Proceedings of the 6th International Coral Reef Symposium, Australia, 1988, Vol. 2

OVERLAP BETWEEN THE FISH FAUNA INVENTORIES OF CORAL REEFS, SOFT BOTTOMS AND MANGROVES IN SAINT-VINCENT BAY (NEW CALEDONIA).

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ABSTRACT

Fish fauna inventories (497 spp. in total) from coral reefs (276 spp.), soft bottoms (287 spp.) and mangrove (75 spp.) of Saint-Vincent Bay (New Caledonia) are compared. Each of these habitats presents a distinct fish assemblage, coral reefs being characterized by grazers and omnivores, soft bottoms by small carnivores and mangroves by detritus feeders and piscivores. The overlap was most important between coral reefs and soft bottoms (101 spp. in common), Chaetodontidae, Pomacentridae, Lethrinidae and Lutjanidae being the main common families. Overlap between soft bottoms and mangrove was of 36 species, essentially Leiognathidae, Lutjanidae and Sphyraenidae. There was almost no overlap between coral reefs and mangrove (13 species, 9 being ubiquitous). These results and a literature survey indicate that in the Indo-Pacific there are few interactions between coastal fish communities which may be essentially self sufficient. Diel feeding migrations and juvenile migrations would be the main active energy flows, nevertheless, the fluxes seem to be limited.

INTRODUCTION

In the south-west Pacific, coral reefs are often associated with other formations, such as soft bottoms and mangroves. The interactions of these habitats on fish populations are so far little known in the region. Prelimininary data show that findings from the Caribbean do not apply in this context (Birkeland & Amesbury, 1987). The present study indicates the inferences that can be made from fish inventories along a coral reef - soft bottoms - mangrove sequence in the south west lagoon of New Caledonia.

MATERIAL AND METHODS

The study area is located at Saint-Vincent Bay, south-west New Caledonia (22°S - 166°E). This bay, sheltered from trade winds by islands, receives important terrigenous inputs from Ouenghi and La Tontouta rivers (figure 1). Coral reefs are mainly developed at the mouth of the bay and on the inner islands. Mangroves cover most of the eastern shores. The major part of the bay is covered by heavily silted bottoms, with few coral reef patches.

The coral reef fish survey was conducted by visual census. A quantitative survey was done by 100 m visual transects. On each side of the line, a diver would record all species over 10 cm and all numerous smaller species. Large scarce species not recorded during transects were looked for during random swimming over the reefs. Small and cryptic species were normally not recorded. Ten stations, two visual transects on each, were thus surveyed over a three month period, in 1986 (figure 1).

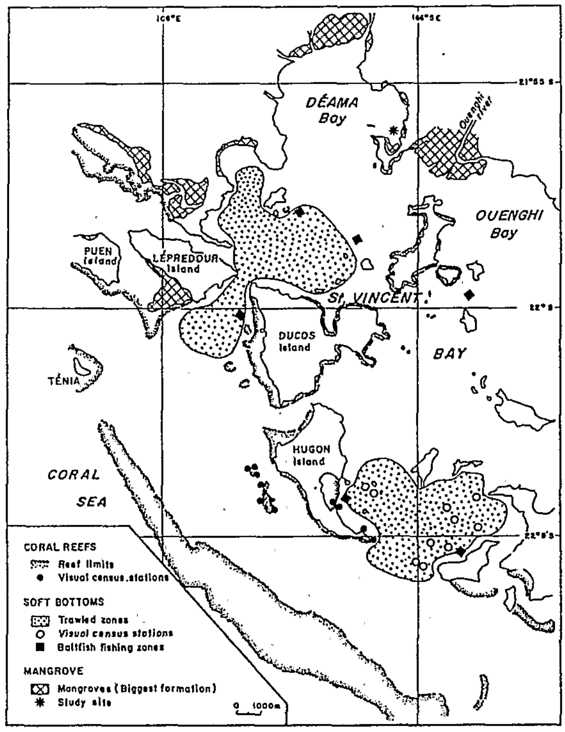

Figure 1. Study area and sampling stations.

Several methods were used to survey the soft bottom fish fauna, from 1985 to 1986 (figure 1). Ten stations (two visual transects on each) were undertaken with the method described previously. One hundred trawlings were performed using a 14 m headrope prawn trawl (2 cm mesh codend and 1.2 m vertical opening). In addition, qualitative data is available from a baitfish survey conducted by ORSTOM (Conand, 1987) and from a commercial bait fishery trial (Hallier & Kulbicki, 1985).

A mangrove was sampled in April - May 1987 (figure 1). Gill nets of 2, 4 and 6 cm mesh were laid at the edge of the mangrove (net length: 200 m, net height: 1.5 m). Nets were set at the end of incoming tide and withdrawn at the end of low tide (18 sets performed). A fyke net, set perpendicular to the mangrove (1 cm mesh at the end trap), was laid for two collections. A rotenone poisoning was also performed in a mangrove channel, gill nets enclosing the poisoned area (2 cm mesh).

Fish were attributed to trophic groups: piscivores, high carnivores (feeding on large invertebrates), small carnivores (feeding on small invertebrates), zooplanktivores, grazers, omnivores, detritus feeders and herbivores.

Fish present in over 75% or more of the samplings are referred as "abundant", in 40 to 74% of the samplings as "common" and in less than 40% of the samplings as "present". If no more than two specimen were present, the species is listed as "rare".

In order to compare the fish communities, the Kulczinski's similarity index was used.

RESULTS

Fish communities

A total of 497 species belonging to 74 families were recorded during our surveys.

The visual survey of inshore reefs near Hugon island revealed the presence of 276 species distributed among 38 families. 33,765 individuals of 202 species were recorded during the visual transects. The relative abundance analysis indicates that most of the species were poorly represented, 81.2% of them being "rare" or "present" (table 1). None were "abundant" and only 38 species could be considered as "common". Using the mean sizes recorded for each species, the total weight was estimated at 664 kg and the biomass at 330 kg/ha. Pomacentridae (40 spp.) are a major component of this community, the first five species in abundance being damselfishes. Chromis caerulae, composed 51% of total abundance. The importance of Pomacentridae is less pronounced in terms of biomass (20% of total weight). The six major species of the inventory contribute to less than 39% of total weight. The trophic structure (table 2) is characterized by the abundance of zooplanktivores (62.7% of the fishes censused), mainly Pomacentridae. High carnivores (Lethrinidae, Lutjanidae) and grazers (Scaridae), 28% of total weight each, are the two other major trophic groups. The trophic structure is consistent with those generally described in indo-pacific reefs.

Table 1. Species distribution and their relative abundance among the three habitats.

		Coral reefs		Soft bottoms			Mangrove
		transect	census	trawls	transect	bait fish	
Families		35	35	59	31	6	38
Species		202	242	245	82	32	75
Species	- abundant	0	-	1	1	-	2
	- common	38	-	12	3	-	7
	- present	110	-	167	48	-	37
	- rare	54	-	65	30	-	29
Total	- families	33		62			38
	- species	276		287			75

The fish fauna inventory of soft bottoms comprises 287 species distributed among 62 families (table 1). Unfortunately, baitfish results could not be used quantitatively. Moreover, species swimming near the surface of the water have not been sampled by either methods (i.e. mullets, garfishes). Visual transects gave the following results: 82 species, 3,760 individuals for an estimated biomass of 54.5 kg/ha (total weight: 109 kg). The biomass estimated by trawling was 19 kg/ha (abundance: 178,900; weight: 2,460kg). Less than 5% of the fish were "abundant" or "common". "Abundant" species are Canthigaster margarita (visual transect), and Orthorombus intermedius (prawn trawl). "Present" species represent more than 58% of the total species, and "rare" species compose 24.5% to 36.6% of the samplings (table 1). The community structure was analysed using trawl data. Leiognathidae is the dominant family, 8 species representing 81.6% of the abundance and 41.5% of the biomass. A characteristic of New Caledonia demersal coastal fish fauna is the absence of Ariidae and Sciaenidae and the low number of Nemipteridae. Table 2 indicates that small carnivores are the main trophic group, essentially because of Leiognathidae. Most zooplanktivores are small pelagic species which were underestimated by trawling. Visual transects indicate that Pomacentridae are also an important part of the soft bottoms fish fauna (32.6% in abundance). Lethrinidae, with 34.2% of visual transect biomass, can also be considered as a major component of the community.

Table 2. Trophic composition according to the habitat. Sp=species, No=Number, Wt=weight (in kg).

	Coral reefs			Soft bottoms			Mangroves		
	sp.	No.	Wt.	sp.	No.	Wt.	sp.	No.	Wt.
Piscivores	32	111	29	57	3011	308.8	22	72	41.5
High Carnivores	47	1813	189.9	38	8565	532.0	11	354	96.9
Small Carnivores	90	3274	72.4	114	163779	1584.9	22	3236	23.9
Zooplanktivores	25	21113	109.3	44	1298	19.5	7	1075	71.6
Omnivores	33	3344	37.9	17	129	1.3	_	_	_
Grazers	32	3311	182.8	9	1936	8.0	_	_	_
Detritus Feeders	1	11	0.1	2	97	0.4	9	481	45.2
Herbivores	16	698	42.7	6	64	5.7	4	43	8.8

Our survey of a sheltered mangrove indicates the presence of 75 species and 38 families (table 1). 5,265 fishes were collected for a total weight of 288 kg. The sampling methods did not allow us to estimate biomass. Like in the two other habitats, few species were frequently collected (table 1). Leiognathus equulus and Pomadasys argenteus could be considered as "abundant" and seven species as "common". More than 89% of the species were collected in less than 40% of the samplings, 29 of them being "rare". The most important species was Rhabdamia gracilis with 39% of abundance. Nematalosa come had the largest weight contribution (23% of total weight). Trophic structure analysis (table 2) shows the importance of small carnivores (Apogonidae, Leiognathidae). These numerous small species (22 species for 61.5% of abundance) have a small contribution to the total biomass (8.3%). High carnivores (Haemulidae, Lutjanidae) and zooplanktivores (Clupeidae, Engraulidae) make together 58.5% of total biomass. Piscivores, represented by few large individuals of numerous species, and detritus feeders characterize this community.

Fish fauna comparisons

Interactions are greater between coral reefs and soft bottoms than between coral reefs and mangrove, species overlap being intermediate between soft bottoms and mangrove (figure 2). Each habitat has a large specific component: 70% of the 497 species recorded in the bay are restricted to one biotope. The most important mangrove fish species (Rhabdamia gracilis, Nematalosa come) were not found elsewhere. Similarly, both soft bottoms "abundant" species (Orthorombus intermedius, Canthigaster margarita) and three important species (Leiognathus sp., L. bindus and Upeneus mollucensis) were collected uniquely on soft bottoms. Reef associated species such as Scaridae (18 spp.) and Labridae (35 spp.) characterize coral reefs data.

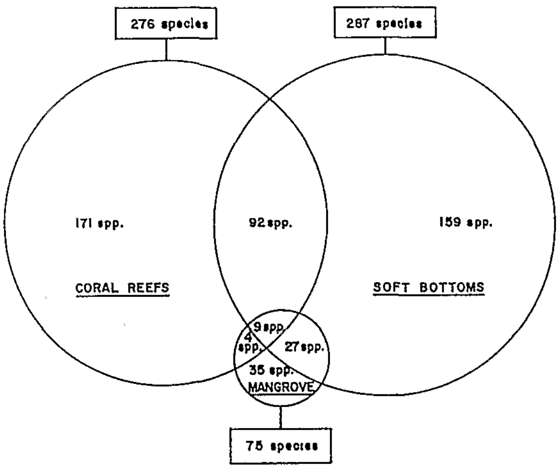

Figure 2. Species overlap between coral reefs, soft bottoms and mangrove fish fauna inventories.

Coral reefs - Soft bottoms

Coral reefs and soft bottoms show the greatest affinity. Kulczinski's similarity index is high (I_K=36), 101 species being common to both habitats. Only two families recorded on coral reefs were not sampled on soft bottoms: Kyphosidae and Aulostomidae. Chaetodontidae (11 spp.) and Pomacentridae (9 spp.) show great overlap (appendix 1). All Chaetodontidae, recorded over soft bottoms inhabit coral reefs. Species common to both habitats constitute 50% of the biomass and 73% of the abundance recorded by visual transect on the reef, for only 27.7% of the biomass and 9% of the abundance of the trawlings. Most of these species are *high carnivores*, *small carnivores* or *piscivores*. Primary consumers, mainly grazers, are poorly represented. The species common to both habitats are usually more abundant on soft bottoms than on coral reef, except for reef associated species.

Soft bottoms - Mangrove

Soft bottoms and mangrove also present a high degree of similarity with 36 common species (I_K=30). About 48% of the species collected in the mangrove (47.7% of the biomass) were caught by trawling. Important overlapping families are Leiognathidae, Lutjanidae and Sphyraenidae (appendix 1). Small carnivores, followed by piscivores, are the main overlapping trophic groups, primary consumers being represented by only two species (Siganus canaliculatus and Valamugil seheli). Four species have a higher relative abundance in the mangrove than over soft bottoms: Pomadasys argenteus, Leiognathus equulus, Lutjanus argentimaculatus and Sphyraena barracuda.

Coral reefs - Mangrove

Coral reefs and mangrove present the lowest affinity. Kulczinski's index value is low (I_K=10). Only 13 species are common to both habitats, nine of them being ubiquitous (appendix 1). Neopomacentrus taeniurus, Epinephelus caeruleopunctatus, E. howlandi and Siganus lineatus are the overlapping species absent from soft bottoms. All ubiquitous species have a carnivorous diet. Gerres ovatus feed mainly on small invertebrates. Arothron hispidus, Dasyatis kuhlii, Lethrinus nematacanthus, Lutjanus argentimaculatus, L. fulvus and L. russelli are high carnivores. Top predators are Sphyraena obtusata and Saurida nebulosus. These species are supposed to be widely distributed across Saint-Vincent Bay. Their relative abundance is greater on soft bottoms, except for Lutjanus argentimaculatus and L. russelli more abundant in the mangrove than elsewhere (appendix 1).

DISCUSSION

The interpretation of our data is impeded by several *methodological problems*. *In particular*, it was not possible to use the same sampling methods in all three environments and the sampling effort, in terms of hours, was higher for soft bottoms than for the two other substrates. Another problem rises from the temporal variability of these fish communities. Except for trawling, sampling was limited to a three month period. Nevertheless, keeping in mind these observations, a number of inferences can be made.

Differences between ecosystems

There are obvious physical and chemical differences between the three habitats. The mangrove is characterized by highly variable salinity, temperature and turbidity; it receives large nutrient and mineral inputs from the continent. Soft bottoms have an extremely diverse substrate which changes gradually from highly silted to coarse grey sand. Water turbidity is still important but, as salinity and temperature, it is much more stable than in the mangroves. Coral reefs enjoy rather stable water conditions and low turbidity.

Environmental conditions explain to a great extent the differences between the fish populations of the three habitats, as physical factors in the Gulf of Carpentaria (Rainer & Munro, 1982). The nature of the substrate and the composition of the benthic communities influence the fish assemblages (Blaber, 1980). Thus, coral reefs are characterized by high levels of grazers (Scaridae) and omnivores (Chaetodontidae and Pomacentridae) and low levels of piscivores and detritus feeders. Soft bottoms are dominated by Leiognathidae (small carnivores feeding both on the benthos and in the water column). The small patch reefs found on soft bottoms have a fish fauna similar to that of coral reefs, but with generally a higher percentage of large carnivorous fish. The main species collected on soft bottoms (Leiognathidae, Mullidae, small Lethrinidae) have small average sizes, whereas more large fish are found in both coral reefs and mangroves. Mangroves are characterized by the invasion of piscivores which come to feed on small species and juveniles sheltered in the mangrove prop roots (Blaber et al., 1985; Blaber, 1986). Detritus feeders also enter the mangrove, where they prey upon the micro- and meiofauna associated with the litter fall (Sasekumar et al., 1984).

Interactions between ecosystems

Although the fish fauna of each habitat is different from the others, some interactions exist following a sequence: coral reefs <-> soft bottoms <-> mangrove. Trophic structure and species overlap analysis tend to indicate exports of energy from mangrove to coral reefs through soft bottoms.

Passive exchanges

A review of the literature indicates that the nutrient dynamics between tropical coastal ecosystems is far from being well understood. Mangrove forests appear to serve more as sinks for carbon and nutrients than as exporters for downstream systems (Wiebe, 1987). Coral reefs - soft bottoms exchanges are not well documented, most studies being essentially focused on seagrass beds which are absent from Saint-Vincent Bay.

Active exchanges

Tidal feeding migrations from nearshore waters to mangroves are probably important to energy flows. The importance of piscivores and detritus feeders increases from coral reefs to mangrove, while grazers and omnivores become less important. Species overlap between soft bottoms and mangrove indicates that the species involved are secondary consumers and piscivores. Mugilidae, which are underestimated by trawling, also enter in the mangrove with the tide to feed on the mudfloor. The importance of carnivores and zooplanktivores in the soft bottoms - mangrove overlap shows that mangrove invertebrates are a major component of the diet of these foraging species, as in Malaysia (Sasekumar et al., 1984). In the Dampier region (NW Australia), piscivores enter mangroves with the tide to feed upon small permanent species (60% of their diet is made of 1-9 cm fish) and juveniles of larger species (Blaber, 1986). In riverine mangroves, few piscivores are usually collected, whereas planktivores are numerous (Blaber, 1980; Robertson & Duke, 1987). The presence of large piscivores, in our study like in Dampier, seems to be related to the lack of estuarine influence. Thus, the effective importance of piscivores in transfering energy may be smaller than it would appear in this survey.

Few day-night studies have been done in mangroves. While no significative difference was found in Costa Rica (Phillips, 1983), Thayer et al. (1987) report day-night variations in the species composition of mangroves and adjacent seagrass beds fish faunae (Florida). However, these differences varied with the species. In Saint-Vincent Bay, piscivores show markedly nocturnal habits. Total abundance and biomass were the greatest in the night samplings, which may indicate the use of the prop roots as a refuge against fish predation.

In the present study, coral reefs - soft bottoms overlap is likely overestimated. The presence of small patch reefs in the trawled areas explains the collection of reef associated species (Scaridae, Chaetodontidae and Pomacentridae). Birkeland & Amesbury (1987) suggest that most of the species common to coral reefs and nearby habitats are widely distributed, because of the motile prey upon which they feed. The importance of secondary consumers in the species overlap lend some support to this hypothesis. Large feeding migrations of reef fishes, resting the day on the reef, are usually described in the Caribbean (Ogden & Zieman, 1977). Parrish (1987) documents such migrations in the Pacific on a smaller scale, the species involved being Apogonidae, Holocentridae, Mullidae, Lutjanidae and Lethrinidae. These families, present in the species overlap, may have similar behaviour. The excretory products of these foraging species may favour an increase of coral (Meyer et al., 1983) and macrophyte (Nelson, 1985) growth.

Juveniles leaving their nursery ground can be considered as an outflow of energy. These migrations may represent little direct transfer of biomass but, as the energy and the material required for the growth of the recruits are supplied by another ecosystem, it is highly efficient for the recipient habitat (Parrish, 1987). At the moment, the nursery value of the mangroves is coming under question, especially for reef associated species. In PNG, Birkeland & Amesbury (1987) found no significant differences for juveniles among habitats, the distribution of juveniles and adults being not closely correlated. Quinn & Kojis (1985) note that the proximity of coral reefs does not affect significantly estuarine fish assemblages. They suggest that mangroves act as a nursery for few reef fish in the Indo-Pacific. From our findings, only two reef associated species can be considered as using the mangrove as a nursery site: *Epinephelus caeruleopunctatus* and *E. howlandi*.

Thus, interactions between these tropical fish communities appear to be less pronounced than it was usually thought, at least in the Indo-Pacific. Tidal feeding migrations would be a major transfer of energy between these systems. At our study scale, juvenile migrations have a limited direct impact.

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Appendix 1. The overlapping species, their feeding habits and relative abundance on each habitat.
Feeding habit: F. H. is : Pi=Piscivore, C1=High Carnivore, C2=Small Carnivore, Z=Zooplanktivore, G=Grazer, O=Omnivore, D=Detritus Feeder, H=Herbivore.
Relative abundance is: A=Abundant, C=Common, P=Present, R=Rare, +=Qualitative record only, -=Absent.
Ubiquitous species are indicated by °.

		F.H.	Relative abundance on Coral reefs	Soft bottoms	Mangrove
Acanthuridae					
Acanthurus	sp.	G	P	P	-
	dussumieri	H	P	P	-
	mata	G	C	R	-
	xanthopterus	H	+	R	-
Naso	sp.	Z	R	R	-
Zebrasoma	desjardini	G	C	R	-
Atherinidae					
Atherina	sp.	Z	-	R	P
Apogonidae					
Apogon	sp.	C2	C	P	-
	aureus	C2	P	P	-
	catalai	C2	R	P	-
	fraenatus	C2	R	P	-
Cheilidopterus	quinquelineatus	C2	R	P	-
Bothidae					
Engyprosopon	grandisquama	C2	R	P	-
Caesionidae					
Caesio	sp.	Z	R	P	-
	erythrogaster	Z	+	R	-
	tile	Z	P	R	-
Carangidae					
Gnathanodon	speciosus (juv.)	C2	-	P	R
Scomberoides	tol	Pi	-	P	P
Carcharhinidae					
Carcharthinus	limbatus	Pi	-	R	R
Centriscidae					
Aeoliscus	strigatus	Z	P	P	-

		F.H.	Relative abundance on Coral reefs	Soft bottoms	Mangrove
Chirocentridae					
Chirocentrus	dorab	Pi	-	P	R
Chaetodontidae					
Chaetodon	auriga	O	C	P	-
	benetti	O	P	P	-
	ephippium	O	P	R	-
	flavirostris	O	C	P	-
	lineolatus	O	P	R	-
	plebeius	O	C	P	-
	speculum	O	R	P	-
	trifascialis	G	P	R	-
	trifasciatus	G	C	P	-
Coradion	altivelis	C2	+	P	-
Heniochus	acuminatus	G	P	P	-
Clupeidae					
Amblygaster	sirm	Z	-	P	P
Dasyatidae					
Dasyatis	kuhlii	C1	+	R	R
Diodontidae					
Diodon	histrix	C1	R	+	-
Eleotridae					
Vireosa	anae	C2	P	+	-
Engraulidae					
Stolephorus	indicus	Z	-	P	R
Thryssa	baelama	Z	-	-	P
Fistulariidae					
Fistularia	petimba	Pi	P	P	-

Appendix 1. Continued.

Family / Genus	Species	F.H.	Relative abundance on: Coral reefs	Soft bottoms	Mangrove
Gerreidae					
Gerres	filamentosus	C2	–	P	P
	ovatus •	C2	P	C	P
Gobiidae					
Acentrogobius	sp.	C2	P	P	–
Amblygobius	sp.	C2	R	P	–
	phalaena	C2	C	+	–
Exyrias	puntang	C2	–	R	R
Haemulidae					
Diagramma	pictum	C1	R	P	–
Pomadasys	argenteus	C2	–	P	A
Labridae					
Cheilinus	bimaculatus	C1	P	P	–
	chlorourus	C1	C	P	–
Halichoeres	sp.	C1	C	+	–
	hoeveni	C2	R	+	–
	trimaculatus	C2	P	+	–
Thalassoma	lutescens	C2	C	+	–
	lunare	C2	C	R	–
Leiognathidae					
Gazza	minuta	C2	–	P	P
Leiognathus	equulus	C2	–	P	A
	rivulatus	C2	–	P	P
	splendens	C2	–	C	C
Secutor	ruconius	C2	–	P	R
Lethrinidae					
Lethrinus	lentjan	C1	P	P	–
	nebulosus	C1	P	P	–
	nematacanthus •	C1	P	C	R
	semicinctus	C1	R	P	–
	variegatus	C1	+	P	–
Lutjanidae					
Lutjanus	argentimaculatus •	C1	R	P	C
	bohar	C1	+	R	–
	fulvus •	C1	+	P	P
	fulviflamma	C1	P	P	–
	kasmira	C1	P	P	–
	quinquelineatus	C1	P	P	–
	russelli •	C1	+	R	P
	vitta	C1	+	P	–
Mugilidae					
Valamugil	seheli	D	–	P	R
Mugiloididae					
Parapercis	cylindrica	C2	C	P	–
Mullidae					
Mulloidichthys	flavolineatus	C2	P	P	–
Parupeneus	sp.	C2	P	R	–
	indicus	C2	R	R	–
	pleurospilos	C2	R	P	–
	spilurus	C2	P	R	–
Upeneus	sp.1	C2	+	P	–
	sp.2	C2	P	P	–
	vittatus	C2	–	C	P
	tragula	C2	R	P	–
Muraenesocidae					
Muraenesox	bagio	Pl	–	P	P
Nemipteridae					
Nemipterus	peroni	C1	P	P	–
Scolopsis	temporalis	C1	R	C	–

Family / Genus	Species	F.H.	Relative abundance on: Coral reefs	Soft bottoms	Mangrove
Ostraciidae					
Ostracion	cubicus	C1	R	P	–
Platycephalidae					
Platycephalus	sp.	Pl	R	P	–
Suggrundus	crocodilus	Pl	+	P	–
Polynemidae					
Polydactylus	microstomus	C2	–	P	P
Pomacanthidae					
Centropyge	tibicen	C2	C	+	–
Pomacentridae					
Abudefduf	coelestinus	O	P	+	–
	whitleyi	O	P	+	–
Amphiprion	clarkii	O	+	R	–
	tricinctus	O	+	R	–
Chromis	caerulea	Z	C	P	–
Dascyllus	aruanus	Z	C	P	–
Neopomacentrus	azysron	Z	+	P	–
	taeniurus	Z	+	–	P
Pomacentrus	amboinensis	O	C	P	–
	philippinus	O	C	P	
Priacanthidae					
Priacanthus	hamrur	C2	R	P	
Scaridae					
Scarus	sp.	G	C	R	–
	ghobban	G	C	P	–
Scorpaenidae					
Pterois	brachyptera	Pl	+	P	–
Serranidae					
Epinephelus	areolatus	Pl	R	P	–
	caeruleopunctatus	Pl	P	–	P
	cyanopodus	Pl	R	P	–
	howlandi	Pl	R	–	P
	maculatus	Pl	R	P	–
	malabaricus	Pl	–	P	P
	merra	Pl	C	R	–
Plectropomus	leopardus	Pl	P	R	–
Siganidae					
Siganus	canaliculatus	H	–	P	R
	lineatus	H	+	–	C
	oramin	H	P	P	–
	puellus	H	P	R	–
Sphyraenidae					
Sphyraena	barracuda	Pl	–	R	P
	obtusata •	Pl	+	P	R
	putnamae	Pl	–	P	R
Synodontidae					
Saurida	gracilis	Pl	–	C	R
	nebulosa •	Pl	+	P	R
	undosquamis	Pl	P	C	–
Synodus	binotatus	Pl	R	P	–
	englemani	Pl	+	P	–
	hoshinonis	Pl	R	C	–
	variegatus	Pl	+	R	–
Tetraodontidae					
Arothron	hispidus •	C1	R	P	R
	manilensis	C2	–	P	P
Canthigaster	valentini	C2	C	+	–
Lagocephalus	sceleratus	C1	R	P	–
Trichiuridae					
Trichiurus	lepturus	Pl	–	P	P