Indian J. Fish., **54**(1) : 11-20, Jan.-Mar., 2007

Coral reef fish abundance and diversity of seagrass beds in Kavaratti atoll, Lakshadweep, India

P.E. VIJAY ANAND* AND N.G.K. PILLAI

Central Marine Fisheries Research Institute, Cochin 682 018, Kerala, India.

** Technical Director, American Soyabean Association, N. 149, Jor Bagh, New Delhi - 110 003.*

ABSTRACT

The community organization of coral reef fishes in the seagrass sub-habitat of Kavaratti toll, Lakshadweep, India was studied during the period from January 1991 to June 1992. Twenty-seven families represented by 65 species were recorded by the visual censes method. The community diversity for families and species was 2.49 and 3.14 respectively. Juveniles and sub-adults of the most adult reef fish, which inhabit other sub-habitats, were recorded here. The high species diversity in the seagrass beds is due to their roles as nurseries, shelter and foraging grounds for many species. Labridae, Chaetodontidae, Acanthuridae and Mullidae were the most speciose families. Ocurrence of siganids was highly seasonal. The cover that seagrass canopy provides conceals many species and perhaps influenced counts. The occurrence of balistids could be related to the presence of interstitial and patches and abundant invertebrate food. Scorpaenids subsisted on abundant invertebrates and juveniles fishes. High counts and pronounced variations make seagrass beds unstable habitats. However, monsoon assemblages were relatively stable perhaps due to lack of excessive new recruits and a habitat shift by most species.

Introduction

Discrete population, small breeding pools, sedentary and non-migratory nature and association with specific habitats are striking characters of coral reef fishes. A variety of habitats found in coral reef areas may be rich or poor in species in each habitat or between differing habitats, supporting markedly different fish communities of which some may be cosmopolitan. Dependence on a particular food item, behavioral interactions and depths across reefs are other factors known to limit reef fish distribution.

Although the study of the ecology of reef fishes is relatively recent, it is developing rapidly, with many workers at present active in the tropical western Atlantic and Caribbean, the Gulf of California, several centers in the vast Indo-West Pacific, and in the Red Sea (Sale, 1980). However, there is an overall paucity of knowledge on this subject from the Indian region, leaving gaps in reviews, which attempted to summarize

a global picture on reef fish community organization.

With the availability of limited facilities, the present investigation will form a basis on coral reef fish community organization which opens up understanding on patterns of numerical densities, species richness, species composition and their occurrence on each of the five sub-habitats classified on Kavaratti atoll and the reef slope in general. The present account deals with sand flats.

Materials and methods

Fish species enumeration and their distribution in the sea grass habitats of Kavaratii Atoll, were studied using the visual censes technique from January 1991 to June 1992 (Vijayanand and Pillai, 2003).

Data collected from each census were grouped by species. These were transformed into a data matrix for the sub-habitat. Results obtained from the data matrix were used to study the following two aspects of the community organization of coral reef fishes:

1. ***Community parameters***: Results of all censuses were combined to obtain the information mentioned below:

a. Species composition of the particular region listed in the order of frequency of occurrence

b. Frequency of occurrence

c. Total abundance;

d. Percentage abundance

e. Shannon-Weiner diversity index (H').

2. ***Seasonal variation in community parameters*:** Results of all censuses were treated separately and were grouped into three distinct seasons prevailing in Lakshadweep region, namely, pre-monsoon (January to April), monsoon (May to August) and post-monsoon (September to December). These seasons have been classified based on a definite change in wind direction in the middle of May (south-westerly) and its subsequent termination in August and replacement by north-easterly winds. The following information was obtained: a. Total number of individuals; b. Total number of species; c. Shannon-Weiner diversity index (H') and d. Evennes index (J').

Results

***Community parameters*:** Table 1 depicts the community parameters of 65 different species found on the sub-habitat. *Acanthurus* spp. Recorded 111 individuals (2.69%) though it was present 15 times, while *Acanthurus triostegus* (173 nos.) occurred 14 times contributing to 4.20%. The diversity was 3.35 and 3.65 respectively. *Zebrasoma veliferum* (21 Nos.), *Acanthurus leucosterunon* (14 Nos.) and *Naso uncornis* (22 Nos.) appeared 6 to 9 times with proportions and diversities ranging between 0.34 and 0.53% and 2.26% and 2.89% respectively.

Two species of apogonids, *Apogon fraenatus* (8 Nos.) and *A. taeniophorous* (6 Nos.) occurred only once. *Balistoides viridescens* (8 Nos.) and *Pseudobalistes flavimarginatus* (12 Nos.) were found 4 and 3 times respectively.

Amongst 8 species of chaetodontids, *Chaetodon auriga* was recorded 18 times (101 Nos.) contributing to 2.45% of fishes recorded with a diversity of 3.94, *C. melannotus* (312 Nos.) *C. xanthocephalus* (33 Nos.) and *Heniochus acuminatus* (25 Nos.) showed diversity values of 3.00, 2.12 and 2.70 respectively, accounting to less than 1%. Other species occurred only once with individuals ranging from 2 to

TABLE 1: *Frequency of occurrence (FO), total abundance (TA), percentage abundance (%) and diversity index (H') for each species recorded in the seagrass sub-habitat of Kavaratti atoll*

SPECIES	FO	TA	%	H'
ACANTHURIDAE				
Acanthurus spp.	15	111	2.69	3.35
Acanthurus triostegus	14	173	4.20	3.65
Zebrasoma veliferum	9	21	0.51	2.89
Acanthurus leucosternon	6	14	0.34	2.26
Naso unicornis	6	22	0.53	2.38
Naso brevirostris	2	5	0.12	0.97
APOGONIDAE				
Apogon fraenatus	1	8	0.19	0.00
Apogon taeniophorus	1	6	0.15	0.00
BALISTIDAE				
Balistoides viridescens	4	8	0.19	1.91
Pseudobalistes flavimarginatus	3	12	0.29	1.19
Rhinecanthus aculeatus	1	1	0.02	0.00
BELONIDAE				
Tylosurus spp.	4	38	0.92	1.77
BLENNIDAE				
Omnobranchus spp.	4	42	1.02	1.98
BOTHIDAE				
Bothus pantherinus	6	11	0.27	2.56
CHAETODONTIDAE				
Chaetodon auriga	18	101	2.45	3.94
Chaetodon melannotus	9	37	0.90	3.00
Chaetodon xanthocephalus	7	33	0.80	2.12
Heniochus acuminatus	7	25	0.61	2.70
Chaetodon citrinellus	1	2	0.05	0.00
Chaetodon collare	1	2	0.05	0.00
Chaetodon kleinii	1	2	0.05	0.00
Chaetodon trifasciatus	1	5	0.12	0.00
DIODONTIDAE				
Diodon histrix	9	17	0.41	2.90
FISTULARIIDAE				
Fistularia petimba	11	149	3.61	2.73
KUHLIDAE				
Kuhlia mugil	3	143	3.48	1.18
LABRIDAE				
Halichoeres scapularis	20	332	8.05	3.75
Stethojulis albovittata	17	167	4.05	3.85
Stethojulis strigiventer	16	183	4.44	2.73
Cheilio inermis	15	84	2.04	3.52
Crois gaimard	8	18	0.44	2.73
Hologymnosus doliatus	7	13	0.32	2.66
Anampses caeruleopunctatus	3	9	0.22	1.39
Chelinus undulatus	1	4	0.10	0.00
Gomphosus coeruleus	1	1	0.02	0.00
Halichoeres marginatus	1	1	0.02	0.00
Thalassoma amblycephalum	1	2	0.05	0.00
Thalsassoma hardwicki	1	1	0.02	0.00

LETHRINIDAE				
Monotaxis gradoculis	2	4	0.10	0.81
MALACANTHIDAE				
Malacanthus latovittatus	1	1	0.02	0.00
MONOCANTHIDAE				
Alutera scripta	11	28	0.68	3.35
Cantherinus paradalis	4	5	0.12	1.91
MUGILIDAE				
Crenemugil crenilabis	2	6	0.15	0.92
MUGILOIDAE				
Parapercis hexophthalma	2	5	0.12	0.97
MULLIDAE				
Parupeneus macronema	13	81	1.97	3.50
Mulloides flavolineatus	12	115	2.79	3.45
Parupeneus barberinus	11	69	1.67	3.25
Parupeneus bifasciatus	9	52	1.26	2.83
Parupeneus pleurostigma	7	36	0.87	2.53
Parupeneus cyclostomus	1	2	0.05	0.00
NEMIPTERIDAE				
Scolopsis bilineatus	1	2	0.05	0.00
OSTRACIIDAE				
Lactoria cornuta	2	2	0.05	1.00
Ostracion meleagris	1	2	0.05	0.00
POLYNEMIDAE				
Polynemus spp.	3	19	0.46	1.08
POMACENTRIDAE				
Abudefduf sexfasciatus	8	40	0.97	2.79
SCARIDAE				
Scarus spp.	18	1752	42.50	4.21
SCORPAENIDAE				
Pterois miles	7	15	0.36	2.79
Dendrochirus zebra	2	3	0.07	0.92
SIGANIDAE				
Signanus stellatus	1	2	0.05	0.00
SPHYRAENIDAE				
Sphyraena spp.	3	38	0.92	1.15
TETRAODONTIDAE				
Tetraodon nigropunctatus	5	6	0.15	2.25
Canthigaster margaritatus	1	2	0.05	0.00
THERAPONIDAE				
Therapon jarbua	1	4	0.10	0.00
ZANCLIDAE				
Zanclus canescens	6	19	0.46	2.33

Number of species recorded = 65

5 times contributing to less than 0.50% in each case except *C. trafasciatus which* contributed to 0.12%.

Diodon histrix (17 Nos.), *Fistularia petimba* (149 Nos.), *Kuhlia mugil* (143 Nos.), *Monotaxis grandoculis* (4 Nos.) and *Malacanthus latovittatus* (one) were single species representing respective families. Of these, *F. petimba* and *K. mugil* accounted for significant numbers on the habitat contributing to 3.61 and

3.48% respectively.

Fourteen labrid species were recorded. *Halichoeres scapularis* (332 Nos.) abundantly occurred (20 times) forming 8.05% of fishes recorded with a diversity of 3.75. *Stethojulis albovittata* (167 Nos.) and *S. strigiventer* (183 Nos.) were conspicuous on seagrass beds forming 4.05 and 4.44% accounting for diversities of 3.85 and 3.49% respectively. *Cheilio inermis* (84 Nos.) was recorded 15 times, accounting to 2.04% with a diversity of 3.52. All other species recorded formed percentages less than 0.50. Of these, *Coris gaimard, Hologymnosus doliatus* and *Anampses caeruleopunctus* recoded 18, 13 and 9 individuals respectively.

Alutera scripta (28 Nos.) was common on seagrass beds occurring 11 times with a diversity of 3.35. *Cantherinus paradalis, Crenemugil crenilabis* and *Parapercis hexophthalma* were found 2 to 4 times with either 5 or 6 individuals. Of the 6 species of mullids recorded, *Parupeneus macronema* (81 Nos.), *Mulloides falvolineatus* (115 Nos.), *P. barberinus* (69 Nos.) were common with diversities of 3.50, 3.45 and 3.25 accounting to 1.97, 2.79 and 1.67% respectively. Though *Parupeneus bifasciatus* and *P. pleurostigma* occurred only 7 and 9 times, they recorded 52 and 36 individuals respectively. *P. cyclostomus* occurred only once.

Scolopsis bilineatus and *Ostracion meleagris* were encountered only once while *Lactoria cornuta* was found twice. All three species registered low percentages. 19 individuals represented the genus *Polynemus*, thrice. A single speices of pomacentrid, *Abudefduf sexfasciatus* (40 Nos.) occurred 8 times. Scarid were the most abundant group (1752 Nos.) on seagrass beds forming 42.50% of the fishes recorded with a diversity of 4.21. Scorpaenidae and Tetradontidae recorded the presence of 2 species each. Of these, *Pterois miles* (15 Nos.) was found 7 times while *Tetraodon nigropunctatus* occurred 5 times. *Dendrochirus zebra* and *Canthigaster margaritata* were rare. *Siganus stellatus* (2 Nos.), *Sphyraena spp.* (38 Nos.), *Therapon jarbua* (4 Nos.) and *Zanculus canecens* (19 Nos.) were single species that represented respective families.

***Seasonal variation in community parameters*:** Total counts during pre-monsoon of '91 varied between 72 (April 7) and 310 (March 4). Other samples recorded counts between 185 and 228 (Table 2 A). In '92, the fluctuation during pre-monsoon was to a lesser magnitude (139 to 204 Nos.) with most of the counts ranging between 139 and 171 Nos. (Table 2 D). Variation in monsoon was also significant with a minimum (90 Nos.) in June 3 and a maximum in May 1 (203 Nos.). Two samples taken in May 1 and June 2 of '92 recorded 56 and 59 individuals respectively. A fluctuating trend was also seen during post-monsoon. Two samples in October 3,4 (52, 64 Nos.) and one in December 7 (63 Nos.) recorded low counts, while the highest (350 Nos.) was found in September 2 (Table 2 C).

Total number of species observed during both the years in pre-monsoon were between 13 and 17. March 4 ('91) recorded a highest of 20 species while a maximum of 10 and 12 species were found in February 2 and March 3 in '92 (Table 2 A&D). Species numbers were relatively stable in the monsoon recording 14 to 17 species (Table 2 B&E), while the variation was relatively high in post-monsoon with a range of 8 to 17 species (Table 2 C).

High species diversity (3.44, 3.00 and

3.38) was found in March 4,5 and April 7 respectively (Table 2 A) in pre-monsoon of '91, while other samples showed diversities above 2.00. During the same season in '92, a minimum (1.89) was observed in March 4 (Table 2 D) while other samples had diversities above 2.00. Species diversity in monsoon in both years was generally high (3.10 to 3.41) except in one sample taken in May 1 ('91) where it was 2.81 (Table 2 B&E). A relatively high variation (1.71 to 3.47) was seen during post-monsoon. Low values (1.93 and 1.71) were registered in September 1 and November 5 (Table 2 C).

Evenness in species distribution varied greatly in pre-monsoon (0.61 to 0.91) in '91 while it was generally uneven (0.50 to 0.67) in '92 (Table 2 A&D). Distribution was most even (0.91) in April 7. In general, the variation was high in monsoon (0.69 to 0.90) and post-monsoon (0.51 to 0.91). In '91, an even distribution (0.90) was observed in May

TABLE 2 : *Total number of individuals (I), number of species (S), diversity index (H') and eveness (J) for each census in different seasons on the seagrass sub-habitat of Kavaratti atoll*

Sample No.							
	A . PRE-MONSOON						
	1	2	3	4	5	6	7
	J	F	F	M	M	A	A
I	201	185	190	310	228	205	72
S	16	13	14	20	17	16	13
H'	2.45	2.51	2.64	3.44	3.00	2.73	3.38
J'	0.61	0.68	0.69	0.80	0.86	0.68	0.91
	B. MONSOON						
	MY	MY	JN	JY	AG		
I	203	114	90	102	129		
S	17	14	14	15	15		
H'	2.81	3.41	3.33	3.41	3.10		
J'	0.69	0.90	0.87	0.87	0.79		
	C. POST-MONSOON						
	S	S	O	O	N	N	D
I	148	350	52	64	146	173	63
S	13	13	8	14	10	17	11
H'	1.93	2.39	2.65	3.47	1.71	2.51	2.99
J'	0.52	0.65	0.88	0.91	0.51	0.61	0.86
	D. PRE-MONSOON 1992						
	J	F	M	M	A	A	
I	204	154	163	139	171	151	
S	13	10	12	14	16	13	
H'	2.24	2.22	2.08	1.89	2.37	2.04	
J'	0.61	0.67	0.58	0.50	0.59	0.55	
	E. MONSOON						
	M	J					
I	56	59					
H'	3.38	3.22					
J'	0.89	0.85					
S	14	14					

2. Two samples, each taken in May and June ('92) had a stable distribution (0.89 and 0.85 respectively). During post-monsoon, October 4 (0.91) accounted for an even distribution (Table 2 C).

Discussion

Labridae, Chaetodontidae, Acanthuridae and Mullidae were the most speciose families on seagrass beds. Among labrids, though *Halichoeres scapularis* showed lower H' value (3.75) it was numerically dominant. The cover that seagrass canopy provides conceals many species and perhaps influenced counts. Its association with seagrass beds was recorded by Randall (1983). *Stethojulis albovittata* and *S. strigiventeri* replaced other species on the list. With H' 3.85 and 3.49 respectively, they indicated strong preference towards seagrass beds. *Cheilio inermis* occurred on sand flats but its main preference was seagrass beds. These species mentioned above emerged as typical dependents on seagrass beds. Hobson (1974) observed *Coris gaimard* to be abundant where the reef was interspread with sand patches from where they excavate buried organisms. Similar conditions offered by seagrass beds could determine its presence on the habitat. A similar explanation holds good for *Hologymnosus doliatus*. Other species were rare, but occur on the habitat for food and shelter. Most labrids, observed were sub-adults. Larger individuals of labrids and other benthic feeding fishes avoid areas of increased algal cover (Choat and Ayling, 1987).

Chaetodon auriga dominated seagrass beds (H'= 3.94). All other species were occasional or rare. All individuals observed were juveniles except adult *Heniochus acuminatus* which were associated with cement pilings of the jetty. *Chaetodon kleinii* is found on reefs with sandy coral bottom and feeds on plankton while *C. melannotus* was more abundant at places with soft coral cover (Anderson *et al*., 1981). *C. kleinii* could obtain plankton from seagrass beds while it appeared that juvenile *C. melannotus* was more abundant at places with soft coral cover (Anderson *et.al*., 1981). *C. kleinii* could obtain plankton from seagrass beds while it appeared that juvenile *C. melannotus* were either omnivores or herbivores. Ontogenic feeding behaviour change was observed in *C. aurigai* (Vijay Anand, 1990). Most juvenile chaetodontids perhaps had this habit, hence their association with grass beds. Bouchon-Navaro (1981) observed juvenile/sub-adult chaetodontids on grass beds.

H' values indicate that *Acanthurus* spp. and *A. triostegus* were consistent in occurrence. Most acanthurids were again juveniles or sub-adults in small schools except *Zebrasoma veliferum* and *A. leucosternon* that were non-schooling. Harmelin-Vivien (1989) observed juvenile acanthurids concentrated in shallow waters. *Naso unicornis I and N. tuberosus* fed on larger algal species (Choat, 1991). In the present study, *N. unicornis* and *N. brevirostris* perhaps inhabited grass beds for macroscopic algae as food. Acanthurids were observed to have more species and individuals on reef crests and in lagoons (Russ, 1984) but species richness on seagrass beds were not significant. Apart from scarids that formed almost 50% of fish recorded, siganids are also expected to be dominant herbivores. However, only a single species, *Siganus stellatus* was recorded once. It appears that occurrence of siganids is highly seasonal as sudden summer peaks in recruitment were observed.

Many apogonids and holocentrids

were collected during night time fishing and these species probably remain concealed during day time. A similar reasoning holds good for *Bothus pantherinus* and *Parapercis hexophthalma* but these species were diurnally active. Certain balistid species were observed to feed on seagrasses (Ogden and Ziemen, 1977). The association of *Baliostoides viridescens, Pseudobalistes favlimarginatus* and *rhinecanthus aculeatus* with sand patches was recorded by Hiatt and Strasburg (1960). In the present study, the occurrence of these species on seagrass beds could be related to the presence of interstitial sand patches and abundant invertebrate food. Other species visiting grass beds for prey procurement from sand were *Monotaxis grandoculis, Malacanthus latovittatus, Crenemugil crenilabis* and *Scolopsis bilineatus.* Bell and Pollard (1989) stated that Monacanthidae and Scorpaenidae were among dominant families on seagrass beds, while Bell *et al.* (1978) observed monocanthids tobe omnivores that acts as herbivores and consume encrusted fauna and flora on seagrass blades. Monocanthids in the present study did not form a dominant group but dependence for food may be in accordance in case of *Alutera scripta* which was the only dominant species. Scorpaenids perhaps depended on the region for food in the form of abundant invertebrates and juveniles fishes, while other species were rare (Harmelin Vivien and Bouchon, 1976) Observations in the present study were in accordance with those of Bell and Pollard (1989) who summarized major characteristics of seagrass beds as nurseries for reef fish, shelter and abundant food source. Several species make use of this zone as juveniles but occur as adults on nearby reefs (Ogden and Ziemen 1977; Weinstein and Heck, 1979; Shulman, 1985). Free moving species belonging to Belonidae, Kuhlidae, Mugilidae, Polynemidae and Sphyraenidae posed problems in censusing but were characteristically of sand flats and seagrass beds.

In contrast to sand flats and other habitats, high counts and pronounced variations make seagrass beds unstable habitats. Pollard (1984) did not find significant seasonal differences and stated that high H' values are due to high species richness and evenness of distribution. But in the present study, monsoon assemblages were relatively stable perhaps due to lack of excessive new recruits and a habitat shift by most species. Lack of new recruits could result, through seasonal variations in spawning. Spawning activity has been selectively modified to match favourable oceanographic conditions for larval survival and dispersal (Johannes, 1978) and such a mechanism possibly explains low rates of settlement on to the 'seagrass nurseries'. Adult fishes, however seem to avoid the area due to unfavourable conditions on the shallow habitat. Seagrass beds contain juveniles of several species that occur in the adult fauna of neighbouring reefs (Ogden and Zieman, 1977) while many species use seagrass beds for short or long durations (Bell and Pollard, 1989; Sheppard *et al.*, 1992). Recruitment of temporary residents was found to be a principal cause of seasonal variation in fish abundance on seagrass beds (Middleton *et al.*, 1984). A higher variation in other seasons (pre-monsoon and post-monsoon) could be explained by the reverse mechanism where new recruits and fishes that use grass beds for the abundant food it stores, migrated from other habitats. The information generated by the present study

identifying habitats that are species rich based on fish species diversity, provides information on species association with seagrass beds which in turn helps to direct fishing operations to such areas with suitable gear.

Acknowledgements

The authors are grateful to Dr. P.S.B.R. James, former Director, Central Marine Fisheries Research Institute, Cochin for providing facilities. They are also grateful to the Lakshadweep Administration for the field facilities. The senior author (PEVA) thanks the Indian Council of Agricultural Research, New Delhi for awarding a Senior Research Fellowship.

References

Anderson, G.R.V., A.H. Ehrlich, P.R. Ehrlich, J.D. Roughgarden, B.C. Russel, and F.H. Talbot 1981. The community structure of coral reef fishes. *Am. Nat.,* **117 :** 476-495.

Bell, J.D., J.J. Burchmore and D.A. Pollard 1978. Feeding ecology of three sympatric species of leather jackets (Pisces: Monacanthidae) from a *Posidonia* seagrass habitat in New South Wales. *Aust. J. Mar. Freshw. Res.,* **29**: 631-643.

Bell, J.D. and D.A. Pollard 1989. Ecology of fish assemblages and fisheries associated with seagrasses. In : Larkum, A.W.D., Mc Comb, A.J. and S.A. Shepherd (eds.) *Biology of Sea grasses – A treatise on the biology of seagrass with special reference to the Australian region*. Elsevier, Amsterdam.

Bouchon-Navaro, Y. 1981. Quantitative distribution of the Chaetodontidae on a reef of Moorea Island (French Polynesia). *J. Exp. Mar. Biol. Ecol.,* **55**: 145-157.

Choat, J.H. 1991. The biology of herbivorous fishes on coral reefs. In : *The Ecology of Fishes on Coral Reefs*. Academic Press INC. San Diego, California, p. 120-155.

Choat, J.H. and A.M. Ayling 1987. The relationship between habitat structure and fish faunas on New Zealand reefs: *J. Exp. Mar. Biol. Ecol.,* **110 :** 257-284.

Harmelin-Vivien, M.L. and C. Bouchon 1976. Feeding behavior of some carnivorous fishes (Serranidae and Scorpaenidae) from Tulear (Madagascar. *Mar. Biol.*, **37** : 329-340.

Harmelin-Vivien, M.L. 1989. Implications of feeding specialization on the recruitment processes and community structure of butterfly fishes. *Environ. Biol. Fishes,* **25**: 101-110.

Hiattt, R.W. and D.W. Strasburg 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 Kona, Hawaii. *Fish. Bull.,* 72 **(4) :** 915-1031.

Johannes, R.E. 1978. Reproductive strategies of coastal marine fishes in the tropics. *Environ. Biol. Fishes.*, **3**: 65-84.

Middleton, M.J., J.D. Bell, J.J. Burchmore, D.A. Pollard and B.C. Pease 1984. Structural differences in the fish communities of *Zostera capricorni* and *Posidonia australis seagrass* meadows in Botany Bay, New South Wales, *Aquat Bot*., **18**: 89-109.

Ogden, J.C. and J.C. Ziemen 1977. Ecological aspects of coral reef seagrass bed contacts in be Caribbean. *Proc. Int. Coral Reef Symp*., **1 :** 377-382.

Pollard, D.A. 1984. A review of ecological studies on seagrass-fish communities with particular reference to recent studies in Australia. *Aquat. Bot.,* **18:** 3-42.

Randall, J.E., 1983.*Red Sea Reef Fishes*. IMMEL Publ., London 192 pp.

Russ, G.R.1984 . Distribution and abundance of herbivorous grazing fishes in the central Great Barrier Reef. II. Patterns of zonation of mid-shelf and outershelf reefs. *Mar. Ecol Prog. Ser.* **20:** 35-44.

Sale, 1980 . The ecology of fishes on coral reefs.

Oceanogr. Mar. Biol., **18**: 367-421.

Sheppard , C. Price A, Roberts 1992. *Marine Ecology of the Arabian region, patterns and processes in extreme tropical environments*. Academic Press Limited, London, pp. 359.

Shulman, M.J. 1985. Coral reef fish assemblages: Intra-and interspecific competition for shelter sites. *Environ. Biol. Fishes.*, **13**: 81-92.

Vijay Anand, P.E. 1990. "*Bionomics of three marine ornamental fishes of Lakshadweep with notes on habitat, feeding trials and packaging*". M.F.Sc. Thesis, Department of Aquaculture, College of Fisheries, Mangalore of the University of Agricultural Sciences, Bangalore. 158 pp.

Vijay Anand, P.E. and N.G.K Pillai 2003. Habitat distribution and species diversity of coral reef fishes in the reef slope of the Kavaratti atoll, Lakshadweep, India. *J. mar. biol. Ass. India*., **45** : 88- 98.

Weinstein, M.P. and K.L. Heck, Jr. 1979. Ichthyofauna of seagrass meadows along the Caribbean coast of Panama and in the Gulf of Mexico: composition, structure and community ecology. *Mar. Biol. Ecol.*, **50:** 97-107.

Date of Receipt : 23-11-06
Date of Acceptance : 19-02-07