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Community organization of reef fishes in the live coral sub-habitat of Kavaratti atoll, Lakshadweep, India

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ABSTRACT

Data on the community organization of coral reef fishes of Kavaratti atoll, Lakshadweep, India were collected during the period January 1991 to June 1992. Species were enumerated by visual census on the live coral sub-habitat for frequency of occurrence, abundance, composition, diversity, evenness and seasonal variation in community parameters. As the live coral zone was composed of a single species of ramose coral (*Acropora formosa*), only 14 families and 39 species of reef fishes made use of this zone, the community diversity being 1.84 and 3.16. Chaetodontids, labrids and pomacentrids were comparatively more abundant. Varying habitats of chaetodontids explain their restricted distribution. Live coral does not seem to be a preferred habitat of labrids. The occurrence of epinephelids was influenced by readily available prey. Most species among live coral were resident, variations resulted from factors affecting new recruits rather than habitat shifts.

Introduction

Discrete populations, 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 within the habitat or between 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 which 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 centres in the cast 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. The present investigation provides a basis on coral reef fish community organization with reference to patterns of numerical densities, species richness, species composition and their occurrence on each of the five sub-habitats of Kavaratti atoll and the reef slope in general. This communication deals with the live coral sub-habitat of Kavaratti atoll.

Materials and methods

Fish species enumeration and their distribution in the sub-habitats of Kavaratti atoll were studied using the visual census technique.

The visual census techniques include a considerable variety of procedures (Sale, 1980). This method is non-destructive and permits repeated sampling of an area without physical disturbances to the populations. In the present investigation due to limited facilities, a combination of/or modification of existing methods has been used to suit the sub-habitats. Belt transects of 30 m length (Goldman and Talbot, 1976) were used to record all visible fish species and numbers from 2 m on either side of a pre-laid line. Transect width was estimated visually (Roberts and Ormond, 1987). Due to shallow depths and absence of SCUBA facility, the fish were observed using a mask and snorkel apparatus (Sale, 1974; Goldman and Talbot, 1976; Bouchon-Navaro and Harmelin-Vivien, 1981; Hutomo and Adrim, 1986; Adrim and Hutomo, 1989; Bouchon-Navaro and Bouchon, 1989) with three intervals to record the observations. The approximate area covered by a single census unit is 120 sq. m. for each sub-habitat. Censuses were conducted fortnightly for 18 months which resulted in 27 censuses for each sub-habitat. Censuses were not conducted when rough weather conditions prevailed. The period of study was from January 1991 to June 1992.

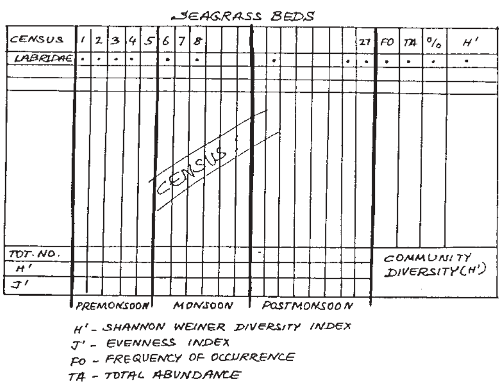

Fig.1 Data matrix for community organisation studies on sub-habitats.

Data collected from each census was grouped by species. These were transformed into a data matrix for the sub-habitat (Fig. 1). Results obtained from the data matrix were used to study the community parameters and seasonal variation in community parameters.

1. *Community parameters* : Results of all censuses were combined to obtain the following aspects:

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^{i})

2. *Seasonal variation in community parameters* : Results of all censuses were treated separately and 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 aspects were studied.

a. Total number of individuals

b. Total number of species

c. Shannon-Weiner diversity index (H^i) (Shannon-Weiner, 1949)

d. Evennes index (J^i) (Pielou, 1966)

Results

Community parameters : Table 1 records the community parameters of 39 species recorded from subhabitat.

Variation in community parameters : The variation in community parameters is given in Table 2. Variation in total number of individuals during the pre-monsoon, was high (61 to 150) in 1991, while the same in 1992 was relatively low (57 to 86). January 1, March 4 and February 2 (1991) recorded 150, 115 and 108 individuals respectively. In the monsoon, June 3, 1991 recorded the least count (63), while in June 2, 1992 it was 240 counts. In general, May in both the years accounted for more fishes (106 to 126 nos). Counts during post-monsoon were also not consistent (72 to 141). Maximum count (141 nos) was recorded on October 3.

Total number of species recorded, ranged between 7 and 16 in pre-monsoon, with the maximum (16) during February 2 and April 6, 1991. Three samples during April 7 ('91), 5 and 6 ('92) accounted for least species counts of 8, 7 and 7 respectively. Species counts were stable (10-15) during monsoon, while in post-monsoon a minimum of 8 species in December 7 and a maximum of 14 species in September 1 were recorded.

During pre-monsoon, species diversity was high only in February 2 (3.39) and April 6 (3.35), while in all other samples it was below 3.00. May 2, June 3, July 4 in 1991 recorded diversities of 3.16, 3.13 and 3.28 respectively, while the least (1.77) was in June 2, 1992. Diversity during other monsoon months ranged between 2.81 and 2.90. In the post-monsoon, all samples taken in September 1, 2 and a single sample in November 6 had diversities of 3.02, 3.04 and 3.26 respectively, while October 3, 4 and December 7 registered values between 22.44 and 2.86.

TABLE 1. *Frequency of occurrence (FO), total abundance (TA), percentage abundance (%) and diversity index (H^i) for each species recorded in the live coral sub-habitat of Kavaratti atoll*

FAMILY / SPECIES	FO	TA	%	H^i
ACANTHURIDAE				
Acanthurus leucosternon	1	1	0.04	0.00
BALISTIDAE				
Balistoides viridescens	14	35	1.31	3.44
Rhinecanthus aculeatus	4	5	0.19	1.91
CHAETODONTIDAE				
Chaetodon auriga	24	123	4.61	4.42
Chaetodon xanthocephalus	12	44	1.65	3.26
Chaetodon trifascialis	5	9	0.34	2.27
Chaetodon trifasciatus	5	19	0.71	2.10
Chaetodon vagabundus	5	13	0.49	2.27
Chaetodon falcula	4	7	0.26	1.96
Chaetodon melannotus	3	9	0.34	1.39

Heniochus acuminatus	3	14	0.53	1.50
Chaetodon citrinellus	2	7	0.26	0.98
CIRRHITIDAE				
Paracirrhites forsteri	7	21	0.79	2.68
FISTULARIDAE				
Fistularia petimba	1	1	0.04	0.00
GRAMMISTIDAE				
Grammistes sexlineatus	1	1	0.04	0.00
LABRIDAE				
Halichoeres scapularis	21	141	5.29	4.21
Halichoeres centiquadrus	6	25	0.94	1.74
Thalassoma hardwicki	4	40	0.15	1.85
Coris gaimard	2	3	0.11	0.92
Labroides dimidiatus	2	2	0.08	1.00
Coris formosa	1	1	0.04	0.00
Cheilinus undulatus	1	1	0.04	0.00
MURAENIDAE				
Gymnothorax undulatus	6	8	0.30	2.43
OSTRACIIDAE				
Lactoria cornuta	2	2	0.08	1.00
Ostracion meleagris	2	2	0.08	1.00
POMACANTHIDAE				
Centropyge multispinis	25	348	14.4	4.55
POMACENTRIDAE				
Dascyllus aruanus	27	657	24.64	4.46
Chromis caerulea	23	579	21.69	4.40
Dascyllus trimaculatus	17	172	6.45	3.80
Dascyllus reticulatus	14	133	4.99	3.62
Abudefduf sexfasciatus	10	89	3.34	3.16
Amphiprion chrysogaster	2	6	0.23	0.92
Pomacentrus pavo	2	4	0.15	1.00
Chrysiptera biocellata	1	3	0.11	0.00
SERRANIDAE				
Epinephelus spp.	17	59	2.21	3.82
Cephalopholis argus	4	4	0.15	2.00
SCORPAENIDAE				
Dendrochirus zebra	13	33	1.24	3.47
Pterois radiata	1	1	0.04	0.00
TETRAODONTIDAE				
Tetraodon nigropunctatus	5	23	0.86	1.19

Number of species recorded = 39

TABLE 2. *Total number of individuals (I), number of species (S), diversity index (H^i) and evenness (J) for each census in different seasons on the live coral sub-habitat of Kavaratti atoll*

Sample No.		1	2	3	4	5	6	7
A PRE-MONSOON 1991		J	F	F	M	M	A	A
	I	150	108	81	115	61	99	86
	S	12	16	11	11	10	16	8
	H^i	2.57	3.39	2.80	2.73	2.90	3.35	2.81
	J^i	0.72	0.85	0.81	0.79	0.87	0.84	0.94
B MONSOON								
		MY	MY	JN	JY	AG		
	I	109	106	63	65	85		
	S	10	15	12	14	13		
	H^i	2.81	3.16	3.13	3.28	2.90		
	J^i	0.85	0.81	0.87	0.86	0.78		
C POST- MONSOON								
		S	S	O	O	N	N	D
	I	72	123	141	78	85	129	91
	S	14	12	10	9	11	12	8
	H^i	3.02	3.04	2.86	2.44	2.84	3.26	2.79
	J^i	0.79	0.85	0.86	0.71	0.82	0.91	0.93
D PRE-MONSOON 1992								
		J	F	M	M	A	A	
	I	84	57	82	86	83	61	
	S	10	9	11	11	7	7	
	H^i	2.70	2.52	2.87	2.85	2.42	2.48	
	J^i	0.81	0.79	0.83	0.77	0.65	0.67	
E MONSOON (2 samples) May, June	I = 126, 240; H^i = 2.83, 1.77; J^i = 0.79, 0.51; S = 12, 11.							

J : January; F : February; M : March; A : April; MY : May; JN : June; JY : July; AG : August; S : September; O : October; N : November; D : December

Evenness in distribution of species was maximum (0.04) in April 7, 1991 and minimum (0.65 and 0.67) in two samples taken in April 5, 6 1992 during pre-monsoon. In general, a majority of samples registered values between 0.80 and 0.88. During monsoon of '91, May 1, 2, June 3 and July 4 showed relatively stable patterns of distribution (0.81 to 0.87), while in August 5 it was 0.78. Two monsoon samples taken in '92 however, showed uneven distribution (0.79 and 0.51). Distribution was not consistent during post-monsoon with a minimum (0.71) in October 4 and a maximum (0.93 and 0.91) in December 7 and November 6 respectively. Except in September 1 (0.79) other samples indicated a relatively stable distribution (0.82 to 0.86).

Discussion

Species richness of three families, namely Chaetodontidae, Labridae and Pomacentridae were high and comparable, each of them consisting of 7 to 8 species. Chaetodontids are known to spend their entire lives associated with a relatively small portion of the reef environment (Goldman and Talbot, 1976), while some species are relatively restricted in their distribution among zones and others widely distributed (Bouchon-Navaro, 1980, 1981; Fouler, 1990). Certain species (e.g., *Chaetodon trifasciatus* and *C. trifascialis*) are considered as obligatory coral feeders (Reese, 1981; Harmelin-Vivien and Bouchon-Navaro, 1983; Harmelin-Vivien, 1989; Sano, 1989), while certain species are considered as facultative coral feeders (Harmelin-Vivien, 1989; Sano, 1989). In the present study, both *C. trifascialis* and *C. trifasciatus* were found among *Acropora formosa* patch reefs but low H^i values (3.20 and 2.77) suggested that they were not frequent as *C. auriga*. *C. vagabundus* is also known to feed on corals (Sano, 1989). Sutton (1985) observed that *C. trifasciatus* had larger territories within lagoon habitats and interpreted this as a response to low population density and poor habitat quality. As patch reefs are not extensive on Kavaratti atoll, it is likely that obligate coral feeders are found in habitats with richer coral cover than on sparse coral patches. Bouchon-Navaro *et al.* (1985) found chaetodontid populations to decrease with degraded coral environment. Due to the facultative feeding habit, *C. auriga* (Hourigan, 1989) is more flexible in habitat choice, and thus the abundance. *C. citrinellus* is a non-coral feeder (Galzin, 1987), while *C. melannotus* is a soft coral feeder (Adrim and Hutomo, 1989) and *C. falcula* was found to feed predominately on polychaete tentacles. Low distribution of these species in the present study is probably due to varying habits mentioned above.

Among the seven labrids, *Halichoeres scapularis* was distinct from other species (H^i = 4.21) in abundance and occurrence. Though this species did not seem to depend on this zone directly, it probably made use of interstitial sand patches for food procurement. This species was extensively associated with sand flats (Randall, 1983). *Thalassoma hardwicki* was observed on quiet reefs (Hiatt and Strasburg, 1960), while *Coris gaaimard* was numerous where the reef was interspread with patches of sand (Hobson, 1974). In the present study, ramose corals perhaps did not suit *T. hardwicki* due to lack of shelter, while the presence of *C. gaimard* supports the observation of Hobson (1974). It is also likely that *C. formosa* also follows the same pattern as these species feed on benthic invertebrates on sand. However, rare occurrence of these species on live coral suggest that their preferred habitats lie elsewhere on the reef.

Of the eight pomacentrids, only *Dascyllus aruanus* and *Chromis caerulea* occurred frequently in high numbers. The fact is substantiated by H^i values (4.46 and 4.40 respectively) that weighted their occurrence in most census conducted. Relatively common species were *D. trimaculatus* and *D. reticulatus*. Shpigel (1982) observed that *D. aruanus* and *D. marginatus* are coral dwelling species and occur together frequently. Reese (1978) stated that mobility of planktivores is constrained for want of shelter or nesting sites. Due to intense site attachment, these species would have been included in most censuses. Pillai *et al.* (1986) reported co-existence of *D. aruanus* and *Chromis caerulea* on coral patches in Minicoy. Apart from this, few more interspecific associations, involving *D. trimaculatus, D. reticulatus* and *Amphiprion chrysogaster* were observed in the present study. The occurrence of *A. chrysogaster* was determined by the presence of small anemones on dead bases of *Acropora formosa*. Other rare species were accidental in occurrence.

The occurrence of *Epinephelus* spp. (probably *E. hexagonatus*) and *Dendrochirus zebra* and occasionally *Gymnothorax undulatus* is influenced by the readily available prey in the form of small pomacentrids and other invertebrates. *E. hexagonatus* were found to inhabit staghorn coral zones in Tutia reef (Talbot, 1965). The abundance and consistent occurrence of *Centropyge multispinis* is due to strong site attachment (as in pomacentrids) and were observed in most censuses. *Ostracion cubicus* was observed to be a weak swimmer, found around coral heads while, *Tetraodon nigropunctatus* fed on corals (Hiatt and Strasburg, 1960). In the present study, occurrence of *O. melegris* and *T. nigropunctatus* could be possibly structured due to these habitats. A similar reasoning holds good for *Balistoides viridescens*. Though *Paracirrhites forsteri* is known to be associated with coral heads (Talbot, 1965; Galzin, 1987), they seem to prefer the tabloid *Acropora humilis* head over *A. formosa*. Other species that occurred only once could be considered as accidental.

Though the number of species did not vary much during monsoon, variation in total individuals indicated that each species supported varying number of individuals and the least during peak monsoon. This is supported by H^i and J^i values. As recruitment occurs during summer and the monsoon follows almost immediately in Lakshadweep, fish species count could possibly be influenced due to mortality or movements from affected areas. A similar reasoning was proposed by Jones (1991). A higher variation in community parameters during pre-monsoon could have resulted due to new recruits from the late post-monsoon months (November, December) coupled with effects of summer months. Summer peaks in recruitment were recorded by Sale and Dybdahl (1975) and Coles and Tarr (1990). As seen earlier, most fish populations among live coral are resident and variations could result mainly through factors affecting new recruits rather than habitat shifts. Sale (1983) observed a highly variable community structure of fishes from one census to another on patch reefs and suggested that a variable pattern of settlement of new juvenile fish plays a major role in determining fish assemblages. Other than random settlement, predation pressure also influences assemblages (Shpigel, 1982).

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