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Diversity of fishes in seagrass beds in the Quirimba Archipelago, northern Mozambique

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Abstract. The diversity of fishes in seagrass beds at Quirimba Island, northern Mozambique, was studied by sampling artisanal fisheries catches from seine nets and fish traps. In total, 46 629 fish were sampled from seine-net catches and 249 species of fish in 62 families were identified. A total of 3544 fish were sampled from fish traps and 61 species in 24 families were identified. Five species accounted for >60% of total fish biomass: *Siganus sutor*, *Leptoscarus vaigiensis*, *Lethrinus variegatus*, *Lethrinus lentjan* and *Gerres oyena*. Some species were present in the seagrass mainly as juveniles, some at all life stages and some as adults only. Catch compositions from the two fishing gears were different; samples from seine nets were dominated by the five species mentioned above, whereas samples from traps were dominated by the seagrass parrotfish *Leptoscarus vaigiensis*. The importance of seagrass beds for fish biodiversity must be considered in future conservation management decisions.

Introduction

Seagrass beds are an important tropical marine habitat, covering large shallow sub-tidal and intertidal areas in the Indo-Pacific (Bandeira 1997) and forming an important component of tropical coastal ecosystems (Ogden and Gladfelter 1983; Parrish 1989; Ogden 1997). Seagrasses provide an important habitat for a wide diversity of fish, invertebrates and other animals, and thus a source of food and income for coastal populations (Fortes 1990; Bandeira 1995).

Little work has been done on fish diversity in northern Mozambique. Loureiro (1998) described reef fisheries at Mecufi, 70 km south of the Quirimba Archipelago and J.L.B. and M. Smith made a collecting trip to the Archipelago in the 1950s (Smith and Heemstra 1991 and references therein). Of the few studies of fish diversity in seagrass beds of the Indo–Pacific, most were done in Australia (e.g. Blaber *et al.* 1992, 1994; Jenkins *et al.* 1997; Gray *et al.* 1998). Many tropical marine fish species are thought of as 'coral reef fish', with seagrass beds as their nursery areas, and there is little concept of a distinct seagrass fish fauna.

In this study we examine the structure of the fish assemblages in the seagrass beds of Montepuez Bay, sampled by use of two artisanal fishing gears. This paper forms part of a wider study of the seagrass fishery of Quirimba Island (Gell 1999), undertaken as part of the Frontier-Moçambique Quirimba Archipelago Marine Research Programme (Whittington *et al.* 1997, 1998).

Methods

Study site

The study was carried out among the southern islands of the Quirimba Archipelago, a chain of 27 small islands close to the coast of Cabo Delgado Province in the north of Mozambique. The islands have extensive fringing reefs on their eastern coasts and are separated from the Mozambican mainland by shallow water. Montepuez Bay (12°25′S,40°37′E), ~50 km^2 in area (Fig. 1), is shallow with large sand banks, intertidal areas and deeper channels, and is dominated by mixed seagrass meadows covering an area of ~35 km^2. It is sheltered from heavy seas by the island of Quirimba but is subject to strong tidal currents. The seagrass meadows are dominated by *Enhalus acoroides* ((L.) Royle, *Thalassodendron ciliatum* (Forsk.) den Hartog and *Cymodocea serrulata* (R.Br.) Aschers. et Magnus (Gell 1999; Gell and M. A. Carvalho unpublished). The seagrass beds of the Montepuez Bay are the main fishing areas for Quirimba Island (Gell 1999; Whittington *et al.* 1997).

Sampling

We sampled fish caught in seine nets (during daytime fishing) and bamboo fish traps from a total of 237 fishing trips undertaken by ~20 fishing boats. The seine nets were 100–200 m long with 4 cm stretched

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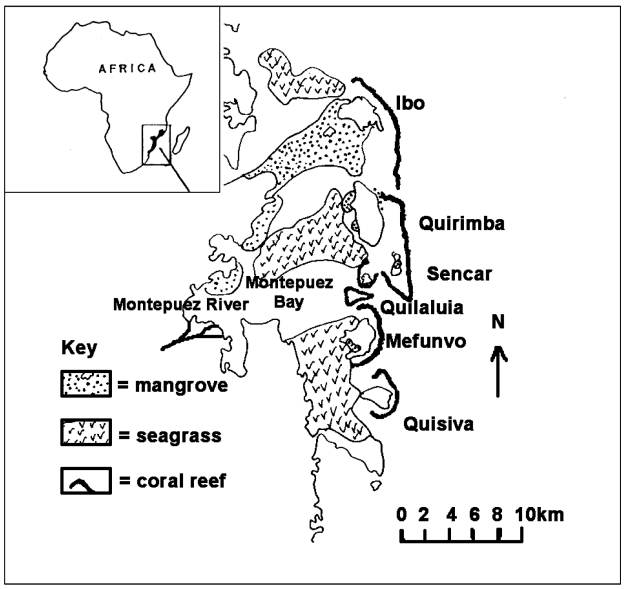

Fig. 1. Location of Montepuez Bay and Quirimba Islands in the Quirimba Archipelago, northern Mozambique. Inset: location of Mozambique.

mesh in the main net and 2 cm mesh in the cod end. Traps were made from woven bamboo panels and were soaked for 24 h or longer. Trap mesh was ~4 cm diameter. Because of gear selectivity, fish that were smaller than ~7 cm in length were not sampled. Most sampling sites were between 2–5 m deep at low tide (tidal range in the area was ~4 m). No sites were deeper than ~8 m.

We sampled catches monthly from May to December in 1996 and 1997. No sampling was done during the wet season (December–March) for logistical reasons. We took samples of fish from fish catches on the boats or on shore, then identified, measured and weighed the fish and returned them to the fishers. We were assisted in sampling the seine-net fish catches by project participants trained in fish identification and fisheries sampling techniques. More detailed identification work was done by the authors.

Results

In total, 46629 fish were sampled from seine-net catches made in the seagrass beds, representing 249 species from 62 families (Table 1). The most abundant species in terms of biomass and number was the African whitespotted rabbitfish *Siganus sutor*, followed by *Lethrinus lentjan* (pink ear emperor), *Leptoscarus vaigiensis* (seagrass parrotfish), *Lethrinus variegatus* (variegated emperor), *Gerres oyena* (blacktip mojarra) and *Calotomus spinidens* (spiny tooth parrotfish); these species accounted for >60% of the sampled biomass (Table 2, Fig. 2).

The main families present were Siganidae (rabbitfishes), Lethrinidae (emperors), Scaridae (parrotfishes), Gerreidae (mojarras) and Labridae (wrasses) (Fig. 3*a*). The species diversity within these groups varied greatly; for example Siganidae and Gerreidae were dominated by one or two species whereas Labridae was represented by 27 species.

Trap samples

From a total of 3544 fish sampled from trap catches, 61 species from 24 families (Fig. 3*b*) were identified. The trap

Table 1. Fish species found in the seagrass beds of Quirimba Island

Acanthuridae
Acanthurus auranticavus
Acanthurus dussumieri
Acanthurus mata
Acanthurus nigricauda
Acanthurus nigrofuscus
Acanthurus thompsoni
Ctenochaetus striatus
Ctenochaetus strigosus
Naso brevirostris
Naso unicornis
Zebrasoma veliferum

Antennariidae
Antennarius commerson
Antennarius indicus

Apogonidae
Apogon aureus
Apogon cyanosoma
Apogon lateralis
Apogon leptacanthus
Apogon nigripinnis
Apogon nigrofasciatus
Cheilodipterus macrodon
Cheilodipterus quinquelineatus
Foa brachygramma
Fowleria variegata
Siphamia mossambica
Atherinidae
Atherinomorus duodecimalis
Atherinomorus lacunosus
Hypoatherina temminckii
Spratelloides gracilis

Aulostomidae
Aulostomus chinensis

Balistidae
Balistapus undulatus
Balistoides viridescens
Melichthys niger
Rhinecanthus aculeatus
Sufflamen chrysopterus
Sufflamen fraenatus

Belonidae
Tylosurus crocodilus crocodilus

Blenniidae
Meiacanthus mossambicus
Petroscirtes mitratus
Petroscirtes variabilis

Bothidae
Bothus mancus
Bothus pantherinus

Caesionidae
Caesio caerulaurea
Caesio lunaris
Caesio teres
Caesio xanthonota
Pterocaesio chrysozona
Pterocaesio marri
Pterocaesio pisang

Callionymidae
Synchiropus marmoratus
Synchiropus stellatus

Carangidae
Alectis indicus
Carangoides ferdau
Carangoides fulvoguttatus
Carangoides orthogrammus
Scomberoides tol
Selar crumenophthalmus

Centriscidae
Aeoliscus punctulatus

Chaetodontidae
Chaetodon auriga
Chaetodon falcula
Chaetodon kleinii
Chaetodon melannotus
Chaetodon trifasciatus
Chaetodon xanthocephalus
Hemitaurichthys zoster
Heniochus acuminatus

Chirocentridae
Chirocentrus dorab

Clupeidae
Herklotsichthys quadrimaculatus
Sardinella gibbosa

Cynoglossidae
Cynoglossus sp.

Dactylopteridae
Dactyloptena orientalis

Diodon8tidae
Cyclichthys orbicularis
Diodon liturosus

Dasyatidae
Taeniura lymma

Echeneidae
Echeneis naucrates
Remora remora

Table 1. (*continued*)

Engraulidae
Encrasicholina heteroloba

Ephippidae
Platax orbicularis

Fistulariidae
Fistularia commersoni

Gerreidae
Gerres acinaces
Gerres oyena

Gobiidae
Amblygobius albimaculatus
Amblygobius semicinctus
Amblygobius sphynx
Bathygobius cyclopterus
Cryptocentrus caeruleomaculatus
Yongeichthys nebulosus

Grammistidae
Grammistes sexlineatus

Haemulidae
Diagramma pictum
Plectorhinchus albovittatus
Plectorhinchus flavomaculatus
Plectorhinchus gaterinus
Plectorhinchus orientalis
Plectorhinchus schotaf
Plectorhinchus sordidus
Pomadasys furcatum

Hemiramphidae
Hemiramphus far
Hemiramphus lutkei
Hyporhamphus affinis

Holocentridae
Neoniphon sammara
Sargocentron diadema
Sargocentron rubrum

Kyphosidae
Kyphosus vaigiensis

Labridae
Anampses caeruleopunctatus
Cheilinus oxycephalus
Cheilinus trilobatus
Cheilinus undulatus
Cheilio inermis
Coris caudimacula
Cymolutes praetextatus
Cymolutes torquatus
Halichoeres hortulanus
Halichoeres marginatus
Halichoeres scapularis
Halichoeres zeylonicus
Labroides dimidiatus
Novaculichthys macrolepidotus
Novaculichthys taeniourus
Oxycheilinus arenatus
Oxycheilinus bimaculatus
Oxycheilinus digrammus
Pteragogus flagellifer
Stethojulis albovittata
Stethojulis bandanensis
Stethojulis interrupta
Stethojulis strigiventer
Thalassoma trilobatum
Thalassoma purpureum
Xyrichtys pavo
Xyrichtys pentadactylus

Lethrinidae
Gnathodentex aureolineatus
Lethrinus harak
Lethrinus lentjan
Lethrinus mahsena
Lethrinus mahsenoides
Lethrinus microdon
Lethrinus nebulosus
Lethrinus obsoletus
Lethrinus olivaceus
Lethrinus rubrioperculatus
Lethrinus variegatus

Lutjanidae
Lutjanus bohar
Lutjanus ehrenbergii
Lutjanus fulviflamma
Lutjanus gibbus
Lutjanus lemniscatus
Lutjanus lutjanus

Monacanthidae
Aluterus scriptus
Amanses scopas
Paraluteres prionurus
Paramonacanthus barnardi
Paramonacanthus frenatus
Pseudalutarius nasicornis
Thamnoconus sp.

Monodactylidae
Monodactylus argenteus

Mullidae
Mulloides flavolineatus
Mulloides vanicolensis
Parupeneus barberinus
Parupeneus cyclostomus
Parupeneus heptacanthus
Parupeneus indicus
Parupeneus macronema
Parupeneus pleurostigma
Parupeneus rubescens
Upeneus moluccensis
Upeneus taeniopterus
Upeneus tragula
Upeneus vittatus

Muraenidae
Siderea picta

Nemipteridae
Scolopsis bimaculatus
Scolopsis ghanam

Ostraciidae
Lactoria cornuta
Ostracion cubicus

Pegasidae
Eurypegasus sp.

Platycephalidae
Papilloculiceps longiceps
Thysanophrys arenicola
Thysanophrys chiltonae

Plotosidae
Plotosus lineatus

Pomacanthidae
Centropyge multispinis
Pomacanthus chrysurus

Pomacentridae
Abudefduf sexfasciatus
Abudefduf sparoides
Abudefduf vaigiensis
Amphiprion allardi
Chromis opercularis
Chrysiptera annulata
Dascyllus aruanus
Dascyllus carneus
Dascyllus trimaculatus
Neoglyphidodon melas
Neopomacentrus fuliginosus
Plectroglyphidodon lacrymatus
Pomacentrus trilineatus

Priacanthidae
Priacanthus cruentatus
Priacanthus hamrur

Rhinobatidae
Rhynchobatus djiddensis

Scaridae
Calotomus carolinus
Calotomus spinidens
Hipposcarus harid
Leptoscarus vaigiensis
Scarus ghobban
Scarus japanensis
Scarus psittacus
Chlorurus sordidus
Scarus viridifucatus

Scombridae
Rastrelliger kanagurta

Scorpaenidae
Dendrochirus brachypterus
Parascorpaena mossambica
Pterois antennata
Pterois miles
Scorpaenopsis venosa
Scorpaenopsis sp.

Serranidae
Cephalopholis argus
Epinephelus flavocaeruleus
Epinephelus fuscoguttatus
Epinephelus longispinis
Plectropomus areolatus

Siganidae
Siganus stellatus
Siganus sutor

Soleidae
Pardachirus marmoratus

Solenostomidae
Solenostomus cyanopterus

Sphyraenidae
Sphyraena barracuda
Sphyraena flavicauda
Sphyraena forsteri
Sphyraena jello
Sphyraena putnamiae
Sphyraena qenie

Syngnathidae
Corythoichthys flavofasciatus
Corythoichthys haematopterus
Corythoichthys schultzi
Hippocampus histrix
Syngnathoides biaculeatus

Synodontidae
Saurida gracilis
Synodus variegatus

Teraponidae
Pelates quadrilineatus
Terapon theraps
Tetraodontidae
Arothron hispidus
Arothron immaculatus
Arothron mappa
Arothron meleagris
Arothron nigropunctatus
Arothron stellatus
Canthigaster bennetti
Canthigaster janthinoptera
Canthigaster solandri
Canthigaster valentini
Lagocephalus sceleratus

Tetrarogidae
Ablabys binotatus

Triglidae
Chelidonichthys kumu

Zanclidae
Zanclus cornutus

Table 2. The 26 most common fish species in samples from seine nets and bamboo fish traps,showing the percentage of the sample they accounted for by weight and by number of fish, mean length, dominant life stage found in the samples and trophic group

Trophic information from stomach contents analysis (Fishbase 1996; Gell, unpublished)

Fish species	Common name	Net fishery			Trap fishery			Dominant life stage	Trophic group
		Weight %	Number %	Mean length in cm	Weight %	Number %	Mean length in cm		
Siganus sutor	African white-spotted rabbitfish	24.4	15.6	13.4	5.0	11.5	11.9	Juvenile	Herbivore
Lethrinus lentjan	Pink ear emperor	12.2	5.1	14.6	0.1	0.1	19.0	Juvenile	Invert. Feeder
Leptoscarus vaigiensis	Seagrass parrotfish	11.0	9.7	13.0	85.9	72.9	17.3	All	Herbivore
Lethrinus variegatus	Variegated emperor	7.4	14.7	9.7	0.5	1.0	12.4	All	Invert. Feeder
Gerres oyena	Blacktip mojarra	6.3	7.0	11.1	0.0	0.0		Juvenile	Invert. Feeder
Calotomus spinidens	Spiny tooth parrotfish	3.2	5.5	10.0	5.9	10.0	12.9	All	Herbivore
Cheilio inermis	Cigar wrasse	3.0	2.4	20.2	1.0	0.7	24.0	All	Invert. Feeder
Sphyraena flavicauda	Yellowtail barracuda	2.6	3.8	17.9	0.0	0.0		All	Piscivore
Stethojulis strigiventer	Three ribbon wrasse	2.4	5.9	9.4	0.1	0.2	10.8	All	Invert. Feeder
Amblygobius albimaculatus	Tailspot goby	2.2	3.3	12.2	0.0	0.0		All	Omnivore
Lutjanus fulviflamma	Blackspot snapper	2.0	0.9	14.7	3.4	6.8	12.0	Juvenile	Fish and invert.
Hemiramphus far	Black-barred halfbeak	1.5	0.4	28.8	0.0	0.0		All	Seagrass and fish
Parupeneus barberinus	Dash-dot goatfish	1.4	1.6	11.3	3.4	4.4	13.9	Juvenile	Crustaceans
Scolopsis ghanam	Arabian spinecheek	1.4	1.7	10.9	0.2	0.4	11.6	All	Invert. Feeder
Lethrinus mahsenoides	Snubnose emperor	1.3	1.5	10.4	2.2	3.3	12.6	Juvenile	Invert. Feeder
Fistularia commersoni	Cornetfish	1.2	0.8	40.6	0.0	0.0		All	Piscivore
Siganus stellatus	Stellate rabbitfish	1.0	1.1	11.7	0.1	0.2		Juvenile	Herbivore
Scarus ghobban	Blue-barred parrotfish	0.9	0.8	43.9	1.1	1.8	13.0	Juvenile	Herbivore
Carangoides fulvoguttatus	Yellow-spotted trevally	0.9	<0.1	33.5	0.0	0.0		Adult	Piscivore
Lactoria cornuta	Longhorn cowfish	0.8	0.2	17.3	0.0	0.1	7.0	All	Invert. Feeder
Upeneus tragula	Freckled goatfish	0.6	1.0	10.3	0.1	0.1	18.5	Juvenile	Invert. Feeder
Pelates quadrilineatus	Four-lined terapon	0.6	1.0	10.6	0.0	0.0		Juvenile	Omnivore
Diagramma pictum	Painted sweetlips	0.6	0.1	28.3	0.5	0.3	19.5	Juvenile	Inverts and fish
Cheilodipterus quiquelineatus	Five-line cardinalfish	0.1	1.0	7.6	0.0	0.0		All	Inverts and fish
Plectorhinchus gaterinus	Black-spotted grunt	0.5	0.4	12.8	0.4	0.1	13.5	Juvenile	Inverts and fish
Pteragogus flagellifer	Flagfin wrasse	0.1	0.1	9.4	3.3	10.1	10.9	Adult	Omnivore

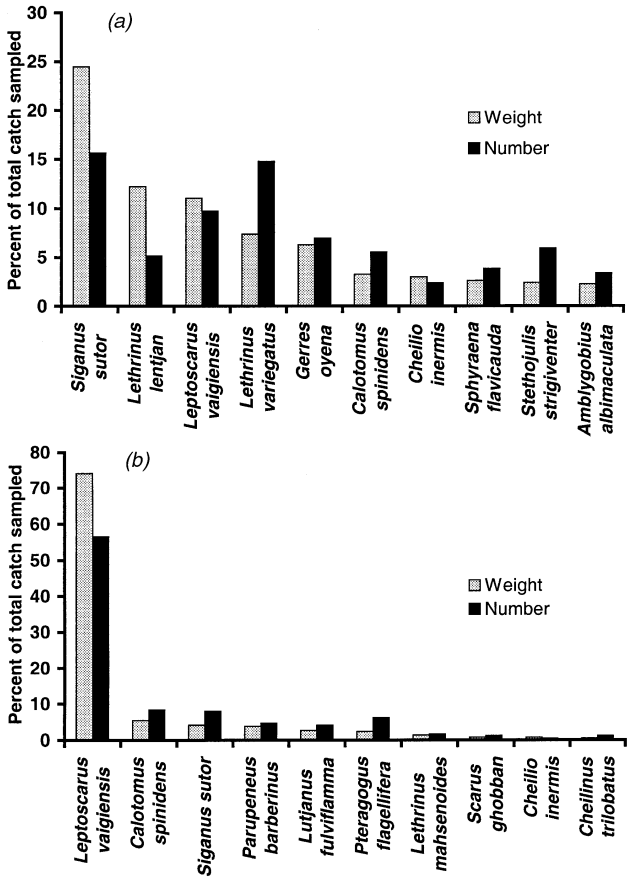

Fig. 2. The 10 most abundant fish species (percent of total weight and percent of total number) in samples taken from the seagrass beds: *(a)* seine-net catches; *(b)* trap catches.

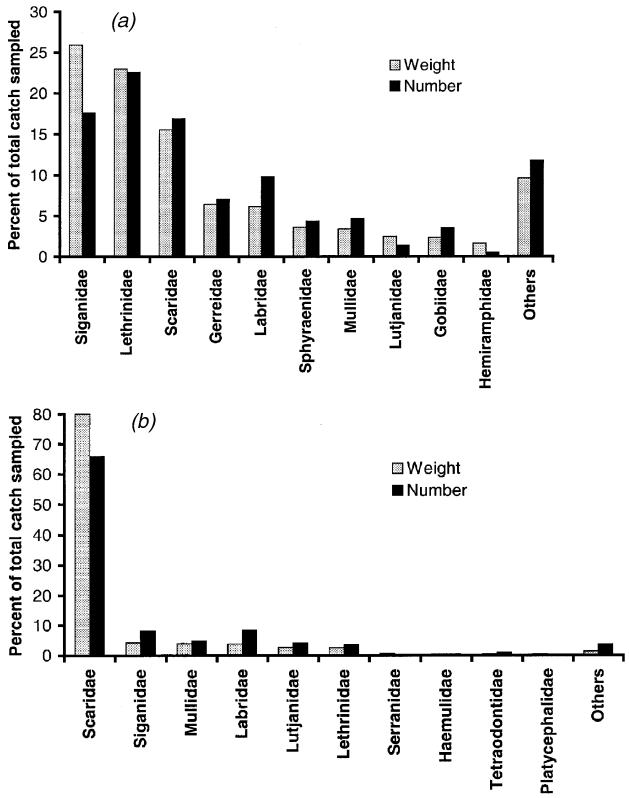

Fig. 3. The most abundant fish families in terms of weight and number: *(a)* seine-net catches; *(b)* trap catches.

fishery was dominated by the seagrass parrotfish *Leptoscarus vaigiensis*, which accounted for >85% of the total weight of fish sampled (Fig. 2*b*, Table 2). *Siganus sutor* and *Calotomus spinidens* were also important components but *Lethrinus lentjan* was rarely caught. The wrasse *Pteragogus flagellifer*, the goatfish *Parupeneus barberinus* and the snapper *Lutjanus fulviflamma* all accounted for >3% of the total catch sampled.

Life-history stages of main fish species in the seagrass fishery

From field observations (presence of ripe individuals in catches, observations of fish sizes in other fisheries in the area, underwater visual census and general underwater observation), and from the literature, we placed the main species caught into one of the following three categories (Table 3).

(a) Present in samples as juveniles only.
(b) Present in samples at all life-history stages (excluding very small fish of <7 cm length, which were not vulnerable to capture)
(c) Present in samples as adults only (some of these fish may actually be in category (b) but juveniles were not caught because of gear selectivity).

Trophic structure

The trophic roles of the 26 most common species are shown in Table 2. These data are derived from analyses of stomach contents, observations of behaviour (Gell unpublished) and information from FishBase (1996). Three of the six most important fish in the catches were herbivores, and herbivores accounted for >40% of the total fish biomass caught. The herbivore stomach contents that were examined contained large quantities of recognizable seagrass and epiphytic material.

There was a very low proportion of predators in the catch. Only three major piscivores were identified among the 25 most abundant fish – *Sphyraena flavicauda* (yellowtail barracuda), *Fistularia commersoni* (cornetfish) and *Carangoides fulvoguttatus* (yellow-spotted jack). Most fish that were not herbivores were invertebrate feeders, particularly on crustaceans and other small invertebrates (for example many of the emperors (Lethrinidae) and the wrasses (Labridae)).

Table 3. The three main categories of fish present in the seagrass beds
Fish in the first category were present mainly as juveniles, fish in the second category were present at all life history stages and fish in the third category were present mainly as adults

Present as juveniles	Present as all life stages	Present only as adults
Siganus sutor	*Leptoscarus vaigiensis*	*Stethojulis strigiventer*
Lethrinus lentjan	*Calotomus spinidens*	*Amblygobius albimaculata*
Lethrinus variegatus	*Cheilio inermis*	*Pteragogus flagellifer*
Gerres oyena	*Sphyraena flavicauda*	*Carangoides fulvoguttatus*
Lutjanus fulviflamma	*Hemiramphus far*	*Diagramma pictum*
Parupeneus barberinus	*Scolopsis ghanam*	*Herklotichthys quadrimaculatus*
Lethrinus mahsenoides	*Fistularia commersoni*	*Tylosurus crocodilus crocodilus*
Siganus stellatus	*Lactoria cornuta*	
Scarus ghobban	*Pelates quadrilineatus*	
Upeneus tragula	*Cheilodipterus quinquelineatus*	
Plectorhinchus gaterinus	*Chrysiptera annulata*	
Naso brevirostris	*Cheilinus trilobatus*	
Lutjanus gibbus	*Petroscirtes variablis*	
Plotosus lineatus	*Novaculichthys macrolepidotus*	
Parupeneus macronema		
Hipposcarus harid		
Lethrinus harak		

Discussion

Fish diversity

The species diversity in Montepuez Bay was high, considering the relatively small area sampled and the use of fisheries sampling. Many species of fish, particularly small species such as gobies and blennies, were not vulnerable to capture in this study, and neither were large pelagic species. Use of fisheries catches restricted us to sampling fish present diurnally. The traps in the present study fished overnight, but the fish attracted to the predominantly unbaited traps were mainly small herbivores, with the occasional predator such as a moray eel or grouper. Nocturnal fishes, particularly large predators thought to migrate into seagrass beds at night, were therefore not sampled. Robblee and Zieman (1984) found two distinct assemblages in St Croix, US Virgin Islands: during day time when small permanently resident seagrass species such as parrrotfishes, and wrasses were dominant, and during night time when grunts, squirrelfishes and cardinalfishes were dominant.. The total number of species in the Montepuez Bay shallow seagrass beds could therefore be much higher than the 249 species we present here.

In a global review of studies of seagrass fish communities (Pollard 1984) the highest number of species was found in a study in Madagascar (Vivien 1974); using poison as a sampling technique, she found 189 species in 46 families, mainly from *Thalassia*. In the literature, the study of a seagrass fishery most similar to our own was a study of a multi-gear, multi-species artisanal fishery in the Philippines in a seagrass-dominated lagoon habitat (Campos *et al.* 1994). In that fishery, 280 fish species in 53 families were identified and the dominant family was the Siganidae, as it was in this study. The similarity of the sampling methods from these two studies – i.e. sampling from local fisheries – is likely to have contributed to the similarity of the results. As we saw in this study when we compared species compositions from seine-net and trap samples, the sampling methods used in fish diversity assessments strongly influence the results obtained. Pollard (1984) found that there was greater similarity among samples collected by use of rotenone in different estuaries than between samples taken by use of rotenone and beam trawls in the same estuary. Harmelin-Vivien and Francour (1992) found significant differences between fish species found by trawling and by visual census techniques in Mediterranean seagrass beds. It is likely that the types of fish most under-sampled by the seine-net and trap fisheries were fast swimmers and more pelagic species such as jacks. Harmelin-Vivien and Francour (1992) found that trawling did not capture many fast swimmers.

Another similarity between the Philippines study (Campos *et al*. 1994) and the study in Montepuez Bay was the habitat fished: a mixture of seagrass and coral communities in close proximity. At the time of the present study the reefs of Quirimba were healthy, with high coral cover and diversity, and large and diverse fish populations (Whittington *et al.* 1997, 1998). Baelde (1990) found that differences in the fauna of seagrass beds in Guadeloupe depended on their proximity to other marine habitats: mangrove-associated seagrasses provided nursery areas for small juveniles, and reef-associated seagrasses were used for foraging by species that shelter among corals for the rest of the time. The Quirimba seagrass beds appear to be important as a fish nursery area, although migration of juveniles was not directly observed. Many of the key species were present in the samples mainly as juveniles. Currents in the area

ensure a high turnover of water across the reefs on the east coasts of Quirimba and nearby islands into Montepuez Bay, allowing good opportunities for the settlement of larvae from a wide area.

This work showed a high diversity of species in the seagrass beds of Montepuez Bay even when limited sampling techniques were used, indicating a potentially much higher total diversity. Seagrasses around the world are at threat from pollution, dredging and other sources associated with poorly managed coastal development (Fortes 1990). Seagrass beds in eastern Africa are a rich and diverse resource and their sustainable management should be a priority.

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References

Baelde, P. (1990). Differences in the structure of fish assemblages in *Thalassia testudinum* beds in Guadeloupe, French West Indies, and their ecological significance. *Marine Biology* **105**, 163–73.

Bandeira, S. O. (1995). Marine botanical communities in southern Mozambique: seagrasses and seaweed diversity and conservation. *Ambio* **24**, 506–9.

Bandeira, S. O. (1997). Seagrasses. In 'A Field Guide to the Seashores of Eastern Africa and the Western Indian Ocean Islands'. (Ed. M. D. Richmond.) pp. 64–7. (SIDA [Swedish International Development Co-operation Agency]/Department for Research Cooperation, SAREC: Stockholm.)

Blaber, S. J. M., Brewer, D. T., Salini, J. P., Kerr, J. D., and Conacher, C. (1992). Species composition and biomasses of fishes in tropical seagrasses at Groote Eylandt, Northern Australia. *Estuarine, Coastal and Shelf Science* **35**, 605–20.

Blaber, S. J. M., Brewer, D. T., and Harris, A. N. (1994). Distribution, biomass and community structure of demersal fishes of the Gulf of Carpentaria, Australia. *Australian Journal of Marine and Freshwater Research* **45**, 375–96.

Campos, W. L, del Norte-Campos, A. G. C., and McManus J. W. (1994). Yield estimates, catch, effort and fishery potential of the reef flat in Cape Bolinao, Philippines. *Journal of Applied Ichthyology* **10**, 82–95.

FishBase. (1996). FishBase 96 CD-ROM. ICLARM. (Manila, Philippines.)

Fortes, M. D. (1990). Seagrasses: a resource unknown in the ASEAN region. ICLARM Education Series 5, 46 pp. International Centre for Living Aquatic Resource Management. (Manila, Philippines.)

Gell, F. R. (1999). Fish and fisheries in the seagrass beds of the Quirimba Archipelago, Northern Mozambique. PhD Thesis, University of York, England.

Gray, C. A., Chick, R. C., and McElligott, D. J. (1998). Diel changes in assemblages of fishes associated with shallow seagrass and bare sand. *Estuarine, Coastal and Shelf Science* **46**, 849–59.

Harmelin-Vivien, M. L., and Francour, P. (1992). Trawling or visual census? Methodological bias in the assessment of fish populations in seagrass beds. *Marine Ecology* **13**(1), 41–51.

Jenkins, G. P., May, H. M. A., Wheatley, M. J., and Holloway, M. G. (1997). Comparison of fish assemblages associated with seagrass and adjacent unvegetated habitats of Port Phillip Bay and Corner Inlet, Victoria, Australia, with emphasis on commercial species. *Estuarine, Coastal and Shelf Science* **44**, 569–88.

Loureiro, N. (1998). Estudo da ictiofauna coralina e pesqueira do distrito de Mecúfi, Província de Cabo Delgado. Tese de Lienciatura, Universidade Eduardo Mondlane, Mozambique.

Ogden, J. C. (1997). Marine managers look upstream for connections. *Science* **278**, 1414–15.

Ogden, J. C., and E. H. Gladfelter. (1983). Coral reefs, seagrass beds and mangroves: their interaction in the coastal zones of the Caribbean. Report of a workshop held at West Indies Laboratory, St Croix, US Virgin Islands, May 1982. UNESCO Reports in Marine Science No. 23.

Parrish, J. D. (1989). Fish communities of interacting shallow-water habitats in tropical oceanic regions. *Marine Ecology Progress Series* **58**, 143–60.

Pollard, D. A. (1984). A review of ecological studies on seagrass fish communities, with particular reference to recent studies in Australia. *Aquatic Botany* **18**, 3–42.

Robblee, M. B., Barber, T. R., Carlson, P. R., Durako, M. J., Fourquean, J. W., Muhlstein, L. K., Porter, D., Yarbro, L. A., Zieman, R. T., and Zieman, J. C. (1991). Mass mortality of the tropical seagrass *Thalassia testudinum* in Florida Bay (USA). *Marine Ecology Progress Series* **71**, 297–9.

Smith, M., and P. C. Heemstra (Eds). (1991). 'Smiths' Sea Fishes.' (Southern Book Publishers: Johannesburg.)

Vivien, M. L. (1974). Ichtyofaune des herbiers de phanérogames marines du Grand Récif de Tuléar (Madagascar). I: Les peuplements et leur distribution écologique. *Téthys* **5**, 425–36.

Whittington, M. W., António, C. M., Corrie, A., and Gell, F. (1997). Technical Report 3: Central Islands Group – Ibo, Quirimba, Sencar and Quilaluia Islands. Marine Biological and Resource Use Surveys of the Quirimba Archipelago, Mozambique. Society for Environmental Exploration, London and the Ministry for the Co-ordination of Environmental Affairs, Maputo. 277 pp.

Whittington, M. W., António, C. M., Heasman, M. S., Myers, M., and Stanwell-Smith, D. (1998). Technical Report 6: Results summary and management recommendations. Darwin/Frontier–Moçambique Quirimba Archipelago Marine Research Programme. Marine Biological and Resource Use Surveys of the Quirimba Archipelago, Mozambique. The Society for Environmental Exploration, London and the Ministry for the Co-ordination of Environmental Affairs, Maputo.

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