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Status of Coral reef around Swaraj Dweep (Havelock Island), Andaman, India

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ABSTRACT

The study was carried out in selected reef sites at Swaraj Dweep (Havelock Island) to assess the status of live coral diversity with related fauna by using the line intercept transects (LIT) survey method. Three sites were selected for this study *viz* (1) Vijayanagar beach, (2) Elephant beach and (3) Radha Nagar Beach. The average length of entire LIT and reef area of each site were 1098 m, 141.3m and 215 m & 675.3 m, 103.3m and 133m respectively. The average of live corals was found dominant in the entire LIT at site 2 (37.7%) followed by site 1 (16.2%), and site 3 (14%) and dead corals were found dominant at site 3 (44.7%) followed by site 2 (33.2%) and site 1 (13.8%). Similarly reef area of live coral was found dominant at site 2 (50.8±2.5%) followed by site-1 (26.9±0.2%) and site 3 (23.7±6.2%). Altogether 80 species of live coral were recorded under 31 genera and 11 family at all LIT in which the family Poritidae was dominant in site 1 (55.1±4.9%) and site 2 (55.2±2.5%). The family Acroporidae was dominant in site 3 (35.2±4.1%). The environmental parameters of all three sites were analyzed that there were little variations observed except CO_2 which remained consistent (0) during the study period.

Figures : 02 References : 29 Tables : 04

KEY WORDS : Acroporidae, Coral, Elephant beach, LIT, Poritidae, Swaraj Dweep.

Introduction

Coral reefs occur in more than 100 countries and territories and whilst they cover only 0.2% of the seafloor, they support at least 25% of marine species and underpin the safety, coastal protection, wellbeing, food and economic security of hundreds of millions of people[5]. Andaman and Nicobar Islands (ANIs) represent one of the richest repositories of biodiversity in the South East Asia. A worker[20] reported that ANIs lined with fringing coral reefs, which host a rich marine biodiversity and also most diverse as well as extensive reef among Indian subcontinent reef areas. Coral formation at Palk Bay, Gulf of Mannar, Andaman and Nicobar Islands are of fringing type. Patch reef occurs along the central west coast, on the Gaveshani Bank and around the Gulf of Kutch Islands. Lakshadweep Islands are well developed atoll reefs[28]. It[8,9] was reported that the reef biodiversity of the sea around the Andaman and Nicobar Islands are well known for their rich resources with the flora and fauna and includes as much as 180 species of benthic algae, 14 species of seaweeds, 12 species of sea grass, 108 species of sponges, 135 species of corals, 103 species of echinoderms and 600 species of finfishes apart from very large number of species of crabs, shrimps, lobsters, gastropods, bivalves and cephalopods. A total of about 177 species of corals belonging to 57 genera under 15 families were reported from the ANIs)[25]. During 2004 - 2006 survey 117 coral species were recorded from the four Islands included Jolly Buoy, Boat, Tarmugli and Swaraj Dweep (Havelock Islands) in South Andaman and 80 species were recorded only in Swaraj Dweep[2,3,4]. An investor[18] has reported 78 coral species and 98 reef fish species during 2004 survey in Swaraj Dweep (Havelock Island). 75 species of coral and 75 species of reef fishes during 2005 survey from the same Island were also reported.

Methodology

The study was carried out during year 2009.

Study area-

Havelock Island has renamed recently (2018) as Swaraj Dweep located near the Rani Jhansi Marine

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TABLE-1 : Biophysical status of reefs at the selected study sites (1, 2 and 3)

Selected sites	Vijayanagar Beach (Site 1)		Elephant Beach Beach (Site 2)		Radha Nagar Beach (Site 3)		Average	
Line Intercept Transect (LIT)	**Entire**	**Reef**	**Entire**	**Reef**	**Entire**	**Reef**	**Entire**	**Reef**
Average length (m)	1098	675.3	141.3	103.3	215.3	**133.7**	485±307	304±186
Sand	19.0	19.1	21.3	3.1	26.4	14.4	22.2±2.2	12.2±4.7
Dead corals on Sand	6.0	8.6	7.0	3.9	6.5	1.1	6.5±0.3	4.5±2.2
Live coral	16.2	26.9	37.7	50.8	14.00	23.7	22.6±7.6	33.8±8.6
Soft coral	0.5	0.9	0.6	0.7	5.5	8.4	2.2±1.7	3.3±2.5
Dead Coral	13.8	22.8	33.2	41.2	44.7	48.2	30.6±9.0	37.4±7.6
Grasses on Sand	24.0	6.4	0	0	0	0	8.0±8.0	2.1±2.1
Others	20.6	15.3	0.3	0.3	2.9	4.9	7.91±6.4	6.6±6.

National Park (RJMNP) with an area of some 113 sq.km (Fig. 1). The administration of the ANIs has permitted and encouraged development of tourism, with a focus on promoting eco-tourism. The calm and pleasant water bodies are ideal for getting into water sports such as diving and snorkeling. The three attractive beaches that the tourists' delight are the (1)Vijaynagar beach (near Dolphin resort), (2) Elephant beach and (3) Radhanagar Beach. Radha Nagar Beach is one of the most popular beaches in the Swaraj Dweep which was named as "Best Beach in Asia" in 2004.

Site-1: Vijayanagar beach

The sea shore of Vijayanagar is having full sandy and scattered rocks. Fringing type of reef, facing the creek opposite to John Lawrence Island open sea, starting from 650-850 m off High Tide Line (HTL) and extending up to 30–70 m (3-11 m depth) inside the sea before steeply sloping.

Site -2: Elephant beach

The seashore is rocky and sandy, interspersed. Fringing type of reef, facing the open sea starting 50-75 m off HTL and extending up to 30-70 m (4-11 m depth) inside the sea before steeply sloping, semi protected reef with a bay formulation. It was observed that cracks have developed in the reef slope due to the Mega earthquake which occurred during December 2004 but Not much damage due to Tsunami occurred[2].

Site 3: Radha Nagar Beach

The seashore is rocky and sandy, interspersed. The reef is of fringing type facing the open sea which is discontinuous starting 70-75 m off HTL and extending up to 60 – 65 m (4-5 m depth) inside the sea before steeply sloping. The reef is semi protected with a bay formulation.

The survey team consisted of, from time to time, two or three field investigators assisted by two diving assistants. Survey stations were selected from topographic maps (Fig.1). The surveys were carried out by snorkelling and free diving and so were essentially confined to the reef flats and slope. This precluded the possibility of taking observations beyond a depth of 10 metres. The surveys were conducted in two phases. Phase-I involved a preliminary survey in which the investigators swam over the reef area to make observations which were qualitative in nature. Phase II consisted of taking detailed quantitative observations using the Line Intercept Transect survey method[10].

Three parallel transects, 50 meters apart, were laid out at each of the stations which was perpendicular to the shore line, commencing from the shoreward edge of the reef and extending up to the end of the reef flat. Observations were taken for every metre length of the

TABLE-2 : The percentage of live corals in the selected sites of study area

Family	Genus	No. of Species	Survey Site Average with SE			Grand average with SE
			Site 1	Site 2	Site 3	
1.Acroporidae:	**3**	**25**	**24.1±3.2**	**28.3±2.2**	**35.2±4.1**	**29.2±2.3**
Acropora aspera, A.brueggemanni, A.cerealis, A. digitifera, A.echinata, A.florida, A. formosa A.gemmifera, A.grandis, A.humilis, A.hyacinthus, A.monticulosa, A.nasuta, A.noblis, A. palifera, A. robusta, A.valenciennesi, A.youngi		18	22.1±3.5	25.7±2.5	30.3±3.8	26.0±2.0
Montipora formosa, M. informis, M.acquituberculata, M.peltiformis, M.monasteriata		*5*	1.5±0.3	2.2±0.9	3.0±1.1	2.2±0.5
Astreopora listeri, A.myriophthalma		*2*	0.5±0.0	0.5±0.1	1.9±0.8	1.0±0.3
2.Pocilloporidae:	3	6	2.6±0.7	1.4±0.3	7.6±0.8	3.9±1.0
Pocillopora damicornis, P.eydouxi, P.meandrina P.verrucosa		*4*	1.0±0.1	0.9±0.0	5.9±1.3	2.6±0.9
Seriatopora hystrix		*1*	0.3±0.1	0.4±0.3	0.8±0.2	0.5±11
Stylophora pistillata		*1*	1.3±0.7	0.1±0.1	1.0±0.6	0.8±0.3
3. Oculinidae*: Galaxea astreata, G.facicularis*	1	**2**	**1.0±0.5**	**0.3±0.1**	**0.4±0.2**	**0.6±0.2**
4. Agariciidae:	5	7	7.4±1.6	2.2±0.6	3.1±0.4	4.2±0.9
Pavona decussata		*1*	0.2±0.1	0.5±0.2	0.3±0.2	0.3±0.1
Leptoseries explanata, L. papyracea		*2*	0.5±0.3	0.4±0.2	3.1±1.7	0.6±0.2
Gardineroseris planulata		*1*	2.9±1.3	0.4±0.2	0.5±0.5	1.3±0.6
Coeloseries mayeri		*1*	0.2±0.1	0.2±0.1	0.2±0.1	0.2±0.1
Pachyseris rugosa, P. speciosa		*2*	3.7±1.5	0.9±0.5	1.1±0.2	1.9±0.6
5. Fungiidae:	2	**4**	**0.5±0.2**	**1.4±0.3**	**1.5±0.3**	**1.2±0.2**
Fungia danai, F.horrid, F.repanda		*3*	0.3±0.1	0.7±0.3	1.0±0.2	0.7±0.2

Ctenactis echinata		*1*	0.3±0.1	0.6±0.1	0.5±0.2	0.5±0.1
6. Merulinidae:	2	***3***	**0.4±0.2**	**1.8±0.8**	**0.8±0.3**	**1.0±0.3**
Hydnopora rigida, H.microconos		*2*	0.4±0.2	1.4±0.7	0.6±0.2	0.8±0.3
Merulina ampliata		*1*	0	0.4±0.2	0.2±0.2	0.2±0.1
7. Mussidae:	2	***4***	**1.1±0.5**	**1.6±0.7**	**5.8±1.8**	**2.8±0.9**
Lobophyllia corymbosa, L.hemprichii		*2*	0.7±0.3	0.4±0.2	1.0±0.7	0.7±0.2
Symphyllia radians, S.recta		*2*	0.4±0.1	1.1±0.4	4.8±1.8	2.1±0.9
8. Faviidae:	9	18	7.3±2.2	7.1±0.3	11.9±1.5	8.8±1.1
Favia favous, F.matthai F. palida, F. stelligera		*4*	1.6±0.7	1.2±0.2	2.1±0.6	1.7±0.3
Favite sabdita, F.complanata F. flexuosa		*3*	0.7±0.2	1.5±0.3	1.7±0.9	1.3±0.3
Goniastrea retiformis		*1*	0.2±0.1	0.2±0.2	0.4±0.2	0.3±0.1
Leptastrea purpurea		*1*	0.2±0.2	0.1±0.1	0.1±0.1	0.12±0.1
Montastrea curta M. valenciennesi		*2*	0.4±0.0	0.5±0.1	1.2±1.0	0.7±0.3
Leptoria phrygia		*1*	1.6±0.5	1.0±0.5	1.3±0.7	1.3±0.3
Diploastrea heliopora		*1*	0.5±0.3	0.4±0.2	3.1±1.7	1.3±0.7
Echinopora horrid, E. lamellose		*2*	0.3±0.1	1.3±0.2	0	0.5±0.2
Platigyra pini, P.sinensis, P.daedalea		*3*	1.9±0.9	0.9±0.1	2.1±0.5	1.6±0.3
9. Poritidae:	2	***9***	**55.1±4.9**	**55.2±2.5**	**32.7±3.1**	**47.6±4.2**
Porites lichen, P.lobata, P. lutea, P. nigrescens, P.rus, P.solida		*6*	52.7±4.8	54.4±2.5	31.4±3.2	46.2±4.1
Goniopora stokesi , G. columna G.tennuidens		*3*	2.4±0.4	0.8±0.1	1.2±0.2	1.5±0.3
10. Helioporidae : *Heleopora coerulea*	**1**	**1**	**0.2±0.1**	**0.3±0.1**	**0.4±0.2**	**0.3±0.1**
11. Milleporidae : *Millepora exaesa*	**1**	**1**	**0.3±0.1**	**0.4±0.1**	**0.5±0.2**	**0.4±0.1**
Total	**31**	**80**				

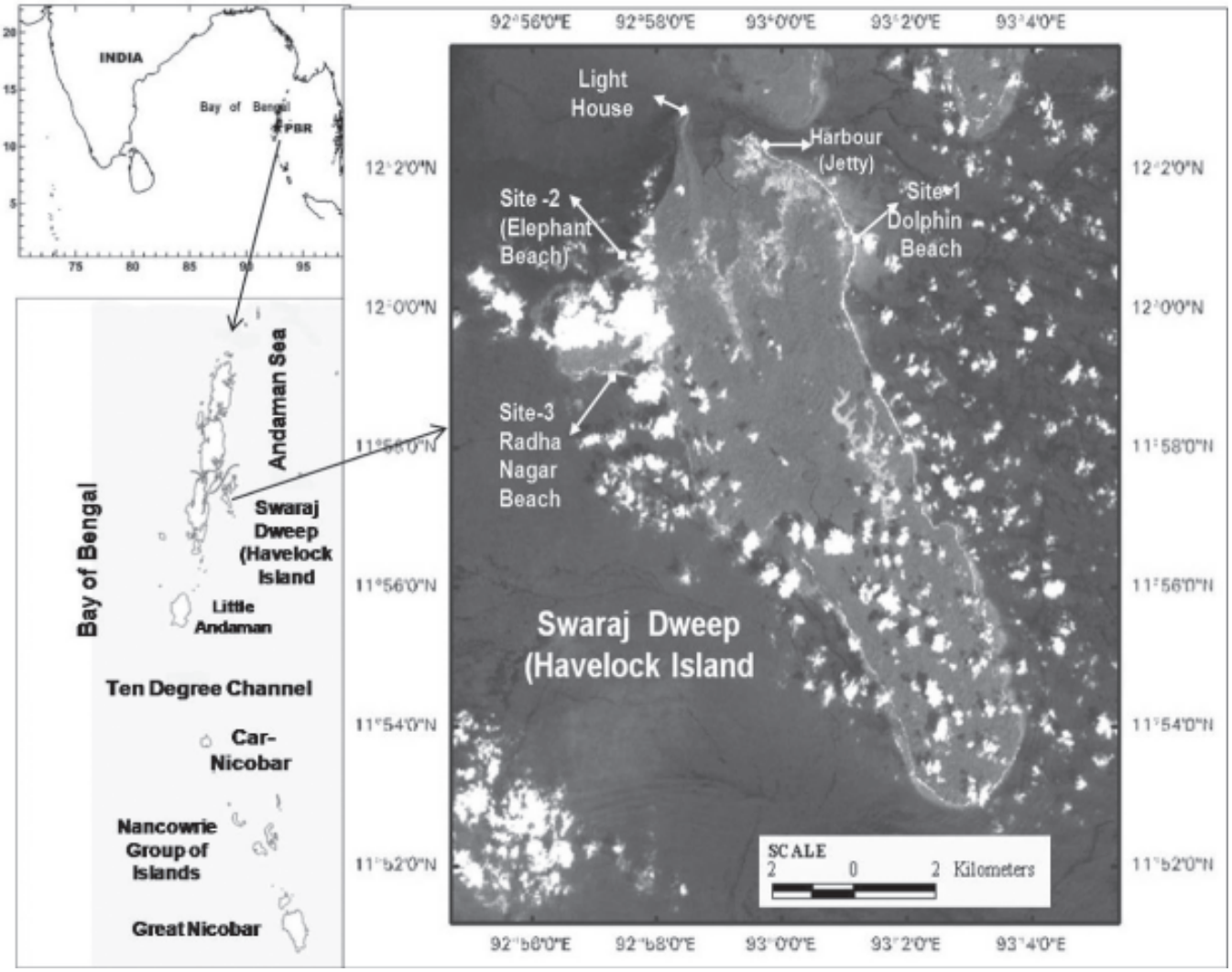

Fig.1 Survey sites at Swaraj Dweep

transect for all the abiotic and biotic elements. The mean values for the data collected from the three transects were used for all computations for each of the stations. Observations were taken on the dominant coral taxa and other conspicuous organisms, with special attention for the coral predators. Particular attention was paid for noting down the possible agents of damage in regions where the reef had suffered damage. Components were classified as hard live corals, soft live corals, dead corals, sand *etc.* All data thus recorded in an underwater slate were transcribed onto data sheets later in the day. The environmental parameters such Air, sea surface and bottom temperature, salinity, pH, dissolved oxygen, CO_2 and transparency of all three sites were analyzed.

Results

Altogether 9 LIT were fixed in which three transect in each site. The average length of entire LIT and reef area of three sites were, 1098m, 141.3m and 215.m and 675.3 m, 103.3m and 133m respectively (Table-1). The average lengths of entire transect (LIT) and reef area of Swaraj Dweep were 484.9±157.1m and 304.1±99.7m respectively. The average percentage of live, dead and soft corals occurred in the reef area were 33.8±4.7, 37.4± 3.9 and 3.3±1.8 respectively. Similarly the percentage of other components recorded in the LIT of reef area such as sand, dead coral on sand and others were 12.2±3 %, 4.5±1.9% and 8.7 ±4.7% respectively. Altogether the grand average of live corals, the Poritidae family was found dominant (47.6±04.2%) per LIT followed by Acroporidae (29.2±2.3%), Favidae (8.8±1.1%), Agariciidae, Pocilloporidae, Mussidae, Fungiidae etc (Table 1).

According to the site wise coral reef status, the average percentage of live corals was found dominant in the entire LIT at site 2 (37.7) followed by site 1 (16.2), and site 3 (14) and dead corals were found dominant at site 3 (44.7) followed by site 2 (33.2) and site 1 (13.8). Similarly the live corals in reef area was found dominant at site 2 (50.8±2.5%) followed by site-1 (26.9±0.2%) and site 3 (23.7±6.2%). The dead coral found dominant at

TABLE-3: Occurrence of fishes in the LIT in percentage

Family & Genus	**Genus**	**No. of Species**	**Site 1**	**Site 2**	**Site 3**	**Average**
1.Acanthuridae:	2	6	0.81	1.2	1.6	1.2±0.2
Acanthurus leucosternon, A. lineatus, A. nigricaudus, A. triostegus		4	0.31	0.82	1.11	0.7±0.2
Naso brevirostris, N. lituratus		2	0.5	0.38	0.49	0.5±0.04
2.Balistidae: *Balistus undulates, B.viridiscens*	1	2	0.43	0.29	0.45	0.4±0.1
3.Blenniidae: *Plagiotremus rhinorhynchos*	1	1	0.23	0.22	0.4	0.3±0.1
4.Chaetodontidae:	2	12	2.4	2.39	2.91	2.6±0.2
Chaetodon auriga, C. decussates, C. collare, C. falcula, C. lineolatus, C. meyeri, C. punctatofasciatus, C. triangulum, C. trifasciatus, C. vagabundas		**10**	1.77	1.89	2.18	19±0.1
Heniochus pleurotaenia, H. acuminatus		2	0.63	0.5	0.72	0.6±0.1
5.Ephippidae: *Platax tiera*	**1**	**1**	**0.43**	**0.19**	**0.31**	**0.3±0.1**
6.Holocentridae:*Holocentrus rubrum*	**1**	**1**	**0.31**	**0.16**	**0.13**	**0.2±0.1**
7.Haemulidae:*Plectorynchus orientalis, P.picus*	**1**	**2**	**0.5**	**0.44**	**0.53**	**0.5±0.0**
8.Labridae: *Halichoeres hortulanus, H. biocellatus*	**1**	**2**	**2.54**	**1.85**	**2.76**	**2.4±0.3**
9.Lutjanidae: *Macolor niger*	**1**	**1**	**0.2**	**0.25**	**0.22**	**0.2±0.0**
10.Mullidae:	2	2	0.58	0.47	0.85	0.6±0.1
Parupeneus barberinus		1	0.27	0.22	0.36	0.28±0.04
Upeneus tragula		1	0.31	0.25	0.49	0.35±0.07
11.Muraenidae: *Gymnothorax flavimarginatus*	1	1	0.16	0.13	0.18	0.2±0.0
12.Nemipteridae: *Scolopsis billineatus*	1	1	0.59	0.44	0.71	0.6±0.1
13.Pomacentridae:	7	19	80.09	81.97	76.47	79.5±1.6
Abudefduf notatus, A. sexfasciatus		2	1.68	1.47	1.84	1.7±0.1

Amphiprion akallopisos, A. clarkia, A. ephippium, A. ocellaris,A. percula		5	0.71	0.81	1.34	1.0±0.2
Premnas biaculeatus		1	0.23	0.16	0.09	0.16±0.04
Chromis dimidiatus, C.nigrura, C.opercularis, C.virida		4	67.88	73.93	65.23	69.0±2.6
Pomacentrus pikei, P.chrysurus		2	5.7	3.41	3.91	4.3±0.7
Dascyllus aruanaus, D.carneus, D.trimaculatus		3	2.62	1.28	3.1	2.3±0.5
Plectroglyphidodon leucozonus		1	1.76	1.31	0	1.0±0.5
Stegastes insularis		1	1.25	1.06	1.66	1.3±0.2
14.Pomacanthidae: *Pomacanthus caeruleus, P. imperator*	**1**	**2**	**1.76**	**1.31**	**0**	**1.0±0.5**
15.Scaridae: *Scarus atrilunula, S. caudofasciatusS. cyabascebs, S. cyanescens,S.dimidiatus, S.psittacus, S.russelli, S.ghobban, S.niger*	**1**	**9**	**1.25**	**1.06**	**1.66**	**1.3±0.2**
16.Serranidae:	3	7	3.3	3.31	5.15	3.9±0.6
Anyperodon leucogrammicus		1	0.27	0.31	0.58	0.4±0.1
Cephalopholis argus, C. leopardus, C.miniata		3	0.77	0.88	1.61	1.1±0.3
Epinepheleus hexagonatus, E.malabaricus, E.merra		3	0.59	0.44	0.71	0.6±0.1
17.Siganidae:*Siganus stellatus, S.guttatus, S.puelloides*	**1**	**3**	**1.91**	**2.02**	**2.7**	**2.2±0.2**
18.Scorpaenidae:*Pterois volitans*	1	1	0.12	0.22	0.31	0.2±0.1
19.Syngnathidae: *Corythoichthys amplexus*	1	1	0.2	0.06	0.31	0.2±0.1
20.Tetraodontidae *Arothron nigropunctatus, A.stellatus*	1	2	0.4	0.59	0.78	0.6±0.1
21.Zanclidae:*Zanclus cornutus, Zebras omascopus*	1	2	1.79	1.43	1.57	1.6±0.1
Total	32	78				

site 2 (33.2), sand at site 3 (26.4), dead coral-on-sand at site 2 (7), Grass on sand was recorded only at site1 (24) and others were recorded dominant at site 1 (20.6) in the entire LIT. Similarly the dead coral found dominant at site 2 (48.2%), sand at site 1 (19.1%), dead coral-on-sand at site 1 (8.6%), Grass on sand was recorded only at site1 (6.4) and others were recorded dominant at site 1 (15.3) in the reef area (Table 1).According to the live coral status of the Swaraj dweep that the family Poritidae was found more dominant. The grand average percentage of (47.6±04.2%) per LIT in with standard error followed by the families Acroporidae (29.2±2.3), Favidae (8.8±1.1), Agariciidae (4.2±0.9), Pocilloporidae (3.9±1.0), Mussidae (2.8±0.9), Fungiidaeetc (Table 2). Among the live coral, the genus *Porites* found as largest component in the LIT of Site 1, Site2 and Site 3 were 52.7±4.8 %, 54.4±2.5 % and 31.4±3.2% respectively. Similarly the genus *Acropora* holding second place in the LIT of all three sites was 22.1±3.5 %, 25.7±2.5% and 30.3±3.8% respectively (Table 2).

The site wise analysis was carried out in all three sites (Table-2). Altogether 80 species of live coral recorded from 31 genera under 11 family at all LIT in which the family Poritidae was recorded dominant at sites 1 (55.1±4.9%) and site 2 (55.2±2.5%). The family Acroporidae was recorded dominant in site 3 (35.2±4.1%). The averages percentage of soft corals was dominant recorded in entire LIT at sites 3 (5.5) followed by site 2 (1) and site 1(0.5,). Similarly it was found dominant at reef area in Site-3 (8.4%) followed by site-1(0.9%) and site-2 (0.7%).

Observations on fish were carried out in both sides of each LIT *i.e.* 1 meter distance at left and right side. Totally 78 reef fish species were identified amongst 32 genera under 21 families were recorded in the LIT of Swaraj Dweep. Among them the family Pomacentridae was the dominant one (79.5±1.6%) followed by Serranidae (3.9±0.6%), Chaetodontidae (2.6±0.2%), Labridae (2.4±0.3%) etc (Table-3).

The other invertebrate fauna were also recorded in the reef during the survey included such as Molluscs (87.88±6.24%), Echinoderms (10.83±2.51%), Arthropods (0.54±0.37%) and *Cnidaria* (0.74±0.30%). Altogether 29 species of invertebrate benthic fauna identified among the 20 genus under 17 families in the LIT, among them the family of Ostreidae found dominantly (60.1±8.4%) included 2 species in different genera *i.e. Saccostrea cuculata and Crassostrea rivularis* followed by the family Cardiidae (22.3±12.3%), Holothuriidae (7.5±2.3%) *etc.,* (Table-4).

Molluscs are also important reef builders on these shores. According to the site wise analysis, Mollusks were observed dominant at all the three sites of the survey followed by Echinoderms and Cnidaria (Fig. 2).

It was revealed that the varieties of animals such as sea anemones, sea fans, giant clams, sea cucumbers, sea urchins, sea stars and typical fishes have special niches in the coral reef ecosystem[21]. Totally 19 species of molluscs recorded in the survey under 10 families indicating the health of the reef. The marine algae also contribute in the formation of coral reefs.

The average environmental parameters of all three sites have been analyzed. Air temperature, surface water temperature, bottom water temperature, salinity, pH, dissolved oxygen, CO_2 and transparency of site 1 were 32.5ºC , 29.5ºC, 29.0ºC, 33.5 ppt, 8, 6.3 ml/lit, 0 and 8 m respectively, in the site 2 they were recorded as 31, 30, 30, 33. ppt, 7.6, 5.7 ml/lit 0 ml/lit and 11.00 m & at site 3 they were analyzed as 31.5, 30, 29.5, 33.5 ppt, 7.8, 6.5 ml/lit, 0 and 9.7 m. It was observed that there were little variations in all the water parameters in all the three sites except CO_2 which remained consistent during the study. Commonly reef health is indicating the fish wealth of the reef which acts as nursery ground of the fish juveniles. During the survey we have noticed that the various fish schoolings in the reef areas which show the reef health of the same area. We also noticed that the ring net fishers captured Indian mackerel and sardines around this island of reef areas.

Discussion and Conclusion

The coral reefs are highly productive due to the efficient retention and recycling of nutrients within the reef systems. The reef building corals are found in the well lighted zone of water up to a depth of 50 to 70m having salinity 32 to 35ppt and temperature above 20ºC. Boulders of Favia and Porites are found growing at about 200m up to almost near the reef rim. The potential fish yield from the world reef is 6 to 9 million tons per year which is almost 9 to 12 % of entire marine fish catch. The Indian reefs have a potential fish yield of 0.2 million tons per year which is about 10 % of the annual marine fish production[27]. The local fishermen of Andaman & Nicobar Islands very much depend on the coral reefs for the sustenance fishery.

Bleaching events increased during last two decades in frequency and intensity due to rising of SST unexpectedly which leads to gradual decline to their status. Andaman Sea also witnessed a few bleaching events[15] during 1998, 2002, 2005 and 2011. Maintaining the integrity and resilience of coral reef ecosystems is essential for the well being of tropical coastal communities worldwide, and a critical part of the solution for achieving the Sustainable Development. Beyond these world-wide coral are vulnerable to various threats

TABLE-4 : The percentage other fauna found in LIT of study area

Family	Genus	Species	Site 1	Site 2	Site 3	Average %
Mollusks (10 families)	11	17	92.48	83.32	87.84	87.88±6.24
1. Strombidae:*Lambis lambis, L.crocata*	1	2	0.65	1.21	1.52	1.12±0.25
2. Conidae:*Conus amadis, C. marmoreus*	1	2	0.49	1.39	1.73	1.21±0.37
3. Cypraeidae: *Cypraea talpa (Talparia talpa), Cypraea tigris*	1	2	0.31	2.17	0	0.83±0.68
4. Trochidae: *Trochus niloticus*	1	1	0.23	0.45	2.54	1.08±0.74
5. Cardiidae:*Tridacna crocea, T.squamosa, T. maxima, T. gigas*	1	4	46.81	8.64	11.36	22.28±12.3
6. Gryphaeidae:*Hyotissa hyotis (oyster)*	1	1	0.07	0	0	0.02±0.02
7. Ostreidae:	2	2	43.31	67.69	69.30	60.1±8.4
Saccostrea cuculata		1	31.65	53.16	43.31	42.7±6.2
Crassostrea rivularis		1	11.66	14.53	25.99	17.4±4.4
8. Pinnidae:*Atrina pectinata*	1	1	0.11	0	0	0.04±0.04
9. Pteriidae:*Pinctada margaritifera*	1	1	0.46	1.70	1.39	1.18±0.37
10. Octopodidae: Octopus sp.,	1	1	0.04	0.07	0	0.04±0.02
Echinoderms (4 families)	5	8	7.2	15.65	9.65	10.83±2.51
11. Holothuriidae:	2	4	5.74	12.16	4.65	7.52±2.34
Holothuria atra, H.scabra		2	5.25	11.57	4.27	7.0±2.3
Bohadschia marmorata,B.argusarmorata		2	0.49	0.59	0.37	0.5±0.1
12. Stichopodidae:*Sticopus variegates, S.chloronotus*	**1**	**2**	**1.38**	**2.58**	**3.27**	**2.41±0.55**
13. Oreasteridae: *Culcita schmideliana*	**1**	**1**	**0.08**	**0.78**	**1.12**	**0.66±0.31**
14. Ophidiasteridae: *Linkea laevigata*	**1**	**1**	**0**	**0.13**	**0.61**	**0.25±0.19**
Arthropods15. Palinuridae:*Panulirus versicolor*	**1**	**1**	**0.10**	**0.27**	**1.27**	**0.54±0.37**
Cnidaria (Sea Anemones) **16. Actiniidae:** *Entacmaea, Quadricolor* **17. Stichodactylidae:***Stichodactyla haddoni, Heteractis magnifica*	**1+2**	**3**	**0.22**	**0.75**	**1.26**	**0.74±0.30**

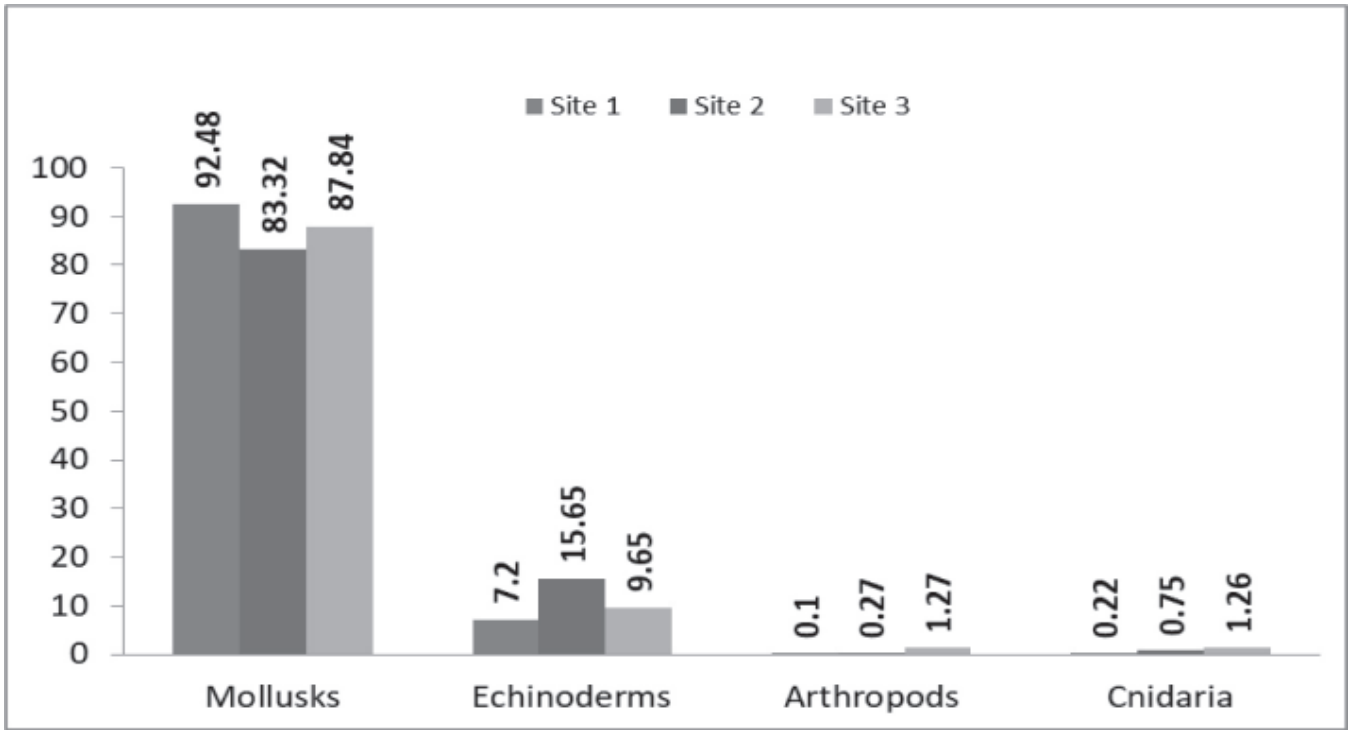

Fig. 2 : Invertebrate faunas in different sites of Swaraj Dweep in %

including diseases, both natural and anthropogenic. Evidential proof substantiates heavy physical damage to coral reefs because of recreational diving activity, which may lead to the collapse of coral habitat if it continues unabated[14]. The most of the Indian coral reefs are under severe stress due to anthropogenic pressure and climate change[7,19]. The sewage channels are directly open to the reef which makes coral under the stress. Smothering due to sedimentation is also recognized as stress on live corals[23]. It was reported that the inshore waters became very turbid at Palk Bay and the Gulf of Mannar due to the occurrence of sedimentation during the northeast monsoon[28]. Various studies indicated that due to massive tourist inflow and recreational diving, induced coral damage have been reported in ANIs, Lakshadweep and also Gulf of Mannar[11,17,21,24,26]. The physically damaged corals are more vulnerable to diseases, increased predation, poses disadvantage in space competition, and eventually leading to coral mortality[12,13,16].

Due to the open dive, tourism in poorly managed reefs in the tropical developing nations hinders conservation[6,16]. Further, hampers the coral growth rate, competitive success, susceptibility to thermal anomalies, and bleaching recovery[1,16,22].

The coral reefs of the Rani Jhansi Marine National Park, which exist under physical conditions that are probably sub-optimal, are today facing an additional threat from the activities of man. Line Intercept Transect (LIT) Surveys were resorted for assessing the health status of corals. Several factors like predation by crown of thorns, effluent discharge and human interference are stated to be responsible factors for damage of corals other than the extreme events. Due to tourism development, the tourists are undergoing such as group reef walk, snorkeling, scuba fun diving, anchoring of boats, leaving of garbage like plastics *etc.,* which are damaging the healthy reef and disturbing new-recruitment of corals. Natural calamities are also affecting the reef health that can be rectified by the ecosystem but damages which are occurring due to human activities cannot be rectified.

The biodiversity of selected reefs of Swaraj Dweep has indicated that they are still in pristine condition and proper management would have protected the biodiversity of these reefs providing opportunities for sustainable development. They are likely to be affected by the threats of global warming and rising sea level but, the biodiversity of coral reefs of Andaman seems to be resilient to a greater extent under such impacts. Cyclones are common during the monsoons[29] and the currents are strong, both of which probably subject the reefs to considerable stress from non-human agencies. The impact of diving in tourism related activities on coral reef health and other factors are to be accounted to assist in reef management strategies and conservation policies in developing countries like India. Eco friendly tourism is very essential to conserve and save these healthy coral reefs Islands. The same to be sustained in regular basis at all the beach and snorkeling area of ANIs.

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