Diversity of Scleractinian Corals in the Adjoining Sea of Saddle Peak National Park, Andaman and Nicobar Islands

[1]C. Raghunathan, [1]Tamal Mondal and [2]K. Venkataraman
[1]Zoological Survey of India, Andman and Nicobar Regional Centre, Port Blair-744 102, Andaman and Nicobar Islands
[2]Zoological Survey of India, M-Block, New Alipore, Kolkata-700 053
*Email: [1]raghuksc@rediffmail.com

Introduction

The Andaman and Nicobar Islands comprised of 572 islands, islets and rocky outcrops, spreading in a linear distance in the Bay of Bengal between latitudes 06º and 14ºN and longitudes 92º and 94º E with a total areas of 8293 sq. km. and a coastline of 1962 km. The Andaman and Nicobar Islands have a Continental Shelf of 35,000 sq. km. with an EEZ of 8149 sq km, includes the ecologically enriched faunal and floral diversities. The Saddle Peak represents the highest altitude of 732 m (from mean sea level) in Andaman and Nicobar Islands. The Saddle Peak forests has been declared as a National Park under the Notification No. 97(D)/96F.No. CWLW/WL/31/1219 dated 28th November 1996 with an area of 32.54 sq. km. and lies between 13°15' to 13°41'N latitudes and 92°37' to 93°70'E longitudes. This National Park is characterized as humid tropical evergreen forests and known for rich species diversity. The continental shelf of Saddle Peak National Park represents well recognized biodiversity in Andaman Sea region *i.e.* in the eastern side. Andaman and Nicobar Islands are well characterized by fringing reef in the eastern side (Venkataraman *et al.*, 2003) and a living coral reef ecosystem is one of the most glorious and fantastic sights on our planet (Rao, 2010). They are most popularly known as the baseline animals for the construction of undersea ecological pyramids of Andaman Sea (Whitaker, 1985). They are a key part of the natural heritage with a good deal of productivity. The presence of coral reef emphasize the development and extensively sustainable platform for wide ecological avenues for the other reef associated faunal components such as sponges, molluscs, echinoderms, polyclads, crustaceans, ascidians, fishes etc. The present study was made to assess the diversity of scleractinian corals around the continental shelf regions of Saddle Peak National Park adjoining marine environment.

Material and Methods

The study was carried out at major four areas of Saddle Peak National Park adjoining areas of North Andaman during 2009 to 2015. Intertidal and subtidal coral surveys were carried out at four sites *viz.* Off Durgapur, Shibpur, Kalipur and Craggy Island as the adjoing areas of Saddle Peak National Park. The GPS coordinates of the selected study areas are given below (Table 1 and Figs. 1 & 2).

Table 1: Coordinates of the study areas

Sl. No.	Study areas	Coordinates	
		Latitude	Longitude
1.	Off Durgapur	13°16.595'N	093°01.202'E
2.	Shibpur	13°16.727'N	093°01.385'E
3.	Kalipur	13°17.337'N	093°00.963'E
4.	Craggy Island	13°13.531'N	093°03.394'E

Sub-tidal surveys were made along reef areas by snorkeling and scuba diving. The diversity of corals and their associated faunal communities were carried out at reef area using primarily Manta Tow survey (Done *et al.*, 1982) in shallow reef

Fig. 1: Map showing the areas surveyed in Saddle Peak National Park adjoining areas

Fig. 2: Areas surveyed in Saddle Peak National Park adjoining sea

areas. The assessment of live corals and associated fauna has been done by randomly laying out 20m long Line Intercept Transects (LITs) while diversity and distribution was carried out by Quadrant method following English *et al.* (1997) at different depth ranges from intertidal to the depth of maximum 35 m. Digitization of individual species was made by underwater camera (Sony-Cyber Shot, Model-T900, marine pack, 12.1 megapixels, Sony-Cyber Shot, Model-TX1, marine pack, 10.2

megapixels and Canon Powershot G15). Species individual of corals were identified in conjunction with Veron and Pichon (1976, 1979, 1982), Veron et al. (1977) Veron and Wallace (1984), Veron (2000) and Wallace (1999). Mass bleaching was recorded in Andaman and Nicobar Islands during May 2010 due to the abrupt rise of Sea Surface Temperature (SST). The health of coral was also monitored through out the study period to get a comprehensive data of status of recovery from bleaching and new recruitment. Diversity of corals was assessed by statistical analysis.

The **Shannon-Weiner diversity index** (H') (Shannon and Weaver, 1964) was evaluated using following formula.

$$H' = -\sum pi \ln pi$$

Where, pi = Proportion of number of individual of a particular species and total number of individual of all the species, H'= Diversity of a theoretically infinite population.

Simpson's Density Index (Simpson, 1949) is one of the truthful indices to calculate the species diversity of any study site. It has been applied to calculate the species density of corals and their associated fauna at different stations in Saddle Peak National Park adjoining areas.

The formula for the Simpson's Density Index as follows.

$$D = 1 - \sum^{s} \frac{ni\ (ni - 1)}{N\ (N - 1)}$$

Where S is the number of species, N is the total percentage cover or total number of organisms and n is the percentage cover of a species or number of organisms of a species. In this form, D ranges from 1 to 0, with 1 representing infinite diversity and 0 representing no diversity.

Evenness of a community was described by the **Pielou's Evenness Index** (J') (Pielou, 1966). The formula of the index is given below.

$$J' = H'/H'_{max}$$

Where H' is the number derived from the Shannon diversity.

Menhinick Diversity Index (Menhinick, 1964) was calculated by using of the formula given below.

$$d = S/\sqrt{N}$$

Where, S = Total number of species, and N = Total number of individuals.

Margalef's Community Index (Margalef, 1968) was calculated by using the following formula.

$$d = S - 1/\log N$$

Where, S = Total number of species, and N = Total number of individuals.

Berger-Parker Diversity Index (Berger and Parker, 1970) was calculated by the following formula.

$$d = N_{max}/N$$

Fisher Alpha Diversity Index (Fisher, 1925) was also calculated.

Similarity Index is the simple measure of the extent to which two habitats species in common. The **Sørensen Index**, also known as Sørensen's similarity coefficient, is a statistic used for comparing the similarity of two samples (Sørensen, 1948). It has been formulated as below.

$$QS = (2C/A + B)$$

Where, A and B are the species numbers in samples A and B, respectively, and C is the number of species shared by the two samples. This expression is easily extended to abundance instead of incidence of species. This quantitative version of the Sørensen index is also known as **Czekanowski Index**.

Results

A total of 186 species of scleractinian corals belonging to 59 genera and 15 families (Table 2) were documented during the study period from four study areas. A maximum number of 165

species under 56 genera and 15 families were reported from Off Durgapur area while minimum 77 species belong to 45 genera and 13 families were found at Craggy Island (Fig. 3 and Plate 1 & 2).

Table 2: Scleractinian Corals of Saddle Peak National Park adjoining sea

Sl. No.	Family/Genus/Species	Off Durgapur	Shibpur	Kalipur	Craggy Island
	Family: ACROPORIDAE Verrill, 1902 Genus: *Acropora* Oken, 1815				
1.	*Acropora gemmifera* (Brook, 1896)	+	+	+	-
2.	*Acropora samoensis* (Brook, 1891)	+	+	+	-
3.	*Acropora bruggemanni* (Brook, 1893)	+	+	+	-
4.	*Acropora anthocersis* (Brook, 1893)	+	-	-	-
5.	*Acropora awi* Wallace and Wolstenholme,1998	+	-	-	-
6.	*Acropora sekiseiensis* Veron, 1990	+	-	-	-
7.	*Acropora granulosa* (Milne Edwards and Haime, 1860)	+	+	+	-
8.	*Acropora elizabethensis* Veron, 2000	+	+	+	-
9.	*Acropora variolosa* (Klunzinger, 1879)	+	+	+	-
10.	*Acropora kosurini* Wallace, 1994	+	+		-
11.	*Acropora globiceps* (Dana, 1846)	+	+		-
12.	*Acropora monticulosa* (Bruggemann, 1879)	+	+	+	-
13.	*Acropora divaricata* (Dana, 1846)	+	+		-
14.	*Acropora formosa* (Dana, 1846)	+	+	+	-
15.	*Acropora cerealis* (Dana, 1846)	+	+	-	-
16.	*Acropora vaughani* Wells, 1954	+	-	-	-
17.	*Acropora cuneata* (Dana, 1846)	+	-	-	+
18.	*Acropora hyacinthus* (Dana, 1846)	+	+	-	+
19.	*Acropora palifera* (Lamarck, 1816) Genus: *Montipora* de Blainville, 1830	+	+	-	+
20.	*Montipora meandrina* (Ehrenberg, 1834)	+	+	+	-
21.	*Montipora verrucosa* (Lamarck, 1816)	+	+	+	-
22.	*Montipora informis* Bernard, 1897	+	+	+	-
23.	*Montipora peltiformis* Bernard, 1897	+	+	+	-
24.	*Montipora effuse* Dana, 1846 Genus: *Astreopora* de Blainville, 1830	+	+	+	-
25.	*Astreopora myriophthalma* (Lamarck, 1816)	+	+	+	+
26.	*Astreopora ocellata* Bernard, 1896 Family: POCILLOPORIDAE Gray, 1842 Genus: *Pocillopora* Lamarck, 1816	+	+	+	+

Sl. No.	Family/Genus/Species	Off Durgapur	Shibpur	Kalipur	Craggy Island
27.	*Pocillopora damicornis* (Linnaeus,1758)	+	+	+	+
28.	*Pocillopora kelleheri* Veron, 2000	+	-	-	-
29.	*Pocillopora eydouxi* MED & H, 1860	+	+	+	+
30.	*Pocillopora elegans* Dana, 1846	+	+	-	+
31.	*Pocillopora effusa* Veron, 2000	-	+	-	-
32.	*Pocillopora fungiformis* Veron, 2000	-	-	-	+
33.	*Pocillopora meandrina* Dana, 1846 Genus: *Seriatopora*	+	-	-	-
34.	*Seriatopora hytrix* Dana, 1846 Genus: *Stylophora* Schweigger, 1819	-	-	-	+
35.	*Stylophora pistillata* Esper, 1797 Family: OCULINIDAE Gray,1847 Genus: *Galaxea* Oken, 1815	+	+	+	+
36.	*Galaxea fascicularis* (Linnaeus,1767)	+	+	+	+
37.	*Galaxea astreata* (Lamarck, 1816)	+	+	+	-
38.	*Galaxea paucisepta* Claereboudt, 1990 Family: SIDERASTERIDAE Vaughan and Wells, 1943 Genus: *Coscinaracea* Milne Edwards and Haime,1848	-	-	-	-
39.	*Coscinaraea monile* (Forskal, 1775)	+	+	-	+
40.	*Coscinaraea columna* (Dana, 1846) Genus: *Psammocora* Dana, 1846	+	-	-	+
41.	*Psammocora contigua* (Esper, 1797)	+	-	-	+
42.	*Psammocora obtusangula* (Lamarck, 1816)	-	-	-	+
43.	*Psammocora explanulata* van der Horst, 1922 Genus: *Pseudosiderastrea* Yabe and Sugiyama, 1953	+ -	- -	- -	+ -
44.	*Pseudosiderastrea tayami* Yabe & Sugiyama, 1935 Family: AGARICIIDAE Gray, 1847 Genus: *Pachyseris* Milne Edwards and Haime, 1849	+	-	-	-
45.	*Pachyseris gemmae* Nemenzo,1955	+	+	+	+
46.	*Pachyseris rugosa* (Lamarck,1801)	+	-	-	-
47.	*Pachyseris speciosa* (dana, 1846) Genus: *Pavona* Lamarck,1801	+	+	+	+
48.	*Pavona duerdeni* Vaughan, 1907	+	+	+	+
49.	*Pavona varians* Verrill, 1864	+	+	+	+
50.	*Pavona diffluens* (Lamarck, 1816)	+	+	-	-
51.	*Pavona explanulata* (Lamarck, 1816) Genus: *Gardineroseris* Scheer and Pillai, 1974	+	+	+	-
52.	*Gardineroseris planulata* (Dana, 1846) Genus: *Leptoseris* Milne Edwards and Haime,1849	+	+	+	+

Sl. No.	Family/Genus/Species	Off Durgapur	Shibpur	Kalipur	Craggy Island
53.	*Leptoseris mycetoseroides* Wells, 1954	+	+	+	+
54.	*Leptoseris solida* (Quelch, 1886)	+	+	-	-
55.	*Leptoseris scabra* Vaughan, 1907 Family: ASTROCOENIIDAE Koby, 1890 Genus: *Stylocoeniella* Yabe and Sugiyama, 1935	+	-	+	-
56.	*Styloceniella armata* (Ehrenberg, 1834)	+	-	-	-
57.	*Styloceniella guentheri* BassetSmith,1890 Family: FUNGIIDAE Dana,1846 Genus: *Cantharellus* Hoeksema and Best, 1984	+	-	-	-
58.	*Cantharellus jebbi* Hoeksema, 1993	+	+	+	-
59.	*Cantharellus noumae* Höksema and Best, 1984	+	-	-	-
60.	*Cantharellus doederleini* (Marenzeller, 1907) Genus: *Cycloseris* Milne Edwards and Haime,1849	-	+	-	+
61.	*Cycloseris erosa* (Doderlein, 1901)	+	+	+	-
62.	*Cycloseris tenuis* (Dana,1846)	+	-	-	-
63.	*Cycloseris cyclolites* (Lamarck, 1801)	+	-	-	-
64.	*Cycloseris curvata* (Hoeksema, 1989)	+	-	-	-
65.	*Cycloseris costulata* (Ortmann, 1889)	+	-	-	-
66.	*Cycloseris colini* Veron, 2000	+	-	-	-
67.	*Cycloseris somervillei* (Gardiner, 1909)	+	+	+	-
68.	*Cycloseris vaughani* (Boschma, 1923)	+	-	-	-
69.	*Cycloseris hexagonalis* MED & H,1848	-	+	-	-
70.	*Cycloseris patelliformis* (Boschma, 1923) *Cycloseris sinensis* Milne Edwards and Haime, 1849 Genus: *Diaseris* Milne Edwards and Haime,1849	- +	+ -	- -	- 71. -
72.	*Diaseris distorta* (Michelin, 1843)	+	-	-	-
73.	*Diaseris fragilis* (Alcock, 1893)	-	-	-	+
74.	Genus: *Ctenactis* Verrill, 1864				
75.	*Ctenactis echinata* (Pallas, 1766)	+	+	+	+
76.	*Ctenactis albitentanculata* Hoeksema, 1989	+	-	-	-
77.	*Ctenactis crassa* (Dana, 1846) Genus: *Fungia* Lamarck,1801	+	-	-	+
78.	*Fungia scutaria* Lamarck, 1801	+	+	-	-
79.	*Fungia paumotensis* Stutchbury,1833	+	+	+	+
80.	*Fungia fungites* (Linnaeus, 1758)	+	+	+	+
81.	*Fungia scabra* Doderlein, 1901	+	+	+	+
82.	*Fungia horrida* Dana, 1846 *Fungia repanda* Dana, 1846	+ +	+ +	+ +	- 83. -

Sl. No.	Family/Genus/Species	Off Durgapur	Shibpur	Kalipur	Craggy Island
84.	*Fungia corona* Doderlein, 1901	+	+	-	-
85.	*Fungia granulousa* Klunzinger, 1879	+	+	+	-
86.	*Fungia concinna* Verrill, 1864	+	-	-	-
87.	*Fungia danai* Milne Edwards and Haime,1851	+	+	-	+
88.	*Fungia fralinae* Nemenzo,1955	+	-	-	+
89.	*Fungia klunzingeri* Doderlein, 1901	-	+	-	-
90.	*Fungia fungites* Linnaeus, 1758	+	-	-	-
91.	*Fungia puishani* Veron and De Vantier, 2000	-	+	-	-
92.	*Fungia scruposa* (Klunzinger,1879)	-	-	-	+
93.	*Fungia seychellensisi* Hoeksema,1993	-	-	-	+
94.	*Fungia spinifer* Claereboudt and Hoekesma, 1987	+	-	-	-
95.	*Fungia taiwanensis* Hoeksema and Dai,1991 Genus: *Zoopilus* Dana, 1846	-	+	-	-
96.	*Zoopilus echinata* Dana, 1846 Genus: Herpolitha Eschscholtz, 1825	+	+	+	-
97.	*Herpolitha limax* (Houttuyn, 1772)	+	-	-	-
98.	*Herpolitha weberi* Horst,1921 Genus: *Halomitra* Dana,1846	+	-	-	-
99.	*Halomitra pileus* (Linnaeus, 1758)	+	-	-	-
100.	*Halomitra clavator* Hoeksema, 1989 Genus: *Polyphyllia* Quoy and Gaimard,1833	-	+	-	-
101.	*Polyphyllia talpina* (Lamarck, 1801) Genus: *Lithophyllon* Rehberg, 1892	+	-	-	+
102.	*Lithophyllon lobata* Horst, 1921	+	+	+	-
103.	*Lithophyllon undulatum* Rehberg, 1892 Genus: *Sandalolitha* Quelch, 1884	+	+	+	+
104.	*Sandalolitha robusta* (Quelch,1886)	+	-	-	-
105.	*Sandalolitha dentata* Quelch, 1884 Genus: *Podabacia* Milne Edwards and Haime,1849	-	-	-	+
106.	*Podabacia motuporensis* Veron, 1990	+	+	-	-
107.	*Podabacia lanakensis* Veron, 2000 Family: MUSSIDAE Ortmann, 1890 Genus: *Symphyllia* Milne Edwards and Haime, 1848	+	-	-	+
108.	*Symphyllia recta* (Dana, 1846)	+	+	+	+
109.	*Symphyllia radians* Milne Edwards and Haime, 1849	+	+	+	+
110.	*Symphyllia erythraea* (Klunzinger, 1879) Genus: *Lobophyllia* de Blainville, 1830	+	+	+	-
111.	*Lobophyllia hemprichii* (Ehrenberg, 1834)	+	+	+	+

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112.	*Lobophyllia pachysepta* Chevalier, 1975	+	+	+	-
113.	*Lobophyllia robusta* Yabe and Sugiyama, 1936 Genus: *Australomussa* Veron, 1985	+	+	+	-
114.	*Australomussa rowleyensis* Veron, 1985 Genus: *Scolymia* Haime, 1852	+	-	+	+
115.	*Scolymia vitiensis* Bruggemann, 1877 Genus: *Acanthastrea* Milne Edwards and Haime, 1848	+	+	-	-
116.	*Acanthastrea regularis* Veron, 2000	+	+	+	+
117.	*Acanthastrea faviaformis* Veron, 2000	+	+	+	-
118.	*Acanthastrea echinata* (Dana, 1846) Family: FAVIIDAE Gregory, 1900 Genus: *Favia* Oken, 1815	+	+	+	-
119.	*Favia danae* Verrill, 1872	+	+	+	+
120.	*Favia maxima* Veron and Pichon, 1977	+	+	+	-
121.	*Favia lizardensis* Veron and Pichon, 1977	+	+	+	-
122.	*Favia matthaii* Vaughan, 1918	+	+	+	+
123.	*Favia truncatus* Veron, 2000	+	+	+	-
124.	*Favia pallida* (Dana, 1846)	+	+	+	+
125.	*Favia speciosa* Dana, 1846	+	+	-	+
126.	*Favia rotumana* (Gardiner, 1899) Genus: *Plesiastrea* Milne Edwards and Haime, 1848	+	+	-	+
127.	*Plesiastrea versipora* (lamarck, 1816) Genus: *Leptoria* Milne Edwards and Haime,1848	+	+	+	+
128.	*Leptoria irregularis* Veron, 1990	+	+	+	-
129.	*Leptoria phrygia* (Ellis and Solander, 1786) Genus: *Diploastrea* Matthai, 1914	+	+	+	+
130.	*Diploastrea heliopora* (Lamarck, 1816) Genus: *Favites* Link, 1807	+	+	+	+
131.	*Favites abdita* (Ellis and Solander, 1786)	+	+	+	-
132.	*Favites acuticollis* (Ortmann, 1889)	+	+	+	-
133.	*Favites micropentagona* Veron, 2000	+	+	-	+
134.	*Favites monticularis* Tamal Mondal et al., 2013	-	+	-	-
135.	*Favites pentagona* (Esper, 1794)	+	+	+	-
136.	*Favites complanata* (Ehrenberg, 1834)	+	+	+	-
137.	*Favites spinosa* (Klunzinger, 1879)	+	+	+	-
138.	*Favites russelli* (Wells, 1954)	-	+	-	-
139.	*Favites halicora* (Ehrenberg, 1834)	-	-	-	+
140.	*Favites flexuosa* (Dana, 1846) Genus: *Platygyra* Ehrenberg, 1834	+	-	-	-

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141.	*Platygyra pini* Chevalier, 1975	+	+	+	-
142.	*Platygyra sinensis* (Milne Edwards and Haime, 1849)	+	+	+	+
143.	*Platygyra carnosus* Veron, 2000	+	+	+	-
144.	*Platygura ryukyuensis* Yabe and Sugiyama, 1936	+	+	+	-
145.	*Platygyra crosslandi* Matthai, 1928	+	+	+	-
146.	*Platygyra verweyi* WijsmanBest, 1976 Genus: *Oulophyllia* Edwards and Haime , 1848	-	-	-	+
147.	*Oulophyllia levis* (Nemenzo, 1959) Genus: *Montastrea* de Blainville, 1830	+	+	+	-
148.	*Montastrea curta* (Dana, 1846)	+	+	+	-
149.	*Montastrea colemani* Veron, 2000	+	+	+	+
150.	*Montastrea annularis* (Ellis and Solander, 1786) Genus: *Barabattoia* Yabe and Sugiyama, 1941	+	+	+	-
151.	*Barabattoia amicorum* (Milne Edwards and Haime, 1830)	+	+	+	-
152.	Genus: *Leptastrea* Milne Edwards and Haime, 1848				
153.	*Leptastrea purpurea* (Dana, 1846)	+	+	+	+
154.	*Leptastrea transversa* Klunzinger, 1879 Genus: *Goniastrea* Milne Edwards and Haime ,1848	+	+	-	-
155.	*Goniastrea edwardsi* Chevalier, 1971	+	+	+	+
156.	*Goniastrea minuta* Veron, 2000	+	+	+	+
157.	*Goniastrea pectinata* (ehrenberg, 1834)	+	+	+	-
158.	*Goniastrea retiformis* (Lamarck, 1816) Genus: *Cyphastrea* Milne Edwards and Haime, 1848				+
159.	*Cyphastrea japonica* Yabe and Sugiyama, 1932	+	+	+	+
160.	*Cyphastrea chalcidicum* (Forskal, 1775) Genus: *Echinopora* Lamarck, 1816	+	+	+	+
161.	*Echinopora lamellosa* (Esper, 1795)	+	-	+	-
162.	*Echinopora pacificus* Veron, 1990	+	+	-	+
163.	*Echinopora gammacea* Lamarck, 1816 Family: PECTINIIDAE Vaughan and Wells, 1943 Genus: *Oxypora* Saville Kent,1871	+	+	+	+
164.	*Oxypora crassispinosa* Nemenzo, 1979	+	+	+	+
165.	*Oxypora glabra* Nemenzo, 1959	+	+	+	-
166.	*Oxypora lacera* (Verrill, 1864) Genus: *Echinophyllia* Klunzinger,1879	+	-	+	-
167.	*Echinophyllia orpheensis* Veron and Pichon, 1980	+	+	-	+
168.	*Echinophyllia echinoporoides* Veron and Pichon, 1980 Genus: *Mycedium* Oken,1815	+	+	+	+

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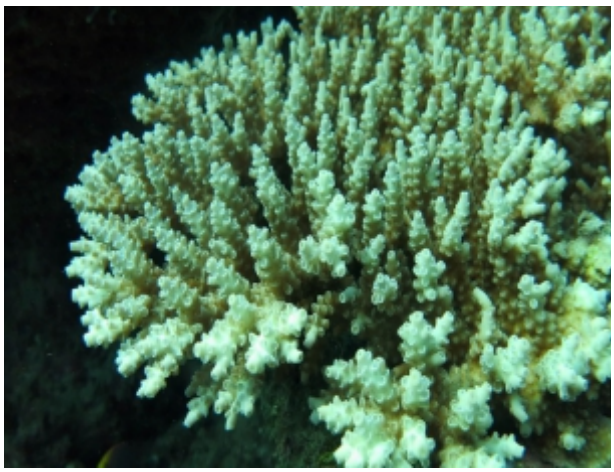
169.	*Mycedium elephantotus* (Pallas, 1766) Genus: *Pectinia* Oken, 1815	+	+	+	-
170.	*Pectinia paeonia* (Dana, 1846)	+	+	+	+
171.	*Pectinia lactuca* Pallas, 1766 Family: PORITIDAE Gray, 1842 Genus: *Porites* Link, 1807	+	-	-	-
172.	*Porites solida* (Forskal, 1775)	+	+	+	+
173.	*Porites stephensoni* Crossland, 1952	+	+	-	-
174.	*Porites brighami* Vaughan, 1907 Genus: *Goniopora* de Blainville, 1830	-	+	-	-
175.	*Goniopora tenuidens* (Quelch, 1886)	-	-	-	+
176.	*Goniopora lobata* Milne Edwards and Haime, 1860 Family: MERULINIDAE Verrill,1866 Genus: *Hydnophora* Fischer de Waldheim,1807	+	+	-	-
177.	*Hydnophora rigida* (Dana, 1846) Genus: *Merulina* Ehrenberg, 1834	-	-	-	+
178.	*Merulina ampliata* (Ellis and Solander, 1786)	+	+	+	-
179.	*Merulina scabricula* Dana, 1846 Genus: *Scapophyllia* Milne Edwards and Haime, 1848	-	-	-	+
180.	*Scapophyllia cylindrica* Milne Edwards and Haime, 1848 Family: DENDROPHYLLIIDAE Gray, 1847 Genus: *Turbinaria* Oken, 1815	+	+	+	-
181.	*Turbinaria mesenterina* (Lamarck, 1816)	+	+	+	-
182.	*Turbinaria frondens* (Dana, 1846) Family: EUPHYLLIDAE Veron, 2000 Genus: *Physogyra* Quelch, 1884	+	+	+	-
183.	*Physogyra lichtensteini* (Milne Edwards and Haime, 1851) Genus: Plerogyra Milne Edwards and Haime, 1848	+	+	+	-
184.	*Plerogyra sinuosa* (Dana, 1846) Genus: *Euphyllia* Dana, 1846	+	-	+	-
185.	*Euphyllia glabrescens* (Chamisso and Eysenhardt, 1821) Family: TRACHYPHYLLIIDAE Verrill, 1901 Genus: Trachyphyllia Milne Edwards and Haime, 1848	-	-	-	+
186.	*Trachyphyllia geoffroyi* (Audouin,1826)	+	-	-	-



Acropora tenuis (Dana, 1846)

Diploastrea heliopora (Lamarck, 1816)

Leptoria phrygia (Ellis and Solander, 1786)

Goniopora lobata Milne Edwards and Haime, 1860

Lithophyllon lobata Horst, 1921

Herpolitha limax (Houttuyn, 1772)

Plate 1: Scleractinian corals of Saddle Peak National Park adjoining sea

Pachyseris gemmae Nemenzo, 1955

Pavona explanulata (Lamarck, 1816)

Turbinaria mesenterina (Lamarck, 1816)

Pocillopora eydouxi MED & H, 1860

Symphyllia erythraea (Klunzinger, 1879)

Symphyllia radians Milne Edwards and Haime, 1849

Plate 2: *Scleractinian corals* of Saddle Peak National Park adjoining sea

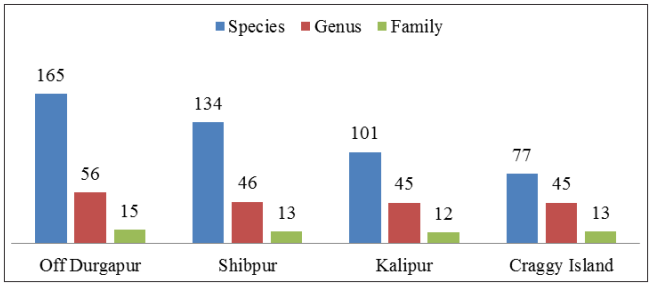


Fig. 3: Species availability of Scleractinian corals at study areas of Saddle Peak adjoining areas

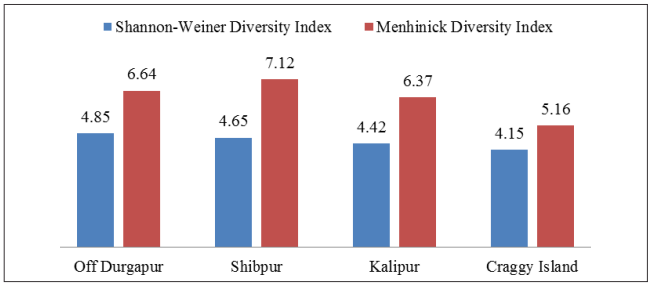


Fig. 4: Shannon-Weiner and Menhinick Diversity Indices of Scleractinian corals at Saddle Peak adjoining areas

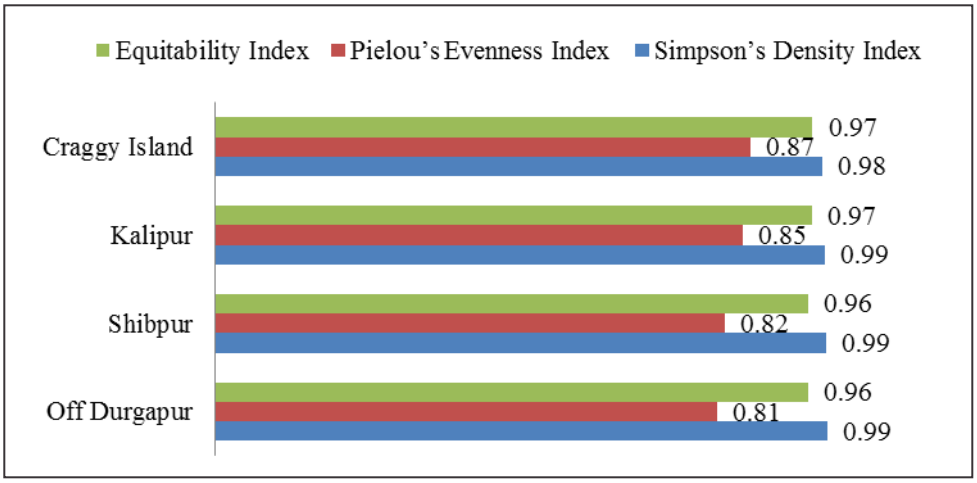


Fig. 5: Equitability, Pielou's Evenness and Simpson's Diversity Indices of *Scleractinian corals* at Saddle Peak adjoining areas

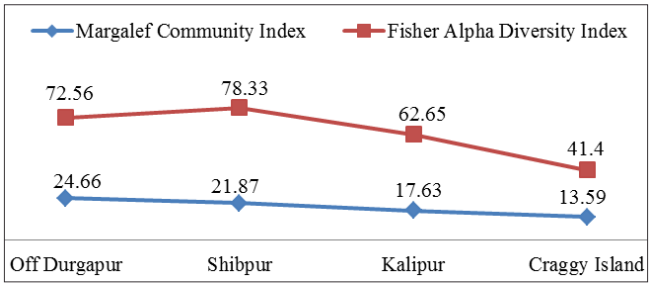


Fig. 6: Margalef Community and Fisher Alpha Diversity Indices of *Scleractinian corals* at Saddle Peak adjoining areas

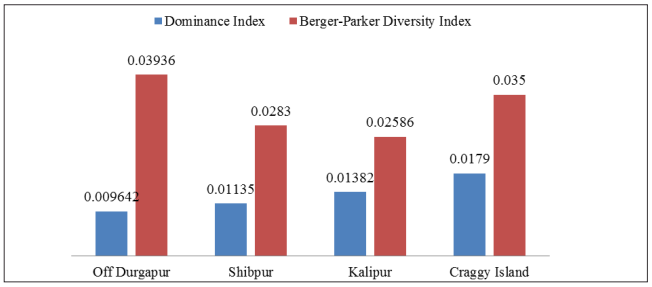


Fig. 7: Dominance and Berger-Parkar Diversity Indices of *Scleractinian corals* at Saddle Peak adjoining areas

The four study areas showed variation in diversity, dominance, evenness, community and equitability indices. Shannon-Weiner Diversity Index reveals that Off Durgapur showed highest diversity with 4.85 whereas Craggy Island showed the lowest with 4.15. The Menhinick Diversity Index implies that Shibpur was more diversed (7.12) whereas the Craggy Island was least diversed (5.16) (Fig.4). Equitability Index of scleractinian corals was maximum for Craggy Island and Kalipur (0.97) whereas minimum (0.96) in rest of the two places. Pileou's Evenness Index was high at Craggy Island (0.87) and low at Off Durgapur (0.81). Simpson's Density Index was similar values at three

areas (0.99) except Craggy Island (0.98) (Fig. 5). Margalef Community Index was varied from 41.40 to 78.33 at Craggy Island and Shibpur respectively whilke Fisher Alpha Diversity Index was ranged between 13.59 and 24.66 at Craggt Island and Off Diglipur respectively (Fig. 6). Dominance Index showed maximum values for Craggy Island (0.0179) and minimum for Off Durgapur area (0.009642). Berger-Parker Diversity Indices were shown higher values for Off Durgapur (0.03936) while lower (0.02586) at Kalipur (Fig. 7).

The data on similarity index between sites registered maximum similarity index (0.78) between Shibpur and Kalipur whereas the minimum (0.44) observed between Kalipur and Craggy Island (Table 3).

Table 3: Similarity Index of *Scleractinian corals* in the study areas

	Shibpur	Kalipur	Craggy Island
Off Durgapur	0.77	0.72	0.46
Shibpur	-	0.78	0.47
Kalipur	-	-	0.44

Coral species were distributed from intertidal region to the depth of 33 m at Saddle Peak adjoining areas. The mean density of corals in Saddle Peak National Park adjoining seas was assessed as 20-32 colonies/10 sq. m. at Craggy Island and Off Durgapur respectively. The live coral cover in the study areas were estimated as 33.75 - 56.28% at Craggy Island and Off Durgapur respectively. It was also reported that 51.66% (Craggy Island) - 79.22% (Shibpur) of corals were bleached in 2010 due to increase in sea surface temperature in Andaman Sea. Subsequently on resumption of normalcy in environmental variables, the recovery of corals was observed as 47.65 - 54.12% during 2011 at the study sites. In addition, a maximum of 16.43% new recruitment of corals was recorded at Off Durgapur and it was minimum (10.55%) at Kalipur (Table 4 and Fig. 8).

Table 4: Status of Scleractinian corals of Saddle Peak adjoining areas

Sl. No.	Study areas	Density of colony/10m2	Bleached corals percentage 2010	Recovery percentage of corals 2011	New Recruitment percentage 2011-2013 (Colony/ 10m2)	Live coral percentage 2014-15
1	Off Durgapur	32	72.14	52.35	16.43	56.28
2	Shibpur	29	79.22	54.12	12.24	43.87
3	Kalipur	25	65.28	50.54	10.55	40.59
4	Craggy Island	20	51.66	47.65	13.68	33.75

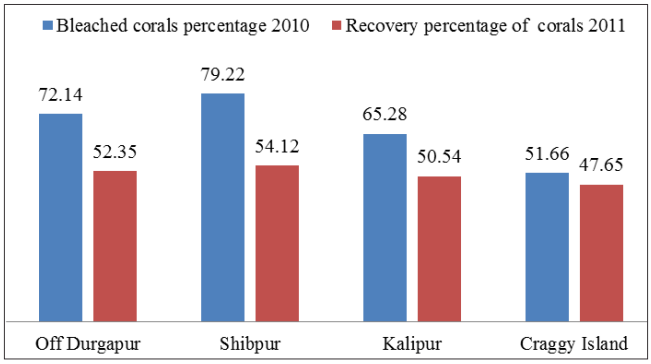


Fig. 8: Percentage of bleaching and recovery of corals at Saddle Peak adjoining areas

Discussion

At the adevent its developmetal pattern, adaptation and evolution coral has been surviving in this planet as extremely ancient animals of reef-building forms over the last 25 million years. With the presence of biogenic habitat scleractinian corals develop massive and complex reef which harbours marine biodiversity at geater extent. Large wave resistant structures of reef have accumulated from the slow growth of corals. Coral reefs are the largest structures on earth of biological origin. The development of reef is aided by algae that are symbiotic with reef-building corals, known as zooxanthellae.

Topologically coral reefs are like a rain forest, it has many strata and areas of strong shade, cast by the over towering coral colonies. Because of the extraordinary structural intricacy, thousands of species of fish and invertebrates live in association with reefs, which are by far our richest marine habitats.

The continental shelf region of Saddle Peak National Park eastern side is covered by a reef which provides an ideal environment for the recturitment of scleractinian corals. Andaman and Nicobar Islands are showing maximum diversity in scleractinian species content among all the reef areas of India (Tamal Mondal et al.,2015, in press) with a total of 577 species where India has a total of 603 species, which contributes about 40% of global scleractinian coral diversity. Andaman and Nicobar reefs are dominated by family Acroporidae, Faviidae, Poritidae, Fungidae and Agariciidae corals. **A total of 186 species of scleractinian corals belong to 59 genera and 15 families were documented during the study period** from four study areas. This represents 32.23% scleractinian corals of Andaman and Nicobar Islands. The values of species diversity indices were above the optimal level. A total of 91 species under the family Faviidae were recorded till now from these groups of islands (Tamal Mondal *et al.*, 2012), whereas 49.45% species of that family can be seen among the scleractinians from the Saddle Peak adjoining seas. It is also pertinent to note that out of 53 species of fungiid corals reported from Andaman and Nicoabar Islands (Tamal Mondal, 2014), 50 species are found in the presently studied area. Besides a new species of scleractinian coral *Favites monticularis* was also described earlier from the Shibpur area (Tamal Mondal *et al.*, 2013). The density of corals was assessed as 20-32 colonies/10 sq. m. with the live coral cover of 33.75 - 56.28% recored during the study period at Saddle Peak National Park adjoining seas. Mortality caused by mass bleaching of coral during 2010, presently under the state of revival due to new recuruitments. The rate of new recruitment was very negligible with the 10.55 to 16.43% in comparison with destruction through mass bleaching event. Scleractinian corals played a significant role for the development of biogenic habitat during the process of coral resilience by the re-aggregation of zooxanthalle. The epitome of the results obtained from the present study suggested that as most of the reef areas in the adjoining sea of Saddle Peak National Park have highly diversed corals and its associated faunal communites which needs to be protected for better conservation as this area is not a declared a protected area yet.

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References

Berger, W.H. and Parker, F.L., 1970. Diversity of planktonic Foramenifera in deep sea sediments. Science, 168:1345-1347.

Done, T.J., Kenchinton, R.A., and Zell, L.D., 1982. Rapid, large area, reef resource surveys using a manta board. Proceedings of the Fourth International Coral Reef Symposium, Manila, 2: 597-600.

English, S., Wilkinson, C. and Baker, V., 1997. Survey manual for tropical marine resources. 2nd Edition. Australian Institute of Marine Science. 390pp.

Fisher, R. A., 1925. Statistical methods for research workers. Oliver and Boyd, Edinburgh. (Page numbers refer to the 10 edition, 1946).

Margalef, R., 1968. Perspective in Ecological Theory. Uni. of Chicago Press. pp.112.

Menhinick, E.F., 1964. A comparison of some species diversity indices applied to samples of field insects. Ecology, 45: 858-862.

Pielou, E.C., 1969. An Introduction to Mathematical Ecology. John Wiley and Sons, New York.

Rao, D.V., 2010. Field Guide to Coral and Coral Associates of Andaman & Nicobar Islands, pp: 1-283. (Published by the Director, Zoological Survey of India, Kolkata)

Shannon, C.E. and Weaner, W., 1964. The Mathematical Theory of communication. The Uni. of Illinois press, Urbana, IL.

Simpson, E.H., 1949. Measurement of diversity. Nature, 167:163-188.

Sørensen, T., 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species and its application to analyses of the vegetation on Danish commons. Biologiske Skrifter / Kongelige Danske Videnskabernes Selskab, 5: 1-34

Tamal Mondal, Raghunathan, C. and K. Venkataraman, 2015. Diversity of scleractinian corals in Great Nicobar Island, Andaman and Nicobar Islands, India. Proc. Zool. Soc. DOI:10.1007/s12595-015-0145-8.

Tamal Mondal, Raghunathan, C. and Venkataraman, K., 2013. Description of Favites monticularis sp. nov. (Faviidae) off North Andaman Islands, India. Journal of Threatened Taxa, 5(10): 4510-4513; http://dx.doi.org/10.11609/JoTT. o3224.4510-3

Tamal Mondal, Raghunathan, C. and K. Venkataraman, 2012. An account of Faviid Corals of Andaman & Nicobar Islands. Research J. Science and Tech. 4(2): 62-66.

Tamal Mondal, Raghunathan, C. and Venkataraman, K., 2014. Checklist of scleractinian corals of India with their IUCN status: a special reference to Andaman and Nicobar Islands Journal of Threatened Taxa, (in press).

Venkataraman, K., Satyanarayan, Ch., Alfred, J.R.B. and Wolstenholme, J., 2003. Handbook on Hard Corals of India., 1-266. (Published by the Director, ZSI, Kolkata).

Veron, J. E. N., 2000. Corals of the World. Australian Institute of Marine Science. 1-3 volumes.

Veron, J.E.N, and Pichon, M., 1976. *Scleractinia of Eastern Australia.* Part I. Australian Institute of Marine Science. 86pp.

Veron, J.E.N, and Pichon, M., 1979. *Scleractinia of Eastern Australia*. Part III. Australian Institute of Marine Science. 421pp.

Veron, J.E.N, and Pichon, M., 1982. *Scleractinia of Eastern Australia.* Part IV. Australian Institute of Marine Science. 159pp.

Veron, J.E.N, and Wallace, C.C., 1984. *Scleractinia of Eastern Australia*. Part V. Australian Institute of Marine Science. 485pp.

Veron, J.E.N., Pichon, M. and Wijsman-Best, M., 1977. *Scleractinia of Eastern Australia*. Part II. Australian Institute of Marine Science. 233pp.

Wallace, C. C., 1999. *Staghorn Corals of the world.* CSIRO Publications, Melbourne. 421pp.

water fish fauna of the Andaman Islands. J. Bombay. Nat. Hist. Soc., 58(1): 287-289.

Whitaker, R., 1985. Endangered Andamans. Department of Enviornment, Government of India, pp 51.