

## STUDIES ON THE MARINE FAUNA OF THE MAHATMA GANDHI MARINE NATIONAL PARK, WANDOOR, SOUTH ANDAMAN PART 1 : CORALS

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### ABSTRACT

A comprehensive survey was carried out during October 1990 to April 1991 to document the marine flora and fauna, found in the Mahatma Gandhi Marine National Park, Wandoor, South Andaman. The present paper deals with coral species distribution, abundance and their present status in five islands of the park. The coral reefs were of fringing type. Nearly 47% of the reef area was covered with live and luxuriant corals of different species. Soft corals formed about 3% and dead corals 36% of the reef areas. Of the 31 corals recorded under 25 genera, *Acropora*, *Porites* and *Millepora* were the dominant forms. In a few stations, corals were partially damaged due to boat anchorage, human interference and crown of thorns starfish predation. Based on the species diversity and extent of live coverage, the status of coral reefs of the park is broadly classified as 'good' in Red Skin and Twin Islands and as 'fair' in Jolly Boys, Tarmugli and Boat Islands.

The marine ecosystems of the Andaman and Nicobar Islands are unique in having very high degree of bio-diversity and endemism in fauna and flora. The coral reefs of these Islands are among the richest in the Indian Sub-continent. They not only protect the coastline against sea erosion but also harbour host of animal communities like fishes, crustaceans, molluscs, echinoderms, sponges and other organisms. Commercial fisheries often indirectly

depend on coral reefs which serve as nursery grounds for juveniles. Of late, the coral reefs have come under heavy pressure due to uncontrolled and inconsistent developmental activities on coastal land leading to deforestation, mangrove habitat destruction and degradation of other marine ecosystems. In order to protect the rich diversity of floral and faunal life including marine life such as corals, nesting sea turtles and endangered mammals, a total of 733.12 km<sup>2</sup> area in Andaman and Nicobar Islands has been declared as protected area which

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include 93 sanctuaries and 6 National Parks.

There is no detailed study on marine flora and fauna of the Mahatma Gandhi Marine National Park, Wandoor, except for brief reports by Singh *et al.* (1986), Dorairaj, *et al.* (1987), Gopakumar *et al.* (1990) James *et al.* (1990), Pratiha Pandey *et al.* (1991), Khan (undated) and Forest Department (undated). Therefore, a comprehensive survey programme was undertaken to study the fauna and flora found in the park. Voluminous quantitative data were gathered for the first time on the occurrence and the density distribution of various marine fauna such as sponges, live corals, soft corals, dead corals, sea cucumbers, gastropods, bivalves, sea stars, sea urchins, crabs, lobsters, fishes and sea anemones. In this paper the data on corals are presented and discussed to give an overview of their distribution, abundance and present status.

#### MATERIALS AND METHODS

The Mahatma Gandhi Marine National Park, Wandoor previously known as 'Wandoor Marine National Park' is located in the South western coast of South Andaman, in the Bay of Bengal between 11°22" and 11°36" N latitudes and 92°30" and 92°40" E longitudes, covering a total area of 281.5 km<sup>2</sup>. Besides vast stretch of enchanting marine waters, magnificent coral reefs, sandy beaches and mangrove swamps, the park includes a labyrinth group of 15 bushy vegetated

islands, namely, Alexandra, Red Skin, Boat, Hobday, Tarmugli, Rifleman, Twins, Grub, Snob, Belli, Puioto, Malay, Jolly Boys and part of Rutland islands (Fig. 1). Under the Wildlife (Protection) Act of 1972, the Park was notified on 24th May, 1983 for the protection of marine life, including corals and nesting sea turtles. As a part of tourism development, two islands in the Park, viz., Jolly Boys and Red Skin are open to tourists to visit (during day time only) in fair seasons. There is a jetty at Wandoor with facilities for berthing motor launches. Though the park is un-inhabited, there are 8 villages adjacent to the park with a population of about 300. The fishermen of these villages pass through the park for fishing beyond the park's boundary. The park is under the overall administrative control of the Chief Wildlife Warden of the Forest Department of Andaman and Nicobar Islands Administration.

Of the 15 Islands in the Park, 5 islands, namely, Jolly Boys, Red Skin, Tarmugli, Boat and Twin Islands were selected for detailed survey. In each island 4 to 9 survey stations were fixed in order to cover the maximum perimeter of each island (Fig. 2). Line transect and quadrat survey methods, with slight modifications, were adopted to study the animal communities distributed from the shore to the reef slope.

*Line Transect Method:* A nylon rope with markers at 1m intervals was laid underwater as a straight transect line from the shore to the reef slope. The survey was done by snorkeling and free diving. While swimming along the

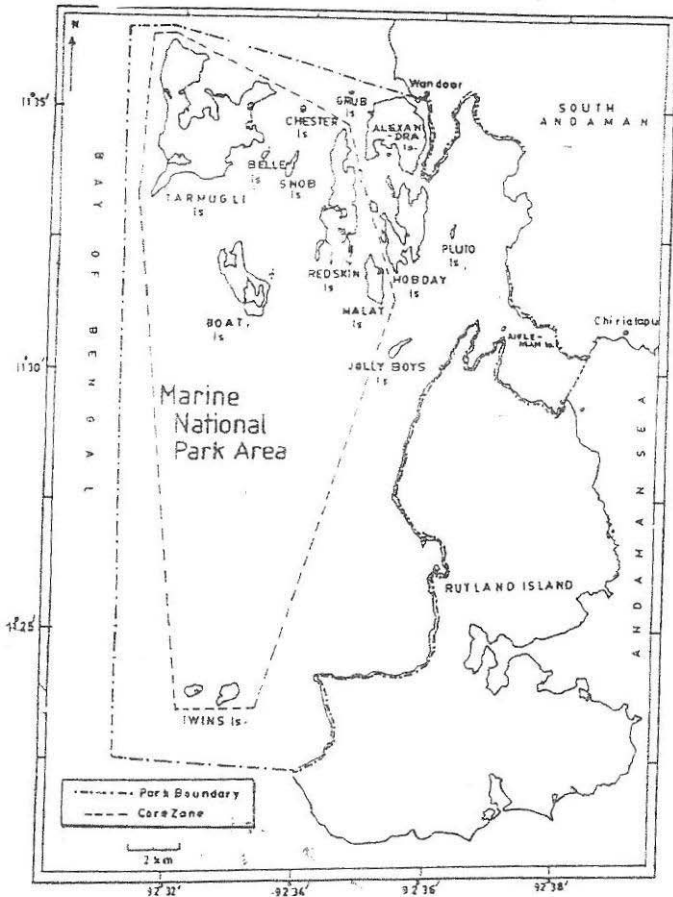


Fig. 1: Map showing core and buffer areas of Wandoor Marine National Park, Andaman

line from shore to seaward end, the number of fish species within a distance of 5 metres on either side of the transect line, were observed and recorded. While returning, other conspicuous less

mobile macrofauna like molluscs, echinoderms etc., found within in a distance of 2.5m on either side of the transect line were visually counted. The counts were analysed for every 10m

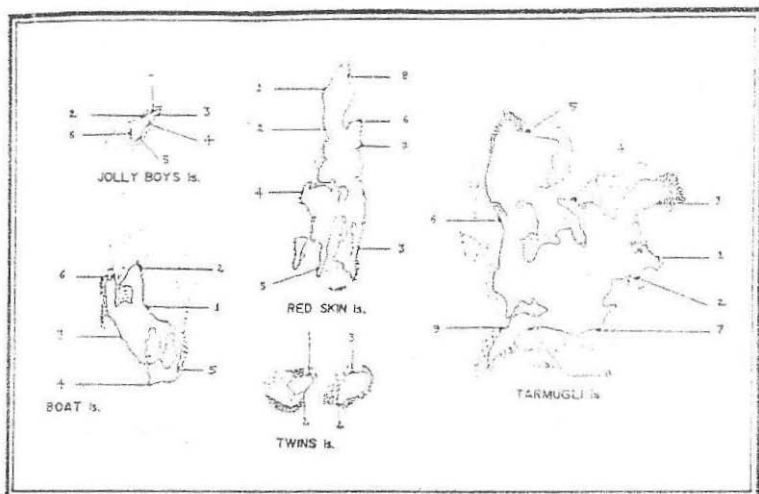


Fig. 2: Maps showing the coral reef sites surveyed off five islands in Wandoor Marine National Park, Andaman

intervals of the transect line so as to express the data in numbers for every  $100\text{m}^2$  for fishes and  $50\text{m}^2$  for other macrofauna like molluscs, echinoderms etc.

A more detailed quantitative survey was conducted to record the coverage of live corals, dead corals, soft corals, flora and substrata like sand and rocks along every metre length of the transect, starting from highest high tide mark and as far as the beginning of the reef slope. The position and proportionate length of the live corals (as hard corals), dead corals (as old, recent, damaged or bleached), soft corals, sponges, flora and other substrata (sand, rock etc.) which lay under the line

were recorded. Wherever possible the fauna were noted upto species level. In the case of coral colonies growing one above the other, the approximate length overlying colony alone was taken into consideration for analysis, even though the presence of the other colony was also noted.

After completing the first transect survey as described above, two more transect surveys were done fifty meters apart on either side of the first transect and similar observations were recorded. The computations of data were made by combining all the three transects to get the average values and thus percentage cover of various components were arrived at for each 10m transect

zone for a particular station.

*Quadrat survey method:* A copper metal quadrat measuring one square metre and subdivided by metal wire into 16 smaller squares (25 cm x 25 cm) was used for the survey. By placing the quadrat at the bottom on the transect line at every 10 metre intervals the substrata like hard corals, dead corals, sand, rock etc., within each small square of the quadrat were mapped on the underwater writing slate. After completing the quadrat survey of one transect as described above, two more transect lines were laid fifty metres apart on either side of the above transect and similar observations were recorded. The computation of data was made combining the parallel quadrat recordings of all the three transects in each location of the island. While analysing the data, any substratum occupying the square for more than half, has been counted as one square. The percentage cover of each component was worked out based on the number of squares occupied by the same component out of 16 squares of the quadrat. The estimate of total percentage cover was done for the whole transect length by adding the total number of squares occupied in all the quadrats throughout the transect length.

A total of 99 transect surveys were made in 33 stations. The total transect distance covered was 15,000 m (in which 1569 quadrats were sampled) to record the occurrence and distribution of marine flora and fauna such as live corals, dead corals, soft corals, sponges, fishes, gastropods, bivalves,

sea cucumbers, sea stars, sea urchins, crabs, lobsters and sea anemones.

Based on the hard coral cover in the reef area, the condition of the reef was broadly categorised as excellent (100%-76%); good (75-51%); fair (50-26%); and poor (25-0%). Obvious causes for reef damages, if any, were also noted.

The hydrographical data for sea water at the surface and near the bottom (substratum) were collected using standard methods.

## RESULTS AND DISCUSSION

### *Physical features of the surveyed islands:*

The coral reefs of the Marine National Park were mostly of fringing type. The density distribution of corals and their species composition in different stations of the five islands are given in Fig 3. Some of the salient observations are presented here.

Among the five islands surveyed, Jolly Boys Island is located in the buffer zone and the remaining islands are located in the core zone of the Marine National Park.

Jolly Boys Island has a total land area of about 17 ha. The coastline vegetation leads to sand and in some places to rocks. There is no mangrove vegetation in the island.

Red Skin Island has a total land area of about 347 ha. The western shore has sandy stretches with sheet rocks at a few places. Fairly extensive mangrove swamps are found in the west, south and eastern parts of the island.

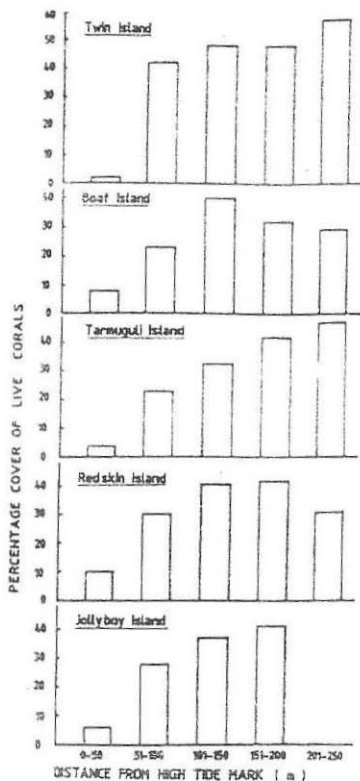


Fig. 3: Histograms showing live coral distribution in coral reefs of Wandoor Marine National Park, Andamans

Tarnuguli Island is the biggest in the core zone of Marine National Park, having a total land area of 945 ha. Very thick mangrove vegetation, sandy beaches and sheet rocks intertwine the coastline of the island. Extensive

mangrove swamps exist in the northern part of the islands. A few patches of swamps are also found in the east, south-eastern and south-western parts of the island.

Boat Island has a land area of about 180 ha. Fairly extensive mangrove swamps are found in the northern and south western parts of the island while sheet rocks are present on the south-eastern and north-western parts of the island. Coastal vegetation leads to sandy as well as rocky beaches.

Twin Islands comprise two small islands situated side by side in east-west direction in the southern most core area of the Park, far away from rest of the Labyrinth group of islands. The total land area of the Twin Islands is about 49 ha. In the island in the east, the coastal vegetation leads to sheet rocks, edged rocks and sandy beaches while in the island in the west, vast stretches of sandy beaches and edged rocks are present.

#### *Hydrophical condition :*

The hydrographical data collected from different coral reef sites surveyed in the five islands are presented in Table 1.

The Surface sea water temperature in all the surveyed islands had been almost uniform but the bottom water showed variations along different islands, with cooler waters recorded along Jolly Boys and Red Skin islands. However, with regard to salinity while there was not much variation between surface sea water and bottom sea water, the salinity values were comparatively lower along Boat and Twin islands in

Table 1 : Hydrographical conditions of coastal waters during the coral reef survey (1990-91) off five surveyed islands in Mahatma Gandhi Marine National Park

Parameters		Jolly Boys	Red Skin	Taruugi	Boat	Twins
<i>Temperature (°C)</i>						
Atmospheric	Range	30.0-32.0	30.0-34.0	30.0-34.0	31.0-34.0	33.0-33.5
	Average	31.6	31.7	32.1	32.8	33.1
Surface Water	Range	29.0-30.0	28.0-30.0	29.0-31.5	29.5-31.0	29.5-30.5
	Average	29.6	29.1	30.1	30.1	30.0
Bottom Water	Range	27.0-28.5	27.5-29.0	28.0-29.5	28.0-30.0	28.5-29.0
	Average	27.8	28.1	28.7	29.1	28.9
<i>Salinity (ppt)</i>						
Surface Water	Range	32.1-33.1	32.0-33.1	30.1-32.9	28.6-33.3	28.8-32.9
	Average	32.6	32.9	31.7	30.2	30.1
Bottom Water	Range	32.0-33.4	32.4-33.1	30.1-33.8	28.8-32.5	29.1-33.0
	Average	32.6	33.0	32.0	30.5	30.3
<i>Dissolved Oxygen Content (ml/l)</i>						
Surface Water	Range	5.6-6.3	4.8-6.0	4.9-6.1	5.7-6.0	5.2-5.8
	Average	6.0	5.3	5.8	5.9	5.6
Bottom Water	Range	5.6-6.1	4.3-6.3	5.9-6.1	5.4-6.1	5.3-5.9
	Average	5.8	5.4	6.0	5.9	5.7
<i>pH</i>						
Surface Water	Range	8.4-8.7	8.2-8.4	8.2-8.4	8.1-8.5	8.1-8.3
	Average	8.5	8.3	8.3	8.3	8.2
Bottom water	Range	8.4-8.7	8.1-8.4	8.2-8.4	8.1-8.5	8.1-8.3
	Average	8.6	8.3	8.3	8.2	8.2
<i>Transparency (m)</i>						
Vertical	Range	3.2-3.7	3.3-4.0	3.5-6.0	3.0-3.8	5.0-6.0
	Average	3.5	3.7	3.9	3.5	5.5
Horizontal	Range	4.5-5.5	3.5-4.8	4.0-5.5	3.5-5.0	5.0-6.8
	Average	4.8	4.3	4.6	4.4	6.1

comparison to other three surveyed islands. The dissolved oxygen content of sea water was comparatively lower along Red Skin than around other islands where the values were almost uniform. The pH values of sea water around Jolly Boys were significantly higher. The transparency of sea water was far greater around Twin Islands

than around other islands.

### Coral Cover

#### Jolly Boys Island

The percentage cover of live corals in the coral reefs off Jolly Boy Island is given in Table 2.

*Station 1*: The live coral occurrence

Table 2 : Percentage cover of live corals in 10m zones from the shore upto reef slope at different survey stations off Jolly Boys Island

Distance from shore (m)	Survey Stations						Average
	1	2	3	4	5	6	
0-10	Nil	Nil	Nil	Nil	Nil	Nil	Nil
11-20	11	Nil	Nil	Nil	Nil	Nil	2
21-30	10	2	29	0.3	1	Nil	7
31-40	27	1	33	3	Nil	Nil	11
41-50	29	9	39	3	2	Nil	12
51-60	32	3	40	2	3	Nil	15
61-70	41	16	67	1	4	1	20
71-80	53	19	85	19	28	Nil	34
81-90	55	43		15	35	8	26
91-100	75	45		51	65	Nil	47
101-110	49	62		39	15	4	30
111-120	31	83		46	21	12	34
121-130	13	26		68	56	3	45
131-140	33	31		74	41	18	38
141-150				35	43	42	24
151-160					17	55	56
161-170					44	68	42
171-180						42	52
181-190						52	34
191-200						34	

begins 11m and the percentage cover of live coral was over 50% from 71 to 100 m from the shore. The dead coral coverage varied from 1 to 54%, the maximum being at 21-30 m zone from the high tide mark. Soft corals were seen in the zones between 41m and 70m, in fairly good proportion (25 to 33%).

*Station II*: The live coral distribution starts at a distance of 80m and luxuriant growth was seen at 91 to 130m zones from the shore. The major species belonged to *Millepora*, *Porites* and *Galaxea*. The latter two coral forms were dominant at the sea-ward end of reef flat. The dead coral percentage was fairly high (23 to 47%) between 11 and

110m from the shore.

*Station III*: The live coral coverage was very high forming 85% at the reef end and the major species belonged to *Montipora* and *Merulina*. The other dominant corals found in the stations were *Porites* and *Acropora*. Soft corals were found only at 51-70m zones. The dead corals were seen from 11m onwards and upto the reef slope beginning at 80m; most of them were old dead corals forming 14 to 50% coverage in each 10m zones. The maximum percentage of dead coral was at 21-30m zone. The damages caused during the snorkeling by the tourists seem to be the major factor for the death of the corals.



*Station IV* : The luxuriant coral growth was found only from 91 to 140m. In 121 to 140m zones, they covered to 68 to 74%. *Porites* (46%) was the dominant coral followed by *Acropora* (29%) and *Montipora* (15%). *Fungia*, *Favia* and *Favites* formed small proportions (2-3%). The percentage of dead corals varied from 51% in 41-50m zone to 5% at 131-140m from the shore. In 51-90m zones, the dead corals form an average of 41% and most of them were old dead corals. Small patches of live corals were observed from 21m onwards. Soft corals belonging to *Sarcophytum* were located in patches at 61-80m, 101-120m and 131-150m zones from the shore.

*Station V* : The coral reef flat starts at 80m from the shore and the reef slope begins at 170m. The percentage cover of live coral in reef area varied from 15 to 65% in different 10m zones, the maximum being at 91-100m zone. The branched coral, *Acropora* was dominant forming about 60% of the total live corals, followed by *Porites* (29%). The cover of dead corals in 60 to 150m zones ranged from 25 to 66% with the maximum at 61-70m zone. Soft coral *Sarcophytum* was only at 81 to 90m and 141 to 160m zones.

*Station VI* : Patches of live corals were observed from 51 to 140m and good coral growth was seen from 141m and upto the reef slope at 200m with maximum distribution at 161-170m zone (68%). The dominant coral forms belonged to *Acropora* and *Montipora* forming 54% and 26% respectively. The dead corals were recorded from

41m and upto reef slope at 200m. The percentage cover of dead corals in four 10m zones from 81 to 120m was very high ranging from 72 to 89%. They were all old dead corals covered with algae. The soft coral (*Sarcophytum*) was seen only at 111 to 130m and 181 to 190m zones.

#### *Red Skin Island*

The percentage cover of live corals in different survey stations of coral reefs off Redskin Island is given in Table 3.

*Station I* : Live corals were seen in patches from 31 to 50m zone. Good coral growth was observed from 51m and upto the reef slope at 100m. The live coral coverage varied from 41 to 76%. *Porites* was the dominant coral, forming about 65% of the total coral coverage, followed by *Merulina* and *Millepora* 10% each, and *Acropora* and *Favites* 7% each. The percentage cover of dead corals was fairly high ranging from 31 to 48% in 41 to 70m zone. The proportion of dead corals in the beginning of the reef (51 to 60m) was very high, caused probably due to tourist interference. The soft coral *Sarcophytum* was recorded from 61 to 90m zone in patches.

*Station II* : The maximum live coral coverage (53%) was observed at 191 to 200m zone. *Porites* was dominant forming 71%, followed by *Acropora* with 15%. Dead corals formed less than 25% in 61 to 120m and 171 to 200m zones, whereas in 131 to 170m zone it formed about 33 to 50%. The latter zone is also the zone for the beginning of the coral reef, with 23 to 48%

Table 3 : Percentage cover of live corals in 10m zones from the shore upto reef slope at different survey stations off Redskin Island

Distance from shore (m)	Survey Stations								Average
	1	2	3	4	5	6	7	8	
0-10	-	-	-	-	-	12	23	-	4
11-20	-	-	-	-	-	27	66	-	12
21-30	-	-	-	-	-	36	61	4	13
31-40	2	-	-	-	-	50	25	1	10
41-50	12	-	-	-	18	46	-	3	12
51-60	42	3	-	28	-	70	-	15	23
61-70	48	10	-	26	-	59	-	37	26
71-80	76	3	-	66	-	47	-	31	27
81-90	69	-	9	47	2	69	-	30	32
91-100	70	6	50	79	4	44	-	50	42
101-110	-	11	57	74	50	-	-	86	46
111-120	-	26	82	67	25	-	-	54	42
121-130	-	23	60	32	47	-	-	43	34
131-140	-	27	-	20	43	17	-	19	25
141-150	-	23	-	-	66	27	-	15	32
151-160	-	25	-	-	9	-	-	40	25
161-170	-	31	-	-	-	-	-	43	37
171-180	-	48	-	-	-	-	-	60	54
181-190	-	39	-	-	-	-	-	-	39
191-200	-	53	-	-	-	-	-	-	53
201-210	-	31	-	-	-	-	-	-	31
211-220	-	-	-	-	-	-	-	-	-

coverage of live corals. Soft coral, *Sarcophytum* was recorded only from 91-100m and 201-210m in small patches.

**Station III :** The inshore region upto 20m from the shoreline is of rocks and further 60m is of sandy. The reef area is very narrow; it starts at 100m from the shore and sloped at 130m. Coral growth was luxuriant at 91 to 130m zone, forming 50 to 82% coverage. *Porites* (56%) and *Goniopora* (23%) were the major coral forms. The cover of dead corals in 81 to 100m zone was about 42%. Soft corals were seen only near the reef slope in small patches.

**Station IV :** Live corals seen in

patches from 51 to 70m zone and beyond that coral growth was luxuriant. Percentage coverage of live coral was very high at 91 to 110m zone (75%). The dead corals were observed only from 41 to 90m zone and in the rest of the zone it was either nil or negligible. The maximum coverage (65%) was at 41-50m zone, followed by (51%) at 51-60m zone. Soft coral was seen only at 61-70m, 101-110 and 121-130m zones in patches. By far the maximum assemblage of coral fauna (about 13 groups) were observed only in this station. The dominant group was *Porites* sp (45%) followed by *Acropora*, *Goniopora* and *Montipora* (10 to 14%).

*Station V* : Luxuriant coral growth was observed from 101 to 150m zone. The maximum of 66% live coral coverage was at 141-150m zone, followed by 50% at 101-110m zone. Of the 8 coral forms recorded *Acropora* was the dominant, forming 39% followed by *Millepora* 25% and *Porites* 22%. Dead corals were seen from 61m from the shore line and upto reef slope, with percentage cover varying from 5 to 48%. The dead corals were mainly formed by *Montipora* sp and were covered by algae.

*Station VI* : Live corals were seen in patches upto 10m and beyond that very good coral growth was observed. In different 10m zones the live coral coverage varied from 27 to 70%. However, live corals were conspicuously absent from 101 to 130m zone. The condition of the corals was also very good, except in the reef slope where it was in damaged condition, due to anchorage of boats. *Porites* (45%) and *Acropora* (28%) were the dominant coral forms. The dead corals were found from the shore upto 100m and again from 131 to 150m. The substratum coverage of dead corals was high at 21-30m zone forming 52%.

*Station VII* : The reef slope starts at 40m from the shore. However, at some points it starts even at 40m from the shore thus considerably limiting the reef area. Live corals upto 10m zone formed 23% substratum coverage. Coral growth was very good from 11 to 30m zone. Percentage coverage was very high in 11-20m zone (66%) followed by 21-30m zones (61%). The major coral

form was *Porites* which constituted upto 59% of the total corals. The substratum coverage of rest of the coral forms was less than 10%. The percentage coverage of dead corals ranged from 7 to 24% in the inshore region upto 40m zone.

*Station VIII* : Live corals were seen from 21m and upto reef slope at 180m. Coral growth was good particularly at 61 to 130m zone, where the coverage was from 31 to 68%. Live coral coverage near reef slope was also in high percentage (60%). Soft corals were seen in patches at 71 to 90m, 111-120m and 131-140m zones. Of the 8 coral forms recorded, *Acropora* was the dominant, forming 59%, followed by *Porites* (12.8%), *Montipora* (9.3%), *Favia* (9%) and *Favites* sp (6.4%). The dead corals were observed from 21 to 170m with substratum coverage of 4 to 47%. Most of them were old dead corals.

#### *Tarmugli Island*

The percentage cover of live corals in the survey sites of coral reefs of Tarmugli island is given in Table 4.

*Station I* : Live corals were in small patches at 11-50m zones, whereas 61-80m zones it covered nearly 45% of the substratum. *Acropora* was dominant forming 62.7% followed by *Leptoria* (18.7%) and *Porites* (16.1%). The dead corals were found from the shoreline to 100m, with high coverage of 59% in 11-20m zone followed by 47% in 41-50m zone. Soft corals were recorded from 61 to 80m zones with the coverage of 7-10% of the substratum.

Table 4 : Percentage cover of live corals in 10m zones from the shore upto reef slope at different survey stations off Tarmugli Island

Distance from shore (m)	Survey Stations									Average
	1	2	3	4	5	6	7	8	9	
0-10	-	-	-	-	-	-	-	-	-	-
11-20	1	-	-	-	-	-	-	-	-	-
21-30	24	6	-	-	-	-	-	0.3	16	5
31-40	3	-	-	11	-	-	-	1	57	7
41-50	1	-	0.3	-	-	-	-	7	44	6
51-60	-	-	28	3	-	-	48	39	51	13
61-70	50	33	58	24	1	-	56	48	36	9
71-80	39	44	38	23	0.3	-	57	56	42	27
81-90	23	54	40	33	12	-	58	57	44	31
91-100	21	58	57	33	13	-	44	58	42	33
101-110	-	-	57	44	20	1	56	44	61	34
111-120	-	-	61	32	21	1	28	56	49	35
121-130	-	-	60	58	17	10	-	38	55	35
131-140	-	-	30	33	19	10	-	-	42	28
141-150	-	-	12	42	32	14	-	-	57	34
151-160	-	-	-	-	19	31	-	-	60	36
161-170	-	-	-	-	34	32	-	-	37	46
171-180	-	-	-	-	35	37	-	-	-	40
181-190	-	-	-	-	32	68	-	-	-	46
191-200	-	-	-	-	9	64	-	-	-	43
201-210	-	-	-	-	25	19	-	-	-	26
211-220	-	-	-	-	75	52	-	-	-	42
221-230	-	-	-	-	68	49	-	-	-	53
231-240	-	-	-	-	69	48	-	-	-	58
241-250	-	-	-	-	60	59	-	-	-	55
251-260	-	-	-	-	23	45	-	-	-	34
261-270	-	-	-	-	37	23	-	-	-	30

*Station II* : The reef slope starts at 100m from the shore. Luxuriant live corals were seen from 61 to 100m zone, their substratum coverage ranged from 33 to 58%, the maximum being at 91-100m zone. Five coral forms were recorded from this station. *Porites* (75%) was the dominant form followed by *Favites* (19.9%), *Fungia* (2.4%), *Acropora* and *Seriatopora* sp (1.2% each). Dead corals were found in more or less uniform density from 11 to 100m: maximum (39%) substratum

coverage being at 61-70m zone.

*Station III* : Live corals start from 41-50m zone and extend upto reef slope at 150m. Good coral growth was observed at 61-70m and 91-130m zones. *Acropora* was the dominant group, forming 52.2% of total corals, followed by *Porites* (36.8%). The coverage of dead corals were between 2 and 61% in 11-140m zones; the maximum being at 31-40m zone (62%). Soft corals were recorded from 71 to 90m zones.

*Station IV* : Live corals were observed continuously from 51 to 150m, with coverage of more than 33% in 81 to 150m zones and maximum (58.3%) in 121-130m zone. Seven coral forms were recorded, of which *Porites* formed 49.7% followed by *Acropora* 33.5% and *Montipora* 10.6%. The dead corals were observed from the shore to reef slope at 150m. The substratum coverage of dead corals was very high ranging from 55 to 64% in 21-60m zones. Upto 50m from the shore, there was no live coral except a small patch at 40m. Soft coral (*Sarcophytum*) was found only at 101-110m zone.

*Station V* : The sea beach upto 40m from high tide mark was completely sandy with some rocky patches. Though live corals were observed from 61m from the shore, good coral growth was noticed from 161m onwards and upto reef slope at 270m zone, except 201-210m zone. A total of 8 coral forms were recorded of which *Acropora* was the most dominant forming 72.9% of the total coral forms, followed by *Porites*, 15.7%. Soft corals were recorded at two distinct zones at 51 to 80m and 221 to 250m, with high concentrations (22%) in the latter zone. The dead corals were found at 41-250m zones from the shoreline and its substratum coverage ranged from 3 to 50%; most of them were old dead corals. Soft corals were recorded at two distinct zones at 51 to 80m and 221 to 250m, with high concentration (22%) in the latter zone.

*Station VI* : Sandy substratum extends upto 80-100m from shoreline.

Live corals were observed in patches from 101 m onwards; luxuriant coral growth was found at 181 to 200m zone in reef area. *Acropora* spp were the dominant corals (73.2%), followed by *Porites* (15.7%). Dead corals were found only from 90m and their substratum coverage was very high (69.3%) at the beginning of the reef at 131-140m, as well as at 151 to 170m zone where it formed about 62%. Soft corals were observed only from 221 to 250m zones.

*Station VII* : Though live corals were observed from 71m from the shore, luxuriant corals were seen only from 150m onwards, except at 211-220m zone, where all the staghorn corals were found either in fully damaged or dead condition, probably due to human interference like boat anchorage. Coral species diversity was very high with 12 coral forms, of which the maximum of 68% was by *Acropora* followed by *Porites* (15.1%) and *Millepora* (8.6%). Old dead corals were found from 31 to 250m with maximum substratum coverage of 61% at 81-90m zone followed by 56% at 101-110m zone. Upto 110m, the dead coral percentage cover varied between 32 and 61%. Soft corals were recorded from 151-160 and 191-200m zones.

*Station VIII* : Both dead and live corals were observed from 21m from the shore to reef slope at 130m. The substratum coverage of dead corals was high at 31 to 70m zones. Between 21 and 50m zone live corals were seen only in patches, whereas, fairly good coral coverage (40-58%) was observed

in the rest of the zone. *Porites* spp were the dominant forms (65.2%), followed by *Acropora* (12.8%). Soft corals were seen only in 61 to 80m zones in small patches.

**Station IX :** Live corals were recorded from 21 to 180m with fairly high percentage at different zones, with maximum (61%) at 101-110m zone. *Millepora* was dominant (35%), followed by *Acropora* and *Porites* (30%). The latter coral was dominant near the reef slope. *Favites* formed 5%. Dead corals were observed from 21m from the shore and up to the reef slope at 180m. The distribution of dead corals was nearly 50% at 71-90m and 121-130m zones. Soft corals were recorded from 91-110m and 131-140m zones with high concentration (23%) at 91-110m zone.

#### Boat Island

The percentage cover of live corals in different survey sites of coral reefs off Boat Island is given in Table 5.

**Station I :** Both dead and live corals were observed from the shoreline to the reef slope at 90m. The percentage of dead coral was high (51%) in 21-30m zone, mostly formed by *Porites*. Luxuriant growth of live corals was observed in the inshore area up to 30m and at 41-50m. The coral reef is patchy in nature dominated by *Porites* which formed 75%. Besides, *Acropora* (16.6%), *Favites* (6.6%) and *Seriatopora* (1.7%) were the only other coral forms found in the station. Soft corals were seen only at 11-20m zone in small patches.

**Station II :** Patches of live corals were found from 41m onwards with fairly good coral growth at 81 to 110m zone. Eight coral forms were recorded of which *Porities* (47.1%) and *Acropora* (40.4%) were the dominant forms. The dead coral coverage ranged from 5 to 65% with more than 50% in 31 to 70m zones. The dead corals were thickly covered by algae in the nearshore zone. Soft corals were recorded from 81-90m and 101-110m zones in small patches.

**Station III :** The major features of the beach were rocky upto 20m and sandy beyond another 20m. Both dead and live corals were observed only from 41m and that extended upto the reef slope at 200m. The maximum substratum coverage of dead corals was 73% at 81-90m zone. Dead coral percentage was also relatively high from 161 to 190m zone, forming an average of 52%. More than 50% substratum coverage of live corals were observed at 61-70m, 121-130m and 141 to 160m zones. Of the 9 coral forms recorded, the dominant coral was *Porites* (44.7%), followed by *Millepora* (24.6%) and *Acropora* (21.0%). Soft corals were recorded in patches at 151-160m zone.

**Station IV :** The live corals were observed from 61m to reef slope at 250m zone. The maximum substratum coverage of 72% was recorded at 221-230m zone. The dominant coral forms were *Acropora* and *Porites* (42% each) followed by *Montipora* (10.6%). The substratum coverage of dead corals ranged from 4 to 71%; the maximum being at 181-180m zone. Soft corals

Table 5 : Percentage cover of live corals in 10m zones from the shore upto reef slope at different survey stations off Boat Island

Distance from shore (m)	Survey Stations						Average
	1	2	3	4	5	6	
0-10	53	-	-	-	-	-	9
11-20	52	-	-	-	-	-	9
21-30	40	-	-	-	-	-	7
31-40	31	-	-	-	1	-	5
41-50	51	1	10	-	5	-	11
51-60	42	3	31	-	15	8	17
61-70	18	28	51	2	18	5	20
71-80	17	33	44	19	40	11	27
81-90	32	49	25	10	24	13	26
91-100		45	46	-	10	14	23
101-110		43	37	16	37	33	33
111-120		23	33	23	48	20	29
121-130		29	56	-	43	48	44
131-140			48	-	45	28	40
141-150			60	-	63	37	53
151-160			68	-	22	11	34
161-170			47	-	33	36	39
171-180			34	-	31	56	40
181-190			15	-	8	44	22
191-200			32	-	27	43	23
201-210				-	13	8	11
211-220				-		10	10
221-230				-		52	52
231-240				-		40	40
241-250				-		32	32

were recorded only near the reef slope at 231 to 250m with density coverage of 13 to 22%.

*Station V* : Patches of live corals were seen at 31m. The substratum coverage of live corals ranged from 1 to 63%. In the middle zones of 111 to 150m, live corals were in good concentration forming between 43 and 63%. Altogether nine dominant coral forms were observed, *Porites* forming (55.8%) and the next being *Acropora* (23%). *Millepora* and *Favites* formed 7.3% and 5.3% respectively. The dead

corals were observed with high substratum coverage of 71% at 51-60m zone, closely followed by 58% at 61-70m zone. Near the reef edge (191-200m) the dead corals were relatively less forming about 3%. Soft corals were recorded in two distinct zones of 111 to 150m and 181 to 200m, with slightly higher distribution in the former zones.

*Station VI* : The live corals exist from 51-60m from the shoreline and were distributed in small patches upto 100m. Coral growth was fairly good at 121-130m, 171-200m and 221-240m

zones, dominated by *Acropora* which formed about 72% of the total live corals. *Porites* and *Millepora* formed about 14% and 9.0% respectively. The dead corals were observed from 21 to 250m, with fairly high substratum coverage of 52-80% at 91 to 130m zones and about 58% at 201-220m zone.

#### Twin Islands

The percentage cover of live of different survey sites of coral reefs off Twin Islands is given in Table 6.

*Station I* : Live corals were distributed in patches at 31 to 60m zones. Coral growth was luxuriant from 61 to 150m zones, with high concentrations

at 111-120m zone, forming 77% coverage. *Acropora* were the dominant forms (75%) followed by *Millepora* (16%) and *Montipora* (5%). The substratum coverage of dead corals ranged from 20 to 75%; the maximum being at 31-40m zone. Though the dead corals were observed from 21 to 150m, their percentage cover near the reef edge (22 to 150m) was relatively less (20 to 38%). Soft corals (*Sinularia* sp) were recorded at only two distinct zones 91-110m and 131-150m zones in moderate density.

*Station II* : The dead corals were found from 31m from the high tide mark to 180m at the reef slope, with

Table 6 : Percentage cover of live corals in 10m zones from the shore upto reef slope at different survey stations off Twin Island

Distance from shore (m)	Survey Stations				
	1	2	3	4	5
0-10	-	-	-	-	-
11-20	-	-	-	-	-
21-30	-	-	-	-	-
31-40	5	-	-	1	2
41-50	17	6	1	-	6
51-60	4	55	15	7	20
61-70	40	66	60	2	42
71-80	53	63	62	18	49
81-90	46	70	45	58	55
91-100	45	30	62	38	44
101-110	37	40	45	43	41
111-120	77	79	58	7	55
121-130	40	75		42	52
131-140	24	59		49	44
141-150	34	63		45	47
151-160		31			31
161-170		23		22	32
171-180		23		72	48
181-190				68	68
191-200				74	74
201-210				46	46
211-220				67	67



substratum coverage ranging from 2 to 79%. The maximum dead corals were found at nearshore zones of 31-50m. The major cause for the damage and death of the corals seems to be the activities of the humans for shell collection. Several people were found actively collecting the shells during the survey. However, one of the best and luxuriant growth of corals was also seen from this station, particularly from 51-90m and 110-150m zones. Coral species diversity was also very high; 11 coral forms were recorded of which *Acropora* formed 51.4% and *Millepora* 30.5%. Some *Acropora* were found in bleached condition, probably due to infestation of Crown of thorns starfish which were also recorded in this station. Soft corals were recorded from two distinct zones of 61-90m and 141-150m, forming nearly 5% in the former and 7% in the latter zone.

*Station III* : Patches of live corals were found from 41 to 60m zone, with substratum coverage of 45 to 62%; *Acropora* and *Millepora* were the dominant forms each forming 42% coverage. Coral formation in the reef region was poor while it was slightly better on the inner side of the reef slope. The dead corals were observed from 31 to 120m, with maximum substratum coverage of 54% at 51-60m zone, followed by 53% at 81-90m zone. Soft corals (*Sinulaira* sp) were observed at 61-80m and 101-110m zones.

*Station IV* : Patches of live corals were observed from 31 to 70m zones. A distinct 10m sand zone was observed at 151-160m, devoid of any coral

forms. Coral growth near the reef end was very good and the substratum coverage varied between 46% and 74% at 171-220m zones. *Acropora* were the dominant corals forming 53% coverage, followed by *Millepora* 35%. *Porites* and *Merulina* were of equal proportions (5%). The dead corals were found from 31m and upto reef edge at 210m. The percentage cover was very high (93.3%) in 111-120m. In the nearshore zones of 41-80m, it formed 63% to 83% while near the reef edge, the dead coral proportion was about 22%. Soft corals were seen in patches at 121-130m and 141-150m zones and in more density (10%) at 181-190m zone.

#### *Overall Status of reefs in Mahatma Gandhi Marine National Park*

In Jolly Boys Island, the live coral coverage in different stations was between 37 and 50%, with an aggregate of 42.3% for the whole island (Table 6). Coral species diversity was moderately good. More than 26 species under 17 genera were recorded, *Acropora* and *Porites* were dominant, forming 33 and 28%, respectively. Soft corals also occurred in all stations and were represented by 3 species; maximum coverage (12.4%) was in Station I. The dead coral coverage was nearly 38%. A small percentage of them was in 'Bleached' condition and it appeared to have been caused by the predation of coral polyps by the dreaded crown of thorns starfish (*Acanthaster planci*) which were observed in the island during the present survey. Wood (1989) had also reported

Table 7 : List of Coral species (hard and soft) recorded off different Islands of Marine National Park, Wandoor

Species	Islands				
	Jolly Boys	Red Skin	Tarmugli	Boat	Twins
HARD (LIVE) CORALS					
POCILLOPORIDAE					
<i>Seriatopora hystrix</i>	+	+	+	+	+
<i>Stylophora pistillata</i>	+	+	+	+	+
<i>Pocillopora verrucosa</i>	+	+	+	+	+
ACROPORIDAE					
<i>Acropora gravida</i>	+	-	+	-	+
<i>A. hyacinthus</i>	-	+	+	+	+
<i>A. nobilis</i>	+	+	+	+	+
<i>A. humilis</i>	+	+	+	+	+
<i>A. efflorescens</i>	+	+	+	-	+
<i>A. palifera</i>	-	+	+	+	+
<i>Astreopora</i> sp.	-	+	+	-	+
<i>Montipora</i> sp.	+	-	+	+	-
AGARICIIDAE					
<i>Pavona</i> sp.	+	+	-	+	+
<i>Pachyseris</i> sp.	-	+	-	-	+
FUNGIIDAE					
<i>Fungia</i> sp.	+	+	+	+	+
<i>Herpolitha</i> sp.	+	+	-	+	-
PORTITIDAE					
<i>Goniopora</i> sp.	+	+	+	+	+
<i>Porites</i> sp.	+	+	+	+	+
FAVIIDAE					
<i>Favia</i> sp.	+	+	+	+	+
<i>Favites</i> sp.	+	+	+	+	+
<i>Platygyra</i> sp.	+	+	+	+	+
<i>Leptoria</i> sp.	+	+	+	+	+
<i>Hydnophora</i> sp.	+	+	+	+	+
<i>Diploastrea</i> sp.	+	+	+	+	-
<i>Echinopora</i> sp.	+	-	-	+	+
OCULINIDAE					
<i>Galaxea</i> sp.	-	+	+	-	+
MERULINIDAE					
<i>Merulina</i> sp.	+	+	+	-	-
MUSSIDAE					
<i>Looophyllia</i> sp.	+	-	-	-	-
<i>Symphylia</i> sp.	+	-	-	-	-
PECTINIDAE					
<i>Mycedium</i> sp.	-	-	-	-	-

Contd. . .

MILLEPORIDAE					
<i>Millepora</i> sp.	+	+	+	+	+
SOFT CORALS					
DENDROPHYLLIDAE					
<i>Sarcophytum</i> sp.	+	+	+	-	+
<i>Sinularia</i> sp.	+	+	-	-	+
<i>Gorgonia</i> sp.	-	-	-	+	-

+ : PRESENT

- : not recorded

similar damages to corals in 4 out of 5 sites in the park.

In Red Skin Island, nearly half (51%) of the reef area was occupied by luxuriant live corals with maximum (62%) at Station VIII. A total of 18 genera and 26 species of corals were recorded in the island. Dominant forms were *Porites* (47%) and *Acropora* (21%). Soft corals were poorly represented and were found only in 3 out of 8 stations : in Station I it formed 4.2%. The dead coral proportion was more or less similar to that observed in Jolly Boys Island.

In Boat Island, live coral coverage (40%) was very low. Species diversity was comparatively low; only 23 species under 14 genera were recorded. *Porites* (46.5%) and *Acropora* (31%) were dominant. However, the maximum dead coral coverage of about 7% was observed in this island. In Station V, nearly half of the reef region was with dead corals. Soft corals were found in four stations, with substratum coverage ranging from 1 to 8%.

In Tarmugli Island the live coral density varied between 20% in Station I and 58% in Station IX. The overall coverage for the island was 45%. A total of 26 coral species under 17 genera were recorded in the island;

*Acropora* (45%) and *Porites* (35%) were the dominant forms (Table 7). Only one species of soft coral (*Sarcophytum*) was recorded in 7 out of 9 stations; its percentage coverage in Station III to V were between 4.2 and 4.9. Of the five islands surveyed, the percentage proportion of dead corals was lowest (31%), in this island; it was as low as 14% in Station IV.

In Twin Islands live coral coverage was very high (53%). In 3 out of 4 stations, its proportion was over 50%. In Station II and III they formed nearly 57% substratum coverage. Coral species diversity was moderately good, with 25 species under 15 genera (Table 8). The dominant corals were *Acropora* spp (55%) followed by *Millepora* (31%). Though *Millepora* was recorded in all the 5 islands, its density distribution was very high in Twin Islands. Soft corals (*Sarcophytum* sp and *Sinularia* sp) were recorded only from all stations. Among the dead corals which formed 38%, a small proportion was in 'Bleached' condition.

The coral species distribution and live coral coverage in different surveyed islands are given in Tables 7 and 8 respectively.

An overall analysis revealed that

Table 8 : Live coral coverage and their composition (%) in the coral reefs off five islands of Marine National Park, Wandoor

Islands	Jolly Boys	Red Skin	Tarmugli	Boat	Twins
<b>LIVE CORAL COVERAGE</b>	42.5	51.4	45.0	40.3	52.9
<b>Composition</b>					
<i>Seriatopora</i>	0.4	0.6	0.1	1.8	0.3
<i>Stylophora</i>	0.1	-	0.2	-	2.3
<i>Pocillopora</i>	0.6	0.9	1.0	0.5	0.9
<i>Acropora</i>	33.0	20.5	44.9	30.6	55.3
<i>Montipora</i>	15.6	6.4	3.4	7.4	1.5
<i>Pavona</i>	0.3	1.2	0.3	-	0.3
<i>Pachyseris</i>	-	0.2	-	-	0.3
<i>Fungia</i>	0.6	0.7	0.3	0.5	1.2
<i>Herpota</i>	0.1	0.1	-	-	-
<i>Goniopora</i>	1.3	4.5	0.5	0.5	1.2
<i>Porites</i>	28.5	47.0	34.7	46.5	3.9
<i>Favia</i>	0.5	2.0	0.6	0.7	0.5
<i>Favites</i>	3.6	5.2	4.8	3.2	0.5
<i>Platygyra</i>	0.6	0.3	0.5	-	-
<i>Leptoria</i>	0.6	0.4	2.1	0.6	-
<i>Hydnophora</i>	0.6	0.1	-	-	-
<i>Diploastrea</i>	0.2	-	0.1	0.2	-
<i>Echinopora</i>	-	-	-	0.6	-
<i>Galaxea</i>	-	0.3	0.1	-	0.1
<i>Merulina</i>	8.0	2.4	0.6	-	1.5
<i>Lobophyllia</i>	-	1.6	-	-	0.2
<i>Millepora</i>	5.3	5.7	5.8	6.9	30.9

nearly 47% of the reefs in the park area were with live and luxuriant corals in varying densities; soft corals formed about 3%. A total of 31 coral species under 25 genera were recorded. *Acropora*, *Porites* and *Millepora* were dominant coral forms. Soft corals were relatively more in Jolly Boys and Twin Islands than in other islands.

Based on species diversity and substratum coverage with live corals, the status of coral reefs of the Park area may be broadly categorized as 'Fair' in Jolly Boys, Tarmugli and Boat Islands and as 'Good' in Red Skin and Twin Islands.

#### General Remarks

Several factors like predation by 'crown of thorns' star fish, siltation of coastal waters, effluent discharge, unfavourable environmental conditions, human interference, etc are stated to be the responsible factors for the damage and destruction of corals. As far as the Marine National park is concerned, the survey has indicated that human interference and 'crown of thorns' star fish infestation, have definitely caused damages to corals. In some areas like Station VI of Redskin island, corals in the reef slope were badly damaged, mostly due to boat anchorage. Shell

collection activity also caused considerable damage to corals at Station II of Twin Islands and Station III of Tarmugli Island. Tourist activities like trampling, overturning the coral blocks and snorkeling have damaged the corals at Station III of Jolly Boys Island.

Wood (1989) had observed significant and localized damages to corals by 'crown of thorns' starfish in the park area. However, James *et al* (1990) had stated that predation by *Acanthaster* might have played some role in the death of corals but it was not of an alarming state. It is well known that some of the reef inhabiting animals like fishes, sea urchins, shrimps, polychaetes and molluscs also feed, to a limited extent, on the coral tissues and cause damage to coral colonies. However, the prey-predator inter-relationship and mechanism of co-existence of corals and coral inhabiting organisms of the Marine National Park have not been studied.

Though there are several reports about the damage and death of corals due to siltation and effluent discharges in the inshore areas of South and Middle Andamans, (Dorairaj *et al*, 1987, Wood, 1989, James *et al*, 1990), these problems have not been encountered in the Marine National Park area, except at a few coastal areas near the New Wandoor and on the west coast of Rutland Island. The strong monsoon winds and cyclones also appear to exert strong influence on reef flats, turning them into rubble banks. The reefs are normally affected during prolonged

exposure at lowest low tides. The tidal amplitude in the Andamans is 2.5m. At times of prolonged exposure, the corals tend to extrude the zooxanthellae and the loss of tissue gives way for algal growth and thus widespread damages are likely to be caused due to unfavourable environmental factors.

Environmental awareness campaign is needed, particularly in the bordering villages of the Marine National Park, Wandoor, to educate and to create an awareness among the general public about the need for protecting the coral reefs and preserving the valuable 'germplasm' of the Marine National Park.

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