetic changes in the feeding habits of *L. mormyrus* from the Central Adriatic Sea have been reported by Froglia (1977). Harpacticoid copepods, small polychaeta and small tellinid bivalves were consumed by juveniles and adults fed on larger crustaceans, bivalves and echinoderms.

Pomadasys olivaceum

The piggy, *Pomadasys olivaceum*, is known from Indo-Malaysia and has spread round the South African coast as far as False Bay (Smith 1965). Juveniles occur in large shoals around shallow water reefs (Joubert & Hanekom 1980; Joubert 1981) off sandy beaches (Lasiak 1981, 1983, 1984a) inshore at depths of 5–19 m (Buxton *et al.* 1984) and are occasionally found in estuaries (Talbot 1955; Winter 1979).

Fish caught off King's Beach varied in length from 21 to 222 mm TL. The vast majority were members of the 0-age group within the 30–50 mm length range (Figure 1). Fish of this size were abundant throughout the year indicating an extended recruitment period (Lasiak 1983). Joubert (1981) presented evidence of an extended breeding period for *P. olivaceum* in Natal. Low numbers of fish were caught off King's Beach between October and February and numbers rose steeply in March remaining high for the remainder of

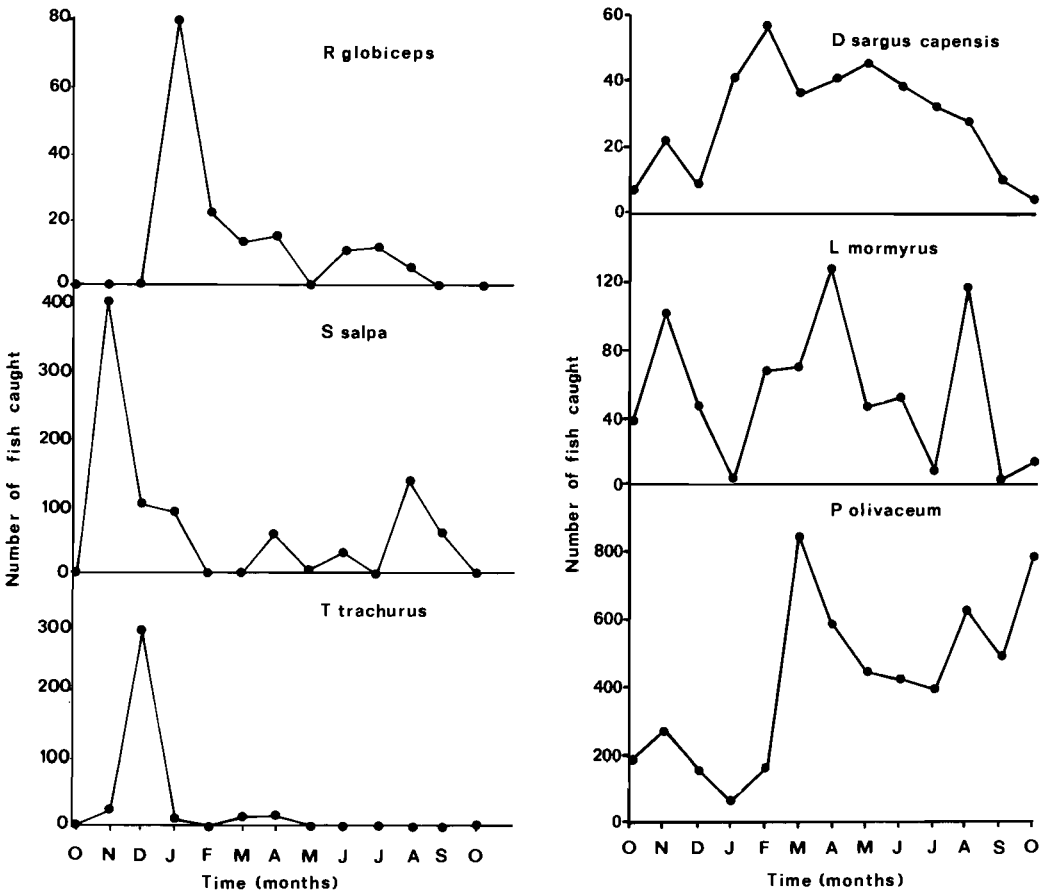


Figure 2 Fluctuations in the numbers of six teleost species caught monthly between October 1979 and October 1980 at King's Beach.

Table 1 Diet of juvenile *D. sargus, L. mormyrus, P. olivaceum, R. globiceps, S. salpa* and *T. capensis* from King's Beach. Based on the frequency of occurrence (%F) and percentage mass (%M) of prey items in the stomachs (*N* is the number of stomachs analysed)

	D. sargus $N = 149$		*L. mormyrus* $N = 217$		*P. olivaceum* $N = 351$		*R. globiceps* $N = 150$		*S. salpa* $N = 111$		*T. capensis* $N = 119$	
Prey item	%F	%M	%F	%M	%F	%M	%F	%M	%F	%M	%F	%M
Sand					2,0	1,2					2,9	0,6
Unidentifiable	36,2	5,9	10,6	5,9	17,1	4,8	10,4	4,6	14,4	3,3	24,3	6,9
Algae	26,2	2,6	0,5	0,2			1,9	0,2	44,1	30,6		
Polychaetes	8,7	2,2	6,9	1,5					3,6	0,8		
Sipunculids							0,7	11,8				
Chaetognaths			22,1	27,0	5,4	1,2					18,6	28,3
G. psammodytes	7,4	1,5	1,8	3,4	1,4	0,6	1,9	1,0				
M. slabberi	6,7	0,8	5,5	2,0	8,6	7,5	1,9	0,5	0,9	0,2	17,1	19,8
Other mysids	8,1	2,9	8,3	6,8	13,7	9,9	0,9	0,3	6,3	1,7	1,4	1,9
Isopods	2,0	0,8			0,3	0,2						
Amphipods	2,7	0,4			0,3	0,2	0,9	0,2				
Tanaids							0,9	0,3				
Callianassa kraussi							2,8	12,8				
Copepods	47,0	10,2	77,9	28,3	49,6	20,1	5,7	1,0	59,5	54,6	38,6	12,0
Ostracods	14,8	1,9	29,0	3,7	9,7	1,8			0,9	0,3	21,4	3,1
Cladocerans	5,4	0,6	11,1	2,2	3,1	1,5			0,9	0,2	10,0	1,9
Megalopa larvae	0,7	0,1										
Other crustacean larvae	4,7	0,8	17,5	5,7	4,1	18,6	6,6	2,1	15,3	8,2	31,4	20,1
Macropetasma africanus	19,5	67,8	2,3	4,3	3,4	13,5	65,1	53,5				
Unidentified crustacea	4,7	0,9	1,8	1,2	5,1	4,5	14,1	10,3			1,4	0,6
Insects	1,3	0,1							2,7	0,2		
Fish	2,7	0,5	0,9	7,8	0,3	14,4	0,9	1,4			2,9	5,0

the study (Figure 2).

A total of 351 stomachs from juvenile fish of ≤ 10 g total mass (9 cm TL) were analysed. On a gravimetric basis the major prey items were copepods (20,1%), crustacean larvae

(18,6%) fish (14,4%), and swimming prawns, *Macropetasma africanus* (13,5%) (Table 1). No seasonal trends in the occurrence of prey items in the diet were detected. Copepods were found in stomachs throughout the year showing a tendency to predominate both in terms of prevalence and mass. The larger crustaceans *Macropetasma africanus* and *Mesopodopis slabberi* form the bulk of the food ingested by *P. olivaceum* of 70–195 mm TL from the O.R.I. reef (Joubert & Hanekom 1980), King's Beach (Lasiak 1982) and the inshore waters of the south coast (Buxton *et al.* 1984). From this it appears that *P. olivaceum* shows an ontogenetic change in size of prey selected possibly resulting from gape limitation.

Rhabdosargus globiceps

The white stumpnose, *Rhabdosargus globiceps*, is endemic to South Africa (Smith 1965). Adults form large shoals and are found to a depth of 80 m (Barnard 1927), while juveniles were thought originally to be estuarine dependent (Talbot 1955; Wallace 1975; van der Elst 1981). Recent work (Lasiak 1981, 1983, 1984a; Buxton & Kok 1983) has demonstrated the presence of juveniles in the shallow marine environment.

All the *R. globiceps* caught off King's Beach were juveniles between 28 and 131 mm total length, with the majority of fish between 40 and 70 mm length (Figure 1). Fry of ≤ 50 mm were caught from January to July indicating a prolonged recruitment period (Lasiak 1983). The greatest number of fish were caught in January and few fish were netted between May and October (Figure 2).

A total of 150 stomachs were examined, 29,3% of these were empty. Crustaceans, the swimming prawn *Macropetasma africanus*, (53,5%) and the benthic prawn, *Callianassa kraussi*, (12,8%) formed the bulk of the diet (Table 1). The most frequently encountered prey item was *Macropetasma africanus*. Buxton & Kok (1983) examined stomachs from *R. globiceps* in the length range 105–150 mm obtained by inshore trawling between Mossel Bay and Algoa Bay. These fish consumed epibenthic organisms associated with soft substrates, particularly polychaetes, ophiuroids, isopods and the sea-urchin *Echinocardium cordatum*. Juveniles within estuaries fed extensively on filamentous algae, amphipods, isopods, and the gastropod *Assiminea* sp. (Talbot 1955). Adult fish consume bivalves, crabs, molluscs, polychaetes and other crustaceans (Talbot 1955; van der Elst 1981).

Sarpa salpa

Christensen (1978) gives the distribution of the streepie, *Sarpa salpa*, from the Black Sea and Mediterranean down the West coast of Africa round to Delagoa Bay. Juveniles are abundant on subtidal reefs (Wallace *et al.* 1984), in tidal pools (Christensen 1978; Beckley 1985) and also frequent the surf zone off sandy beaches (Lasiak 1981, 1983, 1984a).

Specimens caught off King's Beach varied in length from 19 to 258 mm, the majority were 0-age group between 20 and 70 mm total length (Figure 1). Fry of < 40 mm were caught between August and November with major recruitment from August to September (Lasiak 1983). Two peaks in numbers caught were apparent in November and August (Figure 2).

Dietary preferences of 111 juvenile *S. salpa* ≤ 5 g total mass (8 cm TL) were examined. On a gravimetric basis copepods (54,6%) and algae (30,6%) predominated (Table 1). Other prey items identified were polychaetes, cladocera, crustacean larvae, ostracods, insects and the mysid, *Mesopodopsis slabberi*.

Christensen (1978) found that juvenile *S. salpa* < 2,5 cm SL fed extensively on harpacticoids and as fish increased in size the proportion of animal food declined and diatoms became more important. Larger streepies feed almost exclusively on algae, particularly rhodophytes (Christensen 1978; Joubert & Hanekom 1980; Lasiak 1982).

Trachurus trachurus

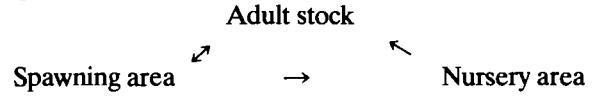
The maasbanker, *Trachurus trachurus*, is of considerable commercial importance in South Africa (Geldenhuys 1973; Hecht 1976; van der Elst 1981). According to Davies (1957) juveniles occur close inshore and in relatively sheltered waters such as bays. Buxton *et al.* (1984) recorded juveniles down to a depth of 50 m although they were most abundant in shallow trawls at 5–19 m.

All maasbankers caught off King's Beach were juveniles between 29 and 86 mm total length (Figure 1). Greatest numbers were caught in December while few fish were netted between May and October (Figure 2).

A total of 119 stomachs were examined, of which 41,2% were empty. Both the frequency of occurrence and gravimetric methods indicated that juveniles fed extensively on planktonic organisms particularly chaetognaths, crustacean larvae, the mysid *Mesopodopsis slabberi*, ostracods and copepods. This compliments the findings of Hecht (1976) on the diet of adults in Algoa Bay.

Discussion and Conclusions

Nektonic animals possess the ability to maintain themselves in food-rich surroundings and to select habitat types which are optimal for different phases in their life histories (Barnes & Hughes 1982). Harden-Jones (1968) envisaged fish migrating between three areas according to their life cycle stage:



Larval fish move from spawning to nursery area passively by drifting with inshore currents. By the time they reach the nursery area it is essential for them to have undergone metamorphosis and thus be capable of position maintenance. Nursery areas are habitats which provide optimal conditions, in terms of food and shelter, for the growth of juveniles. Several areas within the littoral zone, such as semi-enclosed bays, lagoons and estuaries have been recognized as nurseries for nektonic species (Barnes & Hughes 1982). The predominance of juvenile teleosts within surf-zone fish assemblages has been noted by Lasiak 1981; Modde & Ross 1981; McDermott 1983; Robertson & Lenanton 1984.

Exposed sandy beaches are generally characterized by reduced structural complexity *sensu* coral reefs and thus constitute habitats of minimal shelter. The juvenile fish associated with King's Beach may find shelter amongst small offshore reefs or at the nearby harbour breakwater. Multiple regression analysis of environmental parameters with catches of surf-zone fish has indicated a significant correlation with short-term wind conditions (Lasiak 1984a). This does not imply that wind *per se* is of importance, but rather that wind-induced effects on surf conditions and prey availability influence the occurrence of these fish in the surf zone. Heavy

surf may be advantageous in affording protection from predators as a result of increased turbidity or it may be disadvantageous to small juveniles resulting in injury from turbulence. Nearshore accumulations of detached macrophytes within the surf zone off west Australian beaches have been shown to provide shelter for juvenile fish (Lenanton 1982; Lenanton, Robertson & Hansen 1982; Robertson & Lenanton 1984). No comparable information is available in South Africa but accumulations of detached algae do occur at King's Beach.

Based on the low numbers of piscivorous fish caught in the surf zone (Lenanton 1982; McDermott 1983; Lasiak 1984a) it would appear that shallow coastal waters are relatively free of predators and thus afford juveniles protection from predation. However, as Lenanton (1982) pointed out, this is based on the assumption that piscivorous species are adequately sampled by seine netting. The recent inshore trawl survey between Mossel Bay and Algoa Bay (Smale 1984) revealed highest CPUE for two major piscivores *Argyrosomus hololepidotus* and *Pomatomus saltatrix* at depths of 4,5 to 19 m. Juvenile teleosts, including *Pomadasys olivaceum* and *Trachurus trachurus*, formed an important dietary component of these piscivores (Lasiak 1982; Smale 1984).

It is selectively advantageous for fish to grow rapidly and achieve a size beyond the catching rate of abundant, sympatric predators (Barnes & Hughes 1982). This can only be achieved in areas of relative food abundance. Planktonic organisms, particularly copepods, chaetognaths, crustacean larvae and mysids, constituted a major component of the diet of six juvenile teleosts caught off King's Beach. Recent work has shown that the abundance and biomass of zooplankton in the surf zone and inshore waters of the Eastern Cape are an order of magnitude higher than offshore and even higher than recorded in most estuaries (McLachlan 1983; Wooldridge 1983). The swimming prawn, *Macropetasma africanus*, a major prey item taken by *Diplodus sargus*, *Pomadasys olivaceum* and *Rhabdosargus globiceps*, utilizes the surf zone as a nursery area. Cockcroft (1983) has established that *M. africanus* shoals near the bottom by day, disperses into the water column at night and is most abundant just inside the breakers. By frequenting the surf zone and its surrounding waters these juvenile fish maintain themselves within a food-rich area.

The inshore zooplankton community in the Eastern Cape is dominated by mysids, especially *Mesopodopsis slabberi* with copepods being of secondary importance (McLachlan 1983). The differential representation of zooplankters in the diet of juvenile fish as compared with that in the zooplankton assemblage may reflect qualitative prey preference, constraints on the size of prey item ingested or differences in the swimming speed of predator and prey. As McLachlan (1983) pointed out, our knowledge of surf-zone zooplankton is abysmal, the only organisms to have received detailed attention are the mysids (Wooldridge 1983). Little is known about the distribution, behaviour and general biology of zooplankters that comprise a major component of the diet of juvenile teleosts. Consequently it is difficult to ascertain the potential competition for food between predators.

Comparison of the diets of juvenile *D. sargus capensis*, *R. globiceps* and *S. salpa*, as defined by the present study, with those established by previous workers (Christensen 1978; Talbot 1955; Buxton & Kok 1983) indicate considerable trophic plasticity. Dramatic dietary shifts associated with the use of different microhabitats by freshwater fish have been reported by Werner & Hall 1976; Mittelbach 1981; Bowen & Allanson 1982. Evidence for ontogenetic shifts in the diet of *L. mormyrus*, *P. olivaceum*, *R. globiceps* and *S. salpa* are presented. However, the interpretation of the significance of ontogenetic changes in diet are difficult. Dietary shifts may result from age-related morphological changes in the fish, ontogenetic development of novel foraging behaviour, age-specific patterns of habitat use and the consequent differential accessibility of prey items (Schmitt & Holbrook 1984).

More detailed information on trophic resource utilization in relation to prey availability is thus essential in the evaluation and comparison of nursery areas utilized by juvenile teleosts. Shelter and protection from predators afforded by the nursery site is of secondary importance.

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