The fish community of East Cape tidal pools and an assessment of the nursery function of this habitat

Lynnath E. Beckley

Zoology Department, University of Port Elizabeth, Port Elizabeth

Fish occurring in tidal pools in the lower balanoid zone near Port Elizabeth were examined by visual census and rotenone collections. Numerically, Clinidae constituted 28% of the community, Sparidae 23%, Gobiidae 17% and the Cheilodactylidae 12%, while eleven other families contributed to the remaining 20%. The 44 species recorded were classified as either residents (e.g. Clinidae or Gobiidae) or transients. The transient species were chiefly juvenile Sparidae, Cheilodactylidae and Mugilidae although numerous tropical vagrants also occurred in the summer months. Tidal pools, when compared with other coastal habitats, were found to be an important nursery area for some of the transient species, particularly *Sparodon durbanensis, Diplodus cervinus hottentotus, Chirodactylus brachydactylus* and *Cheilodactylus fasciatus.*

S. Afr. J. Zool. 1985, 20: 21–27

Die visgemeenskappe van getypoele naby Port Elizabeth is deur middel van visuele sensusse asook vergiftingsmetodes bestudeer. Clinidae het tot 28% van die gemeenskap bygedra, Sparidae 23%, Gobiidae 17% en Cheilodactylidae 12% terwyl elf ander families tot die oorblywende 20% bygedra het. Vier-en-veertig spesies is gevang en word as permanente of tydelike inwoners geklassifiseer. Die tydelike spesies is hoofsaaklik klein Sparidae, Cheilodactylidae en Mugilidae alhoewel tropiese swerwers in die somermaande voorkom. Dit is gevind dat getypoele as 'n belangrike kweekgebied vir die tydelike spesies, in besonder *Sparodon durbanensis, Diplodus cervinus hottentotus, Chirodactylus brachydactylus* en *Cheilodactylus fasciatus,* dien.

S.Afr. Tydskr. Dierk. 1985, 20: 21–27

Lynnath E. Beckley
Present address: Zoology Department, University of Cape Town, Private Bag, Rondebosch, 7700 Republic of South Africa

Received 9 May 1984; accepted 17 October 1984

Early studies of tidal pool fish in southern Africa were largely taxonomic or distributional (Smith 1960, 1965; Smith & Smith 1966; Penrith 1965, 1969, 1970; Penrith & Penrith 1972; Penrith 1976; Winterbottom 1976) but recently attention has turned to aspects of the biology of various species (Christensen 1978a, 1978b; Veith 1979; Stobbs 1980; Butler 1982; Bennett, Griffiths & Penrith 1983). Community studies were pioneered by Jackson (1950) and later continued by Marsh, Crowe & Siegfried (1978) and Bennett & Griffiths (1984) who reported on the distribution, abudance and diversity of tidal pool fish in the West Cape. In the East Cape, limited information is available on the tidal pool fish community from visual censuses conducted by Christensen & Winterbottom (1981) whilst along the Natal coast there are no accounts of tidal pool fish community structure, although the ichthyofauna of a reef in the surf zone at Durban has been studied (Berry, van der Elst, Hanekom, Joubert & Smale 1982).

The nursery function of various coastal habitats for juvenile marine fish is well known (Clark 1974; Lenanton 1982), and along the coast of southern Africa the importance of estuaries (Wallace & van der Elst 1975; Day, Blaber & Wallace 1981; Wallace, Kok, Beckley, Bennett, Blaber & Whitfield 1984), surf zone reefs (Berry *et al.,* 1982), and the sandy beach surf zone (Lasiak 1981, 1983a) to juvenile marine fish has been demonstrated. Tidal pools along the rocky shores of southern Africa have not been investigated with regard to their possible role as nursery areas for juvenile marine fish. The present study describes the fish community occurring in tidal pools in the East Cape, with particular reference to juvenile fish which, when adult, are resident elsewhere.

Study area

The study area was a 20 km stretch of rocky coast around the Cape Recife headland, near Port Elizabeth (Figure 1). The coast west of Cape Recife is typified by jagged rocks of quartzitic sandstone, with numerous pools and gullies whilst within Algoa Bay, from Cape Recife to Flat Rocks, a gently sloping rock platform of calcareous sandstone, incised by pools occurs (Stephenson, Stephenson & Bright 1938; McLachlan, Lombard & Lourens 1981). Semidiurnal tides occur in the study area and have a mean range of 1,61 m at springs and 0,51 m at neaps (Beckley & McLachlan 1979). The coast west of Cape Recife is exposed to more severe wave action than the coast within Algoa Bay, because most waves approach from the south and south-west as they are generated by storms moving from west to east in the depression belt located south of the African continent (Darbyshire & Darbyshire 1964). Sea

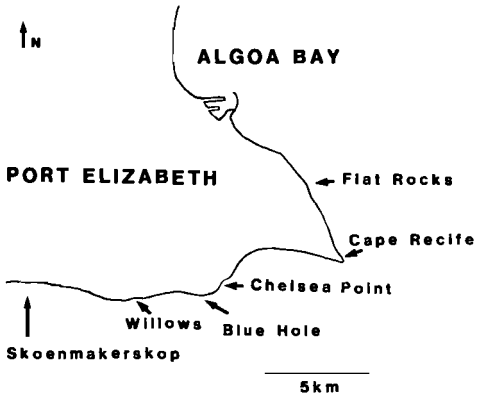

Figure 1 Localities of tidal pools investigated in the Port Elizabeth area.

temperature in the study area has an annual range of 12–27°C but the coast west of Cape Recife is subject to pronounced temperature fluctuations associated with upwelling and downwelling conditions (Beckley 1983a).

Materials and Methods

Visual census

Species composition of fish in tidal pools was monitored monthly from March 1980 to February 1981 at six sites in the study area. A fixed route was followed around pools at each site and a visual census made of the schooling and social species (*sensu* Christensen & Winterbottom 1981). Secretive and cryptic species (*sensu* Christensen & Winterbottom 1981) were not included, except for *Clinus superciliosus, Clinus cottoides, Caffrogobius caffer* and *Caffrogobius saldanhae,* which were easily recognized by the experienced observer. The census recorded presence of species and their relative abundance (rare, common, abundant). When identification of a species was uncertain, it was captured using handnets and identified in the laboratory using Smith (1965). Recent changes in nomenclature communicated by the J.L.B. Smith Institute of Ichthyology have been included.

Rotenone collections

During the period March 1980 to May 1982, 22 large tidal pools in the study area were poisoned using rotenone. Only pools in the lower balanoid zone, which were naturally closed off from the sea during spring low tides, were selected as collecting stations. Collections were made from 14 pools at Blue Hole, three at Cape Recife, two at Skoenmakerskop and one each at Flat Rocks, Willows and Chelsea Point (Figure 1).

Poisoned fish were removed from the pools by handnets, taken to the laboratory, identified, and the length and mass measured to the nearest 1 mm and 0,01 g respectively. Gut contents were removed for later analysis (Beckley in prep.), otoliths were extracted for the Port Elizabeth Museum collection and the actual specimens lodged in the J.L.B. Smith Institute of Ichthyology collection.

Species diversity of the tidal pool fish community was calculated by means of various diversity indices (Odum 1971) given below:

(i) Margalef species richness index $d = (S-1)/\log_e N$

(ii) Shannon-Wiener overall index $\bar{H} = -\sum(n_i/N)\log_e(n_i/N)$

(iii) Pielou evenness index $e = \bar{H}/\log_e S$

where N = total number of individuals; n_i = number of individuals of each species; S = number of species.

Results

Visual census

Twenty-two species of fish were encountered in the visual cen-

Table 1 Species of fish observed during monthly visual censuses of tidal pools at six sites near Port Elizabeth (E = endemic, rare = observed infrequently, common = observed frequently in low numbers or infrequently in shoals, abundant = observed frequently in large numbers)

Family	Species	Common name	Relative abundance
Ariidae	*Galeichthys feliceps*[E]	sea-catfish	common
Syngnathidae	*Syngnathus acus*	longnose pipefish	rare
Cheilodactylidae	*Cheilodactylus fasciatus*[E]	red fingers	common
	Cheilodactylus brachydactylus[E]	two tone fingerfin	abundant
Kuhlidae	*Kuhlia mugil*	barred flagtail	rare
Sciaenidae	*Umbrina capensis*	baardman	rare
Chaetodontidae	*Chaetodon auriga*	threadfin butterflyfish	rare
Scorpidae	*Neoscorpis lithophilus*[E]	stonebream	rare
Sparidae	*Diplodus cervinus hottetotus*[E]	zebra	common
	Diplodus sargus capensis[E]	blacktail	abundant
	Rhabdosargus holubi[E]	Cape stumpnose	common
	Sarpa salpa	strepie	common
	Sparodon durbanensis[E]	musselcracker	abundant
Pomacentridae	*Abudefduf saxatilis*	sergeant major	rare
	Abudefduf sordidus	spot damsel	rare
Mugilidae	*Liza richardsoni*[E]	southern mullet	abundant
Atherinidae	*Atherina breviceps*[E]	Cape silverside	common
Gobiidae	*Caffrogobius caffer*[E]	banded goby	abundant
	Caffrogobius saldanhae[E]	commafin goby	abundant
Clinidae	*Clinus cottoides*[E]	bluntnose klipfish	abundant
	Clinus superciliosus[E]	super klipfish	abundant
Tetradontidae	*Amblyrhyncotes honckenii*	evileyed blaasop	rare

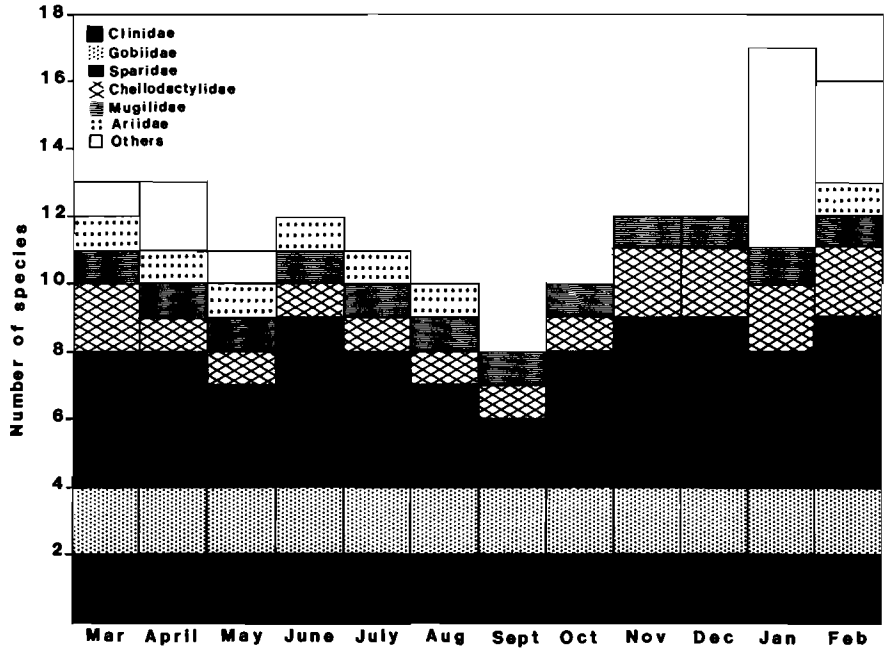

Figure 2 Monthly species richness of schooling and social species as determined by visual census of tidal pools near Port Elizabeth.

suses, with eight species regarded as abundant, six as common and eight as rare (Table 1). The number of species observed each month decreased through the winter months, but increased to a maximum in late summer (Figure 2). This was due to the presence of a number of rare species, including tropical vagrants such as *Abudefduf saxatilis, Abudefduf sordidus, Kuhlia mugil* and *Chaetodon auriga*. Species which were encountered during every month of the census were *Clinus superciliosus, Clinus cottoides, Caffrogobius caffer, Caffrogobius saldanhae, Diplodus sargus capensis, Sparodon durbanensis, Liza richardsoni* and *Chirodactylus brachydactylus*.

Rotenone collections

A total of 3 073 fish were collected from the tidal pools during the study period. Fifteen families and 36 species of fish were represented (Table 2). The majority of these species are endemic to southern Africa, with the remainder being either Indo-Pacific or circum-African in distribution. Only one of the 36 species, *Pavoclinus laurentii*, was previously unknown from the Port Elizabeth area and its known distribution limit is thus extended south from Port Alfred (Penrith 1970).

Clinidae constituted 28% of the fish collected, Sparidae 23%, Gobiidae 17%, Cheilodactylidae 12% and the other 11 families collectively 20% (Figure 3). Diversity indices calculated for the tidal pool fish community were as follows:
(i) Margalef d = 4,36;
(ii) Shannon-Weiner $\bar{H}$ = 2,67;
(iii) Pielou e = 0,75.

The fish collected from the tidal pools were generally small (99% < 150 mm) and comprised both small species (Clinidae, Gobiidae, Blenniidae) and juveniles of larger species (Sparidae, Cheilodactylidae). Length frequency distributions of the most abundant species are given in Figure 4. Of these species, *Galeichthys feliceps, Cheilodactylus fasciatus, Chirodactylus brachydactylus, Diplodus cervinus hottentotus, Diplodus sargus capensis, Rhabdosargus holubi, Sparodon durbanensis, Liza richardsoni* and *Liza tricuspidens* occurred only as juveniles, whilst only sub-adults and adults of *Atherina*

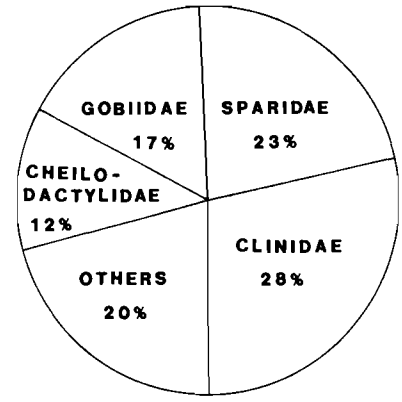

Figure 3 Composition of tidal pool fish collected from pools in the Port Elizabeth area by rotenone poisoning.

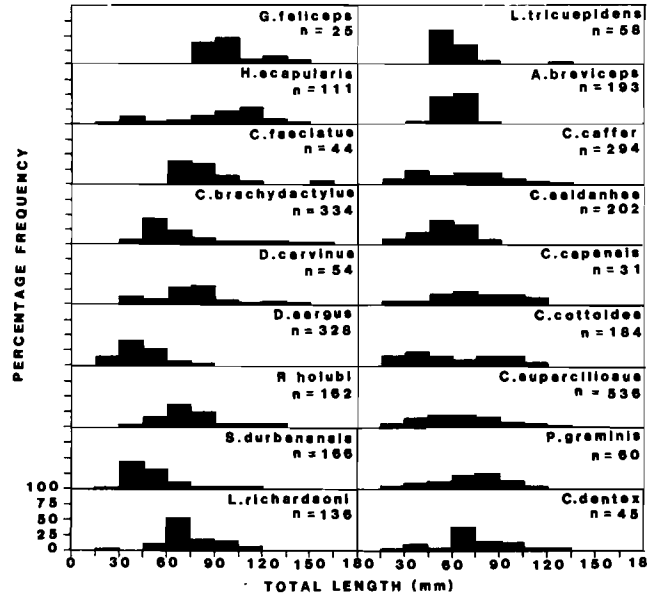

Figure 4 Length/frequency distributions of the 18 most abundant species collected from East Cape tidal pools by rotenone poisoning.

Table 2 Species of fish captured by rotenone poisoning in tidal pools near Port Elizabeth with details of their numerical abundance and size (E = endemic)

Family	Species	Common name	Number	Length range (mm)	Mean length (mm)	S.D.	Mass range (g)	Mean mass (g)	S.D.
Ariidae	*Galeichthys feliceps*[E]	sea-catfish	25	67–122	83,5	14,7	3,15– 21,83	7,8	4,2
Congrogadidae	*Halidesmus scapularis*[E]	slangetjie	111	24–155	91,8	30,4	0,04– 5,40	1,8	1,1
Cheilodactylidae	*Cheilodactylidae fasciatus*[E]	redfingers	44	64–165	84,3	19,8	2,68– 51,24	8,2	9,4
	Chirodactylus brachydactylus[E]	twotone fingerfin	334	42–173	67,2	24,7	0,88– 56,78	5,8	8,0
Serranidae	*Acanthistius sebastoides*[E]	koester	2	140–180	160,0	28,3	58,31–111,43	84,9	37,6
	Epinephelus guaza	yellowbelly rockcod	11	27–276	167,2	82,6	0,24–250,24	111,7	96,0
Chaetodontidae	*Chaetodon marleyi*[E]	double sash butterflyfish	1	67	67,0	–	9,18	9,2	–
Sparidae	*Diplodus cervinus hottentotus*[E]	zebra	54	34–144	73,6	22,3	0,55– 44,82	8,4	8,5
	Diplodus sargus capensis[E]	blacktail	328	21– 89	44,1	14,2	0,12– 9,34	1,6	1,7
	Rhabdosargus holubi[E]	Cape stumpnose	162	42–149	76,2	19,8	1,09– 49,90	8,2	7,3
	Sparodon durbanensis[E]	musselcracker	166	15–169	51,3	19,4	0,05– 72,84	3,0	6,3
Mugilidae	*Liza dumerili*[E]	groovy mullet	13	64–168	107,6	37,7	2,60– 46,34	15,9	15,6
	Liza richardsoni[E]	southern mullet	136	13–110	75,0	15,3	0,04– 12,95	4,8	2,9
	Liza tricuspidens[E]	striped mullet	58	47–132	61,4	11,3	1,04– 19,52	2,4	2,4
Atherinidae	*Atherina breviceps*[E]	Cape silverside	193	37– 77	59,8	7,2	0,39– 3,41	1,5	0,5
Gobiidae	*Caffrogobius caffer*[E]	banded goby	294	13–153	63,8	25,3	0,02– 45,78	4,6	5,4
	Caffrogobius saldanhae[E]	commafin goby	202	18– 91	54,6	14,8	0,03– 9,45	2,3	1,6
	Monishia william[E]	kaalpens goby	10	37– 47	42,8	3,5	0,58– 1,29	0,9	0,2
Blennidae	*Omobranchus woodi*[E]	kappie blenny	1	31	31,0	–	0,22	0,2	–
	Parablennius cornutus[E]	horned blenny	4	58– 72	64,8	6,8	2,01– 4,38	3,1	1,0
	Parablennius pilicornis	ringnecked blenny	1	57	67,0	–	3,73	3,7	–
	Scartella emarginata	maned blenny	6	54– 70	63,8	5,8	1,53– 3,35	2,5	0,6
Clinidae	*Blennioclinus brachycephalus*[E]	lace klipfish	21	40–102	75,2	15,7	0,60– 12,32	4,4	3,1
	Blennioclinus stella[E]	silver bubble klipfish	8	38– 52	43,4	4,7	0,45– 1,37	0,8	0,3
	Clinus capensis[E]	barbelled klipfish	31	23–113	73,8	25,0	0,12– 10,34	3,7	3,2
	Clinus cottoides[E]	bluntnose klipfish	184	18–117	60,1	27,6	0,03– 15,42	3,5	3,8
	Clinus superciliosus[E]	super klipfish	536	22–173	70,2	27,9	0,06– 58,29	6,1	7,8
	Pavoclinus mus[E]	mousy klipfish	6	68– 89	80,3	8,1	3,48– 7,60	5,6	1,5
	Pavoclinus graminis[E]	grass klipfish	68	13–119	71,8	23,5	0,05– 17,79	5,0	3,9
	Pavoclinus laurentii[E]	rippled klipfish	2	31–103	67,0	50,9	0,30– 10,30	5,3	7,1
Scorpaenidae	*Coccotropsis gymnoderma*[E]	smoothskin scorpionfish	1	25	25,0	–	0,17	0,3	–
Gobiesocidae	*Chorisochismus dentex*[E]	rocksucker	45	24–126	76,6	24,0	0,21– 39,43	10,5	9,7
Congridae	*Conger wilsoni*	Cape conger eel	1	556	556,0	–	177,50	177,5	–
Tetradontidae	*Amblyrhyncotes honckenii*	evileyed blaasop	4	31– 69	50,5	19,8	0,59– 7,33	3,7	3,4
	Arothron inconditus	bellystriped blaasop	1	75	75,0	–	17,31	17,3	–
Total			3 073	13–556	65,3	27,7	0,02–250,24	4,9	11,1

breviceps were captured. Full size ranges of *Halidesmus scapularis, Chorisochismus dentex*, the Clinidae and Gobiidae occurred. The remaining 12 species encountered in the tidal pool collections were captured irregularly and in low numbers. They comprised both south coast species and tropical vagrants.

Conspicuously absent from the tidal pools were juveniles of some locally important rock angling species, such as *Coracinus capensis* (galjoen), *Pachymetopon grande* (bronze bream) and *Cymatoceps nasutus* (poenskop).

Discussion

Diversity of fish in East Cape tidal pools was found to be high, with a total of 44 species recorded from visual censuses and rotenone collections during the study period. This is double the number of species collected by Bennett & Griffiths (1984) from the West Cape, but similar to the 40 species recorded by Christensen & Winterbottom (1981) from Port Alfred in the East Cape. All three Cape studies revealed considerably fewer species than the 66 species recorded by Berry *et al.* (1982) from their Natal surf zone reef study. This is because of the abundance of tropical Indo-Pacific species found along the Natal coast (Smith 1980a).

The tidal pool fish communities of the East Cape (present study) and the West Cape (Bennett & Griffiths 1984) differ chiefly in the number of clinid species (9 and 15 respectively) whilst juvenile sparids and tropical vagrants are absent in the West Cape. The Shannon-Wiener index of 2,7 calculated from the rotenone stations near Port Elizabeth, exceeds that of 2,1 calculated by Bennett, Griffiths, & Penrith (1983) for the West

Cape. This is as expected, because this index combines both species richness and evenness of allotment of individuals amongst species.

Comparison of the fish community in East Cape tidal pools with that of another East Cape coastal habitat, the Swartkops estuary (Winter 1979), with regard to the three diversity indices, revealed greater diversity in the tidal pools (Table 3).

Table 3 Comparison of diversity between fish communities in East Cape tidal pools and the Swartkops estuary (Winter 1979)

Diversity index	Tidal pools	Swartkops estuary
Margalef (species richness)	4,4	3,9
Shannon-Wiener (overall)	2,7	2,3
Pielou (evenness)	0,7	0,6

Gibson (1982), in his review of intertidal fish biology, concluded that tidal pool fish could be classified as either resident or transient and this classification can be applied to the East Cape tidal pool fish community as well. *Halidesmus scapularis, Chorisochismus dentex* and the various species of Clinidae, Gobiidae and Blenniidae can be regarded as residents of the East Cape intertidal zone. The transient species include juvenile Sparidae, Cheilodactylidae and Mugilidae, shoals of sub-adult and adult *Atherina breviceps* and seasonal tropical vagrants brought south by the Agulhas current.

Clinidae are particularly well adapted to residency in tidal pools by virtue of viviparous reproduction (Veith 1979) whilst Gobiidae, Blenniidae and Gobiesocidae are also well suited by having demersal eggs, thereby reducing the pelagic phase in their life cycles (Gibson 1969). The reproductive biology of *Halidesmus scapularis* and, in fact, the family Congrogadidae, is unknown (Breder & Rosen 1966), but as they belong to the order Blennioidea they probably have some mechanism to reduce the pelagic phase of their life cycle. Of these resident fish, the biology of the Clinidae has received most attention (Penrith 1969, 1970; Christensen 1978b, 1978c; Veith 1979) whilst *Caffrogobius caffer, Chorisochismus dentex, Parablennius cornutus* and *Scartella emarginata* have also been studied (Pitt-Kennedy 1968; Joubert 1980; Stobbs 1980; Butler 1982).

Of the transient species found in East Cape pools, the tropical vagrants are extremely varied and, in addition to the species recorded during the present study, numerous others have been encountered in pools near Port Elizabeth. These include *Pseudupeneus rubescens* (goatfish), *Ostracion tuberculatus* (boxfish), *Zanclus canescens* (Moorish idol), *Pomacanthus semicirculatus* (angelfish), *Chaetodon lunula* (butterflyfish), *Heniochus acuminatus* (coachman) and *Anthias squamipinnis* (sea goldie).

The two families numerically dominating the transient component of East Cape tidal pool fish were the Cheilodactylidae and the Sparidae. Little is known of the biology of the Cheilodactylidae in southern Africa though Butler (1975) has made some preliminary investigations. The taxonomy of the family has recently been revised by Smith (1980b) and both *Cheilodactylus fasciatus* and *Chirodactylus brachydactylus* are stated to occur inter- and sub-tidally. *C. fasciatus* grows to a length of 300 mm whilst *C. brachydactylus* reaches 450 mm (Smith & Smith 1966). The majority of specimens of both species captured in the tidal pools in the East Cape were juveniles less than 100 mm in length. Juveniles of these two species have not been recorded from East Cape estuaries (Winter 1979; Beckley 1983b, 1984) or sandy beaches (Lasiak 1982), whilst only relatively large specimens were encountered in trawling surveys off the Cape south coast (Wallace, Kok, Buxton & Bennett 1984) and diving surveys of subtidal reefs (Beckley unpublished). Tidal pools thus appear to be an important nursery area for the two species and absence of juveniles from other coastal habitats suggests that they could be dependent on tidal pools as nursery areas. Juveniles of *Cheilodactylus spectabilis*, a New Zealand species, have similarly been found to be restricted to shallow water (1–6 m) whilst adults occur over deeper subtidal reefs (Leum & Choat 1980).

Four species of Sparidae, *Diplodus sargus capensis, Diplodus cervinus hottentotus, Rhabdosargus holubi* and *Sparodon durbanensis* were collected using rotenone and, in addition, *Sarpa salpa* was recorded during visual censuses. *D. sargus capensis* is a very successful inshore species which spawns from May to December, with a peak from July to September (Joubert 1981). The shallow marine environment, including tidal pools (Christensen 1978a; Christensen & Winterbottom 1981), the sandy beach surf zone (Lasiak 1981, 1983a), surf zone reefs (Berry *et al.* 1982), subtidal reefs (Wallace, Kok & Beckley 1984) and the lower reaches of estuaries, particularly macrophyte beds (Winter 1979; Beckley 1983b) have been identified as nursery areas for juveniles of this species. *D. cervinus hottentotus* is also an inshore species which spawns in the spring months (van der Elst 1981). Juveniles appear to be restricted to tidal pools (Christenen 1978a; Christensen & Winterbottom 1981) though a few have been found in the lower reaches of the Swartkops estuary (Winter 1979; Beckley 1983b).

Rhabdosargus holubi is a species which, in its juvenile stage, is extremely abundant in South African estuaries (Wallace & van der Elst 1975; Day, Blaber & Wallace 1981; Beckley 1983b, 1984) and no juveniles have been recorded from inshore trawling and diving surveys (Wallace, Kok & Beckley 1984) or sandy beach seine netting (Lasiak 1982). The juveniles encountered in tidal pools in the present surveys were 42–149 mm in length, whilst *R. holubi* are known to enter estuaries as post larvae of 10–15 mm in total length (Beckley 1985). The two permanently open estuaries nearest the study area, the Swartkops estuary in Algoa Bay and the Gamtoos estuary in St Francis Bay, are 75 km apart and it is suggested that the *R. holubi* found in tidal pools are specimens which failed to recruit to the estuaries as post larvae and which subsequently recruited to tidal pools between the two estuaries.

Adults of *Sparodon durbanensis* frequent rocky and sandy shores and are much sought after by anglers (Smith & Smith 1966; van der Elst 1981). The brightly coloured juveniles are only known from tidal pools (Smith 1965; Smith & Smith 1966; Christensen 1978a; Christensen & Winterbottom 1981; van der Elst 1981) though a single specimen of 18 mm has been captured in the *Zostera* beds in the lower reaches of the Swartkops estuary (Beckley 1983b). This species appears to be dependent on tidal pools as nursery areas and, as extremely little information is available about the biology of this species, it has been designated a priority species in terms of linefish research (Wallace & van der Elst 1983).

The biology of *Sarpa salpa* is, however, well known and this species migrates to Natal in winter to breed (Joubert 1981; van der Elst 1981). The larvae then drift southwards with the Agulhas current to coastal habitats in the Cape, such as tidal

pools (Christensen 1978a; Christensen & Winterbottom 1981), estuaries (Winter 1979; Beckley 1983b), sandy beach surf zones (Lasiak 1981, 1983a) and subtidal reefs (Wallace, Kok & Beckley 1984), which are used as nursery areas.

Of the other transient species occurring in the tidal pools, juvenile mullet occurred frequently, particularly *Liza richardsoni*. Lasiak (1983b) has shown that this species spawns off sandy beaches in the East Cape and, unlike most other South African mullet which rely chiefly on estuarine nursery areas (Wallace *et al.* 1984), *L. richardsoni* juveniles frequent the surf zone as well (Lasiak 1981). Shallow coastal water over a soft substratum has been identified as the major nursery area for juvenile *Galeichthys feliceps* from a trawling survey of the Cape south coast (Wallace, Kok & Beckley 1984) and the few juveniles captured in tidal pools are probably an overflow of this population. The juvenile *Epinephelus guaza* recorded in the tidal pools probably follow the same pattern as identified by Berry *et al.* (1982) for *Epinephelus andersoni* in Natal and, on becoming sub-adults, move from tidal pools to deeper subtidal reefs. *Atherina breviceps* was the only transient species in the pools which occurred chiefly in the adult stage. This species is extremely abundant off East Cape sandy beaches where it breeds (Lasiak 1982) and juveniles are numerous in East Cape estuaries (Beckley 1983b).

For an area to serve as a nursery area for juvenile fish, it must be physiologically suitable in terms of chemical and physical features, it must provide abundant and suitable food and must, in some way, provide a degree of protection from predators (Joseph 1973). Lower shore tidal pools in the East Cape appear to fit these criteria as various juveniles were found to utilize this habitat. Of these transient juveniles utilizing tidal pools, it appears, however, that only *Sparodon durbanensis, Diplodus cervinus hottentotus, Cheilodactylus fasciatus* and *Chirodactylus brachydactylus* rely extensively and, possibly, exclusively on tidal pools as nursery areas.

Acknowledgements

I thank Dawn Phillips and Kim Hartley for field assistance, Dr P.C. Heemstra and Prof M. Smith of the J.L.B. Smith Institute of Ichythology for identification checking, Dr C. Griffiths for critically reading the manuscript and the C.S.I.R. (S.A.N.C.O.R.) for financial support.

References

BECKLEY, L.E. 1983a. Sea-surface temperature variability around Cape Recife, South Africa. *S. Afr. J. Sci.* 79: 436–438.

BECKLEY, L.E. 1983b. The ichthyofauna associated with *Zostera capensis* Setchell in the Swartkops estuary, South Africa. *S. Afr. J. Zool.* 18: 15–24.

BECKLEY, L.E. 1984. The ichthyofauna of the Sundays estuary, South Africa, with particular reference to the juvenile marine component. *Estuaries.* 7: 248–258.

BECKLEY, L.E. 1985. Tidal exchange of ichthyoplankton in the Swartkops estuary mouth. *S. Afr. J. Zool.* 20: 15–20

BECKLEY, L.E. & McLACHLAN, A. 1979. Studies on the littoral seaweed epifauna of St. Croix Island. I. Physical and biological features of the littoral zone. *S. Afr. J. Zool.* 14: 175–182.

BENNETT, B., GRIFFITHS, C. & PENRITH, M-L. 1983. The diets of littoral fish from the Cape Peninsula. *S. Afr. J. Zool.* 18: 343–352.

BENNETT, B. & GRIFFITHS, C. 1984. Factors affecting the distribution, abundance and diversity of rock-pool fishes on the Cape Peninsula, South Africa. *S. Afr. J. Zool.* 19: 97–104.

BERRY, P.F., VAN DER ELST, R.P., HANEKOM, P., JOUBERT, C.S.W. & SMALE, M.J. 1982. Density and biomass of the ichthyofauna of a Natal littoral reef. *Mar. Ecol. Prog. Ser.* 10: 49–55.

BREDER, C.M. & ROSEN, D.E. 1966. Modes of reproduction in fishes. T.F.H. Publications, Jersey City, U.S.A.

BUTLER, G.S. 1975. An investigation into the biology of two inter- and infra-tidal species of Cheilodactylidae (Pisces: Teleostei). Unpublished B.Sc. Honours project, Rhodes University, South Africa.

BUTLER, G.S. 1982. Daily feeding periodicity of the intertidal goby *Caffrogobius caffer*. *S. Afr. J. Zool.* 17: 182–189.

CHRISTENSEN, M.S. 1978a. Trophic relationships in juveniles of three species of sparid fishes in the South African marine littoral. *Fish. Bull. U.S.* 76: 389–401.

CHRISTENSEN, M.S. 1978b. A note on the feeding preferences of *Clinus cottoides* (Pisces: Clinidae) in the Eastern Cape. *S. Afr. J. Sci.* 74: 264–265.

CHRISTENSEN, M.S. 1978c. *Pavoclinus myae*, a new species of clinid fish (Perciformes:Blennoidei) from South Africa, with a note on the identity of *P. graminis* and *P. laurentii* and a key to the known species of *Pavoclinus*. *Spec. Publ. Smith Inst. Ichthyol. Rhodes Univ.* 18: 1–16.

CHRISTENSEN, M.S. & WINTERBOTTOM, R. 1981. A correction factor for, and its application to, visual censuses of littoral fish. *S. Afr. J. Zool.* 16: 73–79.

CLARK, J. 1974. Coastal Ecosystems — ecological considerations for the management of the coastal zone. Conservation Foundation, Washington, U.S.A.

DARBYSHIRE, J. & DARBYSHIRE, M. 1964. Wave observations in South African waters. *S. Afr. J. Sci.* 60: 183–189.

DAY, J.H., BLABER, S.J.M. & WALLACE, J.H. 1981. Estuarine fishes. In: Estuarine ecology with particular reference to southern Africa, (ed.) Day, J.H., pp. 197–221. A.A. Balkema, Cape Town, South Africa.

GIBSON, R.N. 1969. The biology and behaviour of littoral fish. *Oceanogr. Mar. Biol. Ann. Rev.* 7: 367–410.

GIBSON, R.N. 1982. Recent studies on the biology of intertidal fishes. *Oceanogr. Mar. Biol. Ann. Rev.* 20: 363–414.

JACKSON, P.B.N. 1950. The fishes of the intertidal zone of the Cape Peninsula. Unpublished M.Sc. thesis, University of Cape Town, South Africa.

JOSEPH, E.B. 1973. Analysis of a nursery ground. In: Proceedings of a workshop on egg, larval and juvenile stages of fish in Atlantic coast estuaries, (ed.) Pacheco, A.C., pp. 118–121. *Middle Atlantic Coastal Fisheries Centre Tech. Publ.* No. 1.

JOUBERT, I. 1980. The biology of *Blennius cristatus* L. and *Blennius cornutus* L. (Teleostei–Blennioidea) on a Natal Reef. Unpublished M.Sc. thesis, University of Natal, Durban, South Africa

JOUBERT, C.S.W. 1981. Aspects of the biology of five species of inshore reef fishes on the Natal coast, South Africa. *Investl. Rep. oceanogr. Res. Inst.* 51: 1–16.

LASIAK, T.A. 1981. Nursery grounds of juvenile teleosts: evidence from the surf zone of King's Beach, Port Elizabeth. *S. Afr. J. Sci.* 77: 388–390.

LASIAK, T.A. 1982. Structural and functional aspects of the surf-zone fish community in the Eastern Cape. Unpublished Ph.D. thesis, University of Port Elizabeth, South Africa.

LASIAK, T.A. 1983a. Recruitment and growth patterns of juvenile marine teleosts caught at King's Beach, Algoa Bay. *S. Afr. J. Zool.* 18: 25–30.

LASIAK, T.A. 1983b. Aspects of the reproductive biology of the southern mullet, *Liza richardsoni*, from Algoa Bay, South Africa. *S. Afr. J. Zool.* 18: 89–95.

LENANTON, R.C.J. 1982. Alternative non-estuarine nursery habitats for some commercially and recreationally important

fish species of south-western Autralia. *Aust. J. Mar. Freshw. Res.* 33: 881–900.

LEUM, L.L. & CHOAT, J.H. 1980. Density and distribution patterns of the temperate marine fish, *Cheilodactylus spectabilis* (Cheilodactylidae) in a reef environment. *Mar. Biol.* 57: 327–337.

MARSH, B., CROWE, T.M. & SIEGFRIED, W.R. 1978. Species richness and abundance of clinid fish (Teleostei: Clinidae) in intertidal rock pools. *Zool. afr.* 13: 283–291.

McLACHLAN, A., LOMBARD, W. & LOURENS, S. 1981. Trophic structure and biomass distribution on two East Cape rocky shores. *S. Afr. J. Zool.* 16: 85–89.

ODUM, E.P. 1971. Fundamentals of ecology. W.B. Saunders Co., Philadelphia, U.S.A.

PENRITH, M-L. 1965. Note on an extension of the known ranges of distribution of some species of Clinidae (Pisces). *S. Afr. J. Sci.* 61: 413–414.

PENRITH, M-L. 1969. The systematics of the fishes of the family Clinidae in South Africa. *Ann. S. Afr. Mus.* 55: 1–121.

PENRITH, M-L. 1970. The distribution of the fishes of the family Clinidae in southern Africa. *Ann. S. Afr. Mus.* 55: 135–150.

PENRITH, M.J. 1976. Distribution of shallow water marine fishes around southern Africa. *Cimbebasia* (A) 4: 137–154.

PENRITH, M.J. & PENRITH, M-L. 1972. The Blenniidae of western southern Africa. *Cimbebasia* (A) 2: 65–90.

PITT-KENNEDY, S. 1968. A preliminary investigation of feeding in two gobies, *Coryphopterus caffer* and *C. nudiceps*, with notes on their sexual maturity. Unpublished B.Sc. Honours project, University of Cape Town, South Africa.

SMITH, J.L.B. 1960. Fishes of the family Gobiidae in South Africa. *Ichthyol. Bull.* 18: 299–314.

SMITH, J.L.B. 1965. The sea fishes of southern Africa. Central News Agency, Cape Town, South Africa.

SMITH, J.L.B. & SMITH, M.M. 1966. Fishes of the Tsitsikamma Coastal National Park. National Parks Board, South Africa.

SMITH, M.M. 1980a. Marine fishes of Maputaland. In: Studies on the ecology of Maputaland, (eds.) Bruton, M.N. & Cooper, K.H., pp. 164–187. Rhodes University, Grahamstown, South Africa.

SMITH, M.M. 1980b. A review of the South African Cheilodactylid fishes (Pisces: Perciformes), with descriptions of two new species. *Ichthyol. Bull.* 41: 1–4.

STEPHENSON, T.A., STEPHENSON, A. & BRIGHT, K.M.F. 1938. The South African intertidal zone and its relation to ocean currents. IV. The Port Elizabeth district. *Ann. Natal Mus.* 9: 1–19.

STOBBS, R.E. 1980. Feeding habits of the giant clingfish *Chorisochismus dentex* (Pisces: Gobiesocidae). *S. Afr. J. Zool.* 15: 146–149.

VAN DER ELST, R. 1981. A guide to the common sea fishes of southern Africa. C. Struik, Cape Town, South Africa.

VEITH, W.J. 1979. Reproduction in the live-bearing teleost *Clinus superciliosus*. *S. Afr. J. Zool.* 14: 208–211.

WALLACE, J.H., KOK, H.M. & BECKLEY, L.E. 1984. Inshore small-mesh trawling survey of the Cape south coast. 2. The occurrence of estuarine associated fishes. *S. Afr. J. Zool.* 19: 165–169.

WALLACE, J.H., KOK, H.M., BECKLEY, L.E., BENNETT, B.A., BLABER, S.J.M. & WHITFIELD, A.K. 1984. South African estuaries and their importance to fishes. *S. Afr. J. Sci.* 80: 203–207.

WALLACE, J.H., KOK, H.M. BUXTON, C.D. & BENNETT, B.A. 1984. Inshore small-mesh trawling survey of the Cape south coast. I. Introduction, methods, stations and catches. *S. Afr. J. Zool.* 19: 154–164.

WALLACE, J.H. & VAN DER ELST, R.P. 1975. The estuarine fishes of the East coast of South Africa. IV. Occurrence of juveniles in estuaries. V. Ecology, estuarine dependence and status. *Investl. Rep. oceanogr. Res. Inst.* 42: 1–63.

WALLACE, J.H. & VAN DER ELST, R.P. 1983. Marine linefish programme priority species list. S.A. National Scientific Programmes Report No. 70, C.S.I.R., Pretoria, South Africa.

WINTER, P.E.D. 1979. Studies on the distribution, seasonal abundance and diversity of the Swartkops estuary ichthyofauna. Unpublished M.Sc. thesis, University of Port Elizabeth, South Africa.

WINTERBOTTOM, R. 1976. Notes on South African gobies possessing free upper pectoral fin rays (Pisces: Gobiidae). *Spec. Publ. Rhodes Univ. Inst. Ichthyol.* 16: 1–11.