ISSN 2321–340X

Journal of Aquatic Biology & Fisheries | Vol. 5 | 2017 | pp. 123-131

RELATIONSHIP BETWEEN THE ABUNDANCE OF REEF FISH AND THE STRUCTURE OF CORAL REEF COMMUNITY IN VAAN ISLAND, GULF OF MANNAR

Laju, R.L*. and Mathews, G.

Suganthi Devadason Marine Research Institute, 44- Beach Road, Tuticorin- 628001, India
(Affiliated to Manonmaniam Sundaranar University, Abishekapatti, Tirunelveli - 627012. Tamilnadu, India)
**Email: lajurl@yahoo.co.in*

Abstract: The relationships of reef fish abundance, trophic composition, and diversity with reef habitats were investigated at Vaan Island, which lies in the southern tip of Gulf of Mannar Marine National Park. Underwater data on reef fish abundance and diversity were collected by following belt transect method involving scuba diving at three reef habitats namely inshore reef, reef flat and reef edge during the study period between November and December 2016. A total of 48 species from 31 genera belonging to 19 families were recorded. Among the three reef habitats, the highest abundance and diversity of fishes were recorded in the reef edge area. The trophic groups in these three reef sites were dominated by carnivores (26.32%), but herbivores and feeders on sessile invertebrates were relatively lower in abundance. There was a significant variation in fish abundance among the reef habitats. These findings revealed that the complexity of reef structure determines the abundance and diversity of reef fishes in Vaan Island.

Keywords: Reef fish, Corals, Gulf of Mannar, Herbivores.

INTRODUCTION

Coral reefs harbor an unparalleled diversity of fish species (Reaka-Kudla, 1997). Many factors impact the abundance and the spatial and geographic distribution of reef fishes, of which some are the biotic processes such as competition, predation and recruitment (Sale, 1978; Warner and Chesson, 1985; Munday *et al.*, 2001), and some are the abiotic factors like depth and exposure to light (Pinheiro *et al.* 2013). Many studies have indicated that both coral cover (Bell and Galzin, 1984., Sano *et al.*, 1984., Bouchon-Navaro and Bouchon, 1989., Chabanet *et al.*, 1997., Jones *et al.*,2004., Munday, 2014) and topographic complexity (Bozec *et al.*, 2005., Gratwicke and Speight, 2005) are particularly important in explaining the local reef fish diversity and abundance. The Gulf of Mannar (GoM) Marine National Park covering an area of 560 sq km is the Core Zone of Biosphere Reserve and the remaining 9,960 sq km area is the Buffer Zone of Biosphere Reserve. The coral reefs in GoM are degraded by human interferences as well as natural activities. The former include coral mining; destructive fishing methods; seaweed collection; commercial shell collection; introduction of exotic seaweed cultivation; changing land use practices; deforestation and industrial waste input etc. The latter include monsoon, wave action, ocean current and elevated sea surface temperature. The loss of fish due to the destruction of habitats like coral reefs and seagrass beds is impacting the sustained livelihood of the dependent fishermen. The impacts of climate change on corals such as bleaching and mortality; on fish population such as migration; erosion of islands and reduced fish catch for the dependent fisher folk are posing serious threats to the environment and the fishing community.

Coral reefs and the associated reef fishes of GoM have been severely damaged due to the rampant coral mining which was happening until 2004 (Edward *et al.*, 2008). Destructive fishing methods such as trap fishing and near-shore trawling, along with sedimentation and pollution, are causing considerable damage to the coral reefs, thereby threatening the reef fisheries of the GoM (James, 1994., Bakus *et al*., 2000., Edward and Muley, 2002). GoM lost about 32 km^2 of reef area due to coral mining prevalent for about 5 decades until the year 2005 (Edward *et al*., 2008). After the halt of coral mining in 2005, there has been an increase in live coral cover from 37% in 2005 to 43% in 2009 (Edward *et al*., 2012). The main objective of this study is to record the relationship between the reef fish abundance, diversity and the nature of trophic groups in three different reef habitats at Vaan Island.

MATERIALS AND METHODS

Study area

Vaan Island is located at the southern tip of Gulf of Mannar Marine National Park about 8 km away from Tuticorin. The coral reefs are distributed towards the south of the island. They consist mainly of the fringing reef type extending up to a depth of 5 m. Three study locations were fixed based on the nature of occurrence of coral reef habitats in the Vaan Island. They were Inshore reef site (Lat 08º50'04.43" N and Long 78º12'41.76" E), Reef flat (Lat 08º49'50.57" N and Long 78º12'50.39" E) and Reef edge (Lat 08º49'42.56" N and Long 78º13'05.73" E) (Fig.1). Reefs with dense coral cover were noticed in reef edge (RE); they comprised massive and branching corals such as *Acropora* spp., *Porites* spp., *Favia* spp.,

Fig. 1. Map showing the study sites at Vaan Island, Tuticorin.

Favites spp. and *Goniastrea* spp. Inshore reef (IR) and reef flat (RF) had poor live coral cover dominated by branching types including the fast growing species *Acropora formosa, A. nobilis, A. cytherea* and *Montipora digitata* (Table1). These three coral reef habitats were narrow and in close proximity with each other at a distance of about 1 km.

The study was conducted between November and December 2016. Preliminary assessment was carried out around the islands by using manta tow technique to identify the appropriate reef locations. Four 30x5 m belt transects were fixed at each study location to assess the fish abundance and diversity (English *et al*., 1997). All transects were laid on the reefs which were orientated parallel to the Island shore. All fishes spotted were identified by using underwater fish ID cards, and in addition an underwater camera was used for taking photographs of reef fish for further identification up to the species level. The number of individuals belonging to different species, families and trophic levels were divided into trophic groups using literature data (Allen, 1985., Myers, 1989 and Russ, 1989). In order to establish the spatial variation in trophic assemblages, the observed species were categorised into one of 6 trophic levels using data from previous studies described in literature (Hiatt and Strasburg, 1960., Hobson, 1974 and from fish base (fishbase.org). The following are the 6 categories: herbivore, omnivore, browser of sessile invertebrates, carnivore, piscivore, and planktivore. A total of 12 line intercept transects (20 meter) were laid on the reef area to assess the live coral cover (English *et al*., 1997). Based on the coral growth forms in each study location they were classified into five major groups viz. Coral branching, Table coral, Massive coral, Coral foliose and Coral encrusting by following the protocol described by English *et al*. (1997).

The one way ANOVA test was performed to compare the data on the variation of parameters of coral reef fish community at the three reef habitats. Coral and reef fish community relationship were studied by using the simple Pearson correlation coefficient test. All data were computed using the statistical tools of SPSS 16.0. Coral reef fish diversity indices were arrived at using PRIMER 6.0 multivariate software (PRIMER-E, 2000).

Table.1. Common coral species composition belonging to five coral growth forms

Major coral growth forms	Common coral species		
	Station-1	**Staion-2**	**Staion-3**
Branching	*A. muricata, A. hyacinthus, A. Montipora digitata*	*A. muricata, A. nobilis, Pocillopora damicornis, Montipora digitata*	*A. muricata, A. intermedia, A. nobilis, Pocillopora damicornis, Montipora digitata*
Table	-	*Acropora cytherea, A. hyacinthus*	*Acropora cytherea, A. hyacinthus*
Massive	*Porites lutea, Favia pallida*	*Porites lutea, P. solida, Favia pallida, Favites abdita, Goniastrea pectinata, Hydnophora microconos, Paltygyra lamellosa*	*Porites lutea, P. solida, Favia pallida, F. favus, Favites abdita, Goniastrea pectinata, Hydnophora microconos, Paltygyra lamellose*
Foliose	-	*Montiopora folisosa and Turbinaria peltata*	*Montiopora folisosa and Turbinaria peltata*
Encrusting	*Porites and Montipora*	*Porites sp., Favites sp., Montipora* sp.	*Favites sp., Montipora* sp.

RESULTS AND DISCUSSION

The study reveals that the structure of the three coral habitats plays an important role in enhancing the fish abundance, diversity, richness and fish trophic groups. Fish abundance and species richness vary significantly due to benthic community structure (coral cover, depth, diversity and habitat structural complexity). Small sized fishes were found well associated with branches of corals and a few groups were nesting under the table corals, complex rocky-reef and in the small holes in shallow areas, probably in an effective way to avoid the predation encountered in deeper zones (Almany, 2004).

A total of 3,154 fishes were counted during the assessment period in the three reef habitats of Vaan Island. Among the three reef habitats, the highest fish abundance was found to be in RE (reef edge habitat) with 1,711 followed by 919 counts at RF (reef flat). Coral beds of Vaan Island forming an exclusive habitat for a fair number of reef fishes mainly in reef edge area. Reef fishes are strongly influenced by the structure of their habitat; more complex coral reef morphology comprising live coral cover and coral growth forms generally contributes to high abundance of fishes (reference). There was a significant variation in fish abundance among the reef habitats (ANOVA, df=143; F=19.678; P=0.00).

A total of 48 species from 31 genera belonging to 19 families were recorded during the survey period. Among the three sites, the maximum number of species were sighted in RE (reef edge habitat) with 36±1.54 followed by Inshore reef (IR) and Reef flat (RF) sites with 22.75±0.41 and 15.75± 0.4 respectively. Reef fish abundance was higher at RE with 427.75±17.03 no/50m^2 while the other two sites, IR and RF had poor reef fish assemblages (Table.2). Smaller size of fish population has a significant impact on ecosystem function and productivity of reef habitats. These data suggest that the low abundance of reef-associated fishes encountered in Vaan Island reefs was due to the severe coral bleaching event that occurred during June 2016 and resulted in the decrease of live coral cover from 50 to 30% at the three reef habitats.

Inshore Reef (IR) site was dominated by *Lutjanus fulvus* with 16 ±2.12 no/50m^2 and *Scarus ghobban* with 13.5± 1.32 no/50m^2; Reef Flat (RF) was dominated by, *Pempheris vanicolensis* with 18 ±3.63 no/50 m^2, and *Gnathonodon speciosus* 15± 2.08 no/50 m^2; Reef Edge (RE) was dominated by, *Abudeduf saxitalis* with 28.5 ±1.44 no/50 m^2 and *Pempheris vanicolensis* 25.5± 4.37 no/50 m^2. In contrast, reef flat and reef edge areas were occupied by a considerable density of indicator fishes belonging to the Chaetodon group which comprised 6 species and was dominated by *Chaetodon collare* and *Chaetodon decussatus* at high coral cover sites. A study by Pereira and Videira, (2005) on the community structure of Chaetodons in Southern Mozambique revealed that reefs with relatively vast hard coral cover had higher chaetodon abundance. Raj *et al.* (2016) reported three species of coral-feeding

Table: 2. Coral reef fish community at the three habitats of Vaan Island with average abundance (individuals/50 m^2), standard error (± S.E). Fish feeding habitats classified into five tropic groups represented as: CA carnivores; OM omnivores; PI piscivores; PK planktivores; HB herbivores; SIF; browser of sessile invertebrates.

Species	Family	TROPHIC GROUP	St-1	St-2	St-3
Acanthurus bleekeri	Acanthuridae	HB	2±1.22	-	-
Acanthurus mata	Acanthuridae	HB	-	5.5±2.22	6.5±1.6
Acanthurus dussumieri	Acanthuridae	HB	-	5.8±0.85	9.5±1.8
Naso hexacanthus	Acanthuridae	HB	-	-	6±2.2
Acanthurus lineatus	Acanthuridae	HB	-	-	6±2.2
Zebrasoma veliferum	Acanthuridae	HB	-	3.5±2.06	4±1.7
Balistoides viridescens	Balistidae	OM	-	-	5.25±2.1
Odonus niger	Balistidae	OM	-	2.3±1.44	3±1.91
Gnathonodon speciosus	Carangidae	PI	7.75±3.17	15±2.08	21.5±7.51
Chaetodon oxycephalus	Chaetodontidae	SIF	-	6±2.16	7±0.91
Chaetodon collare	Chaetodontidae	SIF	9±2.12	11.5±3.93	18.75±2.5
Chaetodon decussatus	Chaetodontidae	SIF	-	5.75±3.61	6.5±2.5
Chaetodon octofasciatus	Chaetodontidae	SIF	-	-	4.75±1.7
Chaetodon plebeius	Chaetodontidae	SIF	1.5±1.5	10.5±0.96	9.75±1.44
Chaetodon auriga	Chaetodontidae	SIF	-	-	2.5±1.5
Heniochus acuminatus	Chaetodontidae	CA	-	-	3.5±1.32
Plectrohinchus orientalis	Haemulidae	OM	4.75±1.7	5.5±1.89	12±2.16
Diagramma pictum	Haemulidae	OM	1±1	7.5±3.12	5.5±2.06
Sargocentron rubrum	Holocentridae	OM	-	6±2.16	14±3.81
Halichoeres zeylonicus	Labridae	CA	4.5±0.65	-	5.75±1.49
Thalassoma purpureum	Labridae	CA	5.5±1.32	-	3.75±2.39
Thalassoma lunare	Labridae	CA	1±1	5.25±3.09	6±3.83
Xyrichthys pavo	Labridae	CA	-	11±4.04	7±2.65
Coris formosa	Labridae	CA	-	10±3.74	9±3.7
Lutjanus decussatus	Lutjanidae	CA	8±1.41	10±2.16	24±4.14
Lutjanus rivulatus	Lutjanidae	CA	-	-	3.75±2.39
Lutjanus ehrenbergii	Lutjanidae	CA	-	-	8.5±3.3
Lutjanus lunulatus	Lutjanidae	CA	-	-	10.75±2.56
Lutjanus fulvus	Lutjanidae	CA	16±2.12	13.25±2.14	-
Paraupeneus indicus	Mullidae	CA	12.25±1.65	5.5±3.77	8.75±3.3
Pempheris vanicolensis	Pempheridae	OM	4±2.45	18±3.63	25.5±4.37
Pomacanthus annularis	Pomacanthidae	OM	-	-	11±2.52
Pomacanthus imperator	Pomacanthidae	OM	-	3±1.91	7±3.14
Dascyllus sp	Pomacanthidae	OM	2.5±2.5	10±2.16	6±2.16
Dascyllus trimaculatus	Pomacanthidae	PK	3.25±1.18	-	18.25±1.18
Abudeduf saxitalis	Pomacentridae	OM	-	-	28.5±1.44
Pomacentrus caeruleus	Pomacentridae	OM	-	-	13.75±4.7
Amphiprion clarkii	Pomacentridae	OM	5.5±1.89	0.5±0.5	1±1
Scarus ghobban	Scardiae	HB	13.5±1.32	14.5±3.28	18.5±3.3
Chlorurus sordidus	Scaridae	HB	9±1.29	7.25±0.85	14±2.35
Siganus javus	Siganidae	HB	13±1.78	8±3.37	18.75±1.11
Pterois russelii	Scorpaenidae	CA	±0	1.75	3.25±1.97
Cephalopholis formosa	Serranidae	PI	2±1.41	5.5±2.02	8.5±3.3
Epinephelus formosa	Serranidae	PI	2±1.22	9±1.29	4.5±2.1
Epinephelus merra	Serranidae	PI	3±1.29	10.5±1.55	8.5±1.5
Scolopsis vosmeri	Nemipteridae	CA	-	-	5.75±2.17
Zanculus cornutus	Zanciidae	SIF	-	-	1.75±1.03
Arothron mappa	Tetradontiidae	OM	-	2±1.22	-

butterfly fish (*Chaetodon octofasciatus*, *C. plebius*, *C. collare*) from Vaan Island. These species are active coral feeders in the inshore and reef flat areas. During the present observation, some groups of coral feeding butterfly fishes were found on the corals of *Montipora* sp., *Acropsora cythera* and *A. formosa* but very few in *Porites* sp. A few commercially important fishes belonging to the families such as Carangidae, Lutjanidae, Scardiae and Siganidae were also observed during the assessment in all sites. Lutjanidae, Scaridae and Chaetodontidae were the most frequently observed families. In IR, the percentage occurrence of fishes were dominated by Lutjanidae (18.32%) and Scaridae (17.18%); in RF, reefs had rich Chaetodontidae (14.69%), Labridae (11.43%) and Lutjanidae (10.12%); and in RE, the observed families were Chaetodontidae (12.33%), Lutjanidae (10.99%) and Pomacentridae (10.11%). The findings are presented in Table 3.

The trophic groups in the three reef sites were dominated by carnivores (26.32%) including 6 families, with the greatest species richness contributed by Labridae (5 spp.) and Lujanidae (4 spp.). Herbivores represented 21.09% and included 3 families, with Acanthuridae (5 spp.) and Scaridae (2 sp.) as the richest families. Piscivore contribution of 12.24% consists of 2 families. The most representative families were Serranidae (3 spp.) and Carangidae (1 sp.). Sessile invertebrates accounting for 10.91% included Chaetodontidae (6 spp.) and Zanciidae (1sp.). The omnivores represented 21.31% with 7 families. They were Balistidae (2 spp.), Haemulidae (2 spp.), Holocentridae (1 sp.), Pempheridae (1 sp.), Pomacentridae (3 spp.), Pomacentridae (2 spp.) and Tetradontiidae (1 sp.). However, the plankton feeders constituted the smallest group and they represented 8.13% of the total number of species including just a single family of Pomacanthidae with the occurrence of *Dascyllus trimaculatus* fish species (Fig.2).

The abundance of corallivorous and planktivorous fishes do not depend on the coral substratum, but their abundance may respond to other biotic and abiotic environmental factors which characterise the outer reef slope, including reef pass (Chabanet et al., 1997). Thresher (1983) observed that the abundance of planktivorous fishes depend on the speed of the water currents transporting the plankton onto the reefs. In IR, carnivores accounted for 33.57% (6 spp.) the most represented genus being *Lutjanus*, followed by herbivores (26.64% with 4 spp.), omnivores (12.61% with 5 spp.), piscivores (10.47% with 4 spp.), planktivores (9.23% with 1 sp.) and sessile invertebrates (7.46% with 2 spp.). In RF, carnivores accounted for 24.7% with 7 spp. of all individual fishes recorded, followed by omnivores (23.83% with 9 spp.), herbivores (19.36% with 6 spp.), piscivores (17.41% with 4 spp.), planktivores (0% with 0 sp.) and sessile invertebrates (14.68% with 4 spp.). At RE, omnivores accounted for 27.48% with 15 spp. of all individual fishes recorded, followed by carnivores (20.69% with 13 spp.), herbivores (17.27% with 8 spp.), planktivores (15.14% with 1 sp.), with (4 spp.), sessile invertebrates (10.58% with 7 spp.) and piscivore (8.81%).

During the present study, six major trophic groups of fishes were observed and they are primary functional groups which maintain the reef ecosystem. These primary functional groups have been widely used and this generally reflects their role in the flow of energy through reef food chains (Bellwood *et al*., 2004). It should be noted, however, that detritivores were included in the herbivore functional group, based on the mechanical removal of algal or detrital material from the reef (i.e., nominally herbivorous fish). The results revealed a considerably poor presence of obligate herbivorous fishes in the reef area, and this will allow the proliferation of algae over corals killing them in the process. The main reason behind the decline of herbivorous fish population is the operation of shore seine and trap fishing targeting the parrot fishes in the reef habitats.

The Reef Edge (RE) had higher species richness (d= 5.78± 1.54), while poor species richness was noted at Inshore reef (IR) area (d= 3.03± 0.05). A reasonable Evenness (J) value was obtained for all sites with 0.95±0.00 in IR site; 0.97±0.00 in RF site; and 0.95±0.00 at RE site. Shannon-wiener Diversity index (H') was relatively high in RE site (H'= 3.42±0.04) followed by RF site (H'= 3.01±0.04), while the lowest mean value (H'= 2.63±0.05) was recorded at IE site (Table.4).

Of the three reef habitats, RE was dominated by all the four coral growth forms. The highest cover of

Table.3. Percentage composition of reef fish in Vaan Island**.**

Family	St-1	St-2	St-3
Acanthuridae	1.53	6.42	7.48
Balistidae	-	0.98	1.93
Carangidae	5.92	6.53	5.03
Chaetodontidae	8.02	14.69	12.33
Haemulidae	4.39	5.66	4.09
Holocentridae	-	2.61	3.27
Labridae	8.4	11.43	7.36
Lutjanidae	18.32	10.12	10.99
Mullidae	9.35	2.39	2.05
Pempheridae	3.05	7.83	5.96
Pomacanthidae	4.39	5.66	9.88
Pomacentridae	4.2	0.22	10.11
Scardiae	17.18	9.47	7.6
Siganidae	9.92	3.48	4.38
Scorpaenidae	-	0.76	0.76
Serranidae	5.34	10.88	5.03
Nemipteridae	-	-	1.34
Zanciidae	-	-	0.41
Tetradontiidae	-	0.87	-

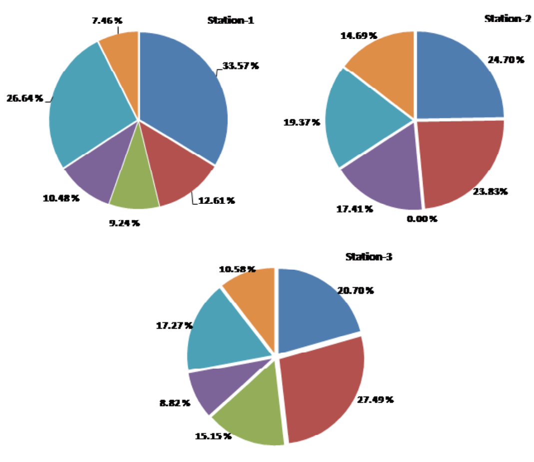

Fig. 2. Trophic composition of reef fishes in Vaan Island. CA Carnivores; OM omnivores; PI piscivores; PK planktivores; HB herbivores; SIF; browser of sessile invertebrates.

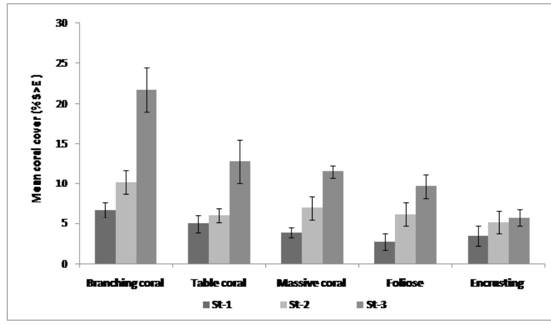

Fig. 3. Mean cover of coral growth forms in Vaan Island

branching coral was observed in reef edge site with a mean value of 21.72 ± 2.75%, followed by RF site with 10.21± 1.43 %. Secondly, table corals were dominant in reef edge habitat with an average cover of 12.82±2.7% and poor occurrence of table coral was noticed in inshore reef area with 4.98±1.09% (Fig.3).

Chaetodon trifascialis is among the most highly specialized of all coral reef fishes and it feeds almost exclusively on only one type of coral, the tabulate *Acropora* (Pratchett, 2005). During the study, not even a single individual of *Chaetodon trifascialis* was spotted in all the three habitats; however, other obligate table coral-associated chaetodon groups were seen on top of the table forms, particularly in *Acropora cytherea* at reef edge habitats. The highest massive coral abundance was found in reef edge (11.49±0.81%), whereas sparse massive coral were noted at inshore reef habitat (3.86±0.66%). Predicting the responses of fish assemblages to coral loss is particularly important, given the sustained and ongoing climate change, which is likely to alter the structure of coral reef habitats (Hoegh-Guldberg *et al* ., 2007).

The relationship between reef fishes and the structures of coral habitat was studied by using correlation test. In Vaan Island, reef fish assemblages

Table: 4. Reef fish diversity indices in Vaan Island

	Station-1	Station-2	Station-3
No. of species (S)	15.75± 0.41	22.75±0.41	36±1.54
number of individuals	131±9.53	229.75±9.09	427.75±17.03
Diversity (H')	2.63±0.05	3.01±0.04	3.42±0.04
Species richness (D)	3.03±0.05	4±0.15	5.78±0.26
Evenness (J)	0.95±0.00	0.97±0.00	0.95±0.00

Herbivorous - *Scarus ghobban* (shoals on Branching coral)

Carnivorous - *Lutjanus ehrenbergii*

Omnivorous - *Pempheris vanicolensis*

Chaetodon octofasciatus-- Coral feeding

Coral feeding - *Chaetodon plebeius*

Omnivorous - *Abudeduf saxitalis*

Fig. 4. Underwater photos of common reef fishes in Vaan Island

depend highly on coral cover and coral morphological structural complexity. Obviously there is a strong positive relationship between coral structure, fish abundance and species richness in the reef habitat. In addition, fish species richness and fish abundance were higher in the branching, table, massive and foliose growth forms and lower in coral encrusting forms which might be due to the low structural complexity. There is often a strong positive relationship between coral cover and fish abundance (Carpenter *et al.*, 1981, Findley and Findley, 2001., Jennings *et al.*, 1996) and diversity (Bell and Galzin, 1984). However, coral reef fishes vary in the degree of their reliance on corals, ranging from highly specialist fishes that are critically dependent on a single coral species for food or habitat (Munday, 2004 and Pratchett, 2005) to fishes that only very loosely associate with live corals (Wilson *et al*., 2008). It is also difficult to separate the relative importance of live coral versus the physical structure provided by high cover and diversity of scleractinian corals (Graham *et al*., 2009). Bouchon-Navaro et al. (1985) also observed that the abundance of Chaetodontidae was significantly correlated to the distribution of long branching coral colonies on the reef. Branching and table growth forms have provided refuge to the butterfly fishes which mainly occur in *Acropora* spp. Reef fishes are significantly correlated to the distribution of branching and table forms in the reef edge and reef flat habitats.

The results of the present study in Vaan Island are in agreement with the idea that aspects of coral community structure influence the fish assemblages in reef habitats. Although variation in the distribution and abundance of both fishes and corals was marked across our study sites, it appears that reefs with higher coral cover support higher abundances and species richness of fishes. The relatively low diversity of herbivorous fishes, which is the result of their overexploitation, is of course a warning signal, as this group in important in terms of resilience and reef recovery. The present study also establishes benchmark data for the reefs of Vaan Island, and the same protocol can also be applied to assess the reef areas and associated fishes in the other islands in Gulf of Mannar.

ACKNOWLEDGEMENT

The authors wish to acknowledge their indebtedness to Ministry of Environment, Forest and Climate Change for the financial support. They also place on record their thanks to the Principle Chief Conservator of Forests and the Chief Wildlife Warden, Government of Tamil Nadu and to the Wildlife Warden, Gulf of Mannar Marine National Park for research permissions.

REFERENCES

Allen, G. R. 1985. FAO species catalogue. Vol. 6. Snappers of the world. An annotated and illustrated catalogue of *Lutjanidae* species known to date. *FAO Fisheries Synopsis*. 125 - 208.

Almany G. R. 2004. Priority events in coral reef fish communities of the Great Barrier Reef. *Ecology* 85:2872–2880.

Bakus, G., Arthur, R., Ekaratne, S. and Jinendradasa, S. S. 2000. India and Sri Lanka, In: McClanahan, T.R., Coral reefs of the Indian Ocean: their ecology and conservation., 295-324.

Bell, J. D. and Galzin, R. 1984. Influence of live coral cover on coral-reef fish communities. *Mar. Ecol. Prog. Ser*., 15, 265-274.

Bellwood, D.R.; Hughes, T.P.; Folke, C.; Nystom, M. Confronting the coral reef crisis. *Nature*, 2004, *429*, 827-833.

Bouchon-Navaro, Y. and Bouchon C. 1989. Correlations between chaetodontid fishes and coral communities of the Gulf of Aqaba (Red Sea). *Environ .Biol. Fish*., 25: 47-60.

Bouchon-Navaro, Y., Bouchon, C. and Harmelin-Vivien, M. L. 1985. Impact of coral degradation on a Chaetodontid fish assemblage (Moorea, French Polynesia). Proceedings of the 5th International Coral Reef Symposium 5, 427–432.

Bozec, Y. M., Doledec, S. and Kulbicki M. 2005. An analysis of fish-habitat associations on disturbed coral reefs: chaetodontid fishes in New Caledonia. *J. Fish. Biol*. 66: 966-982.

Carpenter, K. E., Miclat, R.I., Albaladejo, V.D., Corpuz, V.T., 1981. The influence of substratum structure on the local abundance and diversity of Philippine reef fishes. Proc. 4th Int Coral Reef Sym. 2, 495-502.

Chabanet, P. H., Ralambondrainy, M., Amanieu, G., Faure and Galzin. R. 1997. Relationships between coral reef substrata and fish. *Coral reefs*.16(2):93-102.

Edward, J. K. P., Mathews, G., Patterson, J., Ramkumar, R., Wilhelmsson, D., Tamelander, J., Linden, O. Status of coral reefs of the Gulf of Mannar, southeastern India. Coral Reef Degradation in the Indian Ocean Status (CORDIO) - Status Report 2008, pp. 45– 55.

Edward, J. K. P and Muley, E. V. 2002. Reef restoration- An overview. Proceedings of the National Seminar on Marine and Costal Ecosystems. *SDMRI Research Publication*., 2120- 124.

Edward, J.K.P., Mathews, G., Raj, K. D., Thinesh, T., Patterson, J., Tamelander, J. and Wilhelmsson, D. 2012. Coral reefs of Gulf of Mannar, India - signs of resilience, *Proceedings of the 12th International Coral Reef Symposium*, Cairns, Australia. 9-13.

English, S., Wilkinson, C. and Baker V. 1997. Survey manual for tropical Marine resources. Australian Institute of Marine Science, Townsville Australia.

Findley, J. S. and Findley, M. T. 2001. Global, regional, and local patterns in species richness and abundance of butterflyfishes. *Ecol. Monogr*.71: 69-91.

Gomez, E. D., Birkeland, C. E., Buddemeier, R. W., Johannes, R. E., Marsh, J. A., Jr., Tsuda, R. T. Eds.; *ReefBase*: Penang, Malaysia, 1981; Volume 2, 497-502. pp.

Graham, N. A. J., Wilson, S. K., Pratchett, M.S., Polunin, N. V. C. and Spalding, M.D. 2009.Coral mortality versus structural collapse as drivers of corallivorous butterflyfish decline. *Biodivers. Conservat.* 18, 3325-3336.

Gratwicke, B. and Speight M. R. 2005. The relationship between fish species richness, abundance and habitat complexity in a range of shallow tropical marine habitats. *J. Fish. Biol*. 66: 650-667.

Hiatt, R .W. and Strasburg D. W. 1960. Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. *Ecol. Monogr*., 30 : 65-127.

Hobson, E. S. 1974 .Feeding relationships of Teleostean fishes on coral reefs in Kon, Hii. *Fish bull.* 72: 915-931.

Hoegh-Guldberg, O., Mumby, P. J. Hooten, A. J., Steneck, R. S., Greenfield, P., Gomez, E., Harvell, C. D., Sale, P. F., Edwards, A. J. and Caldeira, K . 2007. Coral reefs under rapid climate change and ocean acidification. *Science*, 318, 1737-1742.

James, D. B. 1994. Management of Beche-de-mer industry in India. In: K. Rengarajan, and James, D B., (Eds.). Proceedings of the National Workshop on Beche-de-mer. Bulletin of *CMFRI*., 46 17-22.

Jennings, S., Boulle, D. P. and Polunin N. V. C. 1996. Habitat correlates of the distribution and biomass of Seychelles' reef fishes. *Environ. Biol. Fishes*. 46 : 15-25.

Jones, G. P., McCormick, M. I., Srinivasan M. and Eagle J. V. 2004. Coral decline threatens fish biodiversity. *Proc .Natl Acad Sci* U .S .A .101: 8251-8253.

Mahadevan, S. and Nayar K. N. 1972. Distribution of coral reefs in Gulf of Mannar and Palk Bay and their exploitation and utilization. In: Proceedings of Symposium on Coral Reef, Mandapam: 181- 190.

Munday, P. L .2004. Habitat loss, resource specialization, and extinction on coral reefs. *Glob. Chang. Biol* . 10: 1642-1647.

Munday, P. L., Jones, G. P. and Cale M. J. 2001. Interspecific competition and coexistence in a guild of coral-dwelling fishes. *Ecology* 82:2177–2189.

Myers, R. F. 1989. Micronesian reef fishes. Coral Graphics, Guam. 298.

Pereira, M. A., Videira E. J. S. and Abrantes K. G. S. 2005. Listagem de peixes associados a recifes e zonas litorais do extremo sul de Moçambique. *J. Inv. Adv. Amb*. 1: 1-7.

Pinheiro, H. T., Martins, A. S. and Joyeux J. C. 2013. The importance of small-scale environment factors to community structure patterns of tropical rocky reef fish. *J .Mar. Biol Assoc* UK 93:1175–1185.

Pratchett, M.S. 2005. Dietary overlap among coral-feeding butterflyfishes (Chaetodontidae) at Lizard Island, northern Great Barrier Reef. Mar. Biol.148, 373-382.

PRIMER-E (2000) Primer 5 for Windows. Plymouth Marine Laboratory, Roborough, lymouth, UK. http://www.primer-e.com. In: Elsevier; Ecological Indicators, 6(2006) 494– 507.

Raj, K. D., Aeby, G. S., Mathews, G., Bharath, M. S., Rajesh, S., Laju, R. L., Arasamuthu, A., Kumar, P.D. and Patterson Edward J. K. 2016. Patterns in the abundance of fish and snail corallivores associated with an outbreak of acute tissue loss disease on the reefs of Vaan Island in the Gulf of Mannar, India. In 13th International Coral Reef Symposium at Honolulu, Hawaii, from 19th -24th June, *2016*.

Reaka-Kudla, M. L. 1997. The global biodiversity of coral reefs: a comparison with rain forests. In: Reaka-Kudla ML, Wilson DE, Wilson EO (eds) Biodiversity II. Joseph Henry Press, Washington DC, 83–108 pp.

Russ, G. 1989. Distribution and abundance of coral reef fishes in the Sumilon Island Reserve, central Philippines, after nine years of protection from fishing. *Asian Marine Biology*., 6: 59-71.

Sale, P. F. 1978. Coexistence of coral reef fishes—a lottery for living space. *Environ Biol Fish*., (3): 85–102.

Sano, M., Shimizu, M. and Nose Y. 1984. Changes in structure of coral reef fish communities by destruction of hermatypic corals – observational and experimental views. *Pac. Sci* 38: 51-79.

Thresher, R. E. 1983. Environmental correlates of the distribution of planktivorous fishes in the one tree reef lagoon. Marine Ecology Progress Series.10:137-145.

Warner, R. R and Chesson P. L. 1985. Coexistence mediated by recruitment fluctuations: a field guide to the storage effect. *Am Nat* 125: 769– 787.

Wilson, S. K., Fisher, R., Pratchett, M. S., Graham, N. A. J., Dulvy, N. K., Turner, R.A., Cakacaka, A., Polunin, N. V. C. and Rushton, S. P. 2008. Exploitation and habitat degradation as agents of change within coral reef fish communities. *Glob. Change Biol.* 14, 2796-2809.