CHAPTER 4:
SCLERACTINIANS' STATUS AT NARARA REEF

Introduction

Methodology

Diversity

Distribution

Community Assemblage

Health Status

4.1 INTRODUCTION:

Scleractinians are popularly known as hard corals or stony corals. They are marine invertebrate organisms belonging to Order Scleractinia of Phylum Cnidaria. However, the term corals is also used for other organisms of the phylum resembling scleractinian fauna i.e. Fire corals and Soft corals, but only scleractinians are the true corals in taxonomical senses (Fig. 4.1). Scleractinians are much delicate fauna with narrow tolerance to the environmental changes. Here in this chapter, their diversity, distribution, abundance and assemblage on Narara reef are dealt. Soft corals recorded during this study are included with associated fauna in following chapter.

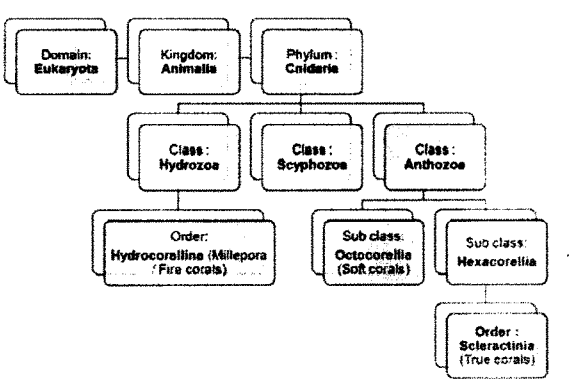


Fig. 4.1: Taxonomical position of Scleractinians.

4.2 METHODOLOGY:

The Narara reef was explored sub-site wise as described in Chapter 2 (Para 2.4); to enhance the chances of encounter of maximum number of different scleractinian species, a random track was followed in each sub-site during each field visit. Each different scleractinian species encountered was identified up to genus *in situ* based on growth forms and type of corallites and recorded in field diary. The hard corals are put into Schedule - 1 of Indian Wildlife Act, 1972 and require special permissions for collecting them from nature for any purpose. Therefore, during the study no live or dead coral colony or part thereof was collected from field for taxonomical examinations. The coralla were photographed with scale for fine structures of corallum and corallites for documentation purpose. The photographs were examined for

taxonomical characters (Plates 4.1, 4.2) later on and finally species were confirmed. The taxonomic identification was carried out as per standard literature (Pillai and Patel, 1988; Venkataraman *et al.*, 2003; Veron, 2000). Here, species names and classification system were adopted from (Venkataraman *et al.*, 2003). The species reported earlier with different name were considered as synonyms and mentioned in detailed species description. GPS coordinates were also noted for significantly large colonies or coral assemblage using hand held GPS receiver (Garmin eTrex-H).

To assess the vertical distribution of hard corals on Narara reef, the intertidal area was roughly divided in to upper intertidal, middle intertidal and lower intertidal (near LTL). Whereas, the occurrence of species in a particular sub-site was considered for horizontal distribution.

The reef area was surveyed systematically using Line Intercept Transect (LIT) method (English *et al.*, 1997) to carry out community analysis. A total twenty-five transects of 20m length were placed randomly over the reef (5 transects per sub-site). All the hard coral colonies intercepted transect were recorded species wise and their maximal projected length was measured.

The surveys were then quantified by finding the relative abundance (RA) values of each hard coral species (Rilov and Benayahu, 1998).

$$RA = P_i \times 100 / P_{total}$$

Where,

P_i = pooled living coverage of the i^{th} species from all transects at a given site

P_{total} = pooled total living coverage of all species in all transects at a given site.

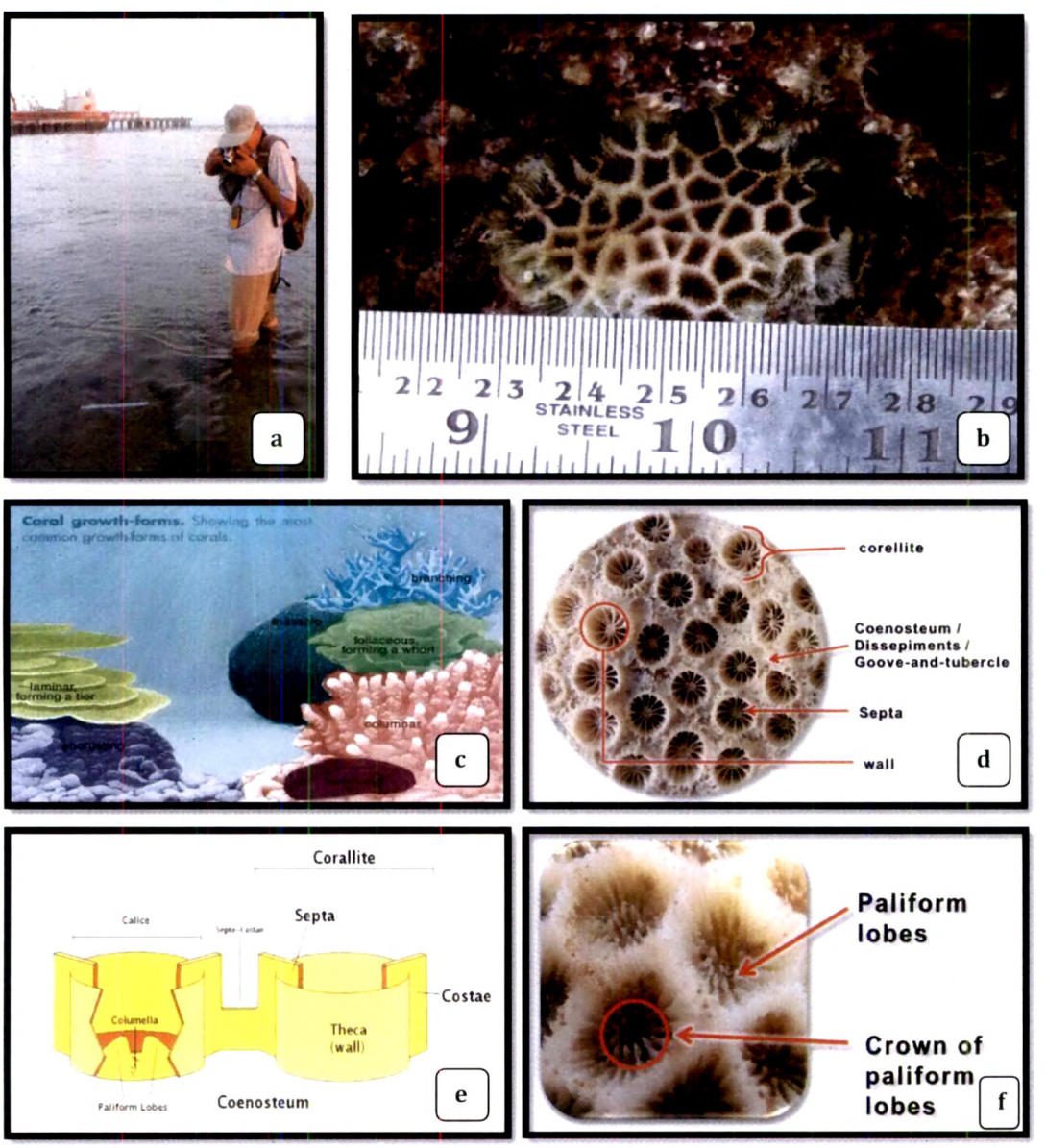
The values of RA were assigned abundance categories (%):

not recorded (RA=0), rare (0<RA<0.1), uncommon (RA = 0.1-1), common (RA=1-10), abundant (Ra=10-20), dominant (RA>20)

Further, to understand the assemblage composition of hard coral communities, univariate community parameters Shannon – Wiener diversity index (H), Simpson richness index, Evenness, Margalef's richness index, Equitability were calculated using PAST software (Hammer *et al.*, 2001).

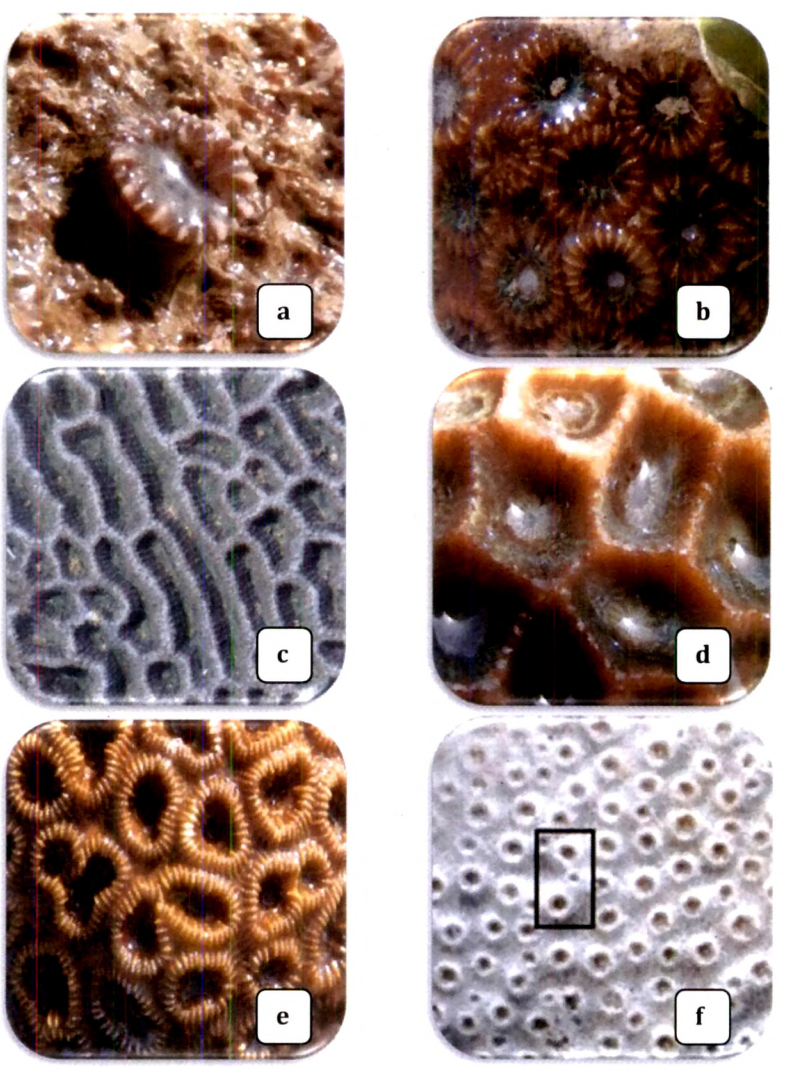
During exploratory and systematic surveys all the coral colonies encountered were qualitatively assessed for any abnormalities e.g. diseased condition and bleaching through visual inspection.

Plate: 4.1



(a) *in situ* photography for colonies' growth forms and size, **(b)** *in situ* macro photography of corallites for taxonomical study, **(c)** growth forms, **(d, e, f)** corallite structures.

Plate: 4.2



(a) Solitary corallites: *Polycyathus* **(b)** Plocoid corallites: *Favia, Cyphastrea, Acanthastrea*
(c) Meandroid: *Symphyllia, Platygyra* **(d)** Ceriod corallites: *Favites, Siderastrea*
(e) Intratentacular Budding **(f)** Extratentacular Budding

4.3 DIVERSITY:

During present study total 26 scleractinian species belonging to 18 genera and 09 families were recorded from Narara (Table 4.1). Out of these, 25 species were of hermatypic corals and 01 was of ahermatypic coral. However, this figure differs from that of the reported by previous workers (Table 4.2), the highest 33 species were reported by (Singh *et al.*, 2004) followed by 28 (Dixit *et al.*, 2010) and 08 (Pillai and Patel, 1988). As the scleractinian taxonomy classically depends upon the close examination of skeletal details, it becomes difficult to determine the correct species of some specimens *in situ*. Here in present study the list is given only for those species which were fully confirmed for correct identification.

Family Faviidae emerged as the most diverse taxon represented by 06 genera and 09 species. *Favia* and *Porites* were the commonly occurring genera whereas *Mycedium* was recorded only once in live condition. No *Acropora* genus was recorded alive as acclaimed previously (Singh *et al.*, 2004), but large quantity of eroded dead remains of *Acropora spp.* skeletons were common all around on the reef area.

The scleractinian diversity of Narara reef accounted for 12% of total scleractinian species reported from all Indian reef regions and 58% of scleractinians reported from GoK reefs (Fig. 4.2). Out of total 26 species, 21 species were common between Narara reef and Gulf of Mannar and Palk Bay reefs followed by 18 species and 13 species between Andaman and Nicobar reefs and Lakshadweep reefs respectively. Two species e.g. *S. savignyana* and *A. hillae*, recorded in present study are restricted to GoK reefs only in Indian subcontinent (Table 4.3 and Fig. 4.3).

It is evident from table 4.2 that 07 species reported by Singh *et al.* (2004) e.g. *M. dane, A. humilis, F. maxima, F. flexuosa, M. annuligera, P. versipora* and *D. helipora* have not been reported by the others from this area. As per them *A. humilis, C. monile, F. maxima, H. excesa, P. versipora, M. annuligera, D. helipora, L. purpurea* and *A. hillae* were the rare stony coral species of MNP & S from Narara reef. Whereas, *M. foliosa* and *M. turgescens* were reported by Dixit *et al.* (2010) and NIO (2009) only. ***P. pini* reported here in this study have not been reported previously from this locality.**

Table 4.1: List of scleractinian species recorded from Narara reef during present study.

Family	Genus	Species	Sr No.
[redacted]			
ACROPORIDAE Verrill, 1902	***Montipora*** de Blainville, 1830	***M. monasteriata*** (Forskal, 1775)	1
		M. explanata Brueggeman, 1879	2
SIDERASTREIDAE Vaughan and Wells, 1943	***Pseudosiderastrea*** Yabe and Sugiyama, 1935	***P. tayami*** Yabe and Sugiyama, 1935	3
	Siderastrea de Blainville	***S. savignyana*** Milne Edwards and Haime, 1850	4
	Coscinaraea Milne Edwards and Haime, 1848	***C. monile*** (Forskal, 1775)	5
PECTINIIDAE Vaughan and Wells, 1943	***Mycedium*** Oken, 1815	***M. elephantotus*** (Pallas, 1766)	6
MERULINIDAE Verrill, 1866	***Hydnophora*** Fischer de Waldheim, 1807	***H. exesa*** (Pallas, 1766)	7
DENDROPHYLLIIDAE Gray, 1847	***Turbinaria*** Oken, 1815	***T. peltata*** (Esper, 1794)	8
		T. reniformis (Bernard, 1896)	9
MUSSIDAE Ortmann, 1890	***Acanthastrea*** Milne Edwards and Haime, 1848	***A. hillae*** Wells, 1955	10
	Symphyllia Milne Edwards and Haime, 1849	***S. radians*** Milne Edwards and Haime, 1849	11
FAVIIDAE Gregory, 1900	***Favia*** Oken, 1815	***F. favus*** (Forskal, 1775)	12
		F. speciosa Dana, 1846	13
	Favites Link, 1807	***F. complanata*** (Ehrenberg, 1834)	14
		F. bestae (Veron, 2000)	15
	Goniastrea Milne Edwards and Haime, 1848	***G. pectinata*** (Ehrenberg, 1834)	16
	Platygyra Ehrenberg, 1834	***P. pini*** Chevalier, 1975	17
		P. sinensis (Milne Edwards and Haime, 1849)	18
	Leptastrea Milne Edwards and Haime, 1848	***L. purpurea*** (Dana, 1846)	19
	Cyphastrea Milne Edwards and Haime, 1848	***C. serailia*** (Forskal, 1775)	20
PORITIDAE Gray, 1842	***Porites*** Link, 1807	***P. lutea*** Milne Edwards and Haime, 1860	21
		P. lichen Dana, 1846	22
		P. compressa Dana, 1846	23
	Goniopora de Blainville, 1830	***G. minor*** Crossland, 1952	24
		G. stutchburyi Wells, 1955	25
[redacted]			
CARYOPHYLLIDAE Grey, 1847	***Polycyathus*** Duncan, 1889	***P. verrilli*** Duncan, 1889	26

Table 4.2: Comparative account of scleractinian species recorded from Narara reef.

Sr No	Species	Pillai & Patel, 1988	Singh et al., 2004#	NIO, 2009	Dixit et al., 2010	Present study
1	*Montipora foliosa*			*^	*	
2	*Montipora turgescens*			*^	*	
3	*Montipora monasteriata*		*	*^	*	*
4	*Montipora explanata*	*	*	*^	*	*
5	*Montipora dane*		*			
6	*Acropora humilis*		*			
7	*Pseudosiderastrea tayami*	*			*	*
8	*Siderastrea savignyana*			*	*	*
9	*Coscinaraea monile*		*	*^	*	*
10	*Mycedium elephantotus*			*^	*	*
11	*Hydnophora exesa*		*	*^	*	*
12	*Turbinaria peltata*	*			*	*
13	*Turbinaria reniformis*				*	*
14	*Acanthastrea hillae*		*		*	*
15	*Symphyllia radians*			*	*	*
16	*Favia favus*	*	*	*	*	*
17	*Favia speciosa*		*	*	*	*
18	*Favia maxima*		*			
19	*Favites complanata*		*	*	*	*
20	*Favites flexuosa*		*			
21	*Favites bestae*				*	*
22	*Goniastrea pectinata*	*		*	*	*
23	*Platygyra pini*					*
24	*Platygyra sinensis*		*	*	*	*
25	*Montastrea annuligera*		*			
26	*Plessiastrea versipora*		*			
27	*Diploastrea helipora*		*			
28	*Leptastrea purpurea*	*	*	*	*	*
29	*Cyphastrea serailia*	*		*	*	*
30	*Porites lutea*		*	*	*	*
31	*Porites lichen*			*^	*	*
32	*Porites compressa*		*	*	*	*
33	*Goniopora minor*			*^		*
34	*Goniopora stutchburyi*			*^	*	*
35	*Goniopora planulata*		*		*	
36	*Polycyathus verrilli*	*			*	*
	Total	**08**	**33**	**21**	**27**	**26**

→ # Though (Singh *et al.*, 2004) has reported total 33 species from Narara, only 20 species' name is given in the report.

→ *^ These species were reported from sub-tidal area of Narara reef by NIO.

Table 4.3: Distribution of scleractinian species recorded in this study in other major coral reef regions.

Sr No	Species	Narara Reef, GoK	Lakshadweep Islands	Palk Bay and Gulf of Mannar	Andaman and Nicobar Islands	Total
1	*Montipora monasteriata*	+		+		02
2	*Montipora explanata*	+	+	+		03
3	*Pseudosiderastrea tayami*	+		+	+	03
4	*Siderastrea savignyana*	+				01
5	*Coscinaraea monile*	+		+		02
6	*Mycedium elephantotus*	+		+	+	03
7	*Hydnophora exesa*	+		+	+	03
8	*Turbinaria peltata*	+		+	+	03
9	*Turbinaria reniformis*	+			+	02
10	*Acanthastrea hillae*	+				01
11	*Symphyllia radians*	+	+	+	+	04
12	*Favia favus*	+	+	+	+	04
13	*Favia speciosa*	+	+	+	+	04
14	*Favites complanata*	+	+	+	+	04
15	*Favites bestae*	+	+	+		03
16	*Goniastrea pectinata*	+	+	+	+	04
17	*Platygyra pini*	+			+	02
18	*Platygyra sinensis*	+	+	+	+	04
19	*Leptastrea purpurea*	+	+	+	+	04
20	*Cyphastrea serailia*	+	+	+	+	04
21	*Porites lutea*	+	+	+	+	04
22	*Porites lichen*	+	+	+	+	04
23	*Porites compressa*	+		+		02
24	*Goniopora minor*	+	+		+	03
25	*Goniopora stutchburyi*	+		+		02
26	*Polycyathus verrilli*	+		+	+	03
	Total	**26**	**13**	**21**	**18**	

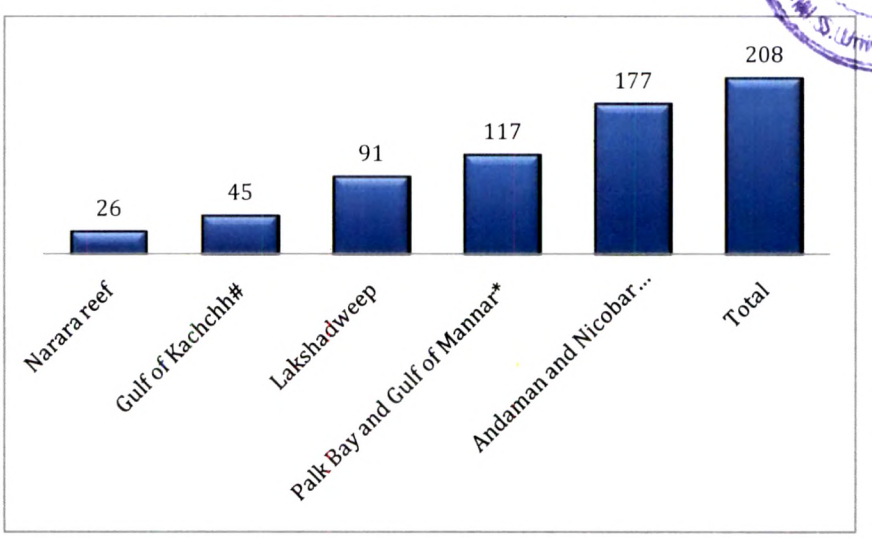


Fig. 4.2: Comparison of scleractinian diversity of Narara reef with major Indian reef region.

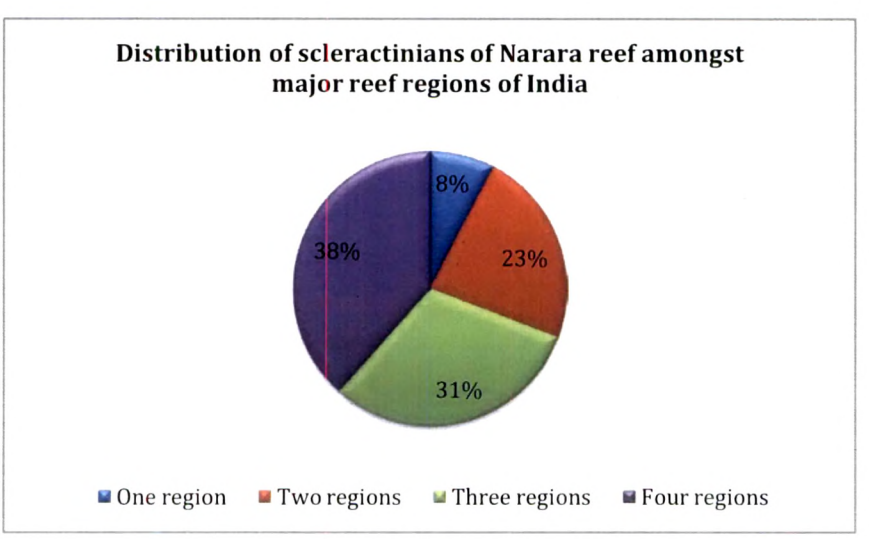


Fig. 4.3: Distribution of scleractinian species recorded during present study from Narara reef amongst four major Indian reef regions.

45 species for GoK (Dixit *et al.*, 2010), 117 for Palk Bay and Gulf of Mannar (Patterson *et al.*, 2008) and others as per (Venkataraman *et al.*, 2003).

4.3.1 SPECIES DESCRIPTION:

Following is the standard taxonomic description of the species recorded in this study. The characters in bold were considered primarily for identification of the specimens *in situ*.

1. ***Montipora monasteriata*** (Forskal, 1775):

Encrusting, massive, growing layer over layer colony with thick plate which may be unifacial or bifacial. **Surface with hillocks and gibbosities.** Corallites mostly immersed. **Calices 0.6 to 0.8 mm in diameter.** Septa in two complete cycles, with prominent directive Septa. **Reticulum is coarse and is uniformly covered with papillae or tubercles or both.** Papillae single or two or three fuse to form small ridges or excrescens. Individual papillae 1 to 1.5 mm at the base and 2 to 3 mm in height. All papillae and tuberculae are composed of fine reticulum with elaborated spines. **Living colonies usually pale brown or pink in color with pink or white margins. (Plate: 4.3)**

2. ***Montipora explanata*** Brueggeman, 1879:

Corallum explanate and encrusting with small gibbosites on the surface. Surface coenosteum glabrous or smooth. It is characterized by the presence of scattered low tubercules. **Corallites 0.5 to 0.8 mm in diameter (Calices < 1 mm in diameter).** Primary septa well-developed, irregular in outline and crowded; second cycle of septa incomplete and usually not seen. **Living coral yellowish brown. (Plate: 4.3)**

3. ***Pseudosiderastrea tayami*** Yabe and Sugiyama, 1935:

Growth form and nature of corallites similar to *Siderastrea*, but corallites larger with one ring of synopticula. Budding extratentacular. **Corallites small, ceriod, 3-6 mm in diameter.** Septa have fine saw like teeth. They are evenly spaced and inner margins of septa are fused. Columellae consist of one to four Pinnules. Colonies are pale grey with distinct white corallite walls in color. **(Plate: 4.3)**

4. ***Siderastrea savignyana*** Milne Edwards and Haime, 1850:

Coralla explanate, emernshing or low mound to one meter across. **Corallites polygonal, tetra to hexagonal, ceriod.** Wall acute with a fine ridge at the top, 3 to 4 mm long and 2 to 3 mm broad. Smaller corallite intercalated. **Septa 25 to 30 nearly arranged, equal thickness at wall, slightly exsert.** 12 septa reach columella, higher cycles unite to lower ones. Primary cycle of septa without any fusion directly reaching columella, Columella a compressed style. Two rows of synapticulae within wall. **(Plate: 4.3)**

5. ***Coscinaraea monile*** (Forskal, 1775):

Corallum encrusting, dome shaped. **Edges free and costate**. Corallites mono to tristomodaeal, sometimes placed within short valleys. **Intercorallite walls poorly developed. Calices 6-8 mm in diameter. Distance between adjacent columella centers 4 to 6 mm.** Depth of calyx about 3 mm. **Septa confluent between centers, bi to trifurcating, 30 to 40 septa around a calyx of which 8 to 12 reach columella and others undergo fusion.** Septa are even and finely serrated giving colonies a smooth appearance. Axial fossa circular and about 1 mm in diameter with single or two to three vertical papillae (Papilliform columella). **(Plate: 4.3)**

6. ***Mycedium elephantotus*** (Pallas, 1766):

Colonies are laminar or encrusting. Corallites are nose-shaped, facing outwards towards the corallum perimeter. Septa and columellae are well developed. Costae from outwardly radiating ribs on the corallum surface which may be highly raised on corallite walls. The coenosteum is never pitted at the insertion of new septo-costae. Polyps are extended only at night. **Colonies are usually uniform brown, grey, green or pink but may have green or red oral discs and have a colored margin around the colony. (Plate: 4.3)**

7. ***Hydnophora exesa*** (Pallas, 1766):

Explanate, upper surface with hillocks; colonies are sub-massive, encrusting or sub-arborescent. Monticules 5 to 12mm long and 4 to 5 mm high, conical or

elongated and are evenly distributed over the corallum, in some parts arranged in regular rows, 3 to 6 mm apart separating continuous valleys. In branching colonies, the monticule axis, which is normally perpendicular to the general surface of the corallum, tends to become increasingly inclined towards the tip of the branches. Septa vertically descending from the apex of the monticule, subequal or larger and smaller alternating with dentate edges. Septal dentations are obsolute on the monticules, but better developed on the lower part of the septa. The columellar structure is irregularly developed, absent in places. When developed, it is trabecular. **Living colonies are cream or dull cream in color. (Plate: 4.4)**

8. ***Turbinaria peltata*** (Esper, 1794):

Corallum shield like or overgrowing dead substratum. Colony margins mostly composed of closely packed, outward projecting corallites. **Corallites 4-5 mm in diameter, level or projecting**, crowded or widely spaced; calices circular, 3 to 4 mm in diameter. Septa 24. Columella 1 to 2 mm in diameter at the bottom of the calyx. **(Plate: 4.4)**

9. ***Turbinaria reniformis*** (Bernard, 1896):

Synonym: *Turbinaria crater* (Pallas) 1766.

Growth forms are not usually as convoluted, unifacial, laminae with plates, horizontal at bottom becoming inclined and folded at top. It is crateriform and foliaceous. Colonies sometimes form tiers, which are mostly horizontal. **Corallites are in average of 2 mm in diameter, often arranged in concentric rows, widely spaced, thin walled, crowded to almost touching with small calices. Septa range from 12 to 24.** Columella deeply seated. **(Plate: 4.4)**

10. ***Acanthastrea hillae*** Wells, 1955:

Synonym: *Acanthastrea simplex* Crossland, 1948.

Submassive or encrusting. Corallites plocoid or cerioid, polygonal or oval. Mono to tristomodaeal. **Calices 10 to 25 mm broad. Polyps are thick walled.**

Septa with typical swollen, tall mussid teeth; Septo-costae are thick near the corallite wall, becoming thin near the columella. **Colonies have moderately fleshy tissue over the skeleton. Oral disc is bright greenish. (Plate: 4.4)**

11. ***Symphyllia radians*** Milne Edwards and Haime, 1849:

Colonies are massive to flat. Surface convex; greater diameter 15 to 20 cm. **Valleys radiating from center to corallum, Valleys are fairly straight, especially if colonies have flat surfaces, otherwise irregularly sinuous, width 25-30 mm, depth 15 to 20 mm.** Collines 2.5 to 3 mm thick, 12 to 15 septa per cm length of colline. Major septa with 6 to 8 teeth, larger upper teeth 1 to 3 mm long. Septal dentations are intermediate between *Symphyllia recta* and *Symphyllia agaricia.* Columella trabecular, formed by the fusion of septal ends, linked by lamellae. Collines ridges. **(Plate: 4.4)**

12. ***Favia favus*** (Forskal, 1775):

Colony submassive, rounded. Corallites, plocoid circular or oval and conical. Calices sometimes distorted. **Greater diameter of calyx 10 to 20 mm. Total septa 40 to 70.** Septa have an irregular appearance. Intercorallite wall thick. Peritheca costate. Paliform lobes are poorly developed. Colonies are dark brown or grey in color. It is often mottled and may have pale calices. **(Plate: 4.4)**

13. ***Favites speciosa*** Dana, 1846:

Encrusting to submassive. Corallites polygonal, circular and plocoid. Coenosteum costate. Septa alternating in size with dentate edges. Collumella present. Encrusting thick. Corallites and calices circular or subcircular or oval, **10 to 20 mm in greater diameter. Total septa 25 to 40, fine and regular**. Peritheca costate and highly blistery due to the presence of perithecal vesicles. Paliform tube poorly developed. Colonies are pale grey, green or brown in color, usually with calices of contrasting color. **(Plate: 4.5)**

14. ***Favites complanata*** (Ehrenberg, 1834):

Corallum encrusting, hillocky with slightly angular corallites. **Corallites polygonal, 10-20 mm long and upto 15 mm broad, one side elevated. Total septa range from 40 to 50. Septal teeth frosted giving a spiny look to the corallum. Exert ends of septa unite at the top of wall. Paliform lobe weekly developed.** Columella is large. Living colonies are wide range but usually brown in color, sometimes with green oral discs. **(Plate: 4.5)**

15. ***Favites bestae*** (Veron, 2000):

Synonym: *Favites melicerum* (Ehrenberg) 1834.

Encrusting with hillocks. **Corallites and calices polygonal, penta or hexagonal. Intercorallite wall acute at the top (fused thinner at the summit than at the base). Calices 5 to 7 mm long, 4 to 5 mm broad, 3 to 4 mm deep. Septa 28-36, alternating in size, very little exert, continuous over the wall;** Septal edges dentate, sides granular, 8 to 12 septa reach the columella. Columella trabecular and 1 to 2 mm in diameter. **(Plate: 4.5)**

16. ***Goniastrea pectinata*** (Ehrenberg, 1834):

Colonies are sub-massive or encrusting. **Corallites are ceriod** to sub-meandroid, usually with less than four centers. Larger corallites are 10 to 11 mm in length, 8-9 mm broad and 4-6 mm deep. **Walls are thick and paliform lobes are well developed. Total septa 24 to 30 with an equal number of smaller ones in between, Septa opposed or alternating all the top of the wall, slightly exsert. Pali prominent forming a circle around the columella.** Living colonies are pale brown or pink, dark brown in deep or turbid water. **(Plate: 4.5)**

17. ***Platygyra pini*** Chevalier, 1975:

Colonies are massive to encrusting, subcerioid to submeandroid with thick walls. Septa are thin and widely spaced. There may be some development of columella and/or paliform lobes. Living colonies are grey or yellow-brown in color with green or cream centers. **(Plate: 4.5)**

18. ***Platygyra sinensis*** (Milne Edwards and Haime, 1849):

Corallum massive or flat, meandroid with thin walls. Corallites monostomodaeal to short meandering valleys up to 2 mm long and 5 mm broad. Collines upto 2 mm thick, collines solid or perforate. Septa of equal thickness at the top of colline, steeply descending. They are thin with slightly exert. Columella is narrow and trabecular, continuous. There are no paliform lobes. Living colonies have a wide variety of color, often bright, as the case of other *Platygyra* species. **(Plate: 4.5)**

19. ***Leptastrea purpurea*** (Dana, 1846):

Colonies are irregular, encrusting or massive; colonies are sub-cerioid. Corallites polygonal, **calices polygonal or in some cases circular**. Larger corallites 9-12 mm long and 5-6 mm broad and about 1 mm deep. **Inter corallite groove deep**. The coenosteum between two adjacent corallite is usually narrow, smooth strip over shadowed by the exsert septa. Septa 40 to 60 depending on the size of the calyx, septa are seldom thickened above the thecal. Costae are poorly developed. Living colonies are pale yellow or cream on their upper surface with dark calices. **(Plate: 4.6)**

20. ***Cyphastrea serailia*** (Forskal, 1775):

Colonies are usually massive or sub-massive, sometimes encrusting. **Corallites round, level or projecting, touching each other to 1 mm apart. Diameter of the calices varies from 1.75 to 2.5. The corallites have 12 septa.** Primary and secondary septa and costae subequal or the former thicker; the costae are equal, or subequal and are poorly developed. Spines closely set or scattered. Thecal vary greatly in height and thickness. Exothecal vesicles may or may not be present. The coenosteum is often largely composed of dissepimental blisters and is highly covered with granulated exothecal spines. The columellae are usually in conspicuous and trabecular. Living colonies are usually gray, brown or cream in color. **(Plate: 4.6)**

21. ***Porites lutea*** Milne Edwards and Haime, 1860:

Massive, hemispherical or helmet shaped and may be very large. The surface is usually smooth. Corallites polygonal and 1 - 1.25 mm in diameter. The ventral triplet of septa fuse each other at the tip to form a trident. Intercorallite wall zig-zag or straight. Pali six. **Usually cream or yellow but may be bright colored** in shallow waters. **(Plate: 4.6)**

22. ***Porites lichen*** Dana, 1846:

Encrusting or sub-massive, flat lamminae or plates or fused nodules and columns. Corallites about 1 mm in diameter, often 2 to 6 running together without intercorallite wall. **Usually aligned in irregular rows separated by low ridges.** Septal structures are variable and irregular. Pali poorly developed. Colonies are bright yellowish-green, sometimes brown in color. **(Plate: 4.6)**

23. ***Porites compressa*** Dana, 1846:

Forming palmate, thick branched or with digitiform, **nodular branches or remose corallum** with vertical flabellate, digitiform thick plate arising from a solid base. Corallites polygonal, 1.5 to 2 mm in length, large and deep, walls thin with twisted mural denticles. Septa steep at the wall. Ventral triplet of septa remain free, do not form a trident. Pali poorly developed, one each on the lateral pairs of septa and the fifth on the ventral directive. Two rings of synapticulae visible. Columella thin, joined to the fused ends of septa by radii. **(Plate: 4.6)**

24. ***Goniopora minor*** Crossland, 1952:

Corallum encrusting to sub-massive, hemispherical. Calices 2 to 3 / 4 mm in diameter. Circular in outline with thick wall. All septal structures are having granulated. Third cycle of septa mostly incomplete. Pali may or may not be present on the primary septa. Pali is poorly developed. There are six thick pali which are in contact forming a crown. **Live coral is brown or green usually with distinguished colored oral discs and pale tips to the tentacles. (Plate: 4.6)**

25. *Goniopora stutchburyi:*

Synonym: *Goniopora nigra* Pillai, 1969.

Corallum thick and explanate. Colonies are sub-massive to encrusting. Corallites and calices polygonal. Calices 2 to 2.5 mm in length and width and shallow giving colonies a smooth surface. Polyps have short tapering tentacles which may or may not be extended during day time. Septa in three cycles, almost straight from wall to columella. **Corallum dark brown / pale brown in living condition, sometimes with pale blue mouth. (Plate: 4.7)**

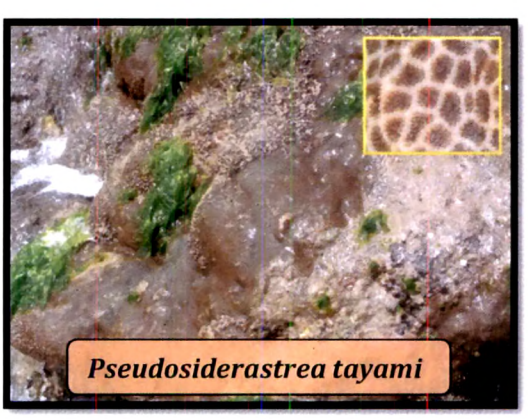
26. *Polycyathus verrilli* Duncan, 1889:

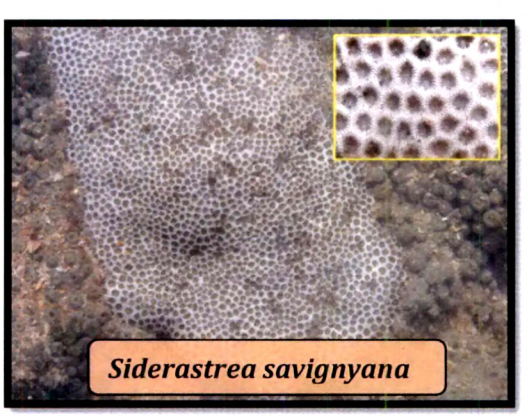
Individual corallites are 2 to 2.5 cm in diameter and 2 to 3 mm high. **(Plate: 4.7)**

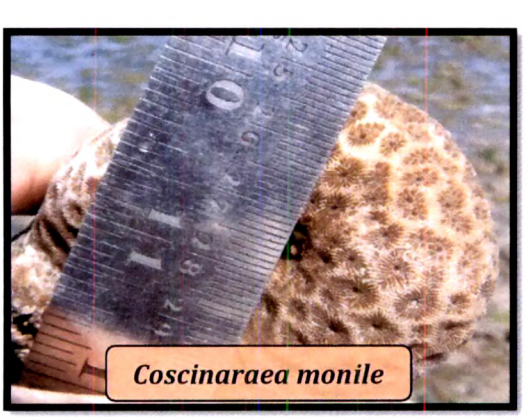
Plate: 4.3


Montipora monasteriata


Montipora explanata


Pseudosiderastrea tayami


Siderastrea savignyana


Coscinaraea monile

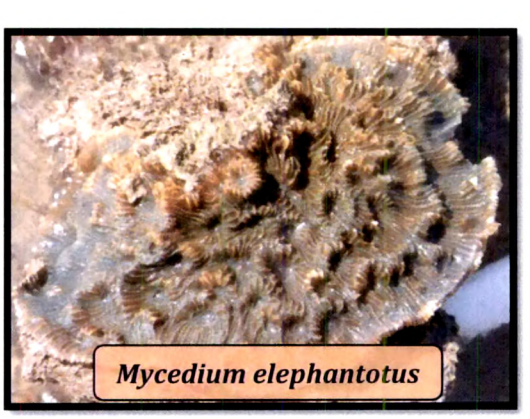
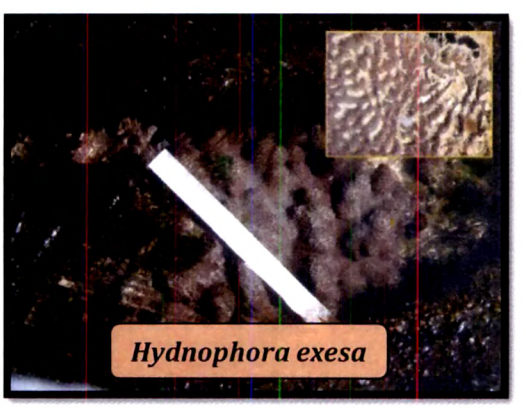
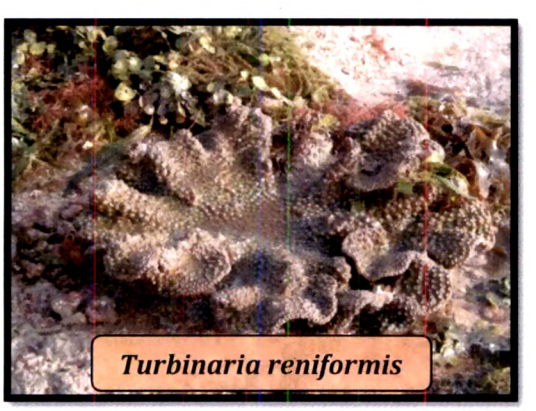

Mycedium elephantotus

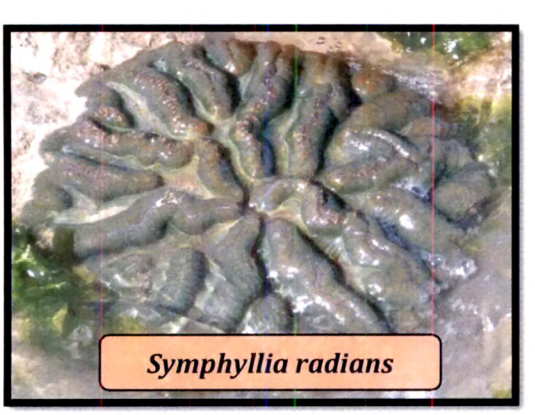
Plate: 4.4


Hydnophora exesa


Turbinaria peltata


Turbinaria reniformis


Acanthastrea hillae


Symphyllia radians

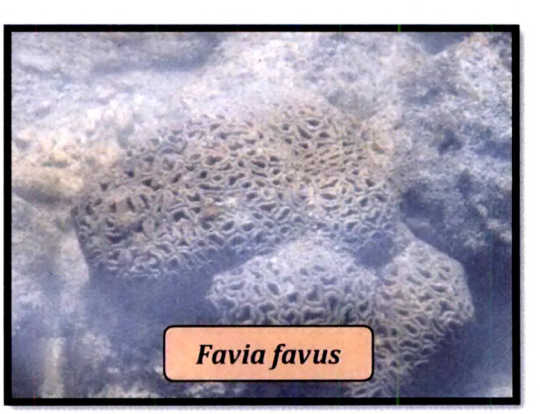
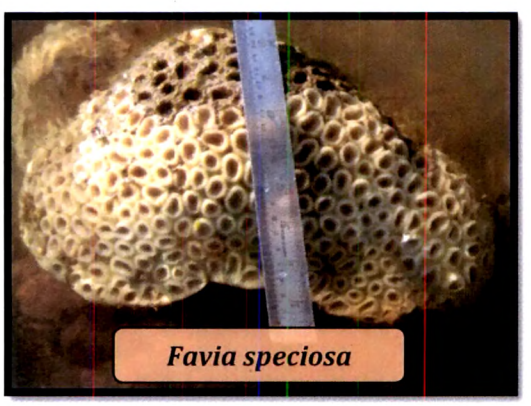
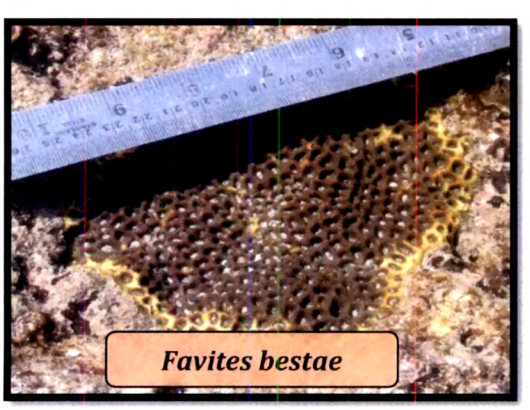

Favia favus

Plate: 4.5


Favia speciosa


Favites complanata


Favites bestae


Goniastrea pectinata


Platygyra pini

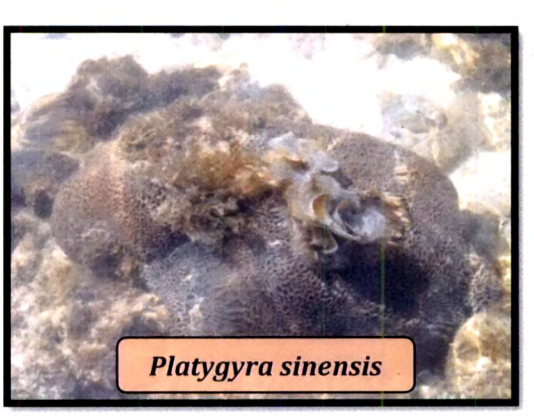
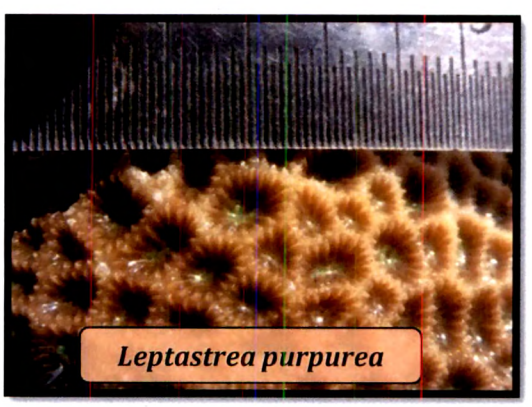
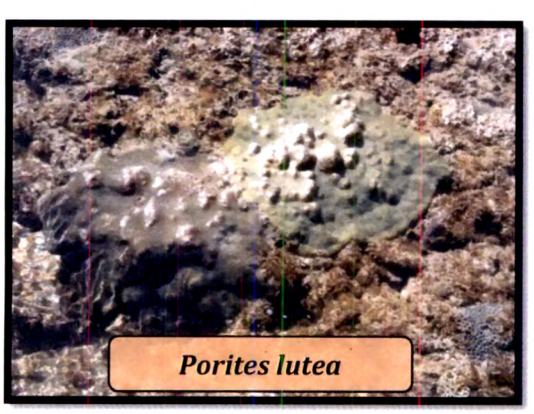

Platygyra sinensis

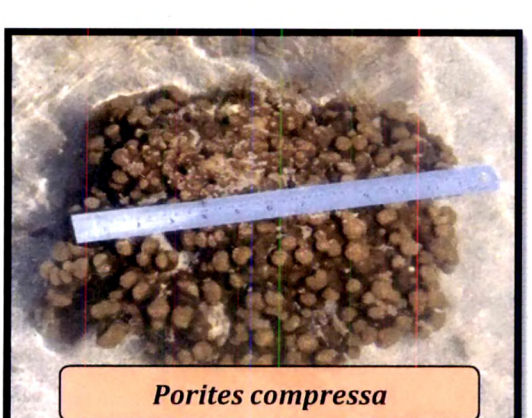
Plate: 4.6


Leptastrea purpurea


Cyphastrea serailia

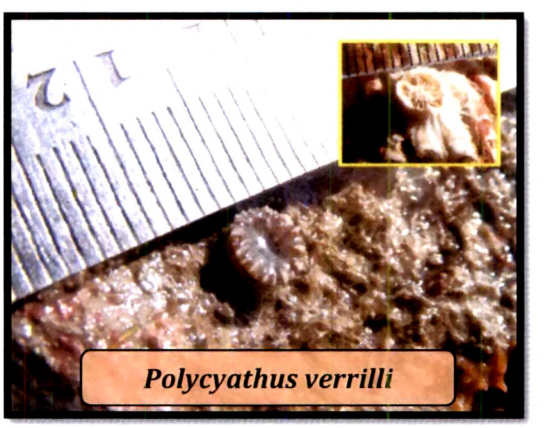

Porites lutea


Porites lichen


Porites compressa


Goniopora minor

Plate: 4.7



4.4 DISTRIBUTION:

During the field visits stony corals were found to occur in all the sub-sites with varied diversity and abundance.

The nearest to shore hard coral formation was found in sub-site S4 in upper intertidal area about 700m down to HTL in a deep lagoon (Lat. 22°28'36.76"N Long. 69°43'50.40"E). It was an interesting observation that all the colonies there in the lagoon were of *C. serailia,* massive and large, forming 100% mono-species assemblage. Sufficient depth of water in the lagoon and continuous feeding of water at low tide times may be the reason for such massive coral growths in the upper intertidal area. Otherwise, the upper intertidal area of Narara mainly consists of mudflat with no coral formation was recorded. Small colonies of *S. savignyana* and *F. favus* were amongst the first species encountered while walking down across intertidal area from HTL to LTL.

Sub-site wise distribution of hard corals is given in table 4.4. The highest number of hard coral species were recorded from sub-site S4 followed by S2, S3, S1 and S5. *S. savignyana, S. radians* and *F. favus* were the commonly occurring species in all the sub-sites. Whereas, three species *viz. P. tayami, C. monile* and *M. elephantotus* were found occurring only at sub-site S4.

Table 4.4: Sub-site wise distribution of Scleractinian species on Narara reef.

Sr No.	Species	Sub-sites					Total sub-sites per species
		S1	S2	S3	S4	S5	
1	***M. monasteriata*** (Forskal, 1775)	+	+	+			03
2	***M. explanata*** Brueggeman, 1879	+	+	+	+		04
3	***P. tayami*** Yabe and Sugiyama, 1935				+		01
4	***S. savignyana*** Milne Edwards and Haime, 1850	+	+	+	+	+	05
5	***C. monile*** (Forskal, 1775)				+		01
6	***M. elephantotus*** (Pallas, 1766)				+		01
7	***H. exesa*** (Pallas, 1766)		+	+			02
8	***T. peltata*** (Esper, 1794)	+		+	+		03
9	***T. reniformis*** (Bernard, 1896)	+	+		+		03
10	***A. hillae*** Wells, 1955			+	+		02
11	***S. radians*** Milne Edwards and Haime, 1849	+	+	+	+	+	05
12	***F. favus*** (Forskal, 1775)	+	+	+	+	+	05
13	***F. speciosa*** Dana, 1846		+	+	+		03
14	***F. complanata*** (Ehrenberg, 1834)	+	+	+	+		04
15	***F. bestae*** (Veron, 2000)		+		+		02
16	***G. pectinata*** (Ehrenberg, 1834)		+		+		02
17	***P. pini*** Chevalier, 1975		+		+	+	03
18	***P. sinensis*** (Milne Edwards and Haime, 1849)		+	+	+		03
19	***L. purpurea*** (Dana, 1846)		+		+		02
20	***C. serailia*** (Forskal, 1775)	+	+	+	+		04
21	***P. lutea*** Milne Edwards and Haime, 1860	+	+	+	+		04
22	***P. lichen*** Dana, 1846	+	+	+	+		04
23	***P. compressa*** Dana, 1846	+	+	+	+		04
24	***G. minor*** Crossland, 1952		+	+	+		03
25	***G. stutchburyi*** Wells, 1955	+	+	+	+		04
26	***P. verrilli*** Duncan, 1889			+	+		02
	Total species per sub-site	13	20	18	24	04	

- Species diversity wise order of sub-sites (highest number of species to least number of species): **S4>S2>S3>S1>S5**

4.5 COMMUNITY ASSEMBLAGE:

During the reef surveys for the hard corals' community analysis only few species out of total species recorded per sub-sites were intercepted by transect lines (Table 4.5). The sparse and patchy distribution of corals on Narara reef might be the reason for this. Further, patchy coral cover is only found in sub-sites S1, S2, S3 and S4; sub-site S5 is predominated by zoantharians with very infrequent occurrence of hard corals. Therefore, hard corals' community analysis was kept restricted to sub-sites S1, S2, S3 and S4 only.

The relative abundance of hard coral species on Narara reef is summarized in table 4.5. It is evident from the data that sub-site S1 is dominated by encrusting coral – *G. stutchburyi* and massive coral – *P. compressa* equally, S2 is dominated by massive coral *P. lutea*, S3 and S4 are dominated by massive life forms of *P. compressa* and *F. favus* respectively.

The community assemblage of any area can be well represented in form of diversity indices. However, the results were somewhat surprising, as they represented bit different scenario than that was set in mind through visually assessment of sub-sites (Table 4.6). The Shannon index is a measure of atrophy of the biotic community. The higher figure states many taxa with a few individuals whereas, many individuals from a few taxa scores for lessen figure. According to the diversity indices calculated, sub-site S2 represented the highest Shannon diversity index (H) 1.978 followed by 1.790, 1.764 and 1.70 for S1, S4 and S3 respectively. Sub-site S3 was dominated by single taxon (D=0.241) than S4, S1 and S2 in decreasing manner. Margalef index (M) was high for S2 (1.456), followed by S1, S3 and S4; it is suggestive that species of S2 are evenly distributed amongst individuals. Simpson diversity index for richness (1-D) which is indicative of evenness of community, the index was highest for S2 (0.844) followed by S1, S4 and S3.

Table 4.5: Percentage live coral cover, relative abundance (RA) and abundance categories of scleractinians of Narara reef.

Species	Sub-sites S1			S2			S3			S4		
	% cover	RA	Status	% cover	RA	Status	% cover	RA	Status	% cover	RA	Status
Montipora monasteriata	0.50	6.54	C	0.50	5.64	C	0.12	1.31	C	0.00	0.00	-
Montipora explanata	0.37	4.84	C	0.26	2.87	C	0.50	5.46	C	0.26	3.67	C
Pseudosiderastrea tayami	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.78	11.01	A
Siderastrea savignyana	0.23	3.01	C	0.13	1.47	C	0.16	1.75	-	0.35	4.94	C
Coscinaraea monile	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-
Mycedium elephantotus	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-
Hydnophora exesa	0.00	0.00	-	0.36	4.06	C	0.24	2.62	C	0.00	0.00	-
Turbinaria peltata	0.14	1.83	C	0.00	0.00	-	0.12	1.31	C	0.38	5.36	C
Turbinaria reniformis	0.70	9.15	C	0.10	1.13	C	0.20	2.19	C	0.32	4.52	C
Acanthastrea hillae	0.00	0.00	-	0.00	0.00	-	0.05	0.55	U	0.42	5.93	C
Symphyllia radians	0.33	4.31	C	0.30	3.38	C	0.37	4.04	C	0.54	7.62	C
Favia favus	0.34	4.44	C	0.70	7.89	C	0.81	8.85	C	0.83	11.72	A
Favia speciosa	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.47	6.64	C
Favites complanata	0.00	0.00	-	0.70	7.89	C	0.55	6.01	C	0.19	2.68	C
Favites bestae	0.28	3.66	C	0.52	5.86	C	0.47	5.14	C	0.20	2.82	C
Goniastrea pectinata	0.00	0.00	-	0.46	5.19	C	0.58	6.34	C	0.45	6.35	C
Platygyra pini	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.25	3.53	C
Platygyra sinensis	0.00	0.00	-	0.35	3.89	C	0.79	8.63	C	0.50	7.06	C
Leptastrea purpurea	0.00	0.00	-	0.07	0.79	U	0.00	0.00	-	0.05	0.71	U
Cyphastrea serailia	0.20	2.61	C	0.89	10.03	A	0.88	9.62	C	0.33	4.71	C
Porites lutea	0.60	7.84	C	1.40	15.78	A	0.84	9.18	C	0.00	0.00	-
Porites lichen	0.86	11.24	A	0.65	7.33	C	0.72	7.87	C	0.00	0.00	-
Porites compressa	1.10	14.38	A	1.18	13.30	A	0.91	9.95	C	0.21	2.96	C
Goniopora minor	0.90	11.76	A	0.21	2.37	C	0.40	4.37	C	0.20	2.82	C
Goniopora stutchburyi	1.10	14.38	A	0.10	1.13	C	0.44	4.81	C	0.35	4.94	C
Polycyathus verrilli	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-

- = Not recorded, A = Abundant, U = Uncommon, C = Common

Table 4.6: Average diversity indices for sub-sites.

Sub-sites	S	N	D	H	1-D	e^H/S	M	J
S1	7.4	153	0.19312	1.7902	0.80688	0.84478	1.26862	0.91542
S2	8.4	177.4	0.156	1.9782	0.844	0.86652	1.4654	0.93184
S3	7.4	183	0.24186	1.70028	0.75814	0.8101	1.22986	0.86892
S4	7	141.666	0.2012	1.764	0.7988	0.8535	1.21828	0.91308

S = Taxa, **N** = Individuals, **D** = Dominance, **H** = Shannon, **1-D** = Simpson, **E^H/S** = Evenness, **M** = Margalef, **J** = Equitability

4.6 HEALTH STATUS:

A few forms of abnormal condition of hard corals were observed in hard corals of Narara reef. These were bleaching, sedimentation, coral diseases and polychaete infestation (Dave and Mankodi, 2009b).

4.6.1 BLEACHING:

During the study period no significant bleaching of hard corals was observed on Narara reef. Generally sporadic, very small scale (affecting a few colonies) partial bleaching was seen during summers in *Siderastrea, Hydnophora, Favia, Favites* and *Goniastrea.* Typically all the affected colonies were bleached near to the top surface which is irradiated maximum during low tides. During June 2008 majority of *Goniopora spp.* colonies were found moderately bleached in sub-site S1 (Plate 4.8 a). However, no information on their recovery or mortality could be recorded as the sub-site is infrequently visited due to difficulties to get permission from jetty security.

4.6.2 SEDIMENTATION/SILTATION:

Narara reef receives no major river runoff in vicinity. Therefore, whatever sedimentation load it experiences might be because of port related activities. Here the sedimentation rate was not quantified using sediment traps as any such structures (traps) on intertidal area might get disturbed or removed by local fishermen. Therefore, only visual observation of coral patches was carried out and concluded qualitatively in this study i.e. degraded condition (sediment cover) of coral patches which apparently seemed to be matter of recent history. Large patches of *Montipora*

and heterogenic assemblage chiefly comprising of *S. radians, T. reniformis* were found victimized by smothering due to sedimentation in sub-sites S1 in June 2008 (Plate 4.8 b, c). Similar condition was also found in sub-site S4, there the main victims were *S. radians* colonies (Plate 4.8 d). No apparent changes in sediment cover were observed in sub-sites S2, S3 and S5 during the study period.

4.6.3 CORAL DISEASES:

Two kind of hard coral disease prevalence was recorded in *Porites* corals from Narara reef during the study. Similar kind of high susceptibility of *Porites* for diseases have also been seen in other Indian reefs also (Thinesh *et al.*, 2009).

White Plague:

In this coral disease, part of colony losses pigments due to bacterial infection. In Narara *Porites* colonies were found with one or two white round patches of varied size (Plate 4.8 e, f). The disease was recorded in total 07 colonies of *Porites lutea*, 04 in sub-site S3, followed by 02 in S2 and 01 in S4 (Table 4.7).

Pink Line Syndrome (PLS):

Pink Line Syndrome is a diseased state of hard coral species *Porites lutea.* The disease is characterized by a thin pink colored line of about 1mm width encircling dead scares on *P. lutea* colonies, with the advancement of the disease it leaves dead skeleton behind. The disease may be induces by number of factors including cyanobacterial pathogen, excess nutrients, elevated temperatures and pollutions (Ravindran and Raghukumar, 2002; Ravindran and Raghukumar, 2006a; Ravindran *et al.*, 2001).

Though the PLS was observed in *P. lutea* population on Narara reef during this study, only a few colonies were observed affected by PLS from sub-sites S2 and S3 (Table 4.8). The PLS affected *P. lutea* colonies were geo-tagged using handheld GPS receiver. Subsequent monthly monitoring of the affected colonies revealed no further progress of the disease with dead scares evident of previous infection by the disease (Plate 4.9 a, b). This fact suggests that such disease might be a seasonal phenomenon, co-occurring

with higher water temperatures in summers. No information on coral diseases is available so far from GoK reefs except this reporting.

Table 4.7: Details of White Plague affected colonies of *Porites lutea* observed on Narara reef.

Sub-site	Month	No. of colonies	GPS locations
S2	March, 2008	1	No data available
	February, 2009	1	Lat. 22°28'22.01592"N Long. 69°41'57.48302"E
S3	October, 2008	2	Lat. 22°29'49.19078"N Long. 69°44'46.29743"E Lat. 22°29'49.11324"N Long. 69°44'44.66710"E
	January, 2009	1	No data available
	April, 2010	1	No data available
S4	December, 2008	1	Lat. 22°28'45.02305"N Long. 69°44'17.87546"E

Table 4.8: Details of Pink Line Syndrome affected colonies of *Porites spp.* observed on Narara reef.

Sub-site	Month	No. of colonies	GPS locations
S2	March, 2009	1	Lat. 22°28'31.32275"N Long. 69°42'02.18757"E
	April, 2009	2	Lat. 22°28'19.17858"N Long. 69°41'51.72776"E Lat. 22°28'31.20748"N Long. 69°42'02.19632"E
	June, 2009	1	Lat. 22°28'32.76632"N Long. 69°42'07.07469"E
	September, 2009	2	Lat. 22°28'34.02521"N Long. 69°42'14.11237"E Lat. 22°28'33.92533"N Long. 69°42'14.69715"E
S3	April, 2009	2	Lat. 22°29'17.34574"N Long. 69°43'15.98982"E Lat. 22°29'17.92358"N Long. 69°43'15.85977"E
	April, 2010	3	Lat. 22°29'17.67796"N Long. 69°43'15.59966"E

4.6.4 POLYCHAETE INFESTATION:

The many hard coral species were reported as vulnerable to be infested by burrowing form of polychaete (Randall and Eldredge, 1976). *Millepora, Montipora, Cyphastrea, Porites* and *Echinopora* were known to respond with structural deformities when infected by burrowing polychaetes (Lewis, 1998; Liu and Hsieh, 2000; Wielgus *et al.*, 2002). Generally more number of polychaete infestations per unit area are indicative of pollution load in the reef ecosystem (Brock and Brock, 1977).

In Narara reef, two genera *Montipora* and *Porites* were common to be observed with burrowing polychaetes' infestation in sub-sites S2 and S3 (Plate 4.9 c, d). According to Mr. M. I. Patel, well-known coral worker from Gujarat, it is key characteristic of *P. compressa* species to have associated burrowing tube worms opening at the apex of each nodule. However, *Montipora* was the preferred genus over *Porites* and number of polychaete tubes was also high in *Montipora* (Fig. 4.4 and 4.5). The infestation was more severe in *Montipora* in sub-site S3. Apart from these three, *Leptastrea purpurea* and *Symphyllia radians* were also observed infested with polychaetes rarely in sub-site S4 (Plate 4.9 e, f).

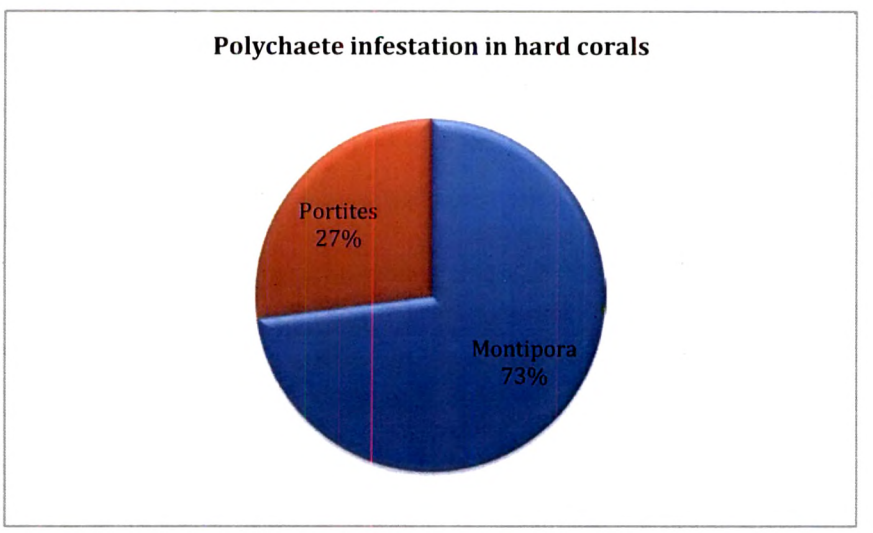


Fig. 4.4 Genera preference of burrowing polychaetes in sub-sites S2 and S3.

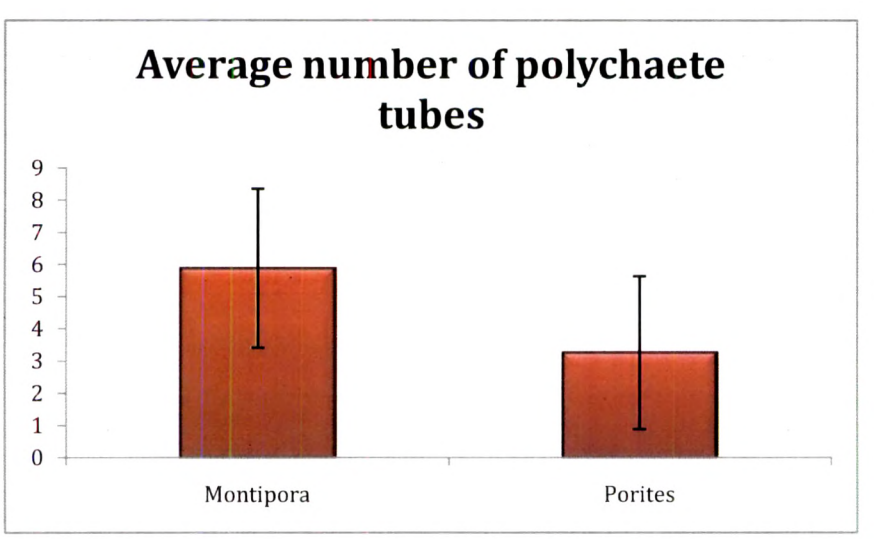
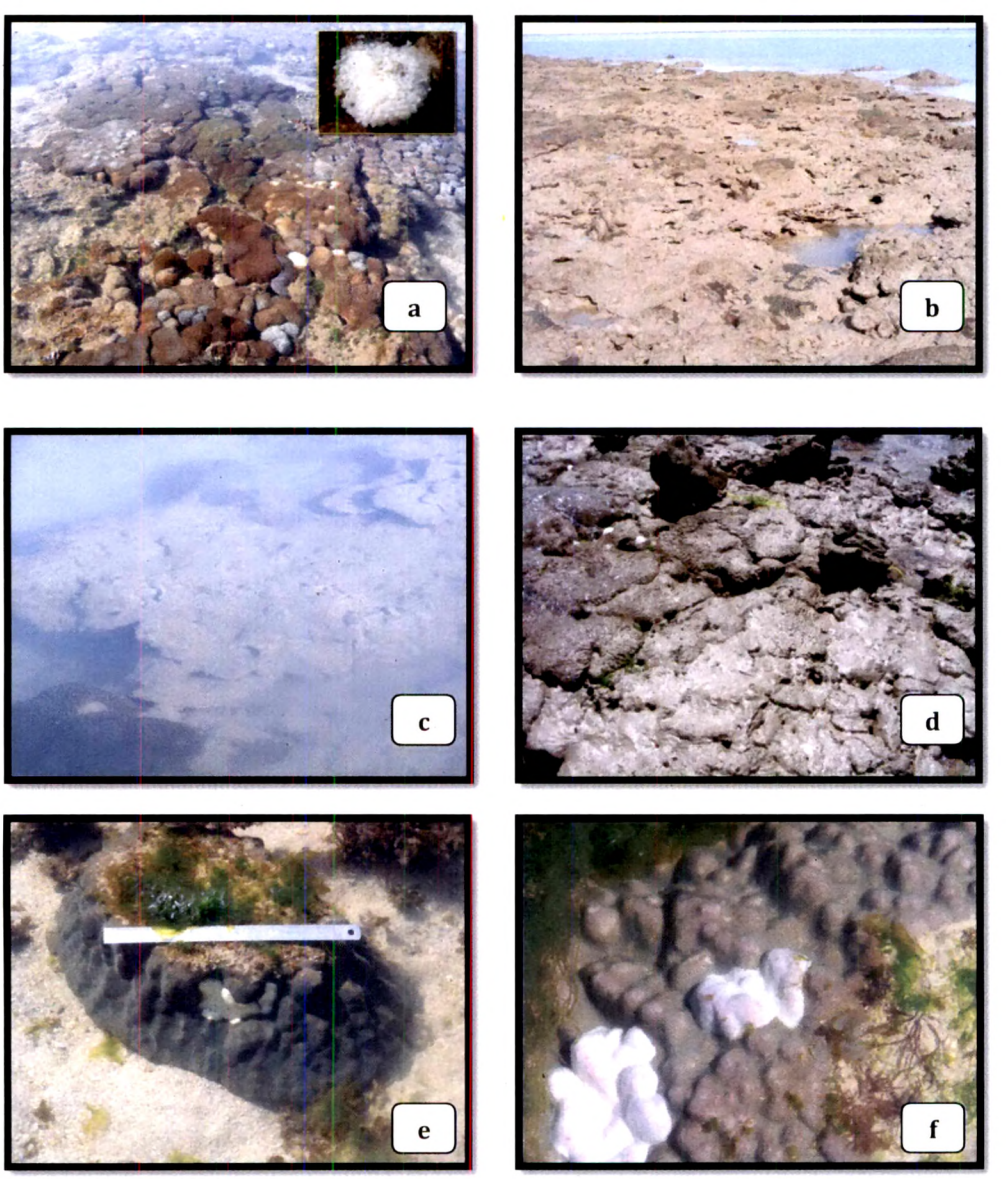


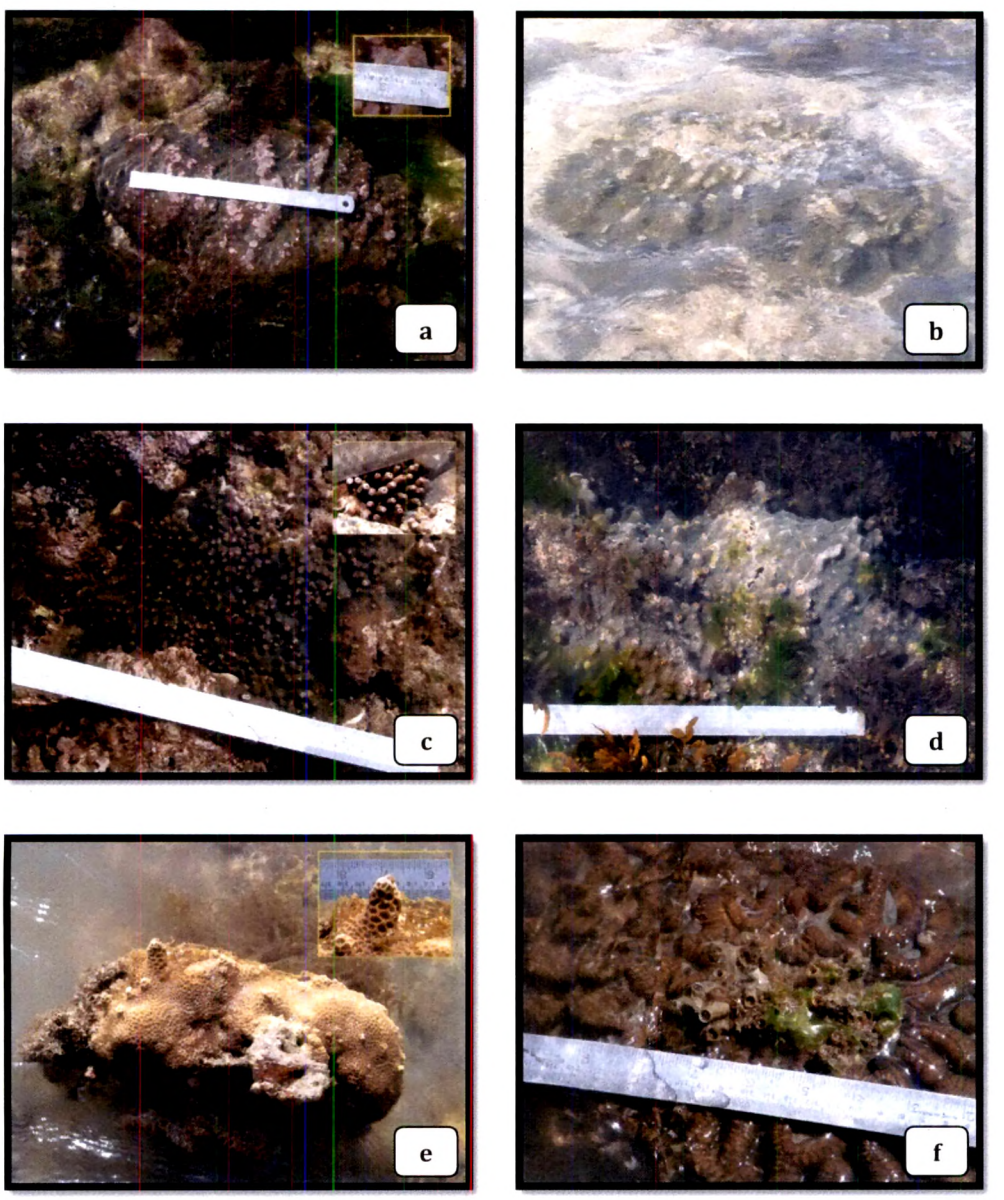
Fig. 4.5: Average number of burrowing polychaetes per 3 inch^2 area.

Plate: 4. 8



(a) *Goniopora spp.* with moderate scale bleaching at sub-site S1 **(b, c)** hard coral colonies buried under sediments at sub-site S1, **(d)** hard coral colonies (majority were *S. radians*) buried under sediments at sub-site S4, **(e, f)** *Porites spp.* with white plague.

Plate: 4. 9



(a) *P. lutea* severely affected by PLS, progressive pink line is of 1mm width (inset), **(b)** *P. lutea* survived of PLS, **(c)** *M. explanata* severely infested by polychaetes, **(d)** *P. lutea*, **(e)** *L. purpurea* and **(f)** *S. radians* infested with polychaetes.