Biodiversity Conservation in Gulf of Mannar Biosphere Reserve

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DIVERSITY OF BRACHYURAN CRABS IN GULF OF MANNAR(SOUTHEAST COAST OF INDIA)

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Introduction

Coral reefs protect the coastline against waves and erosion and constitute one of the most diverse marine ecosystems in the world. Coral reefs provide subsistence, security and cultural utility to the inhabitants of coastal areas in all the tropical nations. Nevertheless, reef degradation is widespread, due to their manifold uses and importance to the people of developing countries. Therefore the International Union for Conservation of Nature and Natural resources (IUCN) considers maintenance of reef fisheries as a global priority. Collection of data about the coral reef resources is the most basic information in a coral reef ecological study. Management could be done only on the basis of such information.

The main objective of any management scheme will be to maintain the 'ecological health' of a coral reef. The purpose of monitoring is to detect significant deviations in reef and associated organisms. Such deviations are generally considered to be signs of stress. One of the most important limitations in assessing the effects of stress on coral reefs is the general lack of quantitative data. Such data indicate 'normal' or 'stressed conditions' of a reef. Coming specifically to the environment where this study was made, even though ecological studies on coral reef of Polk Bay and Gulf of Mannar Mandapam group of islands were done by Pillai (1967), quantitative studies on coral reef communities are yet to be undertaken. In this backdrop the present study was undertaken to assess the diversity of brachyuran crabs in the Gulf of Mannar. Quantitative data on brachyuran crabs of Gulf of Mannar coral reefs have been collected for a period of one year. Compared to other reef organisms, brachyuran crabs have been grossly neglected here and elsewhere in quantitative studies. This lacuna necessitated the present study.

Complete qualitative faunistic inventories of coral reef communities have been made only in the recent past elsewhere (Stephenson *et al.*, 1958; MacNae and Kalk, 1962; Thomassin, 1973; Gibbs, 1975). However these are few in number and generally few systematic groups were covered e.g. crustaceans (Garth, 1964; Thomassin, 1974) and mollusks (Maes, 1967; Salvat, 1967, 1970, 1972; Taylor, 1968, 1971; Salvat and Renaud-Mornand, 1969; Renaud-Mornand *et al.*, 1971) besides fishes. Quantitative studies either by enumerating individuals of various species by surface area or volume, or by calculation of biomass are just beginning.

Brachyuran crabs contribute considerably to the biomass and species diversity of coral reef ecosystems as they attain large standing crops. Therefore presently the diversity of brachyuran crabs in coral reefs of Gulf of Mannar islands was made for a period of one year (January – December, 1994).

Materials and methods

Samples were collected at inner reef flats of four dominant islands, one each from the four groups of islands namely (a) Manauli island, (b) Appa island, (c) Nallathanni island and (d) Karaichalli island. Samples were collected every month during low tide at a depth of 0.5 m and below during the study period. Sampling was done following the quadrate method along transects. Along the 200 metres long transect lying perpendicular to the shore, 50 x 50 cm quadrate was used for sampling at the interval of 5 m. Number of animals was counted and distribution is expressed as individuals/ m^2. Animals were wet weighed and the biomass expressed as gm/m^2. The method used presently is basically the same as that of Reys (1964, 1968) who made a comprehensive review of methods used for biomass studies on a worldwide basis (Reys and Salvat, 1971) and also by Holme and McIntyre (1971).

The species diversity index was calculated using by Shannon and Wiener (1949). The species richness was calculated using formula give by Simpson's index (D). The Evenness index (J) or equitability was calculated using the formula of Pielou (1966).

All these three indices were calculated using the computer programme (BASIC) written by Bakus (1989).

The Gulf of Mannar environment is very much influenced by the Northeast monsoon and during this period (October-November) profound changes take place in the hydrographical conditions and other parameters. Therefore for the sake of convenience the study period was divided into four distinct seasons namely postmonsoon (January – March), summer (April – June), premonsoon (July – September) and monsoon (October – December) and the results are discussed in relation to these four seasons.

Results

Species composition

As many as 32 species of brachyuran crabs were recorded in the Manauli island during the postmonsoon, summer and premonsoon seasons (Table 1). During the monsoon season, only 28 species were recorded. In Appa island 26 species were collected during the postmonsoon and summer seasons, while during premonsoon season 23 species and during monsoon season 22 species were recorded (Table 2). In the Nallathanni island 22 species were collected during postmonsoon and summer seasons which decreased to 20 species during premonsoon and to 18 species during monsoon seasons (Table 3). In Karaichalli island, 18 species were recorded during postmonsoon, summer and premonsoon seasons and 17 species during monsoon season (Table 4). Thus the number of species recorded varied in relation to season. With respect to abundance of species, islands sampled can be given in the following order:

Manauli island > Appa island > Nallathanni island > Karaichalli island.

Mean density

Mean density of brachyuran crabs per m^2 fluctuated from 31.0 to 42.5 in Manauli island, from 31.2 to 43.4 in Appa island, from 24.4 to 35.4 in Nallathanni island and from 20.2 to 29.7 in Karaichalli island (Tables 1-4). Seasonal variations in mean density of brachyuran crabs in of all these islands may be placed in the following order:

Postmonsoon > Summer > Premonsoon > Monsoon.

Mean biomass

Mean biomass of brachyuran crabs per m^2 varied between 576.9g and 1029.8g in Manauli island, 561.9g and 1052.1g in Appa island, 474.5g and 859.6g in Nallathanni island and between 444.4g and 722.29g in Karaichalli island. Seasonal variations in mean biomass of brachyuran crabs per m^2 of all these islands may be placed in the following order:

Postmonsoon > Summer > Premonsoon > Monsoon

Species diversity

Species diversity index in the Manauli island varied between 4.023 and 4.277, between 3.893 and 4.127 in Appa island, between 3.686 and 3.993 in Nallathanni island and between 2.736 and 3.894 in Karaichalli island (Tables 5-7). Postmonsoon season witnessed higher species diversity in the first three islands and in the Karaichalli island high species diversity was witnessed during the premonsoon season. Seasonal variations in species diversity indices of first three islands may be placed in the following order:

Postmonsoon > Summer > Premonsoon > Monsoon

For the Karaichalli island, it was in the order of

Premonsoon > Summer > Monsoon > Postmonsoon

Species richness

Species richness index in the Manauli island fluctuated from 0.943 to 0.949, from 0.946 to 0.948 in Appa island, from 0.946 to 0.951 in Nallathanni island and from 0.706 to 0.966 in Karaichalli island (Tables 5-7). The trend with respect to seasonal variation was more or less similar to that of species diversity as could be seen from the following:

Manauli island	:	Postmonsoon > Summer > Premonsoon > Monsoon
Appa island	:	Postmonsoon > Summer > Monsoon > Premonsoon
Nallathanni island	:	Postmonsoon > Summer > Premonsoon > Monsoon
Karaichalli island	:	Monsoon > Premonsoon > Summer > Postmonsoon

Species evenness

Species evenness values varied between 0.837 and 0.855 in Manauli island, 0.869 and 0.878 in Appa island, 0.876 and 0.895 in Nallathanni island and 0.656 and 0.935 in Karaichalli island (Tables 5-7). Seasonal variations in species evenness were in the following order:

Manauli island : Postmonsoon > Summer > Premonsoon > Monsoon

Appa island : Postmonsoon > Premonsoon > Monsoon > Summer

Nallathanni island : Postmonsoon > Monsoon > Summer > Premonsoon

Karaichalli island : Monsoon > Premonsoon > Summer > Postmonsoon

Discussion

The biological composition of organisms living in and on the surface of coral reefs depends on many factors most of which are still not well understood. Littler *et al.*, (1987) proposed a model, based on prevailing nutrient concentration, wave energy and grazing pressure to describe predominant organisms living on coral reefs. With the passage of time, it has become clear that the distribution and abundance of coral associated animals are more directly linked with the availability of habitat and food. Coral reefs provide brachyuran crabs with food, protection from predators and wave action, and constantly exchanged freshly aerated water medium to live in. The spatial distribution of species varies in relation to the degree of availability of the above requirements. Most of the brachyuran crabs inhabiting coral reefs are xanthid crabs which are essentially herbivorous, normally grazing on algae growing near their niche or on fronds which get drifted into their hiding place. They also have the ability either to catch or dislodge the prey organisms. Knudson (1967) estimated that 90% of the total food consumed by these crabs consists of algae and the remaining 10% of animal matter. Availability of seaweeds and algae are one of the important factors determining the species composition and diversity of brachyuran crabs in the coral dominated environments. Seaweeds and algae protect coral reefs by dampening wave action and slowing currents thereby the associated organisms also. They protect coral reefs by trapping sediments

and reducing the possibility of resuspension of the same. In tropical areas high species diversity and abundance of various groups are associated with the presence of seaweeds and seagrass meadows (Fonseca *et al.*, 1992). In the present study species composition and species diversity were very high in the Manauli island and decreased in the following order in other islands:

Manauli island > Appa island > Nallathanni island > Karaichalli island

As discussed above, one of the reasons for the high species composition and species diversity is the high cover of seaweeds and algal distribution in the Manauli island. During summer and premonsoon seasons the sea is very rough in Gulf of Mannar and the water is more turbid. In such a situation the seaweeds and algae protect the coral reefs and the associated organisms.

When compared to other islands, live coral colonies were very high in the Manauli island. The number of live coral colonies was less in other islands situated in the southern region. Dredging of live coral colonies is being done in Karaichalli island situated in the Tuticorin area. Apart from dredging, the coral reefs are also heavily damaged due to anchoring of boats during low tides. Dredging leads to damage and death of corals through three means namely i. mechanical damage, resulting in breakage of corals which subsequently die ii. sediment loading or siltation resulting in the burial and death of colonies and iii. increased turbidity resulting in bleaching, excessive mucus secretion and death of corals. Also, waters over dredged areas have significantly more bacteria than neighboring seawater (Galzin, 1981) which can cause damage to corals. The removal of live coral colonies can be viewed as habitat destruction. Habitat loss produces significant reduction in the fauna. For example the total number of fish species present in an area, and the population density of each are markedly affected by changes in the live coral cover. Even small changes (< 5%) in live coral cover produced significant changes in the total number of individuals in an area of 250 m^2 (Bell and Galzin, 1984). The seaweeds and algal cover vouch for the high species composition and diversity in the Manauli island. Such cover was less in other islands explaining comparatively less abundance

and diversity in these islands. The species composition and diversity in Karaichalli island were low when compared to other islands. It indicated that the habitat loss is higher in this island. If the present trend continues, the condition of the coral reefs will become bad to worse.

Another major factor controlling the species composition is pollution. The pollution load is high towards the southern side islands from the Manauli island (Dhandapani, 1995). The Karaichalli island is highly polluted due to industrial discharges from the Tuticorin area. Dumping of the fly ash from the thermal power plant also adds to the woe. Diversity indices are also helpful in detecting and evaluating pollution status (Wilhm, 1967). The species diversity of brachyuran crabs in Karaichalli island was lower than in all the other islands. .

The species richness index of brachyuran crabs showed a trend parallel to that of species diversity index in the present study.

Species evenness index is a measure of the uniformity in the distribution of individuals among species. With lesser number of species, the distribution of individuals was even in the Karaichalli Island and therefore high evenness indices were recorded during most of the time. Evenness values were less in other three islands, compared to the Karaichalli Island.

The base-line data collected through the present study on species composition, species diversity, richness and evenness will definitely serve as a ready reference to find out the changes that may happen in this very important and fertile at the same time fragile marine ecosystem.

Table 1. Mean density of brachyuran crabs in Manauli island

Sl. No.	Species	Mean density / m²			
		Post-monsoon	Summer	Pre-Monsoon	mon-soon
1	*Portunus (Monomia) petreus*	0.2	0.2	0.2	0.0
2	*Charybdis (Charybdis) helleri*	0.25	0.25	0.2	0.0
3	*Thalamita danae*	0.4	0.2	0.2	0.2
4	*T. prymna*	0.6	0.5	0.4	0.2
5	*T. integra*	0.5	0.5	0.4	0.4
6	*T. admete*	0.4	0.4	0.2	0.0
7	*Leptodius euglyptus*	0.4	0.4	0.2	0.2
8	*L. gracilis*	0.8	0.6	0.6	0.2
9	*L. exaratus*	1.4	1.4	1.2	0.6
10	*Atergatis floridus*	0.3	0.2	0.2	0.2
11	*A. roseus*	0.2	0.2	0.2	0.0
12	*Platypodia cristata*	2.4	2.2	2.2	1.8
13	*Etisus laevimanus*	6.0	5.6	5.2	4.4
14	*Pilodius areolatus*	2.0	2.0	2.0	1.8
15	*Phymodius monticulosus*	2.2	2.4	2.4	2.0
16	*P. granulosus*	1.2	1.2	1.0	0.8
17	*P. ungulatus*	2.4	2.6	2.6	2.2
18	*P. nitidus*	1.0	1.2	0.8	0.8
19	*Chlorodiella nigra*	6.8	6.6	6.4	6.0
20	*Cymo melanodactylus*	1.2	1.0	1.0	0.8
21	*C. andreossyi*	2.4	2.2	1.8	1.8
22	*Pilumnus vespertilio*	3.0	3.0	2.4	2.0
23	*P. tomentosus*	0.4	0.2	0.2	0.2
24	*Tetralia cavimana*	0.2	0.2	0.2	0.2
25	*Trapezia cymodoce*	0.2	0.2	0.2	0.2
26	*T. areolata*	0.3	0.3	0.25	0.2
27	*T. ferruginea*	0.2	0.2	0.2	0.2
28	*Composcia retusa*	0.4	0.6	0.4	0.4
29	*Tylocarcinus styx*	1.0	0.8	0.8	0.6
30	*Hyastenus oryx*	0.6	0.4	0.4	0.2
31	*Schizophrys aspera*	1.2	1.0	1.0	1.0
32	*Percnon planissimum*	1.6	1.8	1.4	1.4
	Total mean	**42.5**	**40.55**	**36.85**	**31.0**

Table 2. Mean density of brachyuran crabs in Appa island

Sl. No.	Species	Mean density / m^2			
		Post-monsoon	Summer	Pre-Monsoon	mon-soon
1	*Thalamita prymna*	0.8	0.8	0.6	0.6
2	*T. integra*	0.4	0.5	0.4	0.2
3	*T. admete*	0.2	0.2	0.0	0.0
4	*Leptodius exaratus*	1.8	1.8	1.2	1.2
5	*Platypodia cristata*	2.8	2.6	2.4	2.0
6	*Etisus laevimanus*	4.6	4.2	3.8	3.2
7	*Phymodius monticulosus*	3.4	3.2	2.8	3.0
8	*P. granulosus*	0.6	0.2	0.2	0.0
9	*P. ungulatus*	1.2	1.0	0.8	0.8
10	*P. nitidus*	0.4	0.2	0.0	0.0
11	*Chlorodiella nigra*	5.2	4.6	4.0	4.2
12	*Cymo melanodactylus*	0.8	0.4	0.2	0.2
13	*C. andreossyi*	1.2	1.2	1.0	1.2
14	*Pilumnus vespertilio*	2.2	2.0	2.0	2.2
15	*Trapezia cymodoce*	0.4	0.3	0.2	0.2
16	*T. areolata*	0.2	0.2	0.0	0.0
17	*T. ferruginea*	0.2	0.2	0.2	0.2
18	*Composcia retusa*	0.8	0.6	0.6	0.4
19	*Tylocarcinus styx*	1.6	1.2	1.0	1.0
20	*Hyastenus orxy*	1.0	1.2	1.2	0.8
21	*Schizophrys aspera*	1.2	1.0	0.8	0.6
22	*Cyclax suborbicularis*	0.8	1.0	0.8	0.4
23	*Metopograpsus messor*	0.4	0.6	0.2	0.2
24	*Grapsus albolineatus*	6.2	6.4	5.4	4.6
25	*Plagusia depressa tuberculata*	3.2	3.0	2.6	2.2
26	*Percnon planissimum*	1.8	2.0	1.6	1.6
	Total mean	**43.4**	**40.6**	**34.0**	**31.2**

Table 3. Mean density of brachyuran crabs in Nallathanni island

Sl. No.	Species	Mean density / m²			
		Post-monsoon	Summer	Pre-Monsoon	mon-soon
1	*Portunus (Monomia) petreus*	0.2	0.2	0.0	0.0
2	*Charybdis (Charybdis) helleri*	0.3	0.2	0.2	0.0
3	*Thalamita prymna*	1.2	1.2	0.8	0.4
4	*T. integra*	0.8	0.6	0.2	0.2
5	*Carpilius maculatus*	0.4	0.2	0.0	0.0
6	*Leptodius exaratus*	2.8	2.8	2.4	2.4
7	*L. euglyptus*	0.6	0.4	0.4	0.2
8	*Atergatis integerrimus*	1.0	0.6	0.4	0.6
9	*Platypodia cristata*	3.8	2.6	2.2	1.8
10	*Etisus laevimanus*	4.2	3.8	3.6	3.2
11	*Phymodius monticulosus*	2.8	2.8	2.8	2.4
12	*Chloridiella nigra*	4.6	4.8	4.2	3.8
13	*Cymo andreossyi*	2.0	1.2	1.4	1.4
14	*Pilumnus vespertilio*	2.2	2.0	2.0	1.8
15	*Trapezia cymodoce*	0.2	0.2	0.2	0.0
16	*T. ferruginea*	0.3	0.2	0.2	0.2
17	*Composcia retusa*	0.6	0.6	0.4	0.2
18	*Tylocarcinus styx*	1.4	1.2	1.0	0.8
19	*Hyastenus oryx*	0.8	1.0	0.4	0.4
20	*Schizophrys aspera*	1.0	1.2	0.8	0.8
21	*Grapsus albolineatus*	3.4	3.6	3.2	2.6
22	*Percnon planissimum*	1.4	1.2	1.8	1.2
	Total mean	**35.4**	**32.6**	**28.6**	**24.4**

Table 4. Mean density of brachyuran crabs in Karaichalli island

Sl. No.	Species	Mean density / m^2			
		Post-monsoon	Summer	Pre-Monsoon	mon-soon
1	*Thalamita danae*	0.8	0.8	0.6	0.4
2	*T. prymna*	1.0	1.0	0.8	0.8
3	*Leptodius exaratus*	2.0	1.6	1.8	1.4
4	*Atergatis integerrimus*	0.6	0.6	0.8	0.6
5	*Platypodia cristata*	1.8	1.2	1.2	0.8
6	*Etisus laevimanus*	3.6	3.2	3.0	2.6
7	*Pilodius areolatus*	2.2	2.0	1.6	1.4
8	*Phymodius monticulosus*	2.4	2.2	2.0	1.8
9	*Chlorodiella nigra*	4.2	3.8	3.4	3.0
10	*Cymo andreossyi*	1.6	1.6	1.2	1.0
11	*Pilumnus vespertilio*	2.4	2.2	1.8	1.6
12	*Trapezia ferruginea*	0.2	0.2	0.2	0.2
13	*T. cymodoce*	0.3	0.2	0.2	0.0
14	*Composcia retusa*	0.6	0.6	0.8	0.4
15	*Hyastenus oryx*	1.0	1.0	1.2	0.8
16	*Schizophrys aspera*	1.2	1.0	1.0	1.0
17	*Grapsus albolineatus*	2.8	2.4	2.0	1.6
18	*Percnon planissimum*	1.0	1.0	0.8	0.8
	Total mean	**29.7**	**26.6**	**24.4**	**20.2**

Table 5. Species diversity of brachyuran crabs

Station	Post monsoon	Summer	Pre monsoon	Monsoon
Manauli island	4.277	4.241	4.186	4.023
Appa island	4.127	4.084	3.957	3.893
Nallathanni island	3.993	3.918	3.784	3.686
Karaichalli island	2.736	3.863	3.894	3.821

Table 6. Species richness of brachyuran crabs

Station	Post monsoon	Summer	Pre monsoon	Monsoon
Manauli island	0.049	0.949	0.946	0.943
Appa island	0.948	0.947	0.946	0.947
Nallathanni island	0.951	0.948	0.946	0.946
Karaichalli island	0.706	0.957	0.962	0.966

Table 7. Species evenness of brachyuran crabs

Station	Post monsoon	Summer	Pre monsoon	Monsoon
Manauli island	0.855	0.848	0.837	0.837
Appa island	0.878	0.869	0.875	0.873
Nallathanni island	0.895	0.879	0.876	0.884
Karaichalli island	0.656	0.927	0.934	0.935

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