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Fish species composition and abundance on a subtropical, artificial reef on the east coast of South Africa

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The composition and abundance of fish species on a derelict rocky pier on the Durban beachfront, KwaZulu-Natal, South Africa, were assessed by means of underwater visual census, using transects. A total of 74 species were recorded on the reef, with convict surgeons (*Acanthurus triostegus*), sash damsels (*Plectroglyphidodon leucozonus*), blacktail (*Diplodus sargus capensis*) and blennies being most abundant. Species diversity was similar in April and August, although abundances of many species were lower in the latter month. Several species were thought to be resident on the reef, and there was some evidence for seasonal recruitment in others. Like natural shallow reefs, this artificial reef is a rich source of secondary production, enabling it to support an abundant and diverse fish population.

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Introduction

Vetch's Pier is a 500 m long artificial reef situated on the Durban beachfront (29°22'S, 31°02'E), in the province of KwaZulu-Natal (Figure 1). Originally intended as a breakwater for the harbour, construction of the pier began in 1861, but was never completed owing to a lack of funds (Russell 1971). During 1886, the above-water part of the structure was demolished, and the remaining part has since acted as an artificial reef. The reef is a popular dive site for snorkellers, SCUBA divers and aquarists because of its easy access from the shore and, being in the lee of the Bluff headland and the harbour breakwaters, the reef is sheltered from large swells. The reef adjoins the beach and hence provides a sheltered launch site for ski boats, sailing dinghies, paddle-skis, windsurfers and commercial beach-seine fishermen. Average surf temperature in the area is 21°C, with a range of 17°C to 29°C (Natal Sharks Board, unpubl. data), and there is a maximum tidal range of 1.8 m (South African Tide Tables, 1994). Salinity in the area is close to 35‰, with occasional reductions associated with short-term flooding (Berry 1978). In contrast to the rest of the KwaZulu-Natal coast, the longshore drift in the region of Vetch's Pier is reversed, resulting in a southerly flow (Campbell, Macleod & Swart 1985).

Despite its proximity to a large urban area and its high exposure to human activities, little has been documented about the fauna of the reef. Studies on some invertebrates have been published (Fielding 1990; Fielding, Weerts & Forbes 1994), but no literature on the associated ichthyofauna exists. Very little fishing occurs on the reef *per se*, and spearfishing of demersal fish species and harvesting of marine invertebrates in the area is prohibited by the Marine Living Resources Act (No. 18 of 1998). Recently, there has been increased interest in developing the area for tourism, with proposals to develop a marina and promenades where Vetch's Pier now exists (Crockett 1994). In order to obtain baseline information, a study was therefore initiated to establish species composition, abundance and biomass of fishes occurring on the reef.

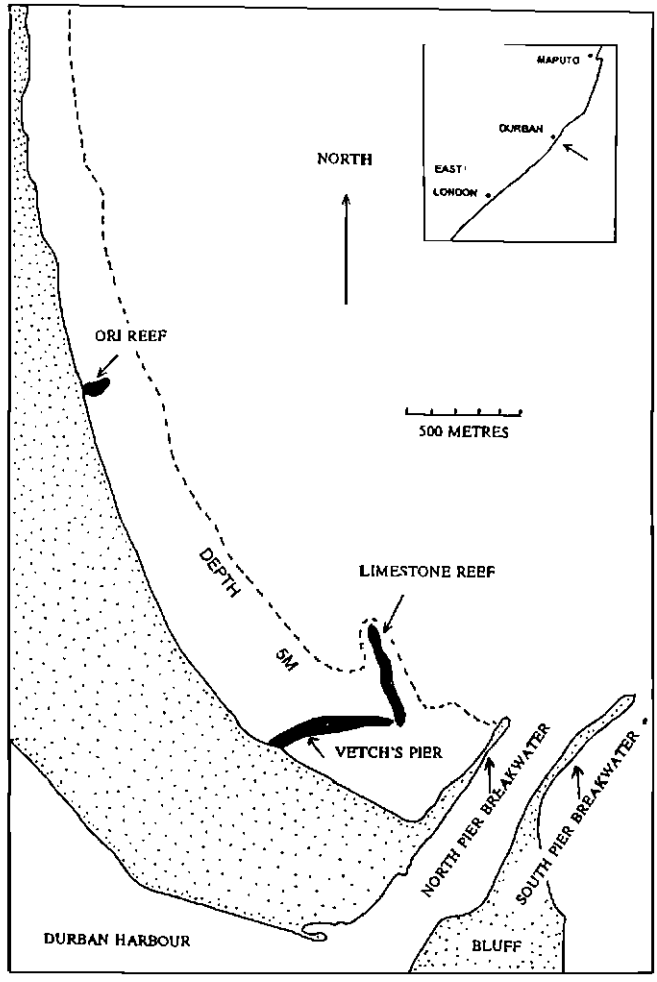

Figure 1 Map of the study area on the Durban beachfront, showing localities mentioned in the text.

Materials and methods

Several preliminary snorkel dives were undertaken by all three of us, *viz.* two divers experienced in fish identification

(S.T.F. and S.C.C.) and one inexperienced diver (P.L.), in order to measure the dimensions of the reef and to ensure that the three of us were familiar with the identities, sizes and abundances of fish species occurring on the reef. The shallow nature of the reef facilitated constant communication and enabled us to achieve consensus on the above criteria. Other than this initial approach, no specific methods were employed to ensure that all three divers were equally proficient.

An underwater visual line transect technique was chosen, as despite its shortcomings, this method is non-destructive and provides rapid estimates of abundance, particularly of patchily distributed species occurring over a large area (Thresher & Gunn 1986; Samoilys & Carlos 1992). The continuous nature of the reef and its well-defined shape also contributed to the decision to use line transects. All species were identified from Smith & Heemstra (1986). Blennies (Family Blenniidae), apart from *Plagiotremus rhinorhynchus* and *P. tapeinosoma*, were recorded as Blenniidae spp. in transects because of difficulties in identification while swimming the transects. The species list was transferred onto perspex slates, together with columns for size frequency classes (0–5 cm, 6–10 cm, 11–15 cm, etc.).

A plastic spool containing 90 m of nylon twine, demarcated at 1-m intervals, was used for the line transect. Using SCUBA, one diver held the spool on the reef-sand edge while a second diver swam the transect line across the reef. On reaching the other side of the reef, the second diver signalled the first diver, who anchored the spool, noted the amount of line extended, and swam along the line, identifying, counting and recording lengths (in 5 cm size classes) of fish within one metre of either side of the line. On completion, both divers returned to the anchored spool, retrieved the transect line and advanced about 15 m seawards along the reef, where the process was repeated. Transect lengths varied according to the width of the reef (see Results) and it was estimated that approximately 33 transects would provide coverage of the entire reef at 15-m intervals. Transects were done between 18th and 21st April, and between 11th and 15th August 1994, approximately 2 h either side of high tide and when weather conditions permitted. These two months were chosen as being representative of warm and cool seasons, respectively (Schumann 1988).

Data analysis

Margalef's species richness, the Shannon-Wiener index and Pielou's evenness index (Pielou 1966) were used to compare results from this study with those from studies on other shallow reefs.

Density estimates (D) were calculated by :

$$D = \frac{\sum_{n=1}^{K} \frac{(S^x)_n}{T_n}}{K}$$

where:

S^x = No. of individuals of species x in transect n

T_n = Area of transect n (m^2)

K = Total no. of transects.

The density estimate for each species was multiplied by the calculated area of the reef to provide an estimate of total numbers for each species. *Post priori* stratification of the reef into inshore, middle and offshore sections resulted in abundance estimates that were very similar to those obtained without stratification, so no stratification was employed in the calculation of overall abundance.

Biomass estimates were only made for the more commonly recorded species for which published length-weight relationships existed (Table 1). The proportion of individuals in each size class was related to the estimated total number (derived from transects) of each of these species (Table 2). Blennies and triplefins were considered as one taxon, using the length-weight parameters for *Parablennius cornutus* (Berry, van der Elst, Hanekom, Joubert & Smale 1982). For each species, the midpoint of each 5 cm length class was converted to a weight by the length-weight equation. The estimated numbers of individuals in each size class were multiplied by the derived weight and summed for each size class to provide an estimate of biomass.

Table 1 Length-weight relationship parameter values (fork length in mm, weight in g) used for calculating mean weight per size class of common fish species at Vetch's Pier, Durban. Values for Blenniidae are based on *Parablennius cornutus*

Species	a	b	Source
Abudefduf sordidus	2.997×10^{-6}	3.5	Berry *et al.* 1982
Acanthurus triostegus	1.4×10^{-5}	3.152	Berry *et al.* 1982
Abudefduf vaigiensis	1.396×10^{-5}	3.18	Berry *et al.* 1982
Blenniidae	7.9×10^{-7}	3.105	Berry *et al.* 1982
Diplodus sargus capensis	3.3×10^{-5}	2.99	van der Elst & Adkin 1991
Parupeneus rubescens	5.4×10^{-6}	3.291	Berry *et al.* 1982
Plectroglyphidodon leucozonus	3.19×10^{-5}	2.957	L.E. Beckley unpubl. data, 1993
Sarpa salpa	5.9×10^{-5}	2.793	van der Elst & Adkin 1991

Results

Description of the reef

The initial snorkelling survey established that the reef is approximately 490 m in length, with a width of between 30 and 70 m. The top of the reef is exposed along almost its entire length at spring low tide and is covered by about 1 m of water at spring high tide (Figure 2). Close to the shore the reef has a flatter profile with sandy patches in between rocky outcrops. As the distance from the shore increases, the vertical profile steepens, resulting in a 3 m drop from the reef top to the adjacent sand at the seaward end. With increasing distance from the shore, there is increased diversity in topography, with larger crevices, gullies and boulders towards the seaward end of the reef. The surface area of the reef top was calculated to be approximately 22 250 m^2.

The dominant macroinvertebrates associated with the reef were brown mussels (*Perna perna*), sea urchins (*Stomopneustes variolaris* and *Tripneustes gratilla*), sea cucumbers (*Holothuria leucospilota*), octopus (*Octopus vulgaris*), spiny rock lobster (*Panulirus homarus*) and red-bait (*Pyura stolonifera*).

Table 2 Numbers recorded, percentage occurrence, densities and estimated numbers of fish obtained from underwater visual transects on Vetch's Pier (Durban) during April and August 1994. CV (Coefficient of variance) presented as standard deviation divided by mean

		Total				Densities				
		April		August		April		August		Derived Nos (April–August)
		Nos.	% of transects	Nos.	% of transects	$\times 10^{-3}/m^2$	CV	$\times 10^{-3}/m^2$	CV	
Acanthurus triostegus	Convict surgeon	209	83.7	50	44.1	46.7	1.0	1.7	1.85	1 038 – 461
Plectroglyphidodon leucozonus	Sash damsel	205	97.3	170	88.2	48.1	0.59	41.2	0.6	1 071 – 509
Abudefduf vaigiensis	Sergeant major	187	72.9	60	38.2	49.6	1.74	19	2.4	1 103 – 422
Blenniidae spp.	Blennies	123	72.9	15	23.5	30.0	1.18	3.7	2.09	668 – 81
Diplodus sargus capensis	Blacktail	106	40.5	100	41.2	23.3	1.74	22.9	1.36	518 – 509
Parupeneus rubescens	Black-saddle goatfish	84	64.8	27	25.0	20.3	1.26	6.4	2.9	451 – 143
Abudefduf sordidus	Spot damsel	33	27.1	36	20.6	8.3	2.43	8.5	2.21	184 – 189
Sarpa salpa	Karanteen	30	2.7	47	5.9	6.5	6.0	10.5	4.21	145 – 233
Chromis dasygenys	Bluespotted chromis	29	18.9	70	44.1	6.2	2.25	15.7	1.42	138 – 350
Thalassoma lunare	Crescent tail wrasse	18	29.7	40	55.9	4.2	1.9	9.1	1.06	93 – 204
Chaetodon auriga	Threadfin butterfly	18	32.4	6	11.7	4.4	1.7	1.4	2.95	99 – 32
Cirrhitichthys oxycephalus	Spotted hawkfish	18	29.7	5	11.7	4.2	1.86	1.2	2.85	93 – 27
Acanthurus nigrofuscus	Brown surgeon	17	32.4	6	11.7	3.9	1.65	1.4	2.94	87 – 31
Stethojulis sp.	Ribbon wrasse	16	16.2	18	32.2	3.7	2.78	4.9	1.76	82 – 108
Chaetodon lunula	Halfmoon butterfly	11	21.6	2	5.8	2.8	2.3	9.1	1.06	61 11
Chaetodon blackburnii	Brown burnie	9	18.9	–	–	2	2.26	–	–	45 – 0
Thalassoma pupureum	Rainbow wrasse	8	16.2	1	29	2.2	2.38	0.3	5.75	48 – 7
Diplodus cervinus hottentotus	Zebra	8	16.2	1	2.9	1.8	2.66	0.2	5.75	40 – 5
Dichistius multifasciatus	Banded galjoen	8	10.8	1	2.9	1.8	3.96	0.3	5.75	40 – 6
Thalassoma hebraicum	Goldbar wrasse	6	16.2	–	–	1.9	2.5		–	43 – 0
Epinephelus marginatus	Yellowbelly rockcod	6	13.5	6	11.7	1.4	2.78	1.7	3.01	31 – 38
Acanthurus dussumieri	Pencil surgeon	6	10.8	4	2.9	1.5	3.16	0.9	5.75	34 – 0
Siderea grisea	Geometric moray	5	8.1	1	2.9	1.1	4.1	0.2	5.75	25 – 5
Epinephelus rivulatus	Halfmoon rockcod	5	8.1	1	2.9	1.1	3.44	0.2	5.75	24 – 4
Coris caudimacula	Spottailed coris	5	5.4	–	–	1.1	4.87	–	–	24 – 0
Thalassoma trilobatum	Ladder wrasse	4	8.1	2	5.9	0.9	3.64	0.5	4.0	20 – 11
Cantherhines pardalis	Honeycomb filefish	3	5.4	7	17.6	0.6	4.28	1.7	2.26	14 – 37
Arothron hispidus	Whitespotted puffer	2	5.4	1	2.9	0.5	4.19	0.2	5.75	11 – 5
Fistularia commersonii	Smooth flutemouth	2	5.4	12	2.9	0.4	6.0	2.7	5.75	10 – 59
Parapercis robinsoni	Smallscale sandsmelt	1	2.7	2	5.8	0.2	6.0	0.4	4.01	4 – 10
Echidna nebulosa	Floral moray	1	2.7	1	2.9	0.2	6.0	0.3	5.75	5 – 7
Pterois miles	Devil-lion fish	1	2.7	1	2.9	0.2	6.0	0.3	5.75	0 – 5
Chromis dimidiata	Choc-dipped damsel	1	2.7	–	–	0.3	6.0	–	–	6 – 0
Pomacanthus striatus	Old woman	1	2.7	–	–	0.3	6.0	–	–	6 – 0
Sargocentron diadema	Crown squirrelfish	1	2.7	–	–	0.3	6.0	–	–	6 – 0
Ostracion cubicus	Boxfish	1	2.7	–	–	0.2	6.0	–	–	6 – 0
Liza tricuspidens	Striped mullet	–	–	8	8.8	–	–	1.9	3.77	0 – 42
Centropyge acanthops	Jumping bean	–	–	2	5.9	–	–	0.4	5.66	0 – 10
Halichoeres nebulosus	Picture wrasse	–	–	1	2.9	–	–	0.2	5.75	0 – 5
Kyphosus bigibbus	Grey chub	–	–	1	2.7	–	–	0.2	5.66	0 – 5

Transects

A total of 71 transects was completed, 37 in April and 34 in August. A list of all 74 fish species observed during preliminary dives, transects and between-transect observations, is given in Appendix 1. Overall numbers of fish species recorded in transects in April and August are listed in Table 2. Eighteen families were recorded in transects, with the Labridae (seven species) and Pomacentridae (five species) having

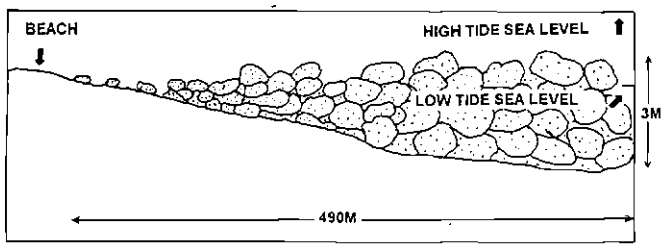

Figure 2 Sketch of the longitudinal profile of Vetch's Pier (Durban).

the most representatives. The total number of species recorded in transects was similar in April and August (36 and 33 taxa respectively), but the total number of individuals recorded was higher in April (1199 versus 709 individuals).

In April, convict surgeons (*Acanthurus triostegus*), sash damsels (*Plectroglyphidodon leucozonus*) and sergeant majors (*Abudefduf vaigiensis*) were dominant, with recorded numbers of similar magnitude (Table 2). In August, sash damsels were still numerically dominant and were recorded in most transects. Numbers of most other species, particularly convict surgeons, sergeant majors, blennies and black-saddle goatfish (*Parupeneus rubescens*) were much reduced in August relative to April. Conversely, recorded numbers of bluespotted chromis (*Chromis dasygenys*) and crescent-tail wrasse (*Thalassoma lunare*) were considerably higher in August. Numbers of sash damsels, spot damsels (*A. sordidus*) and blacktail (*Diplodus sargus capensis*) were fairly similar in both months. Based on estimates of fish densities from transects in April, derived numbers of sash damsels, convict surgeons and sergeant majors on the whole reef were an order of magnitude greater than the other species. However, coefficients of variance were high, so estimates of total numbers should be treated with caution.

Numbers of individuals recorded per species were generally higher in April than in August (Table 2), and overall diversity indices were also higher in April (Table 3). There was an increase in diversity with increasing distance from the shore indicated by increased Shannon-Wiener values towards the end of the reef in both April and August (Figure 3). Linear regressions fitted to each of the plots produced slopes that were positive and significantly different from zero:

April: $F_{calculated\,(0.05,\,1,\,35)} = 18.5$, $p < 0.005$;

August: $F_{calculated(0.05,\,1,\,32)} = 17.8$, $p < 0.005$) (Zar 1974).

Most of the fish observed during transects on the reef were less than 30 cm in length, and, for the six most commonly recorded species, the smaller size classes were generally better represented in April (Figure 4).

Table 3 Comparative diversity indices recorded from transects on Vetch's Pier (this study), ORI reef (Berry *et al.* 1982) and shallow reefs in the Tsitsikamma National Park (Burger 1990)

	Vetch's Pier			
Diversity index	April	August	ORI reef	Tsitsikamma
Margalef	4.94	4.73	~ 1.47	3.84
Shannon-Wiener	2.56	1.81	–	1.17
Pielou	0.71	0.52	~ 0.44	0.33

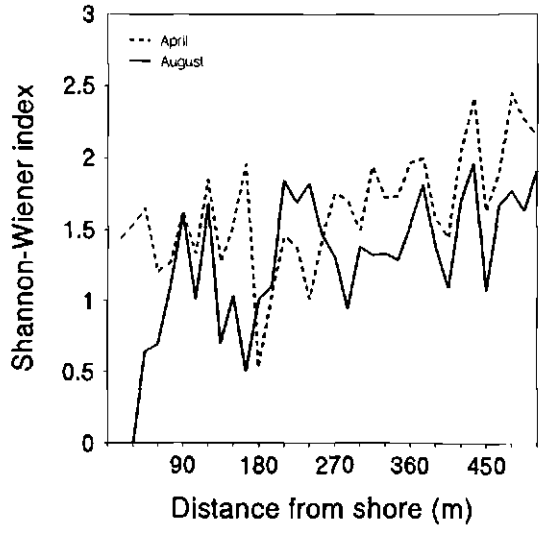

Figure 3 Shannon-Wiener diversity indices for fishes recorded by underwater visual census along the length of Vetch's Pier (Durban) in April and August 1994.

Table 4 Biomass estimates (g/m²) for eight commonly-recorded fish occurring on Vetch's Pier (Durban) in 1994. Values for ORI reef are means obtained from Berry *et al.* (1982)

Species	Common name	April	August	ORI reef
Acanthurus triostegus	Convict surgeon	4.972	0.764	0.543
Diplodus sargus capensis	Blacktail	1.664	3.504	3.13
Sarpa salpa	Karanteen	1.518	2.439	3.55
Plectroglyphidodon leucozonus	Sash damsel	1.281	1.9	–
Abudefduf sordidus	Spot damsel	1.133	0.606	0.089
Parupeneus rubescens	Black-saddle goatfish	0.831	0.476	0.061
Abudefduf vaigiensis	Sergeant major	0.209	0.174	0.049
Blenniidae spp.	Blennies	0.024	0.003	45.05

Biomass estimates

Although it is not possible to attach significance levels to the differences between April and August biomass estimates (since there were no replicates), the differences are considerable, particularly for convict surgeons, blacktail, spot damsels and blennies (Table 4). The changes in biomass were associated with a concomitant change in abundance estimates (Table 2), and/or differences in the size frequencies of the species in April and August (Figure 4).

Discussion

Given the length and varied nature of the South African coastline, it is surprising that very few quantified studies of ichthyofaunal communities on shallow reefs have been published. The earliest study was by Berry *et al.* (1982), on a KwaZulu-Natal littoral reef. Buxton & Smale (1984) produced a preliminary description of the ichthyofauna of the Tsitsikamma marine reserve, followed by a more detailed study by Burger (1990). Beckley & Buxton (1989) provided information on relative abundances and frequency of occur-

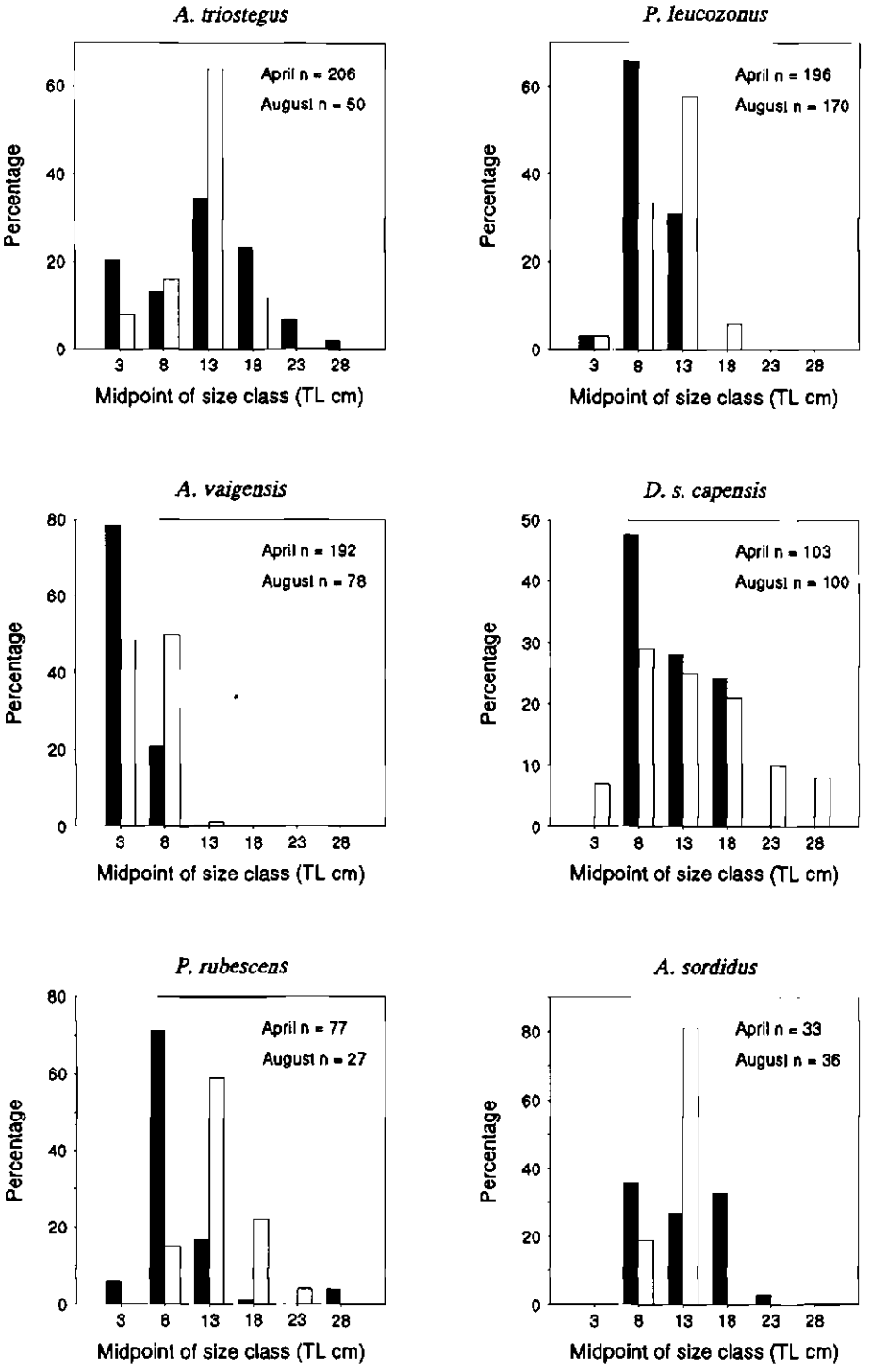

Figure 4 Comparative length frequencies of six commonly recorded fish species on Vetch's Pier (Durban) in April (dark bars) and August (light bars), 1994.

rence of reef fishes in Algoa Bay. Chater, Beckley, Garratt, Ballard & van der Elst (1993) and Chater, Beckley, van der Elst & Garratt (1995) produced the first checklist and estimates of abundance for fishes on shallow coral reefs in the St Lucia marine reserve, northern KwaZulu-Natal.

Although Vetch's Pier is an artificial structure, it has existed for over 130 years. Situated in the lee of the Bluff and the harbour breakwaters, the reef is protected from much of the rough surf which typifies the KwaZulu-Natal coastline. The reef also receives some protection from harvesting pressure, and contains the only large mussel bed protected from exploitation on the KwaZulu-Natal coast (Fennessy, Fielding, Tomalin & Schleyer 1996). Fish species recorded on the reef during this study were generally small, hard substratum-associated species, with western Indian Ocean or Indo-Pacific distributions (Smith & Heemstra 1986). Pelagic species were very rarely seen and were only observed by divers who were swimming between transects.

The observed number of species in transects (40) was much less than the total number of species recorded (74 – Appendix 1). It is therefore apparent that the underwater transect methods used did not provide a comprehensive cen-

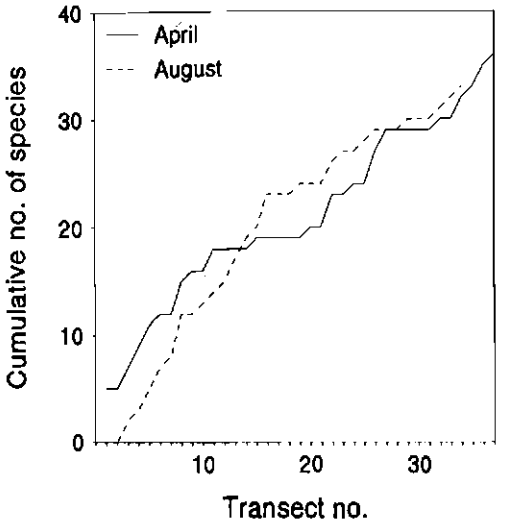

Figure 5 Cumulative species counts of fish, using underwater visual census on Vetch's Pier in April and August, 1994.

sus of fish present on the reef. This is emphasized by the graph of cumulative species counts along the reef (Figure 5). The curve is not asymptotic, indicating that new species were continually being added to the list. Possible reasons for this include the fact that many of the species which were not recorded in transects are solitary e.g. bluebanded surgeon (*Acanthurus lineatus*), evil-eye puffer (*Amblyrhynchotes honckenii*), and tomato rockcod (*Cephalopholis sonnerati*), which reduced the probability of their being observed. Also, several species only occurred towards the end of the reef, particularly under overhangs in deeper water e.g. goldies (*Anthias squamipinnis*), sweepers (*Pempheris adusta*) and the boxfish (*Ostracion cubicus*). These are, therefore, unlikely to be recorded by standard line transect techniques. An increased number of transects and more rigorous searching methods by divers would probably improve the census.

The visual census technique employed in this study also under-estimated the diversity and abundance of cryptic fish species known to occur on the reef (Fennessy, Lotter & Chater 1998). This underestimation of cryptic species has been reported in several visual census studies (e.g. Brock 1982; Lincoln-Smith 1989; Burger 1990), and improved estimates of their occurrence and numbers on Vetch's Pier are only likely to be obtained by extensive rotenone sampling.

Overall, six taxa comprised 70% of all individuals counted during transects (Table 2). This phenomenon, i.e. that of a few species dominating overall counts, was also reported for the nearby littoral ORI reef (Berry *et al.* 1982). On Eastern Cape shallow reefs, dominance of a few fish species was also reported by Buxton & Smale (1984), Beckley & Buxton (1989) and Burger (1990). The total number of all species recorded by visual census on Vetch's Pier (74) was higher than on ORI reef (68 — Berry *et al.* 1982), and also higher than on Eastern Cape reefs (40 — Burger 1990), but much less than that recorded by diving on northern KwaZulu-Natal reefs (353 — Chater *et al.* 1993). Diversity indices for Vetch's Pier were considerably higher than those reported by Berry *et al.* (1982), despite the use of similar census techniques, and were slightly higher than in the Tsitsikamma reserve in the Eastern Cape (Table 3). This trend of decreasing fish diversity with increasing latitude has been reported elsewhere (Turpie, Beckley, Katua & Benn 1996).

The disparity in diversity between Vetch's Pier and ORI reef, which is a shallow subtidal reef 1.5 km north of Vetch's Pier, may be ascribed to the greater habitat diversity and reef area available on the former reef. Higher diversity indices recorded towards the end of Vetch's Pier (Figure 3) may also be explained by the increased habitat diversity further offshore. Also, although not specifically recorded, there were greater numbers of fish and a greater variety associated with the seaward, exposed, side of the reef.

Most species were recorded in both April and August, and species richness (as measured by the Margalef index) was similar in both months (Table 3). This is not an unexpected result, as many of the species recorded on Vetch's Pier are territorial or sedentary, and hence poorly adapted for long distance movement (Gibson 1969; van der Elst 1988; Smith & Heemstra 1986). For species such as the sash damsel, blacktail and spot damsel, there was little difference in abundance between April and August, and these species are probably resident, either permanently or temporarily, on the reef.

However, many species were recorded in lower numbers in August, particularly blennies, convict surgeons and sergeant majors (Table 2). This may be a result of natural mortality, or, alternatively, increased algal cover in the summer months (S. Fennessy, pers. obs.), which, either directly or indirectly, ensures greater food availability. Evidence for the effects of the latter on seasonal changes in reef fish abundance, particularly convict surgeons, has been found in Reunion (Letourneur 1996). It is also possible, however, that there is some exchange of individuals between Vetch's Pier and the adjoining Limestone Reef (Figure 1), particularly for more vagile species such as blacktail, black-saddle goatfish, karanteen (*Sarpa salpa*), wrasses (*Thalassoma* spp.) and surgeons (*Acanthurus* spp.). There is unpublished evidence to suggest that numbers of blennies on Vetch's Pier are in fact more consistent throughout the year (Fennessy, unpubl. data), which would be expected as these are highly resident fishes (Eyberg 1984). Reduced census counts of this taxon in August may be a result of their reduced activity in cooler water i.e. the fish were much less obvious.

Of interest is the presence of karanteen in both April and August. This species has been suggested to undertake a spawning migration from the Cape to KwaZulu-Natal in the winter months, followed by return migration in summer (Joubert 1981). Recently, the occurrence of a return migration has been questioned (van der Walt 1995), and the presence of individuals on Vetch's Pier in both April and August indicates that at least part of the stock remains in KwaZulu-Natal waters.

Four of the most common taxa recorded in this study (convict surgeons, sergeant majors, blennies and blacktail) were also numerous on the nearby littoral ORI reef (Berry *et al.* 1982). However, despite the close proximity of the two reefs, in the latter study sash damsels were not recorded at all, whereas the banded galjoen (*Dichistius multifasciatus*) was much more common. Overall, of the 58 taxa identified to species level in the ORI reef study, only 26 were recorded on Vetch's Pier. It is unclear whether these contrasts are due to

habitat dissimilarities (e.g. ORI reef is exposed to greater wave action) or to the time interval between the two studies. Some species recorded in the ORI reef study were, however, recorded on or over the sand adjacent to the reef, whereas the Vetch's Pier study was confined to the reef itself.

For the six most commonly recorded species, the relatively greater abundance of smaller fish in April (Figure 4) provides some evidence for seasonal recruitment of juveniles to Vetch's Pier. Convict surgeons, sash damsels, sergeant majors and blacktail have winter or spring spawning seasons (van der Elst 1988; L.E. Beckley, unpubl. data, 1993; Mann 1992) which accounts for the influx of smaller individuals onto the reef in the summer. The general increase in numbers of larger fish in the August transects may be an indication of growth occurring while resident on the reef. Late summer recruitment of convict surgeons, sergeant majors and spot damsels to KwaZulu-Natal rock pools has been reported by Beckley, Heemstra & Buxton (1994). Berry *et al.* (1982) also found that there was seasonal recruitment of juvenile blacktail to the nearby ORI reef. Along with blacktail, juveniles of several other species of importance to anglers were recorded on Vetch's Pier, including rockcod (*Epinephelus marginatus* and *E. rivulatus*), zebra (*Diplodus cervinus hottentotus*), stone bream (*Neoscorpis lithophilus*) and banded galjoen.

Apart from the estimates for blennies, biomass values obtained in this study were generally similar to those obtained by Berry *et al.* (1982) for the same species on ORI reef (Table 4). The large disparity between biomass estimates of blennies in this study and the ORI reef study is accounted for by the use of a quadrat census method for blennies in the latter. For some of the species on Vetch's Pier, e.g. convict surgeons and blacktail, there were marked fluctuations in biomass from April to August. These may be ascribed to variations in abundance and sizes of individuals in the two months (Table 2 and Figure 4), which in turn are a result of individual growth, recruitment and/or migration of fish to and from the reef. Thus, for convict surgeons, not only were there fewer fish present in August, the larger size classes were not represented in that month, with a resultant drop in biomass. For blacktail, recorded numbers were similar in both months, but larger fish were present in August, which accounted for the increased biomass of the species in that month.

Despite having a relatively sparse algal component, it is apparent that Vetch's Pier is home to a large variety and abundance of fish (Table 2; Appendix 1). The reef also supports a large biomass of filter-feeding invertebrates, such as red bait and mussels (Fennessy *et al.* 1996). The crevices between the red bait pods and mussels harbour a large variety of small invertebrates (Fielding *et al.* 1994), which in turn are a source of food for the reef-associated fish. This considerable secondary production enables Vetch's Pier to function effectively as a natural reef, despite its artificial origins.

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Appendix 1 List of all fish species observed on Vetch's Pier during preliminary dives (March 1994), and during and between underwater visual census transects (April and August 1994)

Species	Common name
Acanthuridae	
Acanthurus blochii	Tailring surgeon
Acanthurus dussumieri	Pencilled surgeon
Acanthurus lineatus	Bluebanded surgeon
Acanthurus nigrofuscus	Brown surgeon
Acanthurus triostegus	Convict surgeon
Acanthurus xanthopterus	Yellowfin surgeon
Apogonidae	
Apogon aureus	Bandtail cardinal
Blenniidae	
Plagiotremus rhinorhynchus	Twostripe blenny
Plagiotremus tapeinosoma	Piano blenny

Appendix 1 List of all fish species observed on Vetch's Pier during preliminary dives (March 1994), and during and between underwater visual census transects (April and August 1994) (Continued)

Species	Common name
Chaetodontidae	
Chaetodon auriga	Threadfin butterflyfish
Chaetodon blackburnii	Brownburnie
Chaetodon guttatissimus	Gorgeous gussie
Chaetodon lunula	Halfmoon butterflyfish
Chaetodon vagabundus	Vagabond butterflyfish
Chaetodon unimaculatus	Limespot butterflyfish
Heniochus acuminatus	Coachman
Cheilodactylidae	
Chirodactylus jessicalenorum	Natal fingerfin
Cirrhitidae	
Cirrhitichthys oxycephalus	Spotted hawkfish
Dichistidae	
Dichistius multifasciatus	Banded galjoen
Fistulariidae	
Fistularia commersonii	Smooth flutemouth
Haemulidae	
Plectorhinchus chubbi	Dusky rubberlip
Pomadasys olivaceum	Pinky
Holocentridae	
Sargocentron diadema	Crown squirrelfish
Kyphosidae	
Kyphosus bigibbus	Grey chub
Labridae	
Coris caudimacula	Spottail coris
Halichoeres hortulanus	Checkerboard wrasse
Halichoeres nebulosus	Picture wrasse
Stethojulis sp.	Ribbon wrasse
Thalassoma hebraicum	Goldbar wrasse
Thalassoma lunare	Crescent tail wrasse
Thalassoma purpureum	Rainbow wrasse
Thalassoma trilobatum	Ladder wrasse
Mugilidae	
Liza tricuspidens	Striped mullet
Mugiloididae	
Parapercis robinsoni	Smallscale sandsmelt
Mullidae	
Parupeneus rubescens	Black-saddle goatfish
Monacanthidae	
Cantherhines pardalis	Honeycomb filefish
Muraenidae	
Echidna nebulosa	Floral moray eel
Echidna polyzona	Barred moray eel
Siderea grisea	Geometric moray

Appendix 1 List of all fish species observed on Vetch's Pier during preliminary dives (March 1994), and during and between underwater visual census transects (April and August 1994) (Continued)

Species	Common name
Ophichthidae	
Myrichthys maculosus	Ocellated snake-eel
Ostraciidae	
Ostracion cubicus	Boxfish
Pempheridae	
Pempheris adusta	Sweeper
Pomacanthidae	
Centropyge acanthops	Jumping bean
Pomacanthus semicirculatus	Semicircle angelfish
Pomacanthus rhomboides	Old woman
Pomacentridae	
Abudefduf sordidus	Spot damsel
Abudefduf vaigiensis	Sergeant major
Chromis dasygenys	Bluespotted chromis
Chromis dimidiata	Chocolate-dip damsel
Dascyllus trimaculatus	Domino
Plectroglyphidodon leucozonus	Sash damsel
Pomacentrus caeruleus	Blue pete
Pomatomidae	
Pomatomus saltatrix	Elf
Scorpaenidae	
Pterois miles	Devil-lion fish
Scorpaeninae sp.	Scorpion fish
Taenianotus triacanthus	Paper fish

Appendix 1 List of all fish species observed on Vetch's Pier during preliminary dives (March 1994), and during and between underwater visual census transects (April and August 1994) (Continued)

Species	Common name
Scorpididae	
Neoscorpis lithophilus	Stonebream
Serranidae	
Anthias squamipinnis	Goldie
Cephalopholis sonnerati	Tomato rockcod
Epinephelus fasciatus	Redbarred rockcod
Epinephelus faveatus	Bigspot rockcod
Epinephelus marginatus	Yellowbelly rockcod
Epinephelus merra	Honeycomb rockcod
Epinephelus rivulatus	Halfmoon rockcod
Sparidae	
Diplodus cervinus hottentotus	Zebra
Diplodus sargus capensis	Blacktail
Rhabdosargus sarba	Natal stumpnose
Sarpa salpa	Karanteen
Sphyraenidae	
Sphyraena sp.	Barracuda
Tetraodontidae	
Amblyrhynchotes honckenii	Evileye puffer
Arothron hispidus	Whitespotted puffer
Arothron immaculatus	Blackedged puffer
Canthigaster valentini	Model toby
Canthigaster solandri	False eye toby
Zanclidae	
Zanclus canescens	Moorish idol