Species composition and recruitment of tidal pool fishes in KwaZulu-Natal, South Africa

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Fishes occurring in a lower shore tidal pool near Durban, South Africa, were collected using rotenone at monthly intervals for a year. Eighteen teleost families and 50 lower taxa of fishes were recorded. Cryptic Tripterygiidae, Blenniidae and Gobiidae were particularly abundant while Pomacentridae, Acanthuridae, Serranidae, Sparidae and Labridae were recorded in lower numbers. Resident intertidal fishes recolonized the pool between monthly visits, with tripterygiids and gobies showing evidence for year-round recruitment of juveniles. Juveniles of more transient Indo-Pacific species recruited primarily during the summer months.

Key words: low shore pool, species abundance, seasonal abundance, seasonal recruitment, teleosts.

INTRODUCTION

Fishes are important mobile inhabitants of rocky shores and, along the South African coast, there have been several studies on the fish communities inhabiting tidal pools and sub-tidal gullies, particularly in the Western and Eastern Cape (Christensen & Winterbottom 1981, Bennett & Griffiths 1984, Beckley 1985a,b, Bennett 1987, Smale & Buxton 1989, Prochazka & Griffiths 1992). By contrast, although the ichthyofauna of shallow littoral reefs off Durban has been studied by Berry *et al.* (1982) and Fennessy *et al.* (1998a,b) little has been published about tidal pool fishes along the KwaZulu-Natal coast. The present study was undertaken to investigate species composition of a tidal pool fish community in KwaZulu-Natal and, by monitoring recolonization of the pool, to determine when recruitment occurs.

METHODS

Monthly sampling of a rocky shore tidal pool at Treasure Beach (29°57′S, 30°59′E) near Durban commenced in July 1992 and was completed in June 1993. A single pool on the lower shore was selected for the study and had a surface area of 23 m^2 and a maximum depth of 1 m. The pool was completely isolated at spring low tide and entirely inundated during all high tides.

Once a month, at spring low tide, the ichthyocide rotenone (dissolved in ethanol) was applied to the pool and all fishes collected with handnets. Great care was taken to check the perimeter and bottom of the pool to ensure that all fishes were retrieved. In the laboratory, the fishes were identified to the lowest possible taxon and measured (TL mm) before preservation.

RESULTS

A total of 1389 fishes representing 18 families and 50 taxa was collected during the study period (Table 1). The number of fishes collected in the initial sampling in July 1992 was 162, which equates to about seven fish per m^2. Thereafter, between 64 and 173 specimens recolonized the pool each month (Fig. 1). In the initial sampling, 19 species were represented and, although the number of species recolonizing the pool each month was lower than this during the subsequent winter and spring, highest species richness occurred in February when 24 species were

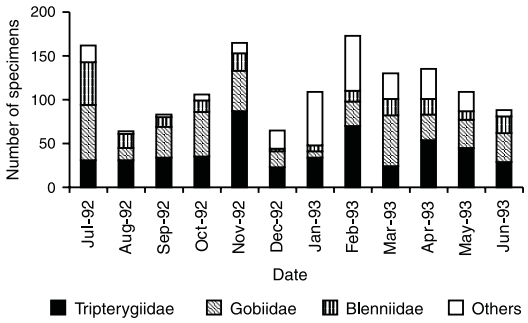

Fig. 1. Number of fish specimens collected each month by rotenone sampling in a tidal pool at Treasure Beach, KwaZulu-Natal, with an indication of the contribution by the major families. The initial sample reflects a climax assemblage and the subsequent monthly samples indicate recolonization of the pool.

Table 1. Fishes recorded from monthly collections in a tidal pool at Treasure Beach, KwaZulu-Natal, during the period July 1992 – March 1993.

Family	Taxon	*n*	Mean TL (mm)	S.D.	Range (mm)
CONGRIDAE	*Conger wilsoni*	1	57.0	—	—
MURAENIDAE	*Echidna nebulosa*	1	118.0	—	—
	Echidna polyzona	1	73.0	—	—
	Gymnothorax flavimarginatus	1	160.0	—	—
	Gymnothorax undulatus	4	175.2	40.4	141–245
	Gymnothorax sp.	2	54.0	7.1	49–59
GOBIESOCIDAE	Unidentified gobiesocid	1	9.0	—	—
SYNGNATHIDAE	Unidentified sygnathid	3	34.0	9.6	30–45
SCORPAENIDAE	*Pterois miles*	2	39.5	26.2	21–58
	Parascorpaena mcadamsi	5	64.8	23.4	25–84
SERRANIDAE	*Epinephelus andersoni*	5	38.4	11.6	32–59
	Epinephelus caeruleopunctatus	3	41.3	15.6	27–58
	Epinephelus faveatus	3	28.0	1.0	27–29
	Epinephelus marginatus	36	75.1	46.4	24–170
GRAMMISTIDAE	*Grammistes sexlineatus*	5	19.0	5.9	15–29
SPARIDAE	*Diplodus cervinus hottentotus*	3	100.3	31.9	79–137
	Diplodus sargus capensis	23	58.6	19.3	34–93
CHAETODONTIDAE	*Chaetodon auriga*	1	32.0	—	—
	Chaetodon lunula	6	43.7	13.8	32–64
POMACENTRIDAE	*Abudefduf notatus*	1	41.0	—	—
	Abudefduf sordidus	17	61.4	19.4	34–95
	Abudefduf vaigiensis	33	49.3	12.3	21–74
	Abudefduf sp.	1	22.0	—	—
	Chrysiptera unimaculata	1	19.0	—	—
	Plectroglyphidodon leucozonus	31	50.5	12.3	16–106
LABRIDAE	Unidentified labrid	14	17.0	5.2	10–23
	Halichoeres sp.	8	28.6	11.2	12–49
	Stethojulis strigiventer	1	55.0	—	—
	Thalassoma purpureum	4	43.0	5.1	38–50
	Thalassoma sp.	6	25.0	5.7	15–32
BLENNIIDAE	Unidentified blenniid	15	17.6	3.8	13–27
	Antennablennius bifilum	50	48.8	11.8	14–69
	Cirripectis castaneus	1	32.0	—	—
	Hirculops cornifer	7	24.8	1.8	23–28
	Istiblennius dussumieri	13	72.1	23.2	41–112
	Istiblennius edentulus	20	96.0	35.9	27–132
	Istiblennius gibbifrons	1	101.0	—	—
	Istiblennius impudens	1	125.0	—	—
	Istiblennius periopthalmus	2	119.5	2.1	118–121
	Omobranchus banditus	45	31.6	11.3	21–51
	Parablennius cornutus	7	21.7	6.1	15–31
	Scartella emarginata	35	47.3	18.0	24–94
TRIPTERYGIIDAE	*Helcogramma obtusirostre*	480	23.6	7.2	15–47
CLINIDAE	*Pavoclinus laurentii*	7	48.4	26.8	19–74
GOBIIDAE	*Bathygobius* sp.	404	28.8	12.2	9–61
	Hetereleotris zonata	24	25.5	6.6	16–41
	Priolepis cincta	3	26.3	2.9	23–28
ACANTHURIDAE	*Acanthurus triostegus*	49	40.3	8.3	28–61
BOTHIDAE	*Bothus* sp.	1	43.0	—	—
MONACANTHIDAE	Unidentified monacanthid	1	15.0	—	—

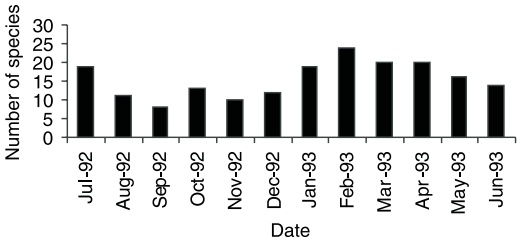

Fig. 2. Number of species collected each month by rotenone sampling in a tidal pool at Treasure Beach, KwaZulu-Natal. The initial sample reflects a climax assemblage and the subsequent monthly samples indicate the number of species recolonizing the pool.

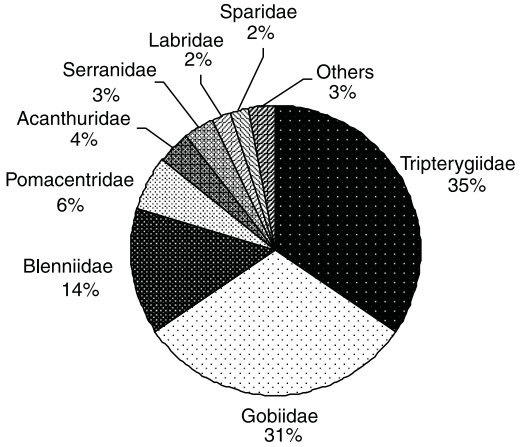

Fig. 3. Pie diagram showing composition of the fishes collected by monthly rotenone sampling in a tidal pool at Treasure Beach, KwaZulu-Natal (*n* = 1389).

recorded (Fig. 2). Cryptic triplefins (Tripterygiidae), gobies (Gobiidae) and blennies (Blenniidae) were the most abundant fishes with juvenile damsel fishes (Pomacentridae), surgeon fishes (Acanthuridae), rock cods (Serranidae), wrasses (Labridae) and sea breams (Sparidae) recorded in lower numbers (Fig. 3).

In general, the fishes in the monthly samples were small in size (Table 1) and comprised both resident and transient species. The rapid recolonization of the pool between monthly sampling by resident intertidal species (triplefins, gobies and blennies) was by both juveniles and adults. The mean size of the triplefins *Helcogramma obtusirostre* recolonizing the pool differed significantly between the months (ANOVA $P < 0.0005$) and those in the initial sample had a mean size of 33.6 mm, with all >24 mm (Fig. 4). In all the subsequent months the means were <28 mm with specimens as small as 11 mm recorded among

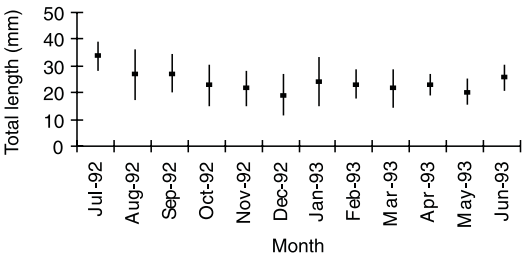

Fig. 4. Mean size (±1 S.D.) of the triplefin, *Helcogramma obtusirostre*, recorded in a tidal pool at Treasure Beach, KwaZulu-Natal. The initial sample reflects a climax population and the subsequent monthly samples indicate the size composition of those recolonizing the pool.

those recolonizing the pool. Juveniles of more tropical Indo-Pacific species recruited to the pools over the late summer months (Fig. 5). These included convict surgeon fishes (*Acanthurus triostegus*), damsel fishes (*Abudefduf vaigiensis, A. sordidus* and *Plectroglyphidodon leucozonus*), butterfly fishes (*Chaetodon* spp.) and wrasses (*Thalassoma* sp. and *Halichoeres* sp.). Juvenile rock cods (mainly *Epinephelus marginatus*) and blacktail (*Diplodus sargus capensis*) were also found in the tidal pools, particularly during the summer months.

DISCUSSION

Recolonization studies have serious drawbacks as the resultant assemblage can be skewed towards pioneer species that may be locally abundant, exhibit high mobility or have large home ranges, and can thus take advantage of the available niches in a pool that had recently had all the fauna removed. Nevertheless, comparisons of recolonizing pioneer assemblages with the original climax assemblage can provide valuable insight into diversity and recruit availability of both resident and transient species in the intertidal zone.

Composition

Although the present study only investigated fishes in a single lower shore pool, and overall species richness is thus probably underestimated, it yielded more taxa than any of the previous studies of fishes occurring in tidal pools along the South African coast. The 18 families recorded from the KwaZulu-Natal pool exceeds the two families documented from west coast tidal pools (Prochazka & Griffiths 1992), the six families found around the Cape Peninsula (Bennett & Griffiths 1984), the nine families collected on the south

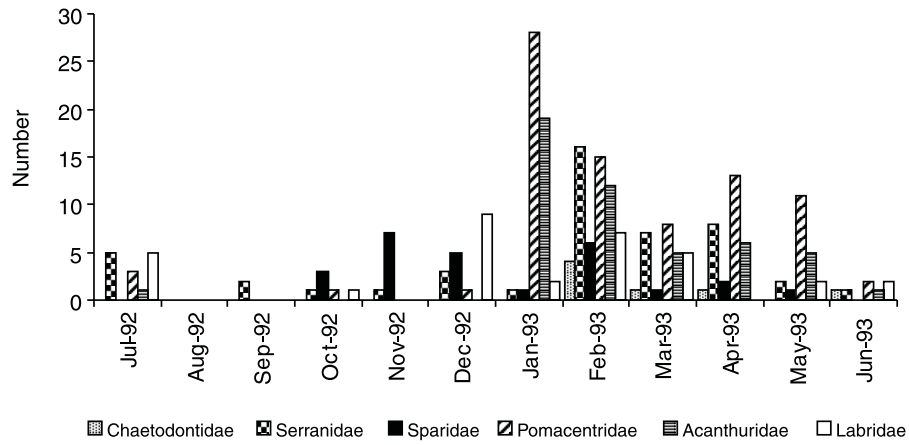

Fig. 5. Monthly abundances of the major transient fish families recolonizing a tidal pool at Treasure Beach, KwaZulu-Natal, showing the summer recruitment period. The initial sample reflects the climax assemblage before experimental elimination.

coast (Bennett 1987) and the 15 families recorded in the Eastern Cape (Beckley 1985a). One of the most striking differences between the KwaZulu-Natal tidal pool fish community and those studied in the Cape provinces was the low importance of the temperate teleost family Clinidae. Low numbers of only one clinid species, *Pavoclinus laurentii,* were sampled in the Treasure Beach pool in marked contrast to the high species diversity of this family in the Western and Eastern Cape studies (Bennett & Griffiths 1984; Beckley 1985a,b; Bennett 1987; Prochazka & Griffiths 1992).

In KwaZulu-Natal there is a replacement of the endemic clinids by triplefins and blennies, the latter being particularly diverse, with a dozen species recorded in the Treasure Beach pool (Table 1). These blennies were generally species that are fairly widespread in the Indo-Pacific region although *Omobranchus banditus* is only distributed from Transkei to Bazaruto Island, *Parablennius cornutus* is found from Namibia to Sodwana Bay and *Scartella emarginata* occurs from Angola to India (Springer 1986). *Helcogramma obtusirostre* was the only tripterygiid recorded from Treasure Beach, although other species are known from subtidal areas along the KwaZulu-Natal coast (Holleman 1986). Fennessy *et al*. (1998b) found *H. obtusirostre* to be the second-most abundant species in a shallow subtidal rotenone station at Vetch's Pier, Durban. The diversity of gobies in the present study was low but the possibility exists that more than one species was included in the taxon *Bathygobius* sp., as the small size of most of the specimens precluded identification to species level using the characteristics given by Hoese (1986).

Tidal pools and subtidal gullies have been found to be important nursery areas for several families of fishes in the Eastern Cape (Beckley 1985a, Smale & Buxton 1989). Of these, the temperate family Cheilodactylidae was conspicuously absent from the Treasure Beach tidal pools while juvenile Sparidae were not as abundant or diverse as they were in the Eastern Cape. The Serranidae, however, showed higher diversity than in the Eastern Cape.

Indo-Pacific species were well represented in the Treasure Beach tidal pool with juveniles of Muraenidae, Scorpaenidae, Grammistidae, Chaetodontidae, Pomacentridae, Labridae and Acanthuridae contributing about 40 % of the species recorded in the study. The occurrence of these more tropical species in KwaZulu-Natal is brought about by the influence of the southward flowing Agulhas Current on both the coastal environment and the biota (Van der Elst 1988). Similar distribution extensions of tropical fauna occur in Australia and New Zealand with the East Australian Current, the Leeuwin Current and the East Auckland Current (Hutchins 1991; Francis & Evans 1992; Hutchins & Pearce 1994).

Recruitment

H. obtusirostre specimens in the 10–20 mm size class recruited to the pool each month after the initial sampling. Tripterygiids have demersal eggs with adhesive filaments (Leis & Rennis 1983) and settlement stage tripterygiid larvae of about

10 mm are regularly captured from the plankton in light traps near Durban (L.E. Beckley, unpubl. data). Gobies also produce demersal eggs (Leis & Rennis 1983) and small juveniles of *Bathygobius* sp. in the size class 10–20 mm also recruited to the pool each month after the initial sampling.

Blennies also produce demersal eggs but, unlike the gobies and triplefins, there was not continuous recruitment of small juveniles for all the species. Small specimens of *O. banditus* <30 mm were recorded from October to May but for the other abundant species, *A. bifilum* and *S. emarginata*, specimens <30 mm were only recorded in April and July, respectively. The *Istiblennius* spp. that recolonized the pool were mainly larger specimens. *P. cornutus* was only recorded in September and all the specimens were <31 mm. Little is known about the reproduction of blennies in KwaZulu-Natal although Eyberg (1984) has studied the biology of subtidal populations of *P. cornutus* and *S. emarginata.* She found that *P. cornutus* had a spawning period from June to September, while *S. emarginata* spawned year round.

Juveniles of *Epinephelus marginatus* were present every month except August although most juveniles <40 mm recruited in the period February to April. This period of recruitment correlates well with a preliminary study on the reproduction of this species, which indicates that *E. marginatus* spawns from November to January in KwaZulu-Natal (S.T. Fennessy, pers. comm.).

Recruitment of juvenile *Diplodus sargus capensis* to the Treasure Beach tidal pool occurred from October to April though the smallest specimens (<40 mm) were recorded in October and November. This correlates well with the finding of Joubert (1981) that the peak of spawning activity for this species occurs from July to September in KwaZulu-Natal. Berry *et al.* (1982) recorded *D. s. capensis* juveniles primarily in summer over a shallow subtidal reef off Durban.

Juvenile *Acanthurus triostegus* (<40 mm) recruited to the Treasure Beach tidal pool from January to April. Acanthurids have a specialized acronurus larval phase that is well adapted for a relatively long pelagic existence before settlement onto reefs (Leis & Rennis 1983). Ichthyoplankton surveys off the east coast of South Africa have shown acanthurid larvae to be most abundant during summer (Beckley 1998) and the smallest, transparent, kite-shaped, acronurus stage *A. triostegus* specimens (28–29 mm) were found in the pool in January. It is unknown if this species actually spawns in KwaZulu-Natal waters although it is common over shallow subtidal reefs around Durban (Berry *et al.* 1982; Fennessy *et al.* 1998a) and in the coral reef areas further north along the Maputaland coast (Chater *et al.* 1993).

Although a few larger *Abudefduf sordidus* (64, 79 and 80 mm) recolonized the pool in spring, recruitment of small juveniles of the dominant pomacentrids only occurred over the summer months. Recruitment of juveniles (<40 mm) of *A. sordidus* occurred in February and March, of *A. vaigiensis* in January and February, and for *P. leucozonus,* recruitment extended from January through to April. Although, to date, no studies have determined if these species actually spawn as far south as KwaZulu-Natal, adults are common subtidally both around Durban (Berry *et al*. 1982; Fennessy *et al.* 1998a) and in the coral reef areas further north (Chater *et al.* 1993). Although pomacentrids produce demersal eggs (Leis & Rennis 1983), unidentified pomacentrid larvae have been recorded in the Agulhas Current in summer (Beckley 1998), and Van der Elst (1981) described how the early juveniles of *A. vaigiensis* associate with floating objects borne along by ocean currents.

The juveniles of the other Indo-Pacific fishes recorded in the tidal pool such as *Gymnothorax* spp., *Pterois miles, Grammistes sexlineatus,* labrids and *Chaetodon* spp. also recruited in the summer months. Although adults frequent coral reef areas along the northeast coast (Chater *et al.* 1993) it is unknown if these species spawn in KwaZulu-Natal waters. Larvae of labrids and chaetodontids have been documented from the Agulhas current during the summer months (Beckley 1998) and these families, which have a pelagic phase of flexible duration, are known for wide dispersal (Victor 1986; Leis 1989). In general, little is known about the basic biology of Indo-Pacific and Western Indian Ocean fishes that occur in KwaZulu-Natal, although Turpie *et al.* (2000) have shown that they contribute significantly to the biodiversity of coastal fishes in South Africa.

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REFERENCES

BECKLEY, L.E. 1985a. The fish community of East Cape tidal pools and an assessment of the nursery function of this habitat. *South African Journal of Zoology* **20**: 21–27.

BECKLEY, L.E. 1985b. Tide-pool fishes: recolonization after experimental elimination. *Journal of Experimental Marine Biology and Ecology* **85**: 287–295.

BECKLEY, L.E. 1998. The Agulhas Current ecosystem with particular reference to dispersal of fish larvae. In: *Large Marine Ecosystems of the Indian Ocean: Assessment, Sustainability and Management,* (eds) K. Sherman, E.N. Okemwa & M.J. Ntiba, pp. 255–276. Blackwell Science, Malden, U.S.A.

BENNETT, B.A. 1987. The rock-pool fish community of Koppie Alleen and an assessment of the importance of Cape rock-pools as nurseries for juvenile fish. *South African Journal of Zoology* **22**: 25–32.

BENNETT, B.A. & GRIFFITHS, C.L. 1984. Factors affecting the distribution, abundance and diversity of rock-pool fishes on the Cape Peninsula, South Africa. *South African Journal of Zoology* **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. *Marine Ecology Progress Series* **10**: 49–55.

CHATER, S.A., BECKLEY, L.E., GARRATT, P.A., BALLARD, J.A. & VAN DER ELST, R.P. 1993. Fishes from offshore reefs in the St Lucia and Maputaland marine reserves, South Africa. *Lammergeyer* **42**: 1–17.

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

EYBERG, I. 1984. The biology of *Parablennius cornutus* (L.) and *Scartella emarginata* (Gunther) (Teleostei: Blenniidae) on a Natal reef. *Investigational Report of the Oceanographic Research Institute* **54**: 1–16.

FENNESSY, S.T., LOTTER, P. & CHATER, S.A. 1998a. Fish species composition and abundance on a subtropical, artificial reef on the east coast of South Africa. *South African Journal of Zoology* **33**: 147–155.

FENNESSY, S.T., LOTTER, P. & CHATER, S.A. 1998b. Cryptic ichthyofauna from Vetch's Pier, Durban. *Lammergeyer* **45**: 43–47.

FRANCIS, M.P. & EVANS, J. 1992. Immigration of subtropical and tropical animals into north-eastern New Zealand. In: *Proceedings of the Second International Temperate Reef Symposium,* 7–10 January 1992, Auckland, (ed.) C.N. Battershill, pp. 131–136. NIWA Marine, Wellington.

HOESE, D.F. 1986. Family No. 240: Gobiidae. In: *Smiths' Sea Fishes* (eds) M.M. Smith & P.C. Heemstra, pp. 774–807. MacMillan, Johannesburg.

HOLLEMAN, W. 1986. Family No. 236: Tripterygiidae. In: *Smiths' Sea Fishes.* (eds) M.M. Smith & P.C. Heemstra, pp. 755–758. MacMillan, Johannesburg.

HUTCHINS, J.B. 1991. Dispersal of tropical fishes to temperate seas in the southern hemisphere. *Journal of the Royal Society of Western Australia* **74**: 79–84.

HUTCHINS, J.B. & PEARCE, A.F. 1994. Influence of the Leeuwin Current on recruitment of tropical reef fishes at Rottnest Island, Western Australia. *Bulletin of Marine Science* **54** (1):245–255.

LEIS, J.M. 1989. Larval biology of butterflyfishes (Pisces, Chaetodontidae): what do we really know? *Environmental Biology of Fishes* **25**: 87–100.

LEIS, J.M. & RENNIS, D.S. 1983. The Larvae Of Indo-Pacific Coral Reef Fishes. New South Wales. University Press, Sydney, and University of Hawaii Press, Honolulu.

PROCHAZKA, K. & GRIFFITHS, C.L. 1992. The intertidal fish fauna of the west coast of South Africa – species, community and biogeography patterns. *South African Journal of Zoology* **27**: 115–120.

SMALE, M.J. & BUXTON, C.D. 1989. The subtidal gulley fish community of the Eastern Cape and the role of this habitat as a nursey area. *South African Journal of Zoology* **24**: 58–67.

SPRINGER, V.G. 1986. Family No. 235: Blenniidae. In: *Smiths' Sea Fishes.* (eds) M.M. Smith, & P.C. Heemstra, pp. 742–755. MacMillan, Johannesburg.

TURPIE, J.K., BECKLEY, L.E. & KATUA, S.M. 2000. Biogeography and the selection of priority areas for conservation of South African coastal fishes. *Biological Conservation* **92**: 59–72.

VAN DER ELST, R.P. 1981. A Guide to the Common Sea Fishes of Southern Africa. C. Struik, Cape Town.

VAN DER ELST, R.P. 1988. Shelf ichthyofauna of Natal. In: *Coastal and Ocean Studies off Natal, South Africa, Lecture Notes on Coastal and Estuarine Studies No. 26*. (ed.) E.H. Schumann, pp. 209–216. Springer-Verlag, New York.

VICTOR, B.C. 1986. Duration of the planktonic larval stage of one hundred species of Pacific and Atlantic wrasses (family Labridae). *Marine Biology* **90**: 317–326.