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Diversity and distribution of shallow water octocorallia from Mahatma Gandhi Marine National Park, South Andaman, India

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Diversity and distribution of octocorals of Mahatma Gandhi Marine National Park (MGMNP), South Andaman were investigated from June, 2013 to May, 2016 using a Line Intercept Transect method with help of SCUBA diving. The study was carried out in 11 different islands named as Alexandra, Belle, Chester, Snob, Grub, Jolly Bouy, Boat, Red Skin Rutland, Tarmugli and Twins Islands. We undertook a systematic study on the diversity of octocorals. Thirty five species belonging to 29 genera were reported from MGMNP of which, the alcyonacea was a dominant group followed by gorgonacea, helioporacea and pennatulacea at all the study sites which is also substantiated by Principal Component analysis, and Ternary plot. Results on Bray-Curtis cluster analysis showed 35 % to 76 % similarity between the study sites in MGMNP.

[Keywords: Soft coral; Octocorallia; Diversity; Marine National Park; MNP; Wandoor, MGMNP].

Introduction

The Andaman and Nicobar Islands are a low mountainous chain of islands, which rise from a submerged north-south trending ridge separating the Andaman Sea from the Bay of Bengal between 6°-14°N and 92°-94°E. 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[1]. Mahatma Gandhi Marine National Park (MGMNP) situated in Wandoor, between 11°22'06 to 11°36'34"N latitude and 92°30'00" to 92°40'33"E longitude in the Bay of Bengal. It is the first Marine National Park of Andaman and Nicobar Islands and situated in southwest coast of the South Andaman Island. The Marine National Park encompasses 15 islands, *viz*., Jolly Bouy, Malay, Pluto, Red Skin, Boat, Snob, Chester, Grub, Hobday, Alexandra, Tarmugli, Twins, Belle, Rifleman and Rutland Island. The total area of Marine National Park is approximately 61.5 km^2, of which, 15 islands covered around 59.77 km^2 areas of land. Fringing reefs are reported in Rutland, Jolly Bouy, Tarmugli, Boat, and Redskin Islands and coral pinnacles in Twin, Chester, Snob and Malay Islands[2-4].

Recently, many studies have been made on the monitoring and assessment of octocorals community, both on global[5,6] and regional levels[7-19] for estimating the status and distribution patterns. Octocorallia comprised of three orders: helioporacea (blue coral), pennatulacea (sea pens), and alcyonacea (soft corals, Stolonifera, gorgonians and telestacea) found in intertidal to abyssal depths around World Ocean from tropical to polar seas[20]. Due to their arborescent form, octocorals increase spatial and ecological heterogeneity and provide niches for many associated species[21-26].

Today, the ocrocorals are facing natural interventions and anthropogenic impacts due to nutrients lead to algal competition[27]. The 9.15 Mw mega earthquake, and subsequent Tsunami event of 26 December 2004 as well as major bleaching event on May 2010 resulted in large scale damage to reef ecosystem in the Andaman and Nicobar Islands[28,29]. Hence, the assessment of the status of the octocorals through statistical approach has become indispensable. The objective of this study is to analyze the octocoral diversity to determine the richness and health of the octocoral community in MGMNP.

Materials and Methods

Approximately 11 sites namely, Alexandra (AI), Belle (BI), Chester (CHI), Snob (SI), Grub (GI), Jolly Bouy (JB), Boat (BI), Red Skin (RS), Rutland (RI), Tarmugli (TAI), Twins (TI) Islands were selected for

the study (Fig. 1). Line Intercept Transect (LIT) and Quadrate methods[30] were utilized to investigate the diversity and distribution of the Octocorallia. Species were identified based on the morphological characteristics and sclerite structure and preserved in 70% ethanol following the method of Breedy[31] and deposited in the National Zoological collection of ZSI, Port Blair. Menhinick Diversity, Shannon – Weiner Diversity, Pielou's Evenness, Principal Component Analysis (PCA) scatter diagram, Ternary plot and Bray-Curtis cluster analysis were made using PAST software[32].

Results

Thirty five species of octocorals under the 29 genera, 15 families were recorded along the transect area from the MGMNP (Table 1, Fig. 2). Maximum number of species were recorded from the Tarmugli Island (22 sp.) followed by Twins Island (15 sp.), Rutland Island (15 sp.), Boat Island (15 sp.), Jolly Bouy Island (14 sp.), Chester Island (13 sp.), Boat Island (12 sp.), Grub Island (11 sp.), Red Skin Island (11 sp.), Snob Island (8 sp.) and Alexandra Island (6 sp.).

The Menhinick Diversity index was recorded as highest at the Twins Island (3.6) and lowest diversity

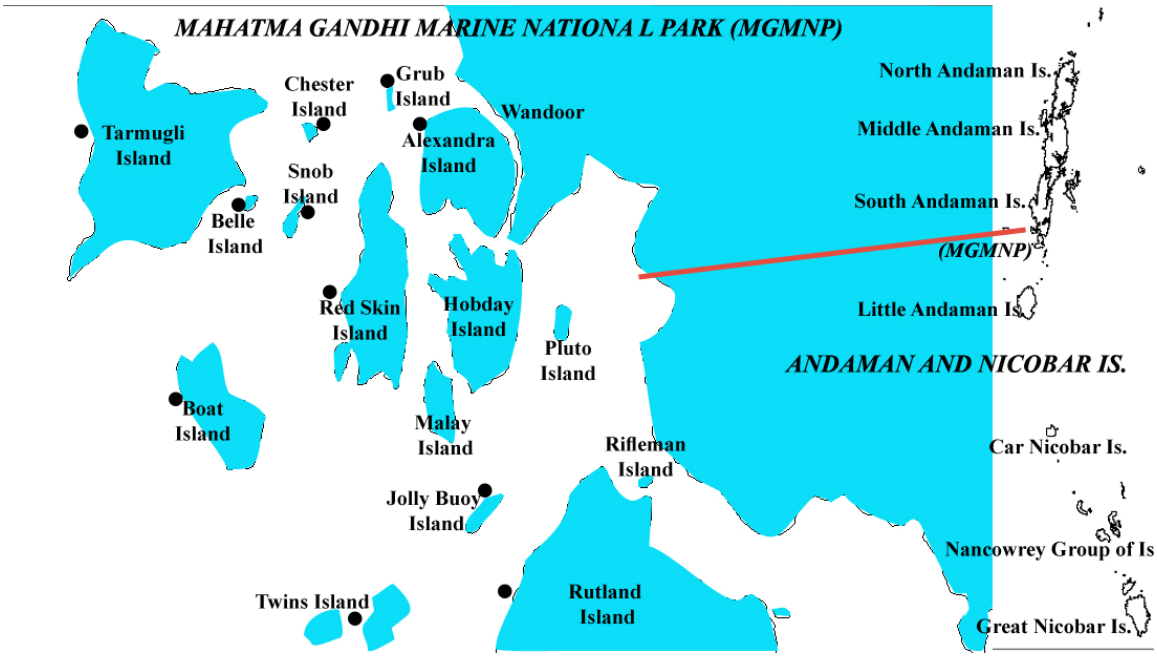

Fig. 1— Map showing the study sites in Mahatma Gandhi Marine National Park, South Andaman Islands.

Table 1 — Distribution of octocoral species from MGMNP group of Islands

S.N	Species	AI	BI	CHI	SI	GI	JB	BI	RS	RI	TAI	TI
	Order: Helioporacea Family: Helioporidae											
1	*Heliopora coerulea*	_	+	+	+	+	+	+	+	+	+	+
	Order: Alcyonacea Family: Nidaliidae											
2	*Siphonogorgia media*	_	_	_	_	_	+	_	_	+	+	+
	Family: Alcyoniidae											
3	*Cladiella* sp.	_	+	+	_	_	+	_	_	_	+	_
4	*Lobophytum* sp.	_	+	+	+	+	+	+	+	+	+	+
5	*Sinularia* sp.	+	+	+	+	+	+	+	+	+	+	+
6	*Sarcophyton* sp.	+	+	+	+	_	+	+	+	+	+	+
	Family: Xeniidae											
7	*Heteroxenia fuscescens*	_	_	_	_	_	+	_	_	_	_	_

(*Contd.*)

Table 1 — Distribution of octocoral species from MGMNP group of Islands (*Contd*.)

S.N	Species	AI	BI	CHI	SI	GI	JB	BI	RS	RI	TAI	TI
	Family: Nephtheidae											
8	*Nephthea sp.*	–	–	–	–	–	+	–	–	+	+	+
9	*Dendronephthya* sp.	–	–	–	–	–	+	+	+	+	+	+
	Family: Subergorgiidae											
10	*Annella mollis*	–	–	+	–	–	–	+	–	–	–	–
11	*Subergorgia suberosa*	+	–	+	+	+	+	+	–	–	+	+
	Family: Plexauridae											
12	*Echinogorgia* sp.	–	+	–	–	–	–	–	–	+	+	+
13	*Menella sp.*	–	–	–	–	–	–	–	–	–	+	–
14	*Trimuricea sp.*	–	–	+	–	–	–	+	–	–	–	–
15	*Villogorgia sp.*	–	–	–	–	–	–	+	–	–	–	–
	Family: Briareidae											
16	*Briareum violaceum*	–	–	–	–	–	–	–	–	–	+	–
	Family: Acanthogorgiidae											
17	*Anthogorgia sp.*	–	–	+	–	–	–	–	–	–	–	–
18	*Muricella sp.*	–	–	–	–	–	–	+	–	–	–	–
	Family: Melithaea											
19	*Melithaea caledonica*	–	–	–	–	–	–	–	+	+	+	+
20	*Melithaea* sp.	–	–	–	–	–	–	–	+	–	–	–
	Family: Isididae											
21	*Isis hippuris*	+	+	+	+	+	+	+	+	+	+	+
	Family: Ellisellidae											
22	*Dichotella sp.*	–	–	+	–	–	–	–	–	–	–	–
23	*Ellisella sp.*	–	–	–	–	–	–	–	–	+	+	+
24	*Junceella eunicelloides*	–	–	–	–	–	–	–	–	–	+	–
25	*Junceella sp.*	–	+	–	+	–	–	+	+	+	+	–
26	*Nicella laevis*	–	–	–	–	–	+	–	–	–	–	–
27	*Nicella sp.*	–	–	–	–	–	–	+	–	–	–	–
28	*Verrucella corona*	+	+	+	+	+	+	+	+	+	+	+
29	*Verrucella sp.*	–	+	–	–	+	+	–	–	+	+	–
30	*Viminella crassa*	–	–	–	–	–	–	–	–	–	+	–
31	*Viminella sp.*	–	+	–	–	–	–	+	–	–	+	+
	Order: Pennatulacea Family: Virgulariidae											
32	*Virgularia gusteviana*	–	–	–	–	+	–	–	–	–	–	–
33	*Virgularia sp.*	+	+	+	–	+	–	–	+	+	+	+
	Family: Pennatulidae											
34	*Pteroeides esperi*	–	–	–	–	+	–	–	–	–	–	–
	Family: Veretillidae											
35	*Cavernularia pusilla*	–	–	–	–	+	–	–	–	–	–	–
	Total	6	12	13	8	11	14	15	11	15	22	15

+ Present; - Absent

AI – Alexandra, BI- Belle, CHI – Chester, SI – Snob, GI – Grub, JB – Jolly Bouy, BI – Boat, RS – Red Skin, RI – Rutland, TAI – Tarmugli, TI – Twins

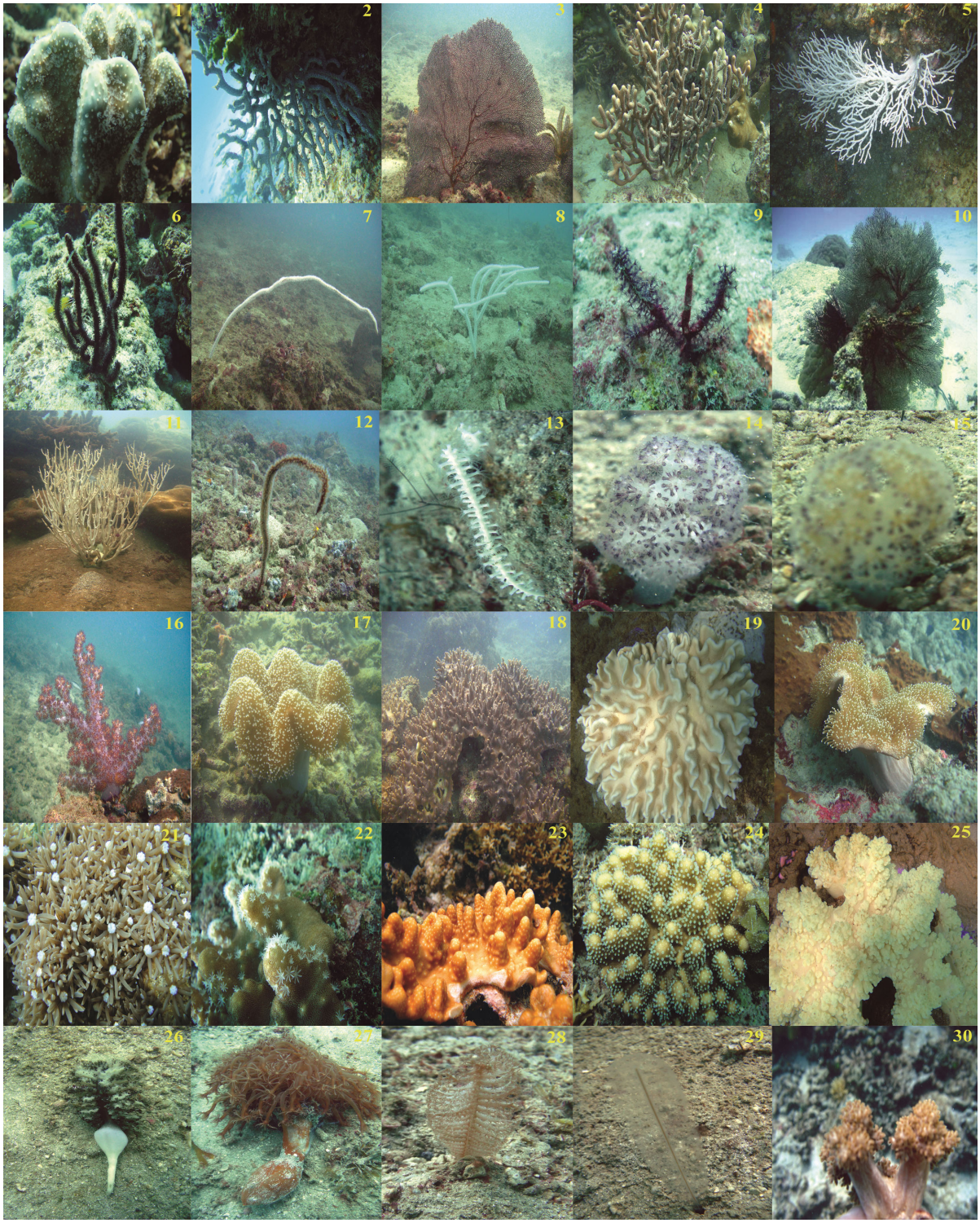

Fig. 2 — underwater pictures of some octocorals from the study site in Mahatma Gandhi Marine National Park, South Andaman Islands. (1. *Heliopora coerulea,* 2. *Siphonogorgia media,* 3. *Verrucella corona*, 4. *Isis hippurius*, 5. *Melithaea* sp. 6. *Menella* sp., 7. *Junceella eunicelloides,* 8. *Dichotella* sp., 9.*Muricella* sp., 10. *Melithaea caledonica,* 11. *Rumphella torta* 12.*Viminella crassa,* 13. *Nicella laevis,* 14 - 16. *Dendronephthya* sp., 17. *Sarcophyton* sp.,, 18, 19 & 23. *Lobophytum* sp., 20. *Sarcophyton* sp., 21. *Briareum violaceum,* 22. *Sinularia* sp. 24 & 25. *Cladiella* sp., 26. *Pteroeides esperi,* 27. *Cavernularia pusilla,* 28. *Virgularia gusteviana,* 29. *Virgularia* sp. 30. *Heteroxenia fuscescens*)

of octocorals in Alexandra Island (2.0). The Shannon – Weiner Diversity index was maximum in Tarmugli Island (2.8) and the minimum in Alexandra Island (1.56). The Simpson's Diversity indices, Tarmugli Island (0.93) was noted maximum and Alexandra Island (1.56) minimum and the Pielou's Evenness index for species community ranged from 0.8 (Boat Island) to 0.957 (Jolly Bouy Island). A maximum number of individuals and percentage of cover reported in the Tarmugli Island (30 nos) and the minimum in Alexandra Island (6 nos) (Table 2).

The diversity and distribution of octocoral cover are in the following order: Tarmugli (15.54%) > Boat (13.47%) > Rutland (10.88%) > Chester (10.36%) > Twins (9.33%) > Belle (8.29%) > Grub (7.77%) > Snob (7.25%) > Jolly Bouy (7.25%) > Red Skin (6.74%) > Alexandra (3.11%). A statistical analysis of the Principal Component, Bray-Curtis similarity cluster and Ternary plot analysis clearly showed that alcyonacean diversity was highly significant and pennatulacea was non-significant between the study sites.

A Principal Component Analysis of different live form categories and genera of octocoral and its contribution with respect to study sites are presented in Fig 3. Percentage of octocoral cover was varied between the study sites, for the three orders helioporacea, alcyonacea, pennatulacea. Among them alcyonacea was dominant at all the study sites whereas, pennatulacea was completely missing in three study sites (Snob Island; Jolly Bouy Island; Boat Island) and helioporacea absent in Alexandra Island. The percentage of octocorals were plotted in Ternary

Table 2— Octocoral diversity index between the study stations in MGMNP

Name of the Islands		Menhinick Diversity index	Shannon - Weiner Diversity Index	Simpson's Diversity Indices	Pielou's Evenness	Individuals	Percentage of cover
Alexandra	AI	2.041	1.561	0.778	0.952	6	3.11 %
Belle	BI	2.75	2.183	0.852	0.807	16	8.29 %
Chester	CHI	2.46	2.194	0.865	0.816	20	10.36 %
Snob	SI	2.138	2.008	0.857	0.931	14	7.25 %
Grub	GI	2.582	2.211	0.88	0.913	15	7.77 %
Jolly Bouy	JB	3.207	2.441	0.908	0.957	14	7.25 %
Boat	BI	2.746	2.471	0.902	0.846	26	13.47 %
Red Skin	RS	2.774	2.205	0.875	0.907	13	6.74 %
Rutland	RI	3.273	2.558	0.907	0.860	21	10.88 %
Tarmugli	TAI	3.469	2.812	0.931	0.876	30	15.54 %
Twins	TI	3.536	2.63	0.919	0.925	18	9.33 %

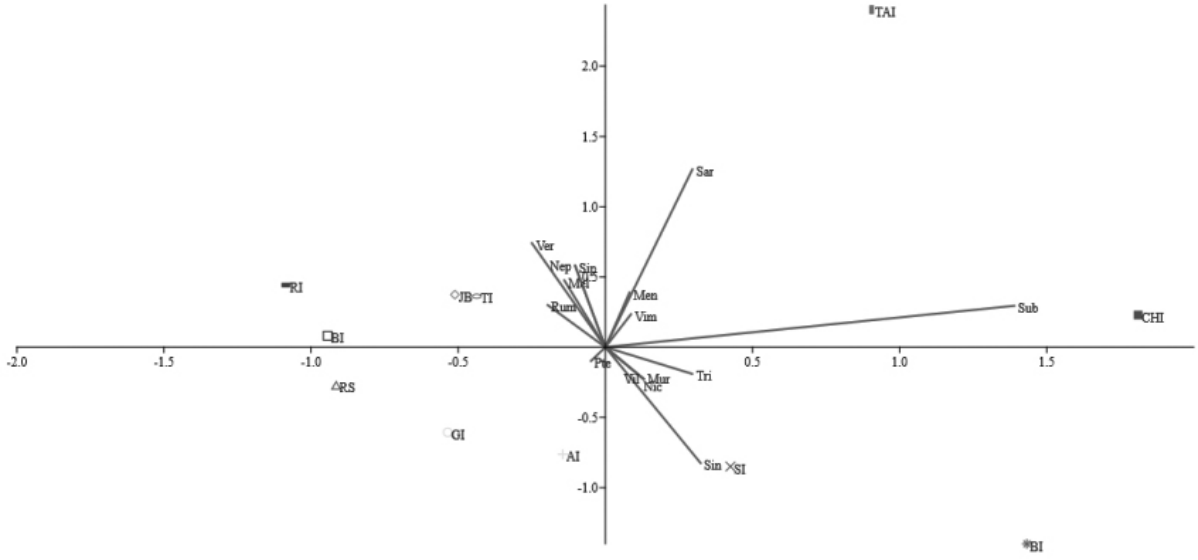

Fig. 3 — Principal Component Analyses (PCA): **A-** Life form categories and **B** – Octocorals recorded in the MGMNP groups of Islands.

plot also illustrated all the study sites closed to the order alcyonacea (Fig. 4). As per the result of Bray-Curtis cluster analysis under paired linkage, maximum similarity between Rutland Island and Twins Island and minimum similarity between Chester Island and Alexandra Island (Fig. 5).

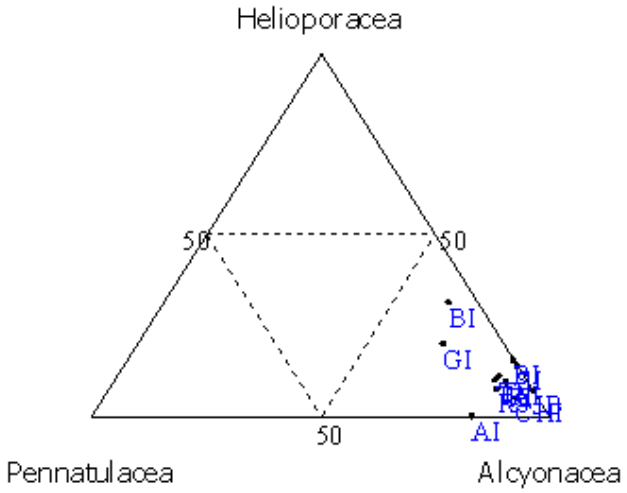

Fig. 4 — Ternary Plot analysis based Octocoral distribution between the study sites in the MGMNP.

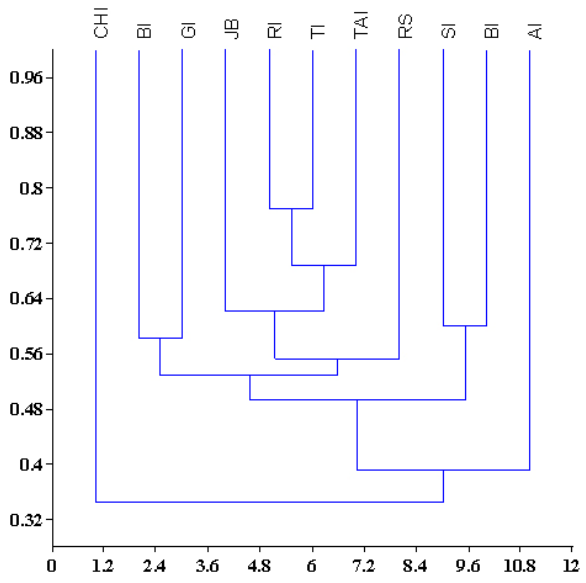

Fig. 5 — Bray-Curtis similarity cluster analysis under paired linkage for the MGMNP group of islands based on the species of octocoral.

Discussion

The Andaman and Nicobar Islands are rich and a variety of marine fauna and flora including endangered schedule faunas. Mahatma Gandhi Marine National Park and Rani Jhansi Marine National Park have been established for protecting the marine fauna. MGMNP has rich diversity of fauna and flora including mollusc, Echinodermata, fishes, sea snakes, sea turtles, birds, marine mammals and so on. Coral and octocorals are playing major role in the marine ecosystem and part of the coastal environment. Coral bleaching reported in 1998, 2010 and around 74-77 % of corals were bleached in Andaman and Nicobar Island[28,29]. Recently, Marimuthu *et al.,*[4] reported maximum live coral cover from Port Blair group of islands, of which Rutland Island, Tarmugil Island, Belle Island, Chester Island, Grub Island, Redskin Islands, Jolly buoy Islands and Twince Islands in MGMNP.

The Octocoral belongs to the Anthozoan subclass Octocorallia comprised of three orders: Helioporacea (blue coral), Pennatulacea (sea pens), and Alcyonacea (soft corals, stolonifera, gorgonians and telestacea) found in intertidal to abyssal depths[20]. The study on the Indian octocoral taxonomy was initiated by Hickson, [33,34] and from Lakshadweep and Maldive, Pratt[7] and Thomson and Handerson[8, 9] from the Gulf of Mannar, Sri Lankan coast at 1200 m depth. Thomson and Simpson[10] reported Octocorals from the collection of Royal Indian Marine Survey Ship in Indian Ocean, while Thomas and George[35,37] reported gorgonian octocorals from Indian water. Ofwegen and Vennam[38] and Alderslade and Shirwaiker[39] studied octocorals from Lakshadweep Islands. Along the west coast of India, Usha *et al.*[15] reported the distribution of octocorals from the Gulf of Kachchh and Gujarat coast.

Taxonomic and ecological studies of octocorals are scanty in Andaman and Nicobar Island. Jaya Sree *et al.*[13] reported 26 species of soft coral, their occurrence and distribution from MGMNP. Followed by Rao and Devi[14] reported 54 species of soft corals from Andaman and Nicobar Islands. Kumar *et al.*[40] reported 13 species belonging to 12 genera of gorgonian octocorals from Ritchie's Archipelago, South Andaman Islands. Kumar *et al.*[17] reported 51 species of gorgonians belonging to 25 genera, eight families and three suborders from Andaman and Nicobar Island and also reported diversity and abundance of shallow water octocorals in Andaman and Nicobar Archipelago, India[18]. Kumar *et al.*[41,42]

reported three pennatulacea and two alcyonacea from Andaman and Nicobar Island. Kumar and Raghunathan[19] documented a checklist of gorgonians from Indian waters. Recently, updated checklist of octocoral of Indian coast[43] and distribution of octocorals reported with 28 species belonging to 17 genera and 6 families from Middle Andaman Islands[44] and 27 species of octocorals belonging to 23 genera and 13 families were reported from Nicobar Islands[45] were published.

The present study reported 35 species of octocorals belonging to 29 genera along with their diversity and distribution as a first time from the study sites of MGMNP. The abundance of Alcyonacea cover is in the following order: Jolly Bouy > Chester > Snob > Rutland > Boat > Red Skin > Tarmugli > Twins and the composition of pennatulacea is in the order Alexandra > Grub > Red Skin > Tarmugli > Boat > Twins > Chester > Rutland. A statistical analysis of the Principal Component, Bray-Curtis similarity cluster and Ternary plot analysis clearly showed that alcyonacean diversity was highly significant and pennatulacea was non-significant between the study sites.

Ternary plot analysis suggested alcyonacea to be the most common group and pennatulacea was least found group in all the study sites. Bray-Curtis similarity cluster analysis shows complete variations between the study sites based on the octocoral species cover. Among them maximum (78 %) similarity reported between Rutland Island and Twins Island and minimum (34 %) similarity reported between Chester Island and other Islands. The number of species of shallow water octocorals in the MGMNP is much higher than other reef areas of the Andaman and Nicobar Islands. A comprehensive underwater study needs to be undertaken to study the anthropogenic impact. The occurrence of octocorals in shallow to deep water also warrants detailed studies.

Conclusion

This study partially confirmed some of the octocorals present in MGMNP and adjacent waters. A total of 35 species have been for the reported first time from this study sites. However, more detailed study required to assess the status survey of octocorals and distribution in shallow to deep waters.

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