Indian J. Fish., 58(1) : 73-77, 2011

Temporal patterns in biodiversity and health status of reef corals of Palk Bay

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ABSTRACT

A detailed study aimed at identifying the changes in biodiversity, live coral cover as well as health status of the Palk Bay Reef corals was carried out over a period of 4 years. The live coral percent cover was measured using Line Intercept Transect method at fixed sites in the reefs of Palk Bay in 2008 in order to study and make comparisons with the surveys conducted in 2004. Substantial decrease in live coral cover was observed over the last four years with a live coral cover of 13.65% and 12.9% in Velapertumuni and Kathuvallimuni Reefs respectively. *Acropora cytherea* and *Favites abdita* were the dominant and abundant species respectively in Velapertumuni Reef with relative abundance values of 21.08 and 10.85 respectively. However, in Kathuvallimunai Reef, *Acropora lamarcki* was found to be the most abundant species with a relative abundance value of 12.68. All other species belonged either to common/uncommon species status. Variations in community structure were also noticed in both the reefs. Even though, the total live coral cover was found to be reduced, the increased recruitment of fast growing species like *Acropora* has contributed to a fair diversity as indicated by the diversity indices. Studies on the disease prevalence in hard corals indicated more incidences of diseases in massive corals as compared to branching corals. Disease conditions such as brown band disease, porites ulcerative white spot syndrome and pink line syndrome/porites pinking were recorded.

Keywords: Biodiversity, Coral reefs, Health status, Palk Bay

Introduction

The reefs in Palk Bay (south India) run parallel to shore between longitudes 79° 17' E - 79° 8' E and the latitude 9° 17' N. The western part of this reef which extends from Pamban pass up to Thedai is called Velapertumunai Reef and the eastern part which extends up to Pamban pass is called Kathuvallimunai Reef. It lies in an east-west direction and is about 200 to 600 m away from the shore at different places with a depth of 1 to 5 m. According to Wilkinson (2004), an estimated 24% of global coral reefs are in danger of collapse from human pressures and another 26% are under the threat of long-term degradation. Mankind can impact reefs directly through vessel grounding, dynamite blasting for fishing, coral mining for construction materials and indirectly through pollution, sedimentation associated with coastal activities such as dredging and river runoff. The reefs in Palk Bay are also impacted by some of these activities over a period of time.

A detailed biodiversity assessment was carried out in both these reefs by the authors in 2004-2005 (Sandhya *et al*., 2005; 2008). The Palk Bay is increasingly getting polluted mainly due to sewage disposal, coastal soil erosion and oil spread due to trawler operations. The dredging carried out as part of the Sethusamudram project would also hamper the biodiversity of this area. As regular assessment of reefs are fundamental to coral reef monitoring, the present study was undertaken aimed at identifying the changes in biodiversity, live coral cover and health of corals over a period of 4 years.

Materials and methods

Line Intercept Transect Method adopted for the survey and analyses for univariate community parameters and identification of the coral samples were the same as those reported earlier (Sandhya *et al*., 2008). K-dominance curves (Lambshead *et al*., 1983) were constructed for finding out the diversity profile of the reef complexes. A community analysis was carried out by finding the relative abundance (RA) values of each species (Rilov and Benayahu, 1998). Studies were also carried out to assess the health status and disease prevalence in the Palk Bay Reef corals.

Results and discussion

The present study in 2008 revealed a total live coral cover of 13.65% and 12.9% in Velapertumuni and Kathuvallimunai reefs respectively (Table 1 and 2). Maximum live coral cover was found at the eighth site (25.1%) and minimum at third site (8.45%) in Velapertumuni Reef. *Acropora cytherea* was the dominant species and *Favites abdita* was the abundant species with relative abundance values of 21.08 and 10.85 respectively. However, in Kathuvallimunai Reef, live coral percent cover was maximum at fifth site (22.8%) and minimum at first site (6%). *Acropora lamarcki* was found to be the abundant species with a relative abundance value of 12.68. All other species belonged either to common or uncommon species status. In Velapertumuni Reef, Pielou's evenness was highest at third and sixth sites (0.96); Shannon diversity was highest at eighth site (2.5); Simpson diversity was highest at third site (0.99). In Kathuvallimunai Reef Pielou's evenness was highest at first and fourth sites (0.98), Shannon diversity was highest at fourth site (2.26) and Simpson diversity was highest at third first site (1.07). Although Shannon index of diversity recorded a value of 2.61 and 2.52 in the reefs (Table 3 and 4), K dominance curve showed a low starting point and gentle slope indicating fair diversity in both the reefs (Fig. 1 and 2).

The present work was aimed at finding the temporal patterns in coral biodiversity of reefs of Palk Bay. A marked reduction in total live coral cover was found in both the

Table 1. Average percentage of live coral cover in Velapertumuni Reef, Palk Bay.

Species/Sites	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	RA
Acropora cytherea	5.15	2.4	1.05	4.6	3.85	3.25	1.70	3.0	1.25	2.80	21.08
A. humilis	1.35	1.1	1.5	0	0	0	0.6	2.4	1.2	1.6	7.34
A. lutkeni	0.7	2.25	0	0	0	0	0.7	0.75	0	1.05	4.12
A. hemprichii	1.05	0	0	0	0	0	0	1.4	0	0	1.87
A. lamarcki	0.4	0.6	0.7	0.75	1.9	1.25	0.75	3.8	0	1.3	8.61
Porites lutea	0.5	1	0.55	0.65	0.9	0.8	1.3	3.35	2.15	0	8.38
P. mannarensis	1	1.8	0	0.6	1	1.75	0.35	2.15	2.6	0	8.46
P. solida	0.3	2.15	0.7	0.8	0.8	1.5	0	0.6	0	0.8	5.76
Montipora digitata	0	0.65	0	0	0	0	2.25	0	0	1.6	3.37
Favia pallida	0	0.75	0.8	1.55	1	1.1	1.15	1.75	1.2	3.1	9.28
Favites virens	0	1	1.25	0	0	0	0	0.85	1.05	0.65	3.59
F. abdita	0	0	0	2.5	3	3.1	2.7	2.65	0.55	0	10.85
Goniastrea retiformis	0	0.7	1	0	0	0	0.7	1.6	1.8	0	4.34
Platygyra daedalea	0	0.65	0.9	0	0	0	0.35	0.8	0.6	0	9.66
Total	10.45	15.05	8.45	11.45	12.45	12.75	12.55	25.1	12.4	12.9	

Not recorded (RA=0), Rare (0<RA<0.1), Uncommon (RA=0.1-1), Common (RA=1-10), Abundant (RA=10-20), Dominant (RA>20).

Table 2. Average percentage of live coral cover in Kathuvallimunai Reef, Palk Bay

Species/Sites	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	RA
Porites mannarensis	0.25	0	2.85	1.7	1.75	1.2	0.55	0.6	0.6	0.55	7.63
P. lutea	0.6	0	1.15	0	1.35	1.7	1.5	3.75	0.35	2.1	9.49
P. solida	0.55	0	1	2.65	0.75	3.25	0	1.7	0.6	1.7	9.26
Acropora cytherea	0.6	1.1	1.35	2.15	3.8	0.6	0.65	1.6	0.55	0.6	9.87
A. lamarcki	0.65	1.9	2.55	1.6	3.15	2.25	2.1	0.55	0.3	1.6	12.68
A. hyacinthus	0.5	1.35	1.3	0	3.2	0.6	0	0.55	0.2	0.55	6.3
A. humilis	0	0.7	0	2.7	0	1.05	0	1.6	0.2	0.45	5.09
A. lutkeni	0	0	0.6	2.85	1.1	0	0	0.55	0.5	0	4.25
Montipora digitata	1	0	0	1.6	0	1.15	0.5	1.1	4.35	0.15	7.51
Favia pallida	0.8	1	0.6	1.1	0.55	0.2	0.55	2.8	3.25	0.6	8.73
Favites virens	0.45	0.5	0.75	3.25	1.65	0.55	1.65	0	0.15	0.3	7.06
Platygyra daedalea	0.6	0.6	0	2.25	3.35	0.5	0.6	0	0.85	0.45	6.99
Goniastrea retiformis	0	0.85	0	0	2.15	0	2.8	0	0.6	0.55	5.24
Total	6	8	12.15	21.85	22.8	13.05	10.9	14.8	12.5	9.6	

Not recorded (RA=0), Rare (0<RA<0.1), Uncommon (RA=0.1-1), Common (RA=1-10), Abundant (RA=10-20), Dominant (RA>20).

Table 3. Univariate community parameters at different sites in Velapertumuni Reef

Sites	J'	H'(loge)	1-Lambda'
1	0.89	1.96	0.92
2	0.95	2.45	0.97
3	0.96	2.22	0.99
4	0.91	1.89	0.90
5	0.95	1.96	0.91
6	0.96	1.99	0.93
7	0.92	2.29	0.96
8	0.95	2.50	0.95
9	0.94	2.16	0.95
10	0.94	2.07	0.93
Pooled data	0.96	2.61	0.99

J= evenness; H'=Shannon diversity; 1-Lambda=Simpson diversity

Table 4. Univariate community parameters at different sites in Kathuvallimuni Reef

Sites	J'	H'(loge)	1-Lambda'
1	0.98	2.25	1.07
2	0.96	1.99	0.97
3	0.93	2.05	0.93
4	0.98	2.26	0.93
5	0.94	2.25	0.92
6	0.89	2.16	0.93
7	0.91	1.99	0.93
8	0.90	2.08	0.91
9	0.77	1.98	0.86
10	0.89	2.24	0.97
Pooled data	0.98	2.52	0.99

J= evenness; H'=Shannon diversity; 1-Lambda=Simpson diversity

reefs when compared with the results of the survey carried out by Sandhya *et al*. (2005). The total live coral cover reduced from 44% to 13.65% in Velapertumuni Reef. A change in the community structure of corals was also noticed in this reef. *Porites solida* was the dominant species in 2004 (Sandhya *et al*., 2005) whereas *Acropora cytherea* was the dominant species in the present study. Biodiversity indices showed an increasing trend in Velapertumuni Reef and K-dominance curve also indicated fair diversity. The increase in diversity indices may be due to the presence of new recruits of *Acropora* which are capable of colonising disturbed environments. In the earlier study, massive corals were dominant at this site, but now more and more branching corals are found to occupy this area.

The total live coral cover of Kathuvallimunai Reef also reduced from 37.8% to 12.9% and no species was found to be dominant. The abundant species was again *A. lamarcki,* which is a branching coral whereas in 2004,

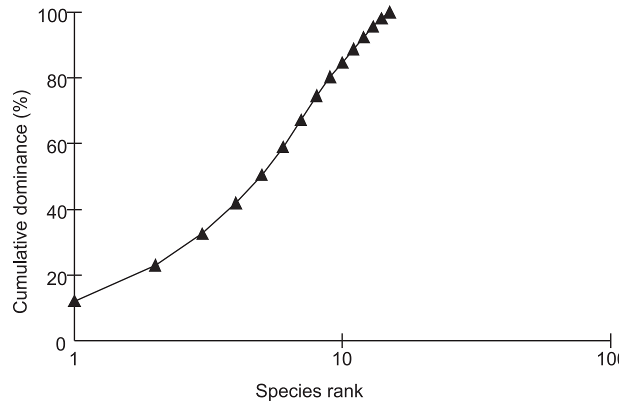

Fig. 1. K- dominance plot for Velapertumuni Reef

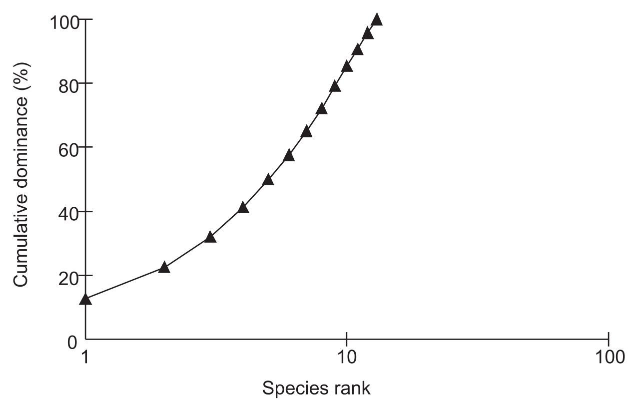

Fig. 2. K- dominance plot for Kathuvallimunai Reef

the dominant species was found to be *Platygyra lamellina* which is a massive coral (Sandhya *et al*., 2008). Most of the massive corals which were dominating this area were partially bleached, bleached or dead and covered with sediments and algae or infested with diseases. Despite these problems, the diversity indices showed an increasing trend with K- dominance curves showing fair diversity. Further, while some communities may persist for long periods of time, others are frequently disturbed and perpetually changing (Karlson, 1999) which may be the reasons for the shift in community structure of both the reefs. In addition, climate fluctuations may also result in reshuffling of local communities as individual species respond to variations in the environment in different ways. As the Palk Bay Reefs are lying adjacent to coastline, it is subjected to frequent disturbances which can represent important predictable features of the selective regime resulting in adaptations that contribute to succession and community development (Horn, 1981). Furthermore, acroporids are found to have successful colonising abilities due to their fast growth rate (Karlson, 1999) which may be the reason for *Acropora* patches growing in most of the places in these reefs. However, the drastic reduction in live coral cover of both reefs is a challenging issue and steps are to be devised for better management of these reefs. Managers and policy makers need to understand the effect of human induced disturbances; assess these damages properly; and develop subsequent, appropriate restoration efforts on these impacted reefs.

Studies on the disease prevalence in hard corals indicated more incidences of diseases in massive corals as compared to branching corals. Brown band disease, Porites ulcerative white spot syndrome and pink line syndrome/ Porites pinking were recorded.

Brown band syndrome was recorded in *Goniopora* sp. and *Favia* sp. Brownband syndrome was characterised by a brown zone of variable width, flanked by healthy living coral tissue at the advancing front and exposed white skeleton at the trailing edge as the band progresses over the surface of the colony. There was a white zone between the healthy tissue and brown band which may comprise bleached tissue and/or denuded skeleton. Dense population of ciliates, packed with zooxanthellae from engulfed coral tissue, causes the brown coloration of the band. The ciliates eat the symbiotic algae within coral polyps. Brown band syndrome was recorded for the first time affecting corals on surveys in the northern and southern sectors of the Great Barrier Reef in 2003 (Willis *et al*., 2004). Borneman (2001) reported incidence of brown band in corals grown in aquaria and opined that this is possibly caused by the ciliate, *Helicostoma nonatum*, which is thought to produce a brown jelly-like condition.

Porites ulcerative white spot syndrome was found to be prevalent among *Porites mannarensis* and *Porites solida*. This disease was manifested as irregular depressed white patches of clean skeleton, devoid of tissue. The patches seemed to expand and coalesce eventually forming large areas of necrotic tissue covered by algae and sediments. Raymundo *et al*. (2003) reported that *Porites* ulcerative white spot syndrome (PUWS) affected more than 20% of *Porites* colonies on 8 out of 10 reefs surveyed in the Philippines. In field surveys conducted for prevalence and distribution patterns of coral diseases in selected islands of Philippines during 2002 – '03, incidence of PUWS as high as 53.7% was reported among *Porites* (Kaczmarsky, 2006) and correlation analyses linked higher prevalence of PUWS to anthropogenic influence.

Pink line syndrome/Porites pinking was recorded in *Porites lutea*, where pink colouration was observed around dead and scarred tissue. This appears to be symptom of a disease or simply a response of the coral to a variety of competitive, invasive or parasitic interactions including cyanobacteria. Ravindran and Raghukumar (2002) reported pink line syndrome (PLS) in *Porites lutea* from the coral lagoon at Kavaratti Island in the Lakshadweep Archipelago in 1996 and they have found that the incidence increased four fold within next four years. They have observed the presence of the cyanobacterium *Phormidium valderianum* exclusively in the PLS affected specimens.

Coral diseases are one of the major factors that alter coral cover and their diversity. Diseases in corals are caused by biotic factors as well as a plethora of abiotic factors including sedimentation, elevated sea surface temperatures, pollutants and other known stressors (Hayes and Goreau, 1998). Thus with an array of factors affecting corals, the etiology of diseases needs to be studied in detail to evolve better management plans for preservation of coral reefs.

Acknowledgements

The authors wish to place on record their sincere thanks to Dr. G. Syda Rao, Director, CMFRI for the encouragement and support extended to carry out this work. Acknowledgements are also due to Dr. G. Gopakumar, Scientist-in-charge, Mandapam Regional Centre of CMFRI for providing the facilities. The help rendered by M. Seeni, Mandapam Regional Centre and N. Jesuraj, Tuticorin Research Centre of CMFRI is gratefully acknowledged.

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Date of Receipt : 03.09.2010
Date of Acceptance : 08.02.2011