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Studies on Scleractinian Coral Diversity in Inglis Island Sanctuary Andaman and Nicobar Islands, India

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Abstract: An extensive survey was conducted for the assessment of Scleractinian coral diversity and health of coral reefs in Inglis Island Sanctuary during January' 2010-June' 2010, following the Line Intercept transect method. A total of 48 coral species belonging to 10 families and 25 genera were recorded from this island. The average percentage of live coral, dead coral and bleached coral cover is 27.3%, 26.5% and 46.3% respectively. Relative abundance values were also derived for each species and they were assigned the status as dominant/ abundant/ common/ uncommon/ rare. Although, no species was assigned "dominant" status and abundant status, *Porites solida* (6.1) and *Echinopora gemmacea* (5.8) were most commonly distributed in this Island. Percentage of species composition was higher in Faviidae (27.1%) and Acroporidae (22.9%) family of hard corals. The species diversity was highest at stn-3 (4.61) and Pieoul's evenness index (0.97) was highest in Stn-2.

Key words: Scleractinia % Live Coral % Relative Abundance % Species Diversity % Inglis Island

INTRODUCTION

Coral reefs are highly productive marine ecosystem in the world with annual gross production rates in the range of 2000-5000g cm^2 through efficient retention and recycling of nutrients [1]. The Andaman and Nicobar Islands is located in the southeast of Bay of Bengal, between 6°-14°N latitude and 91°-94° E longitude. The Andaman and Nicobar comprised of 572 islands in the chain, some of which are volcanic. The islands occupy an area of 8,293 km^2 with a coastline of 1962 km and account for 30% of the Indian Exclusive Economic Zone [2]. The diversity of marine flora and fauna around Andaman and Nicobar Islands has received attention. Matthai [3] listed coral species from Andaman based on collection in the Indian Museum in Kolkata; and Pillai [4] listed 135 coral species from the region and found that the Andaman Island were less diverse (31 genera with 82 species) than the Nicobar Island (43 Genera and 103 species). Wilkinson [5] reported 203 hard corals species occur in Andaman and Nicobar Islands. Recent studies on Scleractinian coral diversity revealed out 197 species belonging to 59 genera from Andaman Islands [6]. The percentage cover of live corals has been estimated for the islands of Mahatma Gandhi Marine National Park [7-9] and North Reef, Cinque, Twin, West Rutland, Tarmughli, Flat, South Button, Outram, Henry Lawrence, Minerva ledges and Neil Island [10]. Kulkarni *et al.* [9] also addressed several ecological parameters in their study, which includes sedimentation, terrestrial zone influence and other anthropogenic factors. In Inglis Island sanctuary, diversity and percentage of live coral covers remains unstudied. No such reports were given from this sanctuary area. Present study reports 48 scleractinian coral species with percentage of live corals, dead corals and bleached corals from this island.

MATERIALS AND METHODS

Study Area: Inglis Island Sanctuary has established in 1987 under Wildlife Protection Act, 1971. It is located at the east side of Andaman and Nicobar Island. Four sites such as West (Stn-1), Northwest (Stn-2), East (Stn-3), South side (Stn-4) have been selected during survey in this Island (Fig. 1). The western side of this island is characterized by sandy shore and fringing reefs at shallow water depth (upto 6m during high tide). The northwest and south part of this island has steeper depth upto 20m with coral reef ecosystem. The east side of the island is characterized by rocky shore and high wave action throughout the year. The east side comprises healthier reef diversity than other site of this island.

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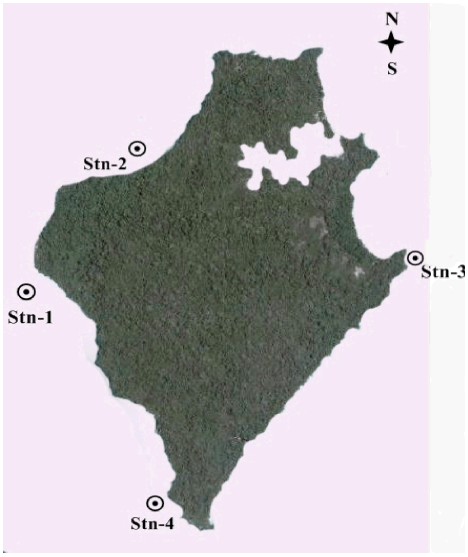

Fig. 1: Location of study sites in Inglis Island

Data Analysis: Data was collected by adapting Line Intercept Transect method [11] at four stations in Inglis Island. Though all conspicuous benthic life forms underlying the transect lines were monitored, since cover by organisms other than corals (i.e., macroalgae, soft corals, coralline algae and sponges) constituted only less than 1% of total cover, reference is made only to reef building corals in this paper. A total of 10 transects of 20m each were placed at four study sites around the island. All hard corals intercepted by transect were recorded and their maximal projected length were measured. An individual colony of a hard coral was defined as any colony growing independently of its neighbours [12].

The relative abundance (RA) of each species was calculated according to the contribution to living cover [13].

$RA=P_i / P \times 100$ (Where, P_i = Total living coverage of one species from all transects taken at a given site; P = Total living coverage of all species in all transects at a given site).

The diversity of corals was calculated following the Shannon-Wiener index (H') [14]. Species richness was calculated following the Simpson's index (d) and the evenness (J') was computed using the formula of Pielou.

Coral Mortality Index [15] for each site was calculated as the ratio of standing dead coral cover to total cover of both live and dead corals.

MI = Dead corals / (Live corals + Dead corals),

Where, MI is the mortality index. If MI > 0.33, the mortality index is considered to be high and the reef is classified as sick.

RESULTS AND DISCUSSION

A total of 48 species belonging to 10 families were reported on the transect area (Table 1). The reefs of Inglis Island showed an average live coral cover of 27.3%, bleached coral cover of 46.3% and dead coral cover of 26.5% from the reefs (Table 2). The maximum percentage of live forms (32.5%) is found at the east side of Inglis Island (Stn-3). The average mortality index (MI) for the reef was 0.43. Dominance and abundance of a single species is lacking in the study sites. Shanon diversity index was highest at Stn-3 (H'= 4.61) while Pieoul's eveness Index (J') showed maximum in Stn-2 (Table 3). The relative abundance reported higher for *Porites solida* (6.1) and *Echinopora gemmacea* (5.8). The hard coral family Faviidae (27.1%) and Acroporidae (22.9%) represented with maximum percentage of species composition than other families (Fig. 2).

In the present investigation the reef of Inglis Island is inaudibly sick (MI>0.33) as because most of the corals are bleached and percentage of live coral coverage become less. In Southeast Asia, reefs are evaluated according to a linear scale cover [16], such that only those reef with >75% corals are considered to be excellent condition. Reefs with 50-75% live coral cover are considered to be in "good" condition; with 25 - 50% live coral cover in "fair" condition; and those with <25% live coral cover, in "poor". According to this classification this reef area falls under category of fair condition. The primary factors for controlling diversity and abundance of plants and animals in natural communities are disturbance, competition and stress [17]. Edinger and Risk [18] defined massive and submassive corals are stress tolerance where as *Acropora* corals as disturbance adapted ruderals due to their rapid growth and mechanical fragility. In the present study, all corals belong to common and uncommon species status (Table 2). Massive coral Faviidae were more in number in this reef with 13 species and branching coral Acroporidae with 11 species (Table 1). According to Hughes [19], branching corals are type 2 corals which usually recruit in larger numbers and are more sensitive to disturbances and so they are better indicators of whole coral community state than corals that are more sustainable, like most of the massive corals which are type 1. There is evidence that for a given number of s pecies, perturbed communities usually

Table 1: List of coral species with their growth form and status according to relative abundance

Sl No.	Species	(C- Common; U- Uncommon) Relative Abundance	Species Status	Growth form
	Family: Acroporidae			
1	*Acropora aspera* (Dana, 1846)	2.3	C	Branching
2	*Acropora cytherea* (Dana, 1846)	2.9	C	Branching
3	*Acropora mirabilis* (Quelch, 1886)	0.6	U	Branching
4	*Acropora vaughani* (Wells, 1954)	1.0	C	Branching
5	*Acropora robusta* (Dana, 1846)	0.3	U	Branching
6	*Acropora austera* (Dana, 1846)	1.0	C	Branching
7	*Acropora granulosa* (Milne Edwards and Haime, 1860)	0.3	U	Branching
8	*Acropora subulata* (Dana, 1846)	2.6	C	Branching
9	*Acropora donei* (Veron and Wallace, 1984)	1.6	C	Branching
10	*Montipora foliosa* (Pallas, 1767)	2.3	C	Foliose
11	*Montipora aequituberculata* (Bernard, 1897)	0.3	U	Foliose
	Family: Pocilloporidae			
12	*Pocillopora damicornis* (Linneaus, 1758)	3.9	C	Branching
13	*Pocillopora verrucosa* (Ellis and Solander, 1786)	1.3	C	Branching
14	*Stylophora pistillata* (Esper, 1797)	4.2	C	Digitate
15	*Seriatopora hystrix* (Dana, 1846)	2.3	C	Branching
	Family: Faviidae			
16	*Goniastrea edwardsi* (Chevalier, 1971)	2.6	C	Massive
17	*Goniastrea minuta*(Veron, 2000)	3.5	C	Massive
18	*Goniastrea retiformes* (Lamrck, 1816)	4.2	C	Massive
19	*Platygyra crosslandi* (Matthai, 1928)	2.9	C	Massive
20	*Diploastrea heliopora* (Lamarck, 1816)	4.5	C	Massive
21	*Favites complanata* (Ehrenberg, 1834)	4.5	C	Massive
22	*Favites pentagona* (Esper, 1794)	1.6	C	Massive
23	*Favites halicora* (Ehrenberg, 1834)	1.0	C	Massive
24	*Favia favus* (Forskal, 1775)	0.6	U	Massive
25	*Favia maritime (Nemenzo, 1971)*	1.3	C	Massive
26	*Echinopora lamellosa* (Esper, 1794)	1.6	C	Encrusting
27	*Echinopora gemmacea* (Lamarck, 1816)	5.8	C	Encrusting
28	*Cyphastrea chalcidium* (Forskal,1775)	1.0	C	Massive
	Family: Mussidae			
29	*Lobophyllia corymbosa* (Forskal, 1775)	1.6	C	Massive
30	*Lobophyllia hemiprichii* (Ehrenberg, 1834)	2.3	C	Massive
31	*Symphyllia recta* (Dana, 1846)	1.3	C	Massive
	Family: Poritidae			
32	*Porites lobata* (Dana, 1846).	4.8	C	Massive
33	*Porites solida* (Forskal, 1775)	6.1	C	Massive
34	*Porites cylindrica* (Dana, 1846)	2.3	C	Massive
	Family: Fungiidae			
35	*Cycloseris costulata* (Ortmann, 1889)	1.0	C	Solitary
36	*Fungia danai* (Milne Edwards & Haime, 1851)	0.3	U	Solitary
37	*Fungia fungites* (Linneaus, 1758)	2.3	C	Solitary
38	*Fungia paumotensis* (Stutchberry, 1833)	3.5	C	Solitary
39	*Fungia scabra* (Doderlein, 1901)	0.6	U	Solitary
40	*Herpolitha limax* (Eschscholtz, 1825)	1.6	C	Solitary
41	*Ctenactis echinata* (Pallas, 1766)	1.3	C	Solitary
42	*Ctenactis crassa* (Dana, 1846)	0.6	U	Solitary
	Family: Oculinidae			
43	*Galaxea fascicularis* (Linneaus, 1767)	1.3	C	Encrusting
	Family: Merulinidae			
44	*Hydnopohora grandis* (Gardiner, 1904)	1.0	C	Branching
	Family: Agariciidae			
45	*Pavona cactus* (Forskal, 1775)	2.6	C	Digitate
46	*Pachyseris speciosa* (Dana, 1846)	1.3	C	Foliose
	Family: Pectinidae			
47	*Pectinia paeonia* (Dana, 1846)	0.3	U	Encrusting
48	*Oxypora crassispinosa* (Nemenzo, 1979)	1.9	C	Encrusting

Table 2: Percentage of live, bleached and dead forms of corals in different study sites of Inglis Island

Status of Corals	Stn 1	Stn 2	Stn 3	Stn 4	Mean%
Bleached coral	43.9	39.9	45.1	56.1	46.3
Live form	31.5	27.8	32.5	17.3	27.3
Dead Corals	24.6	32.3	22.4	26.6	26.5

Table 3: Diversity indices in different study sites. [S= Total no of Species; N= Total no of individuals]

Sites	S	N	H'	J'	d'
Stn1	29	277	4.58	0.94	0.95
Stn2	24	225	4.43	0.97	0.95
Stn3	36	212	4.61	0.95	0.96
Stn4	26	179	4.51	0.96	0.95

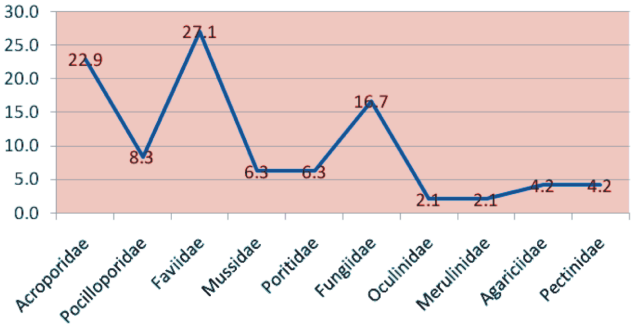

Fig. 2: Species composition (%) in different families of Corals in Inglis Island

comprise a more limited taxonomic spread, whereas under less disturbed conditions the species present belong to a wider range of higher taxa which can be attributed to the species richness of this reef. In the present study Shanon diversity, Simpson diversity and species evenness are moderately high at all the study sites of Inglis Island. According to Odum [20] higher diversity means longer food chains and more cases of symbiosis (mutualism, parasitism and commensalism) and greater possibilities for negative feedback control which reduces oscillations and hence increases stability and species diversity. The indices of reef health considered in the present study i.e., the live coral cover (low live coral cover), reef condition (domination by massive corals) and mortality index substantiate the deprived condition of this reef. Arthur [21] reported a bleached coral cover of 89% in the Gulf of Mannar reefs with a bleaching related mortality of 23% due to the 1997-1998 El~Nino Southern Oscillation event, which elevated sea surface temperatures (SST's) of tropical oceans by more than 30°C. But in the present study, general observation on coral bleaching percentage (46.3%) has been discussed, no comparisons could be made and conclusions drawn due to paucity of island wise data. Coral reef ecosystems are very sensitive to external impacts both natural and manmade, which violate their homeostasis [22]. The majority of damage to coral reefs around the world has been through direct anthropogenic stress [23]. Being one of the most species rich habitats of the world, coral reefs are important in maintaining a vast biological diversity and genetic library for future generations [24]. According to Bryant *et al.* [25], 57% of the world's coral reefs are potentially threatened by human activity such as coastal development, destructive fishing, overexploitation, marine pollution, runoff from deforestation and toxic discharge from industrial and agricultural chemicals. As global pressures on coral reefs and other ecosystems grow with increasing coastal populations, the need for careful monitoring, planning and management become essential [26]. Inglis island sanctuary comprises a rich biodiversity of marine organisms which need to be protected from overexploitation and deterioration. The relatively unaffected reefs of Inglis Island may also get deteriorated if appropriate measures are not taken up at the right time.

Summary: This paper contains results of scleractinian coral diversity in Inglis Island sanctuary. Fourty-eight species of hard corals belonging to 10 families and 25 genera were recorded from four stations of Inglis Island. All coral belongs to common and uncommon status according to relative abundance category and the reef is

also in fair condition. The family Faviidae and Acroporidae showed higher percentage of species composition than other reported families of corals from Inglis Island. Due to massive bleaching and less percentage of live coral cover the reef becomes inaudibly sick but this island has a very good species diversity that can support a rich diversity of reef inhabitants in this Island. To protect the rich biodiversity of marine animals in Inglis island sanctuary, measures has to be taken against overexploitation and deterioration for future marine resources.

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