INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 6, No. 4, p. 205-214, 2015
http://www.innspub.net

RESEARCH PAPER

OPEN ACCESS

A study on the biodiversity of snake island in South Andaman

Bitopan Malakar[1], S. Venu[1], B. Santhosh Ram[1], M.P. Prabhakaran[2]

[1]*Department of Ocean Studies & Marine Biology, Pondicherry University, Brookshabad Campus, Port Blair, A & N Islands, India*

[2]*Department of Biological Oceanography, School of Ocean Studies and Technology, Kerala University of Fisheries and Ocean Studies, Panangad, Kerala, India*

Article published on April 21, 2015

Key words: Snake Island, Islet, Biodiversity, Coral Pool, Intertidal.

Abstract

Snake Island is an uninhabited small rocky islet off Carbyn's Cove in Port Blair, Andaman. The biodiversity of this rocky island is its distinctive feature as it becomes a small habitat for various organisms close to the open sea. During this present study a total no. of 217 species were recorded out of which 205 has been identified. Pisces was the dominant group, followed by cnidarians, molluscs, arthropods etc. The island is highly influenced by sea water as during high tides nearly 75 % of the island is submerged by seawater. This is the reason of dominance of marine organisms (94 %) over terrestrial organisms (6 %) in the island. Another characteristic feature of the island is the formation of numerous rocky and sandy water channels and the presence of a 'coral pool' at the end of one such channel on the north-eastern part of the island. During high tide these channels are filled with water and exchange of seawater takes place in the coral pool, where highest diversity of species was observed. Lack of intertidal species in the island is evident due to the high action of waves from the open sea and lack of hiding areas other than rocky crevices.

***Corresponding Author:** Bitopan Malakar ✉ bitopanmalakar@gmal.com

Introduction

Studies on biodiversity is very essential to understand and keep track of the rapid extinction of many flora and fauna every year due to enormous anthropogenic pressure on our environment. Island biodiversity are some of the most promising biodiversity areas as both terrestrial and marine flora and fauna coexist near close boundaries. The potential of marine flora and fauna is still not clear as many species are yet to be discovered. The marine biodiversity can be estimated by the fact that there are somewhere around 250,000 (Groombridge and Jenkins, 2000) to 274,000 (Reaka-Kudla, 1997) marine species and many still not known till date. India have very high potential of coastal and marine biodiversity considering the vast coast line (more than 8000 km) and its island territories. Venkataraman (2005) estimated the biodiversity of coastal and marine ecosystems in India and found the number of total described species to be around 13,000 or higher.

Andaman and Nicobar group of islands is located in Bay of Bengal between Longitude 92°12' to 93°57' East and Latitude 6°45' to 13°41' North under Indian Ocean Region. These groups of islands have the status of union territories under the Republic of India. Around 1200 km away from mainland India, Andaman and Nicobar Islands are blessed with tropical maritime climate. The Andaman & Nicobar group of islands consists of 572 islands, islets and rocky crops with a coastline of around 1,912 km and most of the islands (about 550) are in the Andaman Group, 28 of which are inhabited (Krishnan *et al.*, 2013). There are 106 protected areas here out of which two are Marine National Parks viz. Mahatma Gandhi Marine National Park at Wandoor and Rani Jhansi Marine Natural Park at Havelock (Roy *et al.*, 2009). About 6,540 species of fauna and 2500 species of flora have been reported from these islands out of which many are endemic to these islands only (Roy *et al.*, 2009). Coral reefs of Andaman and Nicobar Islands are the most diverse in India with 424 reported species of scleractinian corals from 86 genera and 19 families (Raghuraman *et al.*, 2013). Similarly, out of total 1439 species of fishes from Andaman and Nicobar Islands, 1089 (75.68%) inhabit coral reefs (Rajan and Sreeraj, 2013). It is estimated that more than 75% of marine fauna of Andaman and Nicobar Islands and Lakshadweep Islands are yet to be reported (Venkataraman, 2005). Hence, Andaman & Nicobar group of islands are very important with respect to biodiversity in India. There have been many studies on the aspects of biodiversity of these islands. Special mention can be made of two recent studies of Barren Island (Chandra and Rajan, 2010) and Narcondam Island (Raman *et al.*, 2013) wherein assessment of biodiversity was made of these two volcanic islands of Andaman. Out of the 572 islands from Andaman and Nicobar many are very small islands or islets and their biodiversity status is not known or studied in details. Snake Island and Sepia Islands are two such islets near Port Blair which have never been studied. Hence this study was carried out to assess the biodiversity of Snake Island and to ensure the need to conserve the island as it is home to a number of terrestrial and marine flora and fauna.

Material and methods

Study Area

Snake Island is located within geographical coordinates of 11°38'17.61"N to 11°38'14.14"N latitude and 92°45'14.55"E to 92°45'18.62"E longitude. It is located at a distance of around 980 m from Carbyn's Beach and 965 m from the mouth of Carbyn's Cove.

It is one of the two uninhabited islets present there, the other being Sepia Island which is smaller than Snake Island and located to the south-east of Snake Island. Snake Island comprises an estimated area of around 5570 m^2 which is made up of mainly igneous rocks and very little sand cover. Snake Island was a good scuba diving destination prior to Tsunami in 2004 after which the island lost its charm. The name of the island came from the fact that the island is a breeding spot for sea snakes as the locals believe. Getting access to the island is not easy due to the high wave action over the rocky shores of the island. So the study was carried during the post monsoon season

when the sea is relatively calm. Scientific work on this island has been limited. Jeyabaskaran *et al.* (2007) reported White pox, White band and Black band diseases from the corals of North Bay, Snake Island and New Wandoor. During the study a total of 9 trips to the island were undertaken from December, 2010 to March, 2011. Two trips were undertaken every month, one trip to get data during high tide and the other during low tide. A fisherman's boat (non-motorised) was hired for the trips to the island.

Species Recording and Identification

Most of the species especially fishes, corals etc. were recorded using underwater photography and videography while snorkelling, skin diving and SCUBA diving in and around the island up to 5 m depth and mostly in the shallow channels present inside the island. Due to very high wave and high current in and around the islands skin diving was mostly restricted in the water channels formed during the high tide inside the island. No diving was carried out in the eastern part due to very high wave action. SCUBA diving was carried out only once in the western part of the island to assess the biodiversity. Terrestrial and intertidal species were either recoded using photography or by collection. Marine species were preserved in formalin as per requirement after collection. Few fishes were caught using hook and line and later identified in lab. Camera used for underwater photography were Sony DSC-N1 with underwater casing and Sealife Mini II, and Nikon COOLPIX L20 for photography of terrestrial species. The species identification was done using standard identification keys and references (Ali, 2002; Allen, 2003; Anon, 1987, Dayrat, 2009; Emerson, 1976; Gosliner, 1996; Hurtado-Ponce, 1992; Kaliaperumal, 1995; Kotpal, 2000; Munro, 2000; Rajan, 2001; Randall, 1997; Rao, 2003; Rao[1], 2003; Roy, 2009; Satyamurti, 1956 and Veron, 2000).

Quadrat Method

Quadrat method (Hill and Wilkinson, 2004) was used to estimate the abundance and distribution of benthic non-motile and slow moving intertidal species. This method was applied once during the survey period. Quadrate of 50 cm X 50 cm was used to survey an area of about 25m² each on east, west, north and south (4 locations) on the island by placing 5 quadrats on each site. Species inside the quadrate were identified and their numbers were noted in each quadrat. Using PRIMER 6 software following diversity indices was estimated for species richness, dominance, evenness and diversity.

a. Margalef's Richness (d)
b. Dominance (λ)
c. Simpson's Evenness (J')
d. Shannon- Index [H'(log2)]

Solid Waste

Solid wastes present in the island which are carried by the action of waves and current to the island were counted in each trip to get an idea of solid waste pollution that can affect the biodiversity of the island. These wastes were categorised depending on their origin like plastic, glass, cloth etc.

Results

Biodiversity

During the study a total of 217 species of fauna and flora were recorded from the Snake Island including terrestrial and marine. Among these, 205 were identified (Annexure) and 12 species remain unidentified. Pisces dominated in numbers (91) (Table: 1) from the study area comprising of 44% (Figure: 2) followed by Cnidaria (51 numbers and 25%) and Mollusca (21 numbers and 10%). Other groups such as Annelida, Arthropoda, Echinodermata, Urochordata, Aves and Plants were found in lesser numbers.

205 species (Table: 2) were recorded from the island are from 149 different genus out of which 57 are from pisces, 32 from cnidarians and 18 from molluscs.

The recorded species are broadly subdivided into Terrestrial flora and fauna' and 'Marine flora and

fauna' depending upon their presence in terrestrial or marine zone in the Island.

Marine fauna dominated with 93 % (Figure: 3) from the total identified flora and fauna followed by terrestrial fauna (4 %), terrestrial flora (2 %) and marine flora (1 %).

Intertidal Species

The following species (non-motile and slow moving intertidal species) were recorded under 50cm X 50cm (0.25 m²) quadrat were randomly placed 5 times each in the intertidal zone in the East, West, North and South of the island.

Table 1. No. of species recorded and identified from Snake Island.

Sl. No.	Groups	Species (No.)
1.	Porifera	3
2.	Cnidaria	51
3.	Annelida	4
4.	Arthropoda	9
5.	Mollusca	21
6.	Echinodermata	11
7.	Urochordata	2
8.	Pisces	91
9.	Aves	6
10.	Plants	7
		Total - 205

Table 2. Total no. of genus recorded for each group of flora and fauna.

Sl. No.	Flora and Fauna Groups	Total Genus Recorded
1.	Porifera	3
2.	Cnidaria	32
3.	Annelida	4
4.	Arthropoda	9
5.	Mollusca	18
6.	Echinodermata	11
7.	Urochordata	2
8.	Pisces	57
9.	Aves	6
10.	Plants	7
		Total - 149

Abundance of *Tetraclita formosana* (rock barnacle) was highest (Table: 4) and least was *Acanthopleura spinosa* (chiton). Three species i.e. *Patelloida sp.*, *Tetraclita formosana* and *Saccostrea sp.* occurred in all the stations. While *Nerita costata* and *Thais hippocastanum* occurred in three stations and *Acanthopleura spinosa* and *Turbinaria decurrens* occurred in two stations only. The only plant species recorded was *Turbinaria decurrens* which is a macroalgae.

Table 3. No. of identified flora and fauna from Snake Island.

Division	Flora	Fauna
Terrestrial	4	8
Marine	3	190

Species richness (Table: 5) is maximum in the North (0.42) and least in the East (0.13). Again, highest diversity is seen in the South (0.73) and least in the East (0.47). Dominance is maximum in the East (0.79) and minimum in the West (0.70). Evenness in distribution is highest in the East (0.92) and least in the North (0.49).

Table 4. Species recorded under quadrat method & their numerical abundance and occurrence of species per station.

Common Name	Species	Total abundance	Occurrence
Limpet	*Patelloida sp.*	131	4
Chiton	*Acanthopleura spinosa*	8	2
Acorn or Rock Barnacle	*Tetraclita formosana*	542	4
Gastropod	*Nerita costata*	152	3
Cupped oyster (Bivalve)	*Saccostrea sp.*	101	4
Gastropod	*Thais hippocastanum*	24	3
Seaweed	*Turbinaria decurrens*	34	2
	Total abundance	992	
	Total no. species	7	
	Total no. of stations	4	

Solid Wastes

Solid waste can directly influence the healthy biodiversity of marine ecosystem. It can hamper the growth of corals, animals (birds, mammals etc.)might entangle to nets, ropes and other plastic debris, and even some animals are reported to consume plastic debris (Azzarello *et al.*, 1987) leading to bioaccumulation and also to death many a times.

Table 5. Intertidal species diversity indices of Snake Island.

Quadrat	No. of species	Margalef's Richness (d)	Shannon-Wiener Index [H'(log2)]	Dominance (λ)	Simpson's Evenness (J')
East	4	0.13	0.47	0.79	0.92
West	6	0.34	0.68	0.70	0.72
North	6	0.42	0.64	0.73	0.49
South	6	0.40	0.73	0.72	0.69

Solid wastes recorded during the study are presented in Table: 6. It is clear that plastic items were the primary component of solid waste in the island followed by thermocol and glass items. Plastic items ranged from bottles, cans, packets, tubes, nets etc. Other items mostly consist of glass bottles, clothes, thermocol pieces, sandals and shoes, ropes, nets etc.

Table 6. Solid waste recorded from 8 trips.

Sl. No.	Items	No.
1.	Plastic bottles and cans	57
2.	Other plastic items	64
3.	Glass bottles	25
4.	Thermocol pieces	29
5.	Nets and ropes	13 + 2 large nets
6.	Others (clothes, iron pieces etc.)	12
	Total	201 items

Table 7.

Annexure					
1	*Stylissa sp.*	70	*Neries sp.*	138	*Halichoeres hortulanus*
2	*Xestospongia sp.*	71	*Eupolymnia sp.*	139	*Halichoeres marginatus*
3	*Ircinia sp.*	72	*Spirobranchus giganteus*	140	*Halichoeres argus*
4	*Hibiscus tiliaceus*	73	*Sabellastarte sp.*	141	*Thalassoma jansenii*
5	*Ficus rumphii*	74	*Tetraclita formosana*	142	*Coris caudimacula*
6	*Pemphis acidula*	75	*Lepas sp.*	143	*Labroides dimidiatus*
7	*Cyperus javanicus*	76	*Porcellanella picta*	144	*Scarus rubroviolaceus*
8	*Anagnia subfascia*	77	*Eriphia sebana*	145	*Chlorurus troschelii*
9	*Monomorium sp.*	78	*Grapsus albolineatus*	146	*Cirrihitus pinnulatus*
10	*Halcyon sp.*	79	*Dardanus sp.*	147	*Caranx melampygus*
11	*Calidris sp.*	80	*Eupagurus sp.*	148	*Parupeneus bifasciatus*
12	*Haliaeetus leucogaster*	81	*Acanthopleura spinosa*	149	*Parupeneus barberinus*
13	*Egretta garzetta*	82	*Acmaea sp.*	150	*Parupeneus macronemua*
14	*Egretta gularis*	83	*Patelloida saccharina*	151	*Kyphosus cinerascens*
15	*Corvus sp.*	84	*Cypraea (Eraosaria) erosa*	152	*Kyphosus vaigiensis*
16	*Padina sp.*	85	*Cypraea onyx adusta*	153	*Siganus virgatus*
17	*Sargassum sp.*	*86*	*Cyprea mauritiana regina*	154	*Siganus vermiculatus*
18	*Turbinaria decurrens*	*87*	*Thais hippocastanum*	155	*Acanthurus triostegus*
19	*Aurelia aurita*	88	*Nerita costata*	156	*Acanthurus lineatus*
20	*Montipora sp.*	89	*Nerita polita*	157	*Acanthurus leucosternon*
21	*Acropora aspera*	90	*Engina mendicacaria*	158	*Acanthurus tristis*
22	*Acropora cerealis*	91	*Phos sp.*	159	*Naso lituratus*
23	*Acropora monticulosa*	92	*Dendropoma maxima*	160	*Ctenochaetus striatus*
24	*Acropora sp.1*	93	*Ostrea sp.*	161	*Caesio sp.*
25	*Acropora sp.2*	94	*Donax sp.*	162	*Chaetodon vagabundus*
26	*Astreopora sp.*	95	*Scapharca sp.*	163	*Chaetodon lunula*
27	*Pocillopora damicornis*	96	*Pinctada sp.*	164	*Chaetodon lunulatus*
28	*Physogyra lichtensteini*	97	*Saccostrea sp.*	165	*Chaetodon collare*
29	*Galaxea astreata*	98	*Tridacna sp.*	166	*Chaetodon plebeius*
30	*Galaxea facicularis*	99	*Phyllidia varicosa*	167	*Chaetodon auriga*
31	*Psammocora digitata*	100	*Onchidium verrucosus*	168	*Chaetodon falcula*
32	*Psammocora sp.*	101	*Octopus sp.*	169	*Chaetodon meyeri*
33	*Pavona cactus*	102	*Ophiarthrum pictum*	170	*Chaetodon decussatus*
34	*Pavona danai*	103	*Ophiothrix spiculata*	171	*Forcipiger flavissimus*
35	*Leptoseries sp.*	104	*Linckia sp.*	172	*Heniochus pleurotaenia*
36	*Pachyseris sp.*	105	*Diadema savignyi*	173	*Zanclus cornutus*
37	*Fungia fungites*	106	*Echinometra mathaei*	174	*Scolopsis bilineatus*
38	*Fungia sp.*	107	*Echinus sp.*	175	*Gnathodentex aureolineatus*
39	*Ctenactis sp.*	108	*Culcita novaguineae*	176	*Monotaxis grandoculis*
40	*Merulina sp.*	109	*Stichopus variegates*	177	*Pomacanthus annularis*
41	*Turbinaria sp.*	110	*Holothuria cinerascens*	178	*Pomacanthus imperator*
42	*Acanthastrea sp.*	111	*Synapta maculata*	179	*Centropyge eibli*
43	*Lobophyllia hemprichii*	112	*Pearsonothuria graeffei*	180	*Lutjanus bohar*
44	*Lobophyllia sp.*	113	*Didemnid sp.*	181	*Lutjanus decussates*
45	*Symphyllia recta*	114	*Polycarpa sp.*	182	*Lutjanus russelli*
46	*Symphyllia radians*	115	*Echidna nebulosa*	183	*Lutjanus monostigma*
47	*Favia lizardensis*	116	*Gymnothorax sp.*	184	*Lutjanus fulviflamma*
48	*Favia matthaii*	117	*Sargocentron caudimaculatum*	185	*Lutjanus kashmira*
49	*Favia sp.*	118	*Sargocentron sp.*	186	*Macolor niger*
50	*Favites abdita*	119	*Myripristis sp.*	187	*Aethaloperca rogaa*
51	*Favites complanata*	120	*Apogon cyanosoma*	188	*Epinephelus caeruleopunctatus*
52	*Favites halicora*	121	*Cheilodipterus quinquelineatus*	189	*Ephinephelus merra*
53	*Goniastrea retiformis*	122	*Abudefduf notatus*	190	*Cephalopholis sonnerati*
54	*Goniastrea sp.*	123	*Abudefduf septemfasciatus*	191	*Plectorhinchus chaetodontoides*
55	*Platygyra pini*	124	*Abudefduf sordidus*	192	*Plectorhinchus orientalis*

56	*Platygyra sp.*	125	*Abudefduf vaigiensis*	193	*Kuhlia mugil*
57	*Leptoria phrygia*	126	*Amphiprion clarkii*	194	*Meiacanthus sp.*
58	*Montastrea colemani*	127	*Amphiprion akallopisos*	195	*Istiblennius sp.*
59	*Diploastrea heliopora*	128	*Pomacentrus cuneatus*	196	*Blenniella sp.*
60	*Echinopora sp.*	129	*Pomacentrus chrysurus*	197	*Cirripectes sp.*
61	*Porites lobota*	130	*Pomacentrus amboinensis*	198	*Pempheris vanicolensis*
62	*Porites solida*	131	*Pomacentrus lepidogenys*	199	*Istigobius sp.*
63	*Porites lutea*	132	*Chromis dimidiate*	200	*Synodus* sp.
64	*Goniopora sp.*	133	*Chromis viridis*	201	*Pterois volitans*
65	*Protopalythoa sp.*	134	*Chrysiptera unimaculatus*	202	*Balistapus undulates*
66	*Cryptodendrum adhaesivum*	135	*Neopomacentrus azysron*	203	*Balistoides viridescens*
67	*Heteractis magnifica*	136	*Dascyllus trimaculatus*	204	*Diodon liturosus*
68	*Sarcophyton sp.*	137	*Plectroglyphidodon sp.*	205	*Mobula sp.*
69	*Lobophytum sp.*				

Discussion

The present study has revealed the rich biodiversity of Snake Island and some of its important abiotic components. This study also revealed the threat to the biota present in the island due to solid waste pollution. Though the island looks small, yet it holds a lot of diversity behind the mere rocky structures as seen from Carbyn's Beach. During the study the 'coral pool' in the north-eastern part of the island was the most interesting spot because of the richness in species diversity from corals, sponges etc. to higher organisms like tunicates and fishes. The abundance of two genus of fishes was clearly observed while diving. First, *Abudefduf* was the most abundant genus in shallow waters with less than 1 m depth. Second *Acanthurus* was the most common genus sighted at depth ranging from 0.5 m to 3 m depth. Pomacentrids were most abundant in the greater depth up to 10 m which was observed while SCUBA diving. Among cnidarians *Pavona* and *Porites* were the most abundant genus in the coral pool followed by *Acropora*, *Favia* and *Favites* in the coral pool and other areas. Though coral reef is present around the island, most corals are dead, rubble cover most of the area. Healthy but scattered colonies of a good number of coral species (*Porites spp., Psammocora spp., Diploastrea heliopora, Symphyllia spp.* etc.) are present in the western part as observed while Scuba diving. As for molluscs, gastropods and bivalves were clearly the most abundant in the intertidal zone. *Nerita* was the most common genus for gastropods and *Saccostrea* was the most common genus for bivalves. The presence of rock barnacle, *Tetraclita formosana* and crab, *Grapsus albolineatus* was significant on the steep rocky walls mostly at the low tide level with regular water splashes. The six birds species identified were not resident birds but were sighted in the island as they visit the island to prey upon different organisms present in the island especially fishes. Three of the four terrestrial species of plants identified were recorded at a raised rocky platform of around 4 m height with sandy bottom in the northern part of the island. The fourth species, *Pemphis acidula* was very interesting as it was a single plant which has grown over the rocks in the western side with seawater splashes during high tide. In a similar study of Barren Island in Andaman which is a volcanic island, 130 species flora and more than 130 species of fauna (Chandra and Rajan, 2010) are reported prior to eruption in 1991. More such studies were carried out in Narcondam Island (Raman *et al.*, 2013), North Bay (Roy *et al.*, 2009) etc.

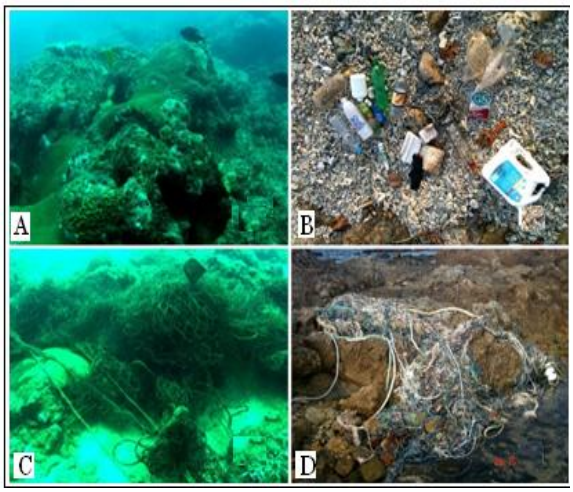
Under the quadrat method only 7 species (non-motile and slow moving intertidal species) were recorded in the island. This suggests that the lack of intertidal species in the island which may be due to the high wave action which continuously change the topography especially in the northern and southern parts of the island. The species recorded were those which can attach firmly or permanently to the rocky substratum of the island. Another reason maybe lack of hiding areas like seaweed cover or sandy cover during low tide (which is the period of desiccation)

during day time, the only available cover area are the crevices of rocks which absorbs lot of heat which is not suitable for most of the intertidal species. Though other intertidal species were recorded during the study like sea urchin, sea cucumber, some molluscs etc., they were not recorded when quadrat were placed at four sites of area 25 m² each at the east, west, north and south of the island. This is due to their lack of abundance in the island and was rarely sighted during the study.

Fig. 1. a. *Pemphis acidula* **b.** *Anagnia subfascia* **c.** *Egretta garzetta* **d.** The coral pool **e.** *Acropora cerealis* **f.** *Neries sp.* **g.** *Grapsus albolineatus* **h.** *Onchidium verrucosus* **i.** *Pearsonothuria graeffe* **j.** *Polycarpa sp.* **k.** *Abudefduf septemfasciatus* **l.** View of the island during high tide when most of the area gets submerged.

The presence of lot of solid wastes lying in the island shows the indirect influence of anthropogenic activities even in an isolated island like Snake Island. During the course of the study two large ghost nets were recorded, one over the rocky shore of the island and one entangled in the coral reef at a depth of around 8 m in the western part of the island. These wastes are carried by the action of waves and current from the open sea and especially from the mouth of Carbyn's Cove. Another important source is the municipal garbage dumping zone near to the mouth Carbyn's Cove from where some of the solid wastes get released into the sea directly or by wind, rain water runoff etc. Hence proper dumping and disposal of solid wastes must be planned so that healthy and important ecosystems like that of Snake Island are not affected. Especially dumping of solid wastes close to Crabyn's Cove should be planned in a proper manner and the solid wastes flowing out of the mouth should be screened before letting to flow into open sea.

It is very essential for making the locals aware of such an important biodiversity site so that they become a part of conservation of Snake Island and its rich biota in future. There are many smaller islands in Andaman and Nicobar Islands like that of Snake Island which never get their due importance. Similar study like this in all such islands can help to build a good biodiversity database which would provide more reliable data in future research and can become an important tool in conservation of island biodiversity in India.



A. View of the damaged coral reef in the western part of the island; B. Solid wastes lying in the island; C. The ghost net which was entangled to the coral reef in the western part of the island; D. The ghost net which was lying on the rocky shore of the island.

Acknowledgement

The authors would like to acknowledge the help received from their friends and local fishermen (who provided their boat) for all their assistance during the course of survey. The authors also would like to thank Pondicherry University for providing adequate facility to carry out the wok in Port Blair. Also assistance received from regional offices of Zoological Survey of India and Botanical Survey of India in Port Blair in identifying different species is gratefully acknowledged.

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