J. Mar. Biol. Ass. India, 47 (2) : 139 - 143, July - Dec., 2005

Assessment of species diversity and coral cover of Velapertumuni Reef, Palk Bay, India

Sandhya Sukumaran*, Rani Mary George** and C.Kasinathan*

*Regional Centre of Central Marine Fisheries Research Institute, Marine Fisheries P. O., Mandapam Camp - 623520, Tamil Nadu, India, Email : sandhyasukumaran@hotmail.com
** Central Marine Fisheries Research Institute, P. B. No. 1603, Cochin – 682 018, India

Abstract

Velapertumuni Reef, a fringing reef of Palk Bay was surveyed for the assessment of the coral cover and biodiversity during September 2004, following the Line Intercept Transect Method and their geographical positions were fixed using the Global Positioning System. The percentages of live and dead coral cover at each site were derived and a total of 12 hard coral species were found on the transects; *Porites solida* was the major species at 6 sites, followed by *Favia pallida* at 2 sites and *Acropora cytherea* and *Porites lutea* were dominant in 5th and 8th sites respectively. Therefore, except for one site the massive corals were dominant in all other areas. The total live and dead coral cover for the reef as a whole was estimated as 44% and 26% respectively and the remaining part was covered with coralline algae, sand and rubble. Dead coral cover was dominated by poritids, but acroporids showed the highest ratio of dead coral to live coral cover. Further, relative abundance values were derived for each species and they were assigned status as dominant/abundant/common/uncommon/rare. Accordingly, *P. solida* was the only species in the "dominant "category; *P. lutea* and *F. pallida* belonged to the category "abundant" and all other species were given either "common" or "uncommon" status. The Shannon indices of diversity in most of the sites were low varying from 0-2 and the reef as a whole showed a diversity of 1.47. The species richness and evenness values also showed low values of 5.4 and 0.59 respectively.

Key words : Velapertumuni Reef, Coral cover, Community analysis, Palk Bay.

Introduction

Coral reefs worldwide are experiencing substantial degradation (Wilkinson, 2000). Extensive coral mortality can be attributed to natural stresses such as coral bleaching, catastrophic low tide events, and storms (Done, 1999). These factors reduce the reef's resilience and ability to recover in the face of further natural or man-made catastrophes (Hughes and Connell, 1999).

Coral reefs of fringing type are found in the Palk Bay and Gulf of Mannar at the southeastern coast of India. In Palk Bay, at Mandapam they lie along the eastern side of Rameswaram Island. Pillai (1969) made a detailed study on the coral biodiversity of this reef. Kumaraguru *et al.* (2003) studied the effect of bleaching due to the increased sea surface temperature (SST) in Palk Bay. But information regarding the biodiversity profile, species status, etc. is not available which makes comparisons very difficult. Recently, the Department of Ocean Development and Space Application Centre, Ahmedabad (1997) have produced coral reef maps of India, but species wise listing of live and dead corals in relation to depth of occurrence is lacking. In this scenario a detailed biodiversity assessment will help in making comparisons in future studies of this reef. The exact locations of each transect survey were fixed using GPS. The above transect survey gives an idea about the general diversity patterns observed along different sites in Velapertumuni Reef. The present study aims to get insights into the health of this reef by deriving percentage of live and dead coral cover and diversity indices.

Materials and methods

Velapertumuni Reef is a fringing type of reef (Lat. 9°17'N and Long. 79°8' -79°9'E).It is part of the fringing reef of Palk Bay, which extends westward upto Thedai from Pamban Pass (Fig.1). The eastern half of this fringing reef, which extends upto Pamban Pass, is called Kathuvallimuni 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.

Sampling was carried out during September 2004. Line Intercept Transect Method (English *et al.*, 1994) was adopted for the assessment of live and dead coral cover. A 20m length of fiberglass tape was stretched parallel to the reef crest at 10 different sites and fraction of the length of the line intercepted by the coral was recorded. This measure of cover expressed as a percentage is considered to be an unbiased estimate of the proportion of the total

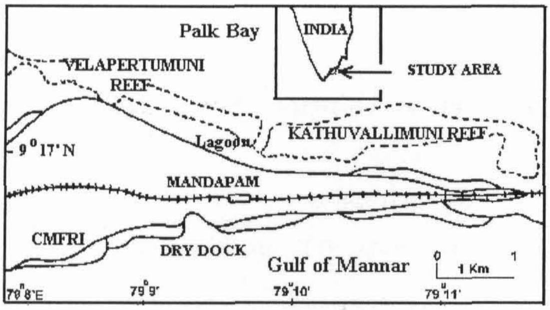

Fig.1. Location of the study site

area covered by that coral if the following assumptions apply; that the size of the object is small relative to the length of the line and that the length of the line is small relative to the area of intersect (English *et al.*, 1994). The depth at which transects were taken varied from 1-5m. The colonies were sampled and identified following Pillai (1967 a, b & c., 1973); Veron (1986); Venkataraman *et al.* (2003). The diversity indices, dominance curve, etc. were derived using PRIMER5 Software.

The relative abundance (RA) of each species (Rilov and Benayahu, 1998) was calculated according to the contribution to living cover:

$$RA = \frac{Pi}{P\ total} \times 100$$

Pi = pooled living coverage of the ith species from all transects at a given site.

P total = pooled total living coverage of all species in all transects at a given site.

The resulting values were transformed into abundance categories (%): 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).

K-dominance curves (Lambshead *et al.*, 1983) present the different species ranked in order of dominance according to their contribution to living coverage on the x-axis (logarithmic scale) with percentage dominance on the y-axis (cumulative scale). The starting point of the curve and its inclination are indicative of the diversity profile of the examined community; for example, a steep slope with high starting point reflects low diversity. K- dominance curve was constructed on the data sets.

Dissolved oxygen values were estimated by using a DO pocket meter "Oxi 3i5i" model, salinity by "ATAGO" handheld Salinometer, light intensity by "TES" digital Lux meter, *p*H by "Eutech" handheld *p*H meter and temperature by an ordinary centigrade thermometer. Geographical position of each transect was fixed using "GARMIN Model 12XL" GPS.

Results

Water quality parameters of 10 different sites indicated that the sea surface temperature and salinity varied from 28 – 30°C and 33 -34 ppt. respectively at various sites during September 2004 (Table 1). Dissolved oxygen values (surface) recorded a minimum of 5.3ppm at sites 1 and 10 and a maximum of 7ppm at sites 6 and 9 respectively at different times on fourteenth and twenty fourth of September 2004. *p*H observed was in the range of 7.5 and 8. Light intensity ranged from 81,400 to 4,69,000 lux at different times. A total of 12 hard coral species were found on the transects. *Porites solida* was the major species at 6 sites, followed by *Favia pallida* at 2 sites. *Acropora cytherea* and *Porites lutea* dominated in 5th and 8th sites respectively (Table 2). The results revealed that except for one site the massive corals were dominant in all the other sites. The total live coral cover for the reef as a whole was found to be 44%. The various species were *Porites solida, P.lutea, Montastrea valenciennesii, Favia pallida, Favites abdiata, F.complanata, Platygyra daedalea, Hydnophora microconus, Goniastrea retiformis, Acropora cytherea, A.corymbosa* and *A.digitifera.* (Table 3). Total dead coral cover for the reef was derived as 26% (Table 4.). The remaining part of the reef was covered with coralline

Table 1. *Water quality parameters at 10 sites : S1 – S10 (September 2004)*

Sample sites	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Date (Sept.2004)	14	14	14	14	14	24	24	24	24	24
Time (hrs)	8:40	9:30	10:20	11:30	12:10	8:35	9:09	10:10	11:30	12:05
Depth (m)	5	4	3	3	2.8	1.6	4.2	3.6	4.3	4.5
Temp. (°C)	29.5	29.3	29.5	29.8	28	28.3	30	30.1	30.3	30
Salinity(ppt)	34	34	34	33	34	33	33	34	33	33
DO (ppm)	5.3	5.4	6.1	6.5	6.5	7	5.4	6.7	7	5.3
*p*H	8	7.5	8	8	8	8	7.5	8	8	7.5
Light intensity (lux) x 000	81.4	92.9	469.0	135.9	103.1	85.0	95.6	124.0	87.5	113.0

Table 2 *Percentage live coral cover at 10 different sites*

Species	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Lat: Long:	9°17'17.3"N 79°9'48.2"E	9°17'15" N 79°9'48" E	9°17'13"N 79°9'47"E	9°17'13.6"N 79°9'47.3"E	9°17'27.5"N 79°9'19.2"E	9°17'36.1"N 79°8'12.3"E	9°17'40.3"N 79°8'30.6"E	9°17'42" N 79°8'31.9"E	9°17'42.7"N 79°8'32.1"E	9°17'43" N 79°8'33" E
P.solida	22.2	7.5	9.7	10.4	1	4.3	70.8	10	30	55
P.lutea	0	3.3	2.5	0	0	0	0	35	10	23
M.valenciennesii	0	1.4	0	0	0	0.5	0	0	0	0
F.pallida	3.5	1	2	0.3	9	6.3	0	20	35	12
F.abdiata	0	0.5	0	5.7	5.3	0	0	5	3	1
F.complanata	0	1	1.4	0	0	0	0	0	0	0
P.daedalea	1.6	0	0	0	0	0	0	0	1	0
H.microconus	0	0.4	0	0	0	0	0	2	0	0
G.retiformis	0	0	0.7	0	0	0	0	0	0	0
A.cytherea	1.3	0	0	0	10.8	0	0	2	3	2
A.corymbosa	2.6	0	0	0	3.6	0	0	0	5	0
A.digitifera	1.9	0	0	0	0	0	0	0	0	0

algae, sand and rubble. Dead coral cover was dominated by poritids, but acroporids showed the highest ratio of dead coral to live coral cover. Margalef species richness and Fisher α (species richness) showed the highest value in second site (Table 5). Another major component of diversity i.e., evenness or equitability was highest in 5th site. Shannon index of diversity which is a more realistic estimate of biodiversity was found to be highest in 2nd site. Margalef species richness and Pielou's evenness values were 2.895 and 0.59 respectively. Shannon diversity recorded a low value of 1.478 (Table 6.).

The results of the community analysis are also depicted in Table 3. All twelve species of corals are classified into different categories in accordance with their relative abundance. *P. solida* was the only species which belonged to the "dominant" category and *P.lutea* and *F. pallida* were placed under the category "abundant". Relative abundance values of all other species were less than 1, giving them either common or uncommon species status. The K – dominance curve constructed on the data sets confirmed the low diversity of this reef with its steep slope and high starting point (Fig.2). In terms of relative abundance of each species of coral according to their contribution to living coverage, *P.solida* was the most dominant (Table 3).

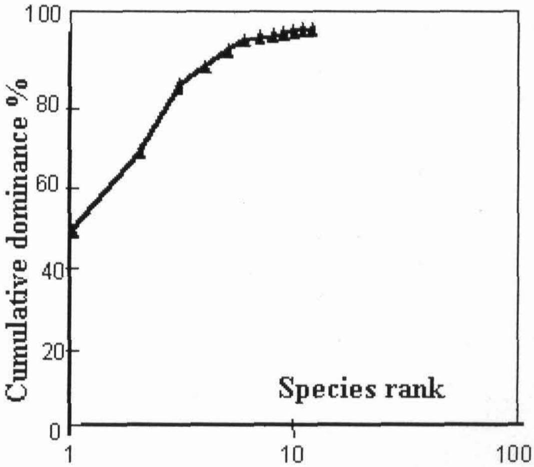

Fig.2.K- dominance plot for Velapertumuni Reef

Discussion

Pillai (1969) has described this reef with reference to horizontal distribution of corals and recorded around 15 species belonging to 9 genera from 40 stations. He found about 54 colonies of encrusting and massive species. The present linear transect survey is in agreement with his observations since here the massive species showed dominance. Kumaraguru *et al.* (2003) determined the biophysical status of coral reefs using the Line Intercept Transect Method. They recorded live coral cover of 34.2, 32.9 and 36.9% from Mandapam North zones -1, 2 and 3 respectively during bleaching recovery in August 2002. These three zones are part of Velapertumuni Reef on which the present study was focused. However, the authors could record a total live coral cover of 44% from this reef which is a clear indication of the recovery of corals from bleaching events reported earlier.

Table 3. *Total percentage coral cover of each species and status according to relative abundance*

Species	% cover	Relative abundance	Status
P.solida	22.1	49.5	D
P.lutea	7.4	16.5	A
M.valenciennesii	0.2	0.4	U
F.pallida	8.9	19.9	A
F.abdiata	2.1	4.6	C
F.complanata	0.2	0.5	U
P.daedalea	0.3	0.6	U
H.microconus	0.2	0.5	U
G.retiformis	0.1	0.2	U
A.cytherea	1.9	4.3	C
A.corymbosa	11.1	2.5	C
A.digitifera	0.2	0.4	U

D= Dominant, A=Abundant, U= Uncommon, C= common,

Birkeland (1997) has asserted the utility of living coral cover as an index of reef health. On the basis of using percent cover of living coral as an index of reef health, about 60 – 70% of the reefs in Indonesia and Philippines have been concluded to be seriously degraded with only 5% still in excellent condition (Yap and Gomez, 1985). According to Birkeland (1997), change through time of living coral cover and age distribution of corals in the community are more reliable indicators of the state of the reefs. The very poor coral representation in the reef of present study with wide interspaces shows that the reef is in declining phase. The widely spaced corals on a reef are suggestive of an adverse environmental condition (Mayer, 1918). He has pointed out a similar condition at Thursday Island where corals are widely separated due to serious interferences of silt. The dominant forms in this reef are poritids and faviids. They are massive corals with comparatively larger polyps and they dominate many sites. Small polyped coral forms like *Acropora* are common but not abundant or dominant since they have less tolerance to environmental perturbations. Marshall and Orr (1931) have shown that generally corals with large polyps are more efficient in removing the silt falling on them by means of ciliary action or by mere expansion of polyps, than the small – polyped ones. The frequent occurrence of a particular species in some areas suggests its ability to thrive against hostile conditions like wave action, temperature and salinity variations, tidal influence and sedimentation. This can be the reason for the dominance of massive poritids and faviids in our study when compared to acroporids . Further, the bottom type was silty and water became cloudy when bottom was stirred with a stick, which is an indication of the increased siltation and sedimentation on this reef.

Table 4. *Velapertumuni Reef - percentage of dead coral cover*

Groups	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Poritids	0	5	20	5	0	0	0	35	23	40
Favids	7	0	2.5	18	0	2	0	5	12	19
Acroporids	0	0	12	0	0	2.5	0	10	20	23

Table 5. *Diversity indices for 10 sites*

Sample	S	N	d	J'	Fisher α	H'(loge)
S1	6	33	1.4	0.6	2.1	1.1
S2	7	15	2.2	0.7	5.0	1.5
S3	5	16	1.4	0.7	2.5	1.2
S4	3	16	0.7	0.7	1.1	0.8
S5	5	30	1.2	0.9	1.7	1.4
S6	3	11	0.8	0.7	1.4	0.8
S7	1	70	0	-	0.2	0
S8	6	74	1.2	0.7	1.5	1.4
S9	7	87	1.3	0.7	1.8	1.4
S10	8	93	0.9	0.6	1.1	1.1

In the present investigation in many of the sites the Shannon indices of diversity were low varying from 0 - 2 and the reef as a whole showed a diversity of 1.47. In ecological studies diversity frequently refers not only to the number of taxa (taxon "richness") but also to a measure of equitability or evenness in the abundance of taxa. Within the continuum of spatial scales, three levels are often discussed with respect to taxonomic diversity: within habitat (alpha), between habitat (beta) and regional (gamma) diversity. The present study is focused on finer spatial scales because they address the immediate factors regulating the local co-existence of species in communities. Likewise, species richness and evenness recorded low values in this reef. The K-dominance curve showed a steep slope and high starting point, indicating low diversity. Species diversity on reefs is strongly influenced by environmental conditions and geographic location, so that remote or high latitude reefs often have relatively low species richness (Birkeland, 1997) and hence in the present study the low diversity could be due to environmental and anthropogenic interventions as according to Kumaraguru *et al.* (2003), the summer of 2002 had the hottest days

Table 6. *Diversity indices for the reef*

Sample	S	N	d	J'	Fisher α	H'loge)
Total	12	45	2.9	0.5	5.4	1.47

S = total species, N = total individuals,
d = Margalef species richness, J' = evenness,
Fisher α = species richness, H' = Shannon diversity

in Palk Bay region causing reefs to bleach in late March which intensified during April and May. The low diversity could also be attributed to the above mentioned bleaching phenomenon since recovery is a slow process. Pillai (1996) has attributed the poor reef growth in Palk Bay to the intense quarrying of coral from this reef in the sixties. According to UNEP report (1985) the development of Tuticorin Harbour, oil pollution and industry have caused significant damage in the Gulf of Mannar and Palk Bay area. Although the coral reefs have encountered natural disturbances and recovered in the past, changes in community structure and shifts in the balance of coral reef processes have increased in scale and frequency in recent decades, recovery is delayed more often, and situations that used to be acute are now chronic. The coral reefs of Palk Bay need careful consideration from policy makers, in the absence of which, the reefs will perish in no time and seaweeds will dominate the ecosystem. Immediate attention is needed for chalking out measures for conservation to protect what is left of our reefs.

Acknowledgements

The authors wish to acknowledge Prof. (Dr.) Mohan Joseph Modayil, Director, CMFRI, Cochin for all the encouragements and support to carry out this work. Acknowledgements are also due to Dr. N.Kaliaperumal, RC CMFRI, Mandapam for providing all the facilities and Dr.C.S.G.Pillai, expert in coral taxonomy, for his critical comments and valuable suggestions.

References

Birkeland, C.1997. Introduction to Life and death of coral reefs. *In:* Birkeland, C. (Ed.) *Life and death of coral reefs.* International Thomson Publishing, New York. p. 1-12.

DOD & SAC, (1997) *"Coral reef maps of India,"* Department of Ocean Development and Space Application Centre, Ahmedabad, India.

Done, T.J.1999. Coral community adaptability to environmental change at the scales of regions, reef and reef zones. *Am.Zool.*,39:66-79.

English,S., C.Wilkinson and V.Baker.1994. *Survey Manual for Tropical Marine Resources.* Australian Institute of Marine Science, Townsville, Australia, p. 34-35.

Hughes,T.P. and J.H. Connell. 1999. Multiple stressors on coral reefs: a long term perspective. *Limnol. Oceanogr.*, 44: 932-940.

Kumaraguru,A.K.,K.Jayakumar and C.M.Ramakritinan. 2003.Coral bleaching 2002 in the Palk Bay, South east coast of India. *Curr. Sci.*, 85(12): 1787 – 1793.

Lambshead P.J.D, H.M.Platt and K.M.Shaw.1983. The detection of differences among assemblages of marine benthic species based on an assessment of dominance and diversity. *J. Nat. Hist.*, 17:859-874.

Marshall, S.M. and A.P.Orr.1931. Sedimentation on Low Isles Reefs and its relation to coral growth. *Scient. Rep. Gt.Barrier Reef Exped.*,1(5):93-133.

Mayer,A.G.1918.Ecology of Murray Island Coral Reefs. *Pap.Dep.Mar.biol.Carnegie Instn.Wash.*, 213:1-48.

Pillai, C.S.G. 1967 a. Studies on Indian corals – I. Report on a new species of *Montipora* (Scleractinia, Acroporidae). *J.Mar.Biol.Ass.India*, 9(2): 399 – 401.

————1967 b. Studies on Indian corals – 2. Report on a new species of *Goniopora* and three new species of *Porites* (Scleractinia, Poritidae). *Ibid.* 9(2): 402-406.

————1967 c. Studies on Indian corals – 5. Preliminary reports on new records of hermatypic corals of the suborder Astrocoeniina. *Ibid.* 9(2): 412-422.

———— 1969. The distribution of corals on a reef at Mandapam (Palk Bay), S. India. *ibid.*11(1&2): 62-72.

———— 1973. A review of the genus *Acropora* (Scleractinia, Acroporidae) with the description of a new species. *Ibid.* 15:296 – 301.

———— 1996. Coral reefs of India : Their Conservation and Management. *In*: Pillai, C.S.G. and N.G.Menon (Eds.),*Marine Biodiversity, Conservation and Management*, CMFRI, Cochin, India. p.16-31.

Rilov, G. and Y.Benayahu.1998. Vertical artificial structures as an alternative habitat for coral reef fishes in disturbed environments. *Mar. Environ. Res.*, 45: 431 – 451.

UNEP (1985). Environmental problems of the marine and coastal areas of India: National Report. *UNEP Regional Seas Reports and Studies.* 59: 33 pp.

Venkataraman, K., Ch. Satyanarayana, J.R.B. Alfred and J. Wolstenholme.2003. *Handbook on Hard corals of India*, Zoological Survey of India, Kolkata. 266pp.

Veron,J.E.N.1986.*Corals of Australia and Indo – Pacific*, Australian Institute of Marine Science, Townsville, Australia.644pp.

Wilkinson, C.R. 2000. Executive Summary. *In*: Wilkinson, C.R.(Ed.) *Status of coral reefs of the world*: 2000. Australian Institute of Marine Science, Townsville, Australia. p.7-19.

Yap,H.T and E.D. Gomez. 1985.Coral reef degradation and pollution in the East Asian Seas region. *In*: Dahl, A.L and J. Carew – Reid (Eds.), *Environment and resources in the Pacific*,UNEP Regional Seas Reports and Studies, No.69: 185-207.

Accepted: 18 October 2005