CHAPTER 5: REEF ASSOCIATED FAUNA AND FLORA

Introduction

Methodology

Associated fauna

Associated flora

Interrelationship

5.1 INTRODUCTION:

The coral reefs are the most cryptic habitat providing suitable shelter to thousands of animals and plants. The life forms inhabiting reefs are part of a complex food web. In the reef environment prey-predatory relationships are common and more complex than any other ecosystems. Alteration in diversity at varied trophic level leads to serious alterations in food web of the ecosystem (Bruno and O'Connor, 2005). However, to study the integrity of associated fauna and flora with the corals is a mammoth task and requires inputs from knowledge bearers of varied fields. Considering the limits of this study here an attempt is made to study associated fauna and flora in terms of diversity and their distribution on the Narara reef. During the study a few interrelationships among the animals were also enlisted.

5.2 METHODOLOGY:

During the field visits, macro fauna other than hard corals (scleractinians) and sea weeds were recorded for their occurrence and distribution. The organisms sighted directly following random track in the reef area (mangroves and high tidal mudflat habitats were not considered for associated fauna and flora) were considered in the study, the small rocks were dislodged at random to record underneath organisms. Majority of the invertebrate life forms require close examination of their morphology and anatomy for taxonomic identification. However, during this study no specimens alive or dead were collected from field for identification and any other studies from the reef area. Therefore, the organisms were identified up to genus or species *in situ* wherever possible; in the case where organisms could not be identified, the same were photographed for further confirmation by comparing with standard photographic guides. The organisms for which species cannot be ascertained through photographs (e.g. sponges) were considered as group. Most of the associated fauna inhabit under the rocks in the crevices which makes the surveys difficult, therefore, quantification was done only for a few faunal groups. Any associations or interdependence between organisms were also recorded and photographed.

5.3 ASSOCIATED FAUNA:

All together 11 animal phyla were represented during this study namely Porifera, Cnidaria, Annelida, Platyhelminthus, Nemertea, Arthropoda, Mollusca, Echinodermata, Echiura and Chordata covering total 132 species of associated fauna (Table 5.1).

Table 5.1: List of groups of associated fauna recorded from Narara reef.

Sr. No.	Phylum/ Group	No. of species
1	Sponges	39*
2	Cnidarians	14
3	Annelids	06
4	Molluscs	42
5	Arthropods	16
6	Flat worms	01
7	Nemertea	01
8	Echiura	01
9	Echinoderms	07
10	Pisces	04
11	Urochordates	01
	Total	132

* (Singh *et al.*, 2004)

Out of the above listed associated fauna Sea anemones, Coralimorpharians, Octopuses, Puffer fishes and Bonellia worm were studied in detail for their distribution and abundance.

5.3.1 SPONGES (PHYLUM: PORIFERA):

Sponges are brightly colored organisms (Plate 5.1 a, b). The sponges are among the prime competitors of the scleractinians for the space. The burrowing sponges can overgrow the live coral colonies and can significantly damage the hosts. In Narara, majority of the sponges observed were of encrusting forms growing under the rocks in all the sub-sites except S5 as this sub-site is predominated by mud deposition and lacks firm suitable substratum. Though in this study the sponges were dealt as a group, earlier study reported 39 species of sponges (Singh *et al.*, 2004) from Narara reef. during present study it was revealed that sponges dominate (84%) the biotic communities found underside of rocks and boulders (Fig. 5.1, Plate: 5.1 c).

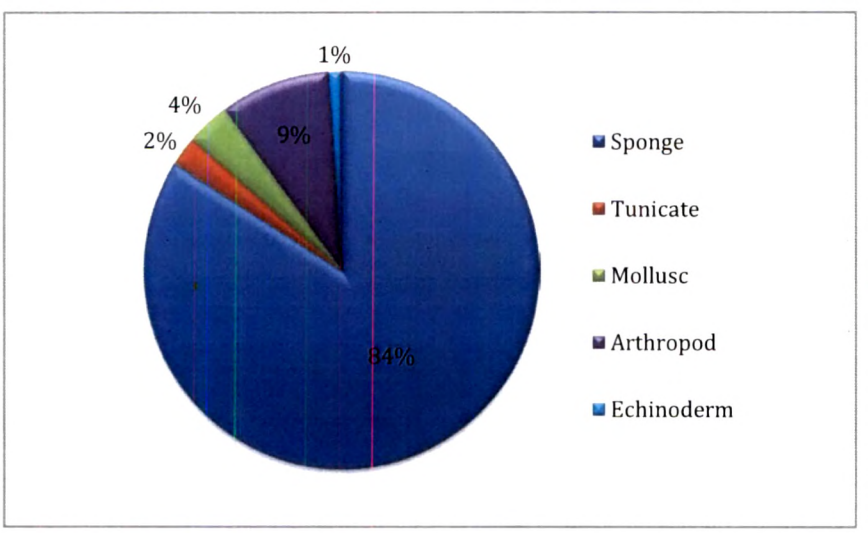
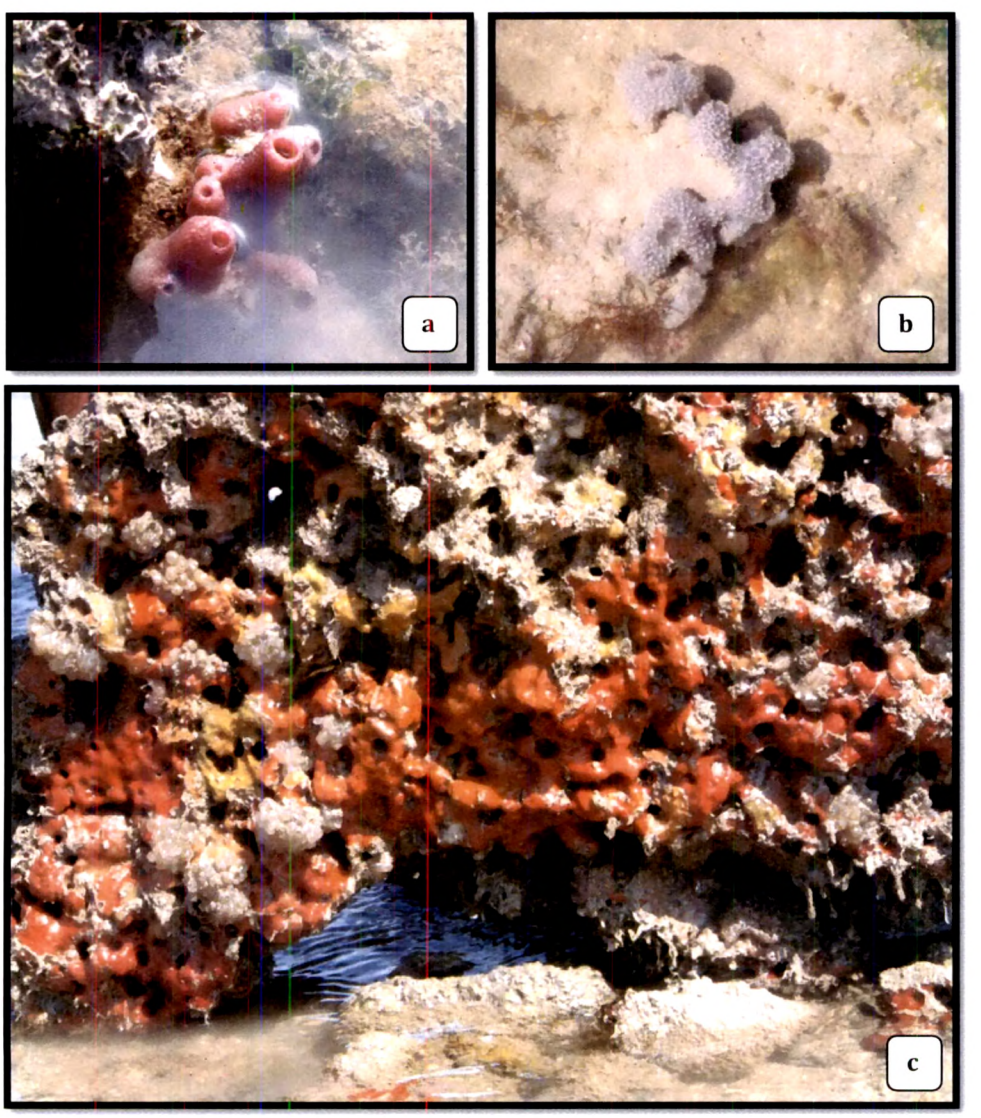


Fig. 5.1: Faunal Assemblage under rocks and boulders.

Plate: 5.1



(a, b) sponges in sandy bottom, **(c)** typical biotic community dominated by sponges underneath rocks.

5.3.2 CNIDARIANS (PHYLUM: CNIDARIA):

The cnidarians are among the conspicuous animals in reef environment. In Narara reef, except jellyfishes and *Porpita sp.* all the cnidarians were sessile forms; 4 species of Zoantherians, 4 species of Actiniarians, 1 species of Ceriantherians, 1 species of Coralimorpharians and 2 species of Alcyonarian were recorded (Table 5.2).

Table 5.2: List of cnidarian species recorded from Narara reef and their distribution.

Sr. No.	Species	Common Name	Sub-sites				
			S1	S2	S3	S4	S5
1	*Jellyfish*	Jellyfish	+	+	+	+	
2	*Porpita sp.*	Blue button		+			
3	*Stichodactyla gigantea*	Giant Sea anemone	+	+	+	+	+
4	*Stichodactyla haddoni*	Giant Sea anemone	+	+	+	+	+
5	*Parapsita ratiata*	Sea anemone		+			
6	*Heteractis sp.*	Sea anemone	+	+	+	+	+
7	*Cerianthus sp.*	Tube anemone			+	+	
8	*Rhodactis sp.*	Corallimorpharian	+	+	+	+	+
9	*Zoanthus sp.*	Zoanthus (green)	+	+	+	+	+
10	*Zoanthus sp.*	Zoanthus (orange)	+	+	+	+	+
11	*Zoanthus sp.*	Zoanthus (green mouth)				+	+
12	*Palythoa tuberculosa*	Zoanthus		+		+	
13	*Lobophytum sp.*	Soft coral	+	+		+	
14	*Unidentified sp.*	Soft coral		+	+		

As the study was carried out during low tides, pelagic cnidarians like jellyfishes and Porpita (Plate: 5.2 a, b) were recorded occasionally. However, during the month of April, 2008 large numbers of jellyfishes were observed during low tide, but that was not repeated in the following year suggesting it a non cyclic phenomenon. Such proliferation of jellyfish population is reported to coincide with increased water temperature or any alteration in water chemistry (Mills, 2001; Purcell, 2005). Therefore, it might be an indication of something unusual during April, 2008.

The members of order Actiniaria were represented by 04 species belonging to 03 genera i.e. *Stichodactyla gigantea, S. haddoni, Heteractis sp.* and *Parapsita ratiata* were recorded from all the sub-sites (Plate: 5.2 c, d, e and f). *Heteractis sp.* dominated in number of individual recorded (Fig. 5.2). Sporadic bleaching in *Stichodactyla spp. and Heteractis sp.* following monsoon was observed through out reef area (Plate: 5.5 b, c). However, smothering of *Heteractis sp.* due to excess sediments were more encountered in sub-site S4 (Plate: 5.5 d).

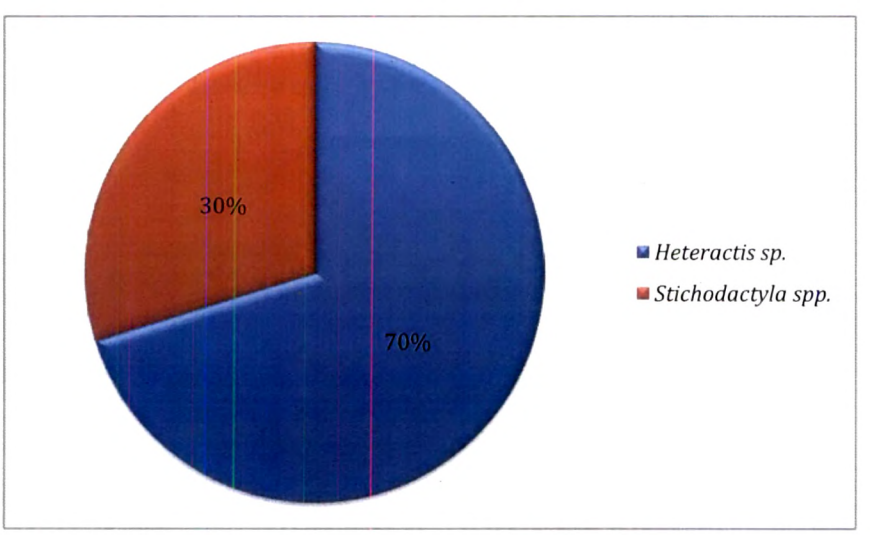


Fig. 5.2: Population comparison of two sea anemone species *Hateractis s*p. and *Stichodactylia spp.*

The order Ceriantharia was represented by only one member of genus *Cerianthus.* The *Cerianthus sp.* was observed to occupy sandy substratum rather than mud covered with sand (Plate: 5.3 a). The species was recorded from sub-sites S3 and S4 with very infrequent sighting during present study.

Plate: 5.2

(a) Jellyfish, **(b)** *Porpita sp.*, **(c)** *Stichodactyla gigantea*, **(d)** *Stichodactyla haddoni*, **(e)** *Heteractis sp.* **(f)** *Parapsita ratiata.*

A new record of distribution range of *Rhodactis sp.* (Class: Anthozoa, Order: Corallimorpharia) from Gulf of Kachchh is reported for the first time here in this study. There is no much information available on the occurrence and distribution of the taxa from the Indian water except a record of *Rhodactis rhodostoma* (Hemprich and Ehrenberg in Ehrenberg, 1834) (synonym: *Discosoma rhodostoma*) from Gulf of Mannar (Fautin, 2010). During this study, occurrence of the corallimorpharian species was recorded from Narara reef, however, its distribution was also recorded from other places in GoK e.g. Kalubhar Island and Pirotan Island by the author.

The corallimorpharians resembles true corals because of their colonial habit. Phylogenetically they are placed between the actiniarians and scleractinians but they are closer to the sea anemones (actiniarians).

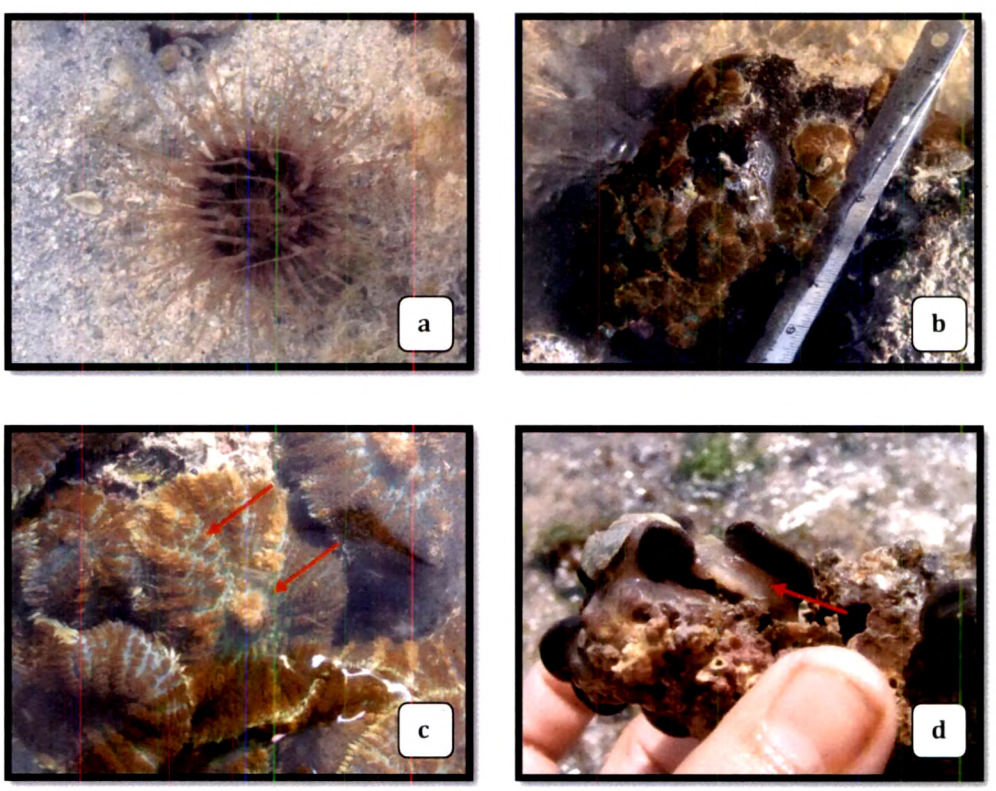
Description of Rhodactis sp. specimen (based on in situ observations):

> Colonial. Lack of exoskeleton unlike scleractinians. Short column attached to hard substratum with base and on the other end wider oral disc (25-30 mm in diameter) is present. The mouth is characteristically exerted in the center on the oral disk which differs from the introvert mouth found in sea anemones. Tentacles are short and arranged in row radiating from the center, alternate marginal tentacles are bit longer. Dark greenish in color (Plate: 5.3 b, c and d).

In Narara reef, corallimorpharian's distribution was recorded in sub-sites S1, S2, S3 and S4. They were found in colonies in water lodged areas of reef flat and reef edge in sandy substratum or over the small rocks in Narara.

Worldwide, corallimorpharians were studied for their aggressive role in interspecific competition, and can defeat other members of class Anthozoa (Chadwick, 1987; Langmead and Chadwick-Furman, 1999a; Langmead and Chadwick-Furman, 1999b; Work *et al.*, 2008). Unfortunately, no such studies are done in India.

Plate: 5.3



(a) *Cerianthus sp.*, **(b)** Corallimorphaian – *Rhodactis sp.*, colonial assemblage **(c)** *Rhodactis sp.* - exerted mouth and arrangement of tentacles in radiating rows, **(d)** *Rhodactis sp.* - short column.

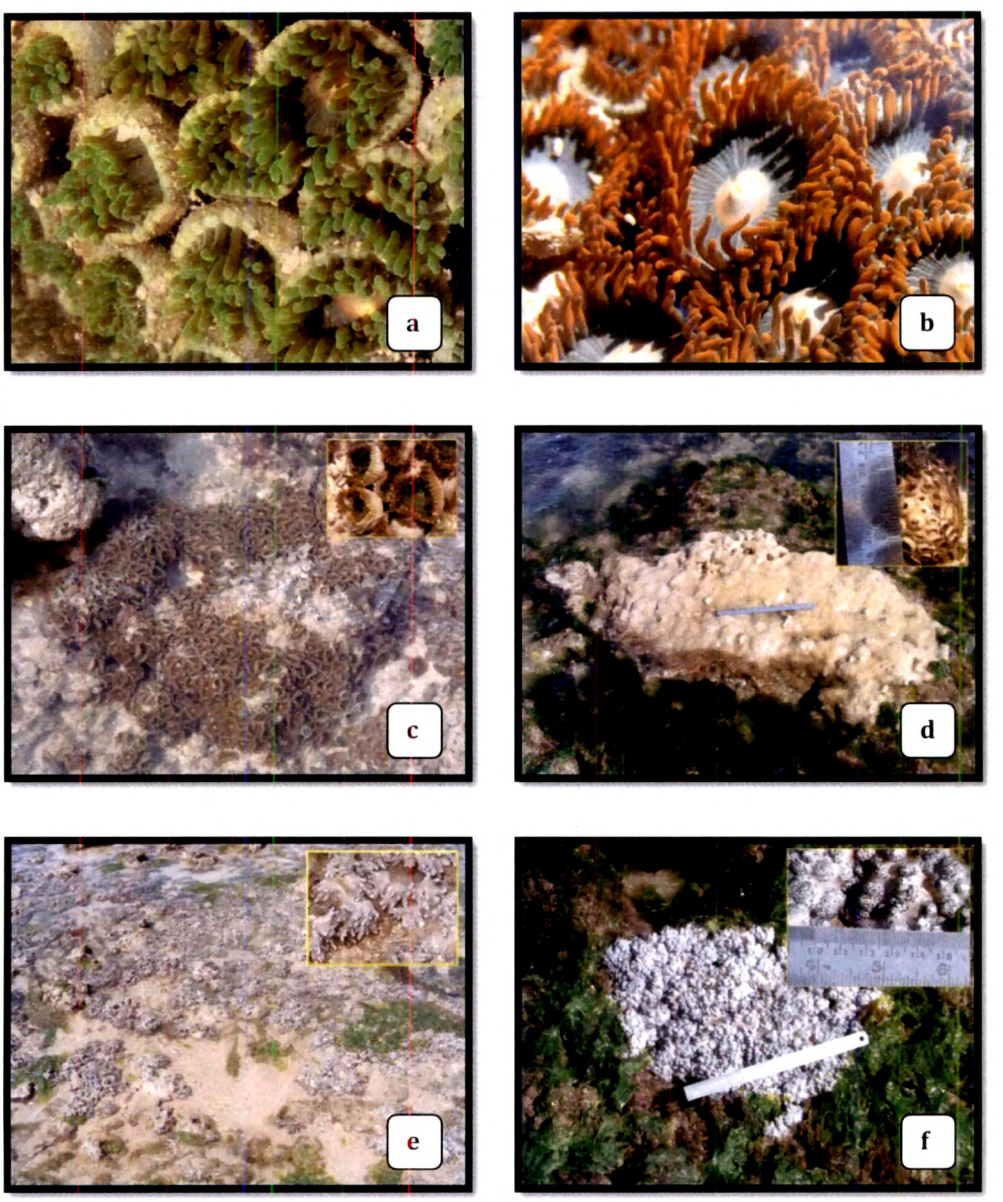
The members of order Zoantheria, commonly known as zoanthus, are colonial animals resembling small sea anemones; however, they are attached with each other through a stolon. In Narara 04 species of zoanthus were recorded 03 belonging to genus *Zoanthus* and 01 of *Palythoa*. The *Zoanthus spp.* (Green Zoanthus, Orange Zoanthus and Green Mouth Zoanthus) were recorded from all the sub-sites, with predominating sub-site S5 (Plate: 5.5 a). About 100-150 m broad belt parallel to LTL (50-75 m above LTL) is formed by luxuriant growth of the zoantherians on the sub-site S5. The assemblage in the belt was dominated by green zoanthus whereas, the creeks at the end of intertidal were dominated by larger green mouth zoanthus. During the low tides, the intertidal of this sub-site retains very shallow but less turbid waters merely not more than average 10-15 cm deep. Such clear water is more suitable to zoanthids with smaller polyps. The water-mass gets its way to the sea during low tides through the creeks hence high turbidity is a common phenomenon in the lower end of the intertidal. Thus domination of larger sized green mouth zoanthids in the creeks is apparent as they can easily cope up with the sediment load.

The *Palythoa tuberculosa* was only recorded from sub-sites S1, S2 and S4. Their distribution was sparse but covering large patch of substratum in sub-site S4.

Apart from hexacorallians, two species belonging to sub-class Octacorallia (class: Anthozoa) were also recorded. Octacoralls/Alcyonarians are generally known as soft corals as they lack hard exoskeleton unlike scleractinians. The soft corals do not contribute in reef formation, but they can withstand more turbid waters and nutrient reach reef environment.

The distribution of soft coral *Lobophytm pauciflorum* (Plate: 5.4 e) was found only in sub-sites S1, S2 and S4. One more unidentified species of soft coral (Plate: 5.4 f) was observed in sub-site S2. Except sub-site S1, the distribution of *L. pauciflorum* was recorded sparse and in small patches.

Plate: 5.4



(a, b, c) Zoanthus spp., **(d)** *Palythoa tuberculosa*, inset: closer view of polyps, **(e)** *Lobophytm pauciflorum*, inset: closer view of branches, **(f)** unidentified soft coral sp. from S2.

Plate: 5.5

(a) Zoanthus dominated sub-site S5, **(b, c)** sporadic bleaching in sea anemones, **(d)** smothered *Heteractis* sp. in sub-site S4.

5.3.3 ANNELIDS (PHYLUM: ANNELIDA):

During the study total 06 different species of annelids were recorded. However, it was not possible to identify the annelids without examining the specimens; they are referred with common names as per table 5.3.

Table 5.3: Conspicuous annelid fauna recorded from Narara reef.

Sr. No	Species/common name	Distribution		
		Upper	Middle	Lower
1	*Sabellastarte indica*		+	
2	*Sabella sp*			+
3	*Decorative worm*	+		
4	*Serpulid worms*		+	+
5	*bristle worm*			+
6	*sand worm*	+	+	
7	*marine leach*			+

Tube worms:

Sabellids worms:

The worms are popular as Peacock worm or feather duster worm. In Narara total 02 different kinds of sabellids were recorded. Out of them *Sabellastarte indica* (Plate: 5.6 a) was found to prefer sandy substratum of middle intertidal area. They were more abundant on sub-site S4 than the other sub-sites. This might be because of vast middle intertidal area with sandy substratum. 10-15 tubes of the worm in one meter square area were frequent in sub-site S4.

Another sabellid worm (Plate: 5.6 b) could not be identified. Totally different from the *S. indica*, these worms were always recorded in the live coral colonies (Plate: 5.6 c). However, no preference for coral species could be derived.

Decorative worms:

These worms were common in mud deposited shores. They use bivalve shells to strengthen their tubes; hence, they were given the terms "Decorative worms" (Plate: 5.6 d). These worms were abundant in high tidal mudflats in sub-sites S2 and S3.

Serpulid worms:

These tube dwelling worms differ from the sabellid worms based on tubes they made. The tubes of serpulid worms are calcareous and hard rather than soft tubes of sabellids (Plate 5.5 e). The tubes of serpulid worms were more in sub-site S2, on the rocks with fine layer of silt in the middle intertidal area. These worms were observed to capture tiny preys with mucus threads extended in water. However, going towards lower intertidal area their abundance was recorded to increase. The rocks in near LTL were compactly covered with numerous tubes of serpulids in sub-site S2 (Plate 5.6 f)

Free moving worms:

Bristle worms:

The worms also known as fire worms (Plate: 5.7 a) as a slight touch to their bristles can induce severe burning sensation. These worms were only recorded in the lower intertidal area, common to all sub-sites, moving into crevices and underneath of rocks and live coral colonies. They were less sighted because of obscure living habit.

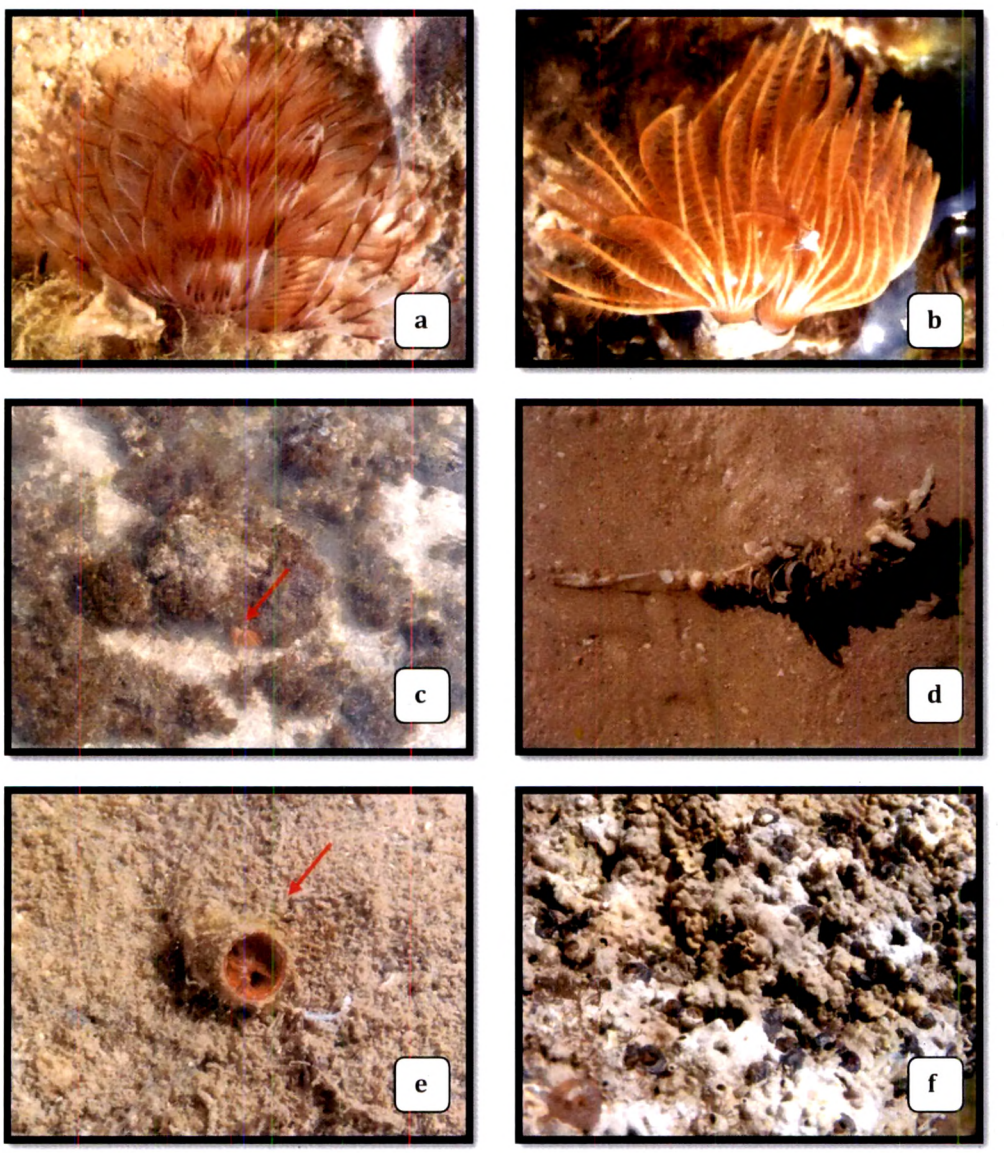
Sand worms (Nereis):

These worms were recorded from the sandy substratum of upper and middle intertidal area intertidal (Plate: 5.7 b). As the case with bristle worms they were also less sighted during study period.

Marine leach:

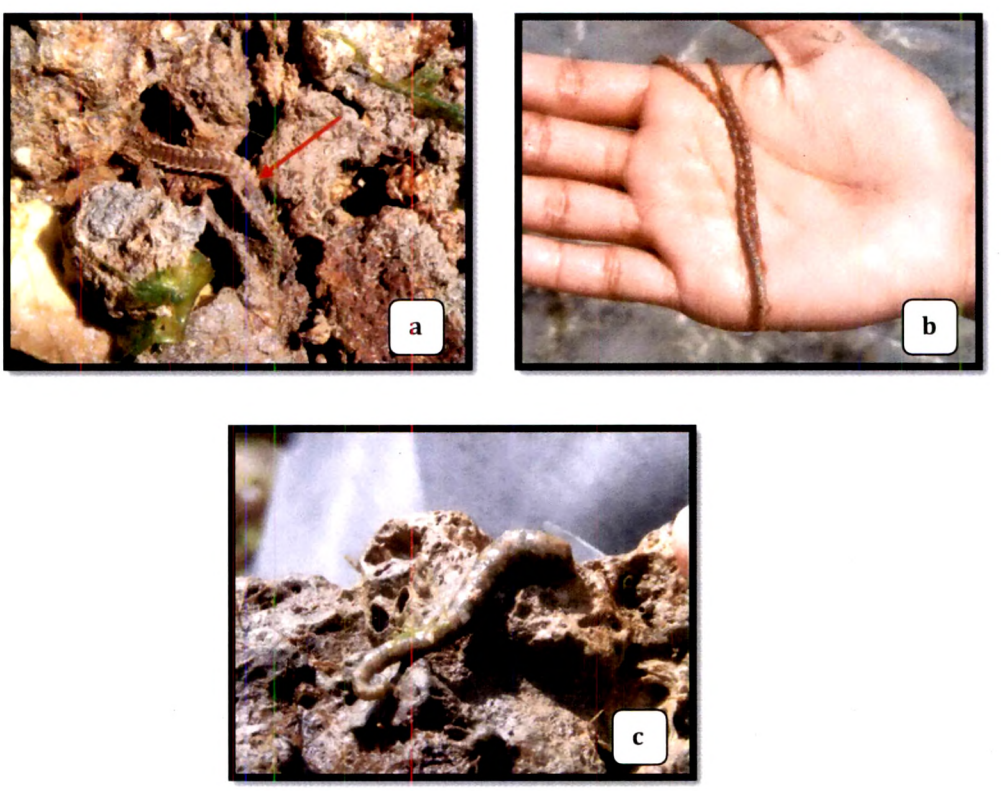
Only one time during study period 3 individuals of marine leach were observed attached on the side of rocks in lower intertidal area of sub-sites S3 (Plate: 5.7 c).

Plate: 5.6



(a) *Sabellastarte indica* in the sandy substratum, **(b)** Sabellid worm, **(c)** Sabellid worm with live coral colony, **(d)** Decorative worm (with tube) in mudflat, **(e)** tube of serpulid worm, **(f)** numerous tubes of serpulid worms on rocks/boulders.

Plate: 5.7



(a) bristle worm, **(b)** sand worm, **(c)** marine leach.

5.3.4 MOLLUSCS (PHYLUM: MOLLUSCA):

Molluscans form a highly diverse group among the reef associated fauna. They are present in the beach sand, under the rocks, moving over the sediments and pelagic ones like octopuses and squids. They have adopted to various food habits i.e. herbivores, scavengers, predators etc. and can occupy every micro habitat.

During this study total 42 molluscan species were recorded out of which 09 were bivalves, 32 gastropods and 01 of cephalopods and scaphopods each. The distribution of the some of the molluscan fauna was observed to be restricted (Table 5.4). However, no much detail could be collected for sub-site S1.

Species like *C. cultellus, Cerithium spp., D. lima, M. blanda, Nassarius spp., Natica spp., T. telescopium, U. vestiarium* were limited to upper intertidal zone only. Whereas, *C. flavum, A. plicata, C. dracaena, M. brunneus, P. flava, S. ungulis, S. phymotis, T. radiates, T. coronatus, D. fragilis, H. infucata* and *M. viridis* were limited to middle intertidal zone. The lower intertidal zone was inhabited by *P. crassicostatus, Aplysia sp., A. semicostata, B. granularis, Cantharus spp., D. konkanensis, N. undata, P. rubigenosa, T. pyrum* (observed one time only), *T. coronatus, B. stellifer* and *O. verruculatum.*

Octopus vulgaris is one of the tourist attractions in MNP & S because of its mysterious morphology and its ability to camouflage. Being pelagic in nature they were recorded from sub-sites S1, S2, S3 and S4 during low tides where they can swim freely in sufficiently deep tide-pools. No such tide-pools are in sub-site S5 thus, total absence except one sighting from the sub-site. The *O. vulgaris* were recorded in the mid and lower intertidal areas where they can take shelter under rocks and burrows in sandy bottom. This had also reflected in lesser individuals encountered from sub-site S4 (Fig. 5.3) as the mid intertidal area of this sub-site is comparatively flat and sand covered with lesser rocks which can serve as hide to the cephalopod.

Table 5.4: List of molluscan species recorded from Narara reef and their distribution.

Species	Sub-sites					Species	Sub-sites				
	S1	S2	S3	S4	S5		S1	S2	S3	S4	S5
Class: Bivalvia						*Nassarius reeveanus*				+	
Cardium flavum			+	+		*Natica maculosa*		+	+	+	
Cultellus cultellus						*Natica picta*		+	+	+	
Paphia malabarica						*Nerita undata*			+		
Pasmmobia radiata						*Polia rubigenosa*					
Pecten crassicostatus					+	*Pyrene flava*					+
Pinctada fucata			+	+		*Scutus ungulis*			+	+	+
Pinna bicolor			+	+		*Stomatia phymotis*			+		+
Sunetta sp						*Telescopium telescopium*					+
						Trochus radiatus			+		
Class: Gastropoda						*Turbinella pyrum*				+	
Angaria plicata				+		*Turbo coronatus*			+		
Aplysia sp.					+	*Umbonium vestiarium*		+	+	+	+
Astrea semicostata						**Nudibranchs**					
Bursa granularis					+	*Bornella stellifer*			+		
Cantharus spiralis			+	+	+	*Discodoris fragilis*			+		+
Cantharus undosus		+	+	+	+	*Hypselodoris infucata*			+	+	+
Cerithium spp.		+	+	+	+	*Melibe viridis*				+	
Cyprea caurica dracaena			+			*Onchidium verruculatum*		+	+	+	+
Diodora lima				+	+						
Drupa konkanensis			+	+		**Class: Cephalopoda**					
Mitrella blanda		+	+	+		*Octopus vulgaris*	+	+	+	+	+
Murex brunneus			+		+						
Nassarius distortus		+	+			**Class: Scaphopoda**					
Nassarius olivaceus		+				*Dentilium sp.*			+		

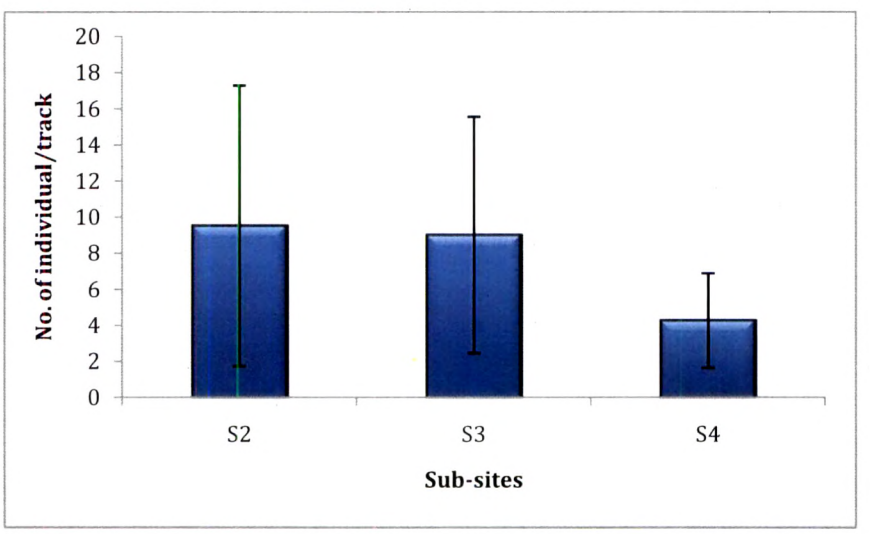


Fig. 5.3: Sub-site wise average of *O. vulgaris* encountered per visit on Narara reef.

Ecologically, the molluscans like *Nassarius spp.* who feed upon the detritus and dead remains of organisms help in removing the decaying organic material from the ecosystems. Whereas, grazer molluscs feed upon the micro/filamentous algae and act as micro controllers. Empty shells of *U. vestiarim*, popularly known as button shells, were observed to be occupied by hermit crabs extensively than the other shells. Empty shells of *P. bicolor* and *C. flavum* were found to be preferred by reef fishes for egg laying. However, in coral reef ecosystem some of the molluscs like *Drupa spp.* are known to feed upon the polyps of hard corals and are seen as biological threat (Edwards, 2010).

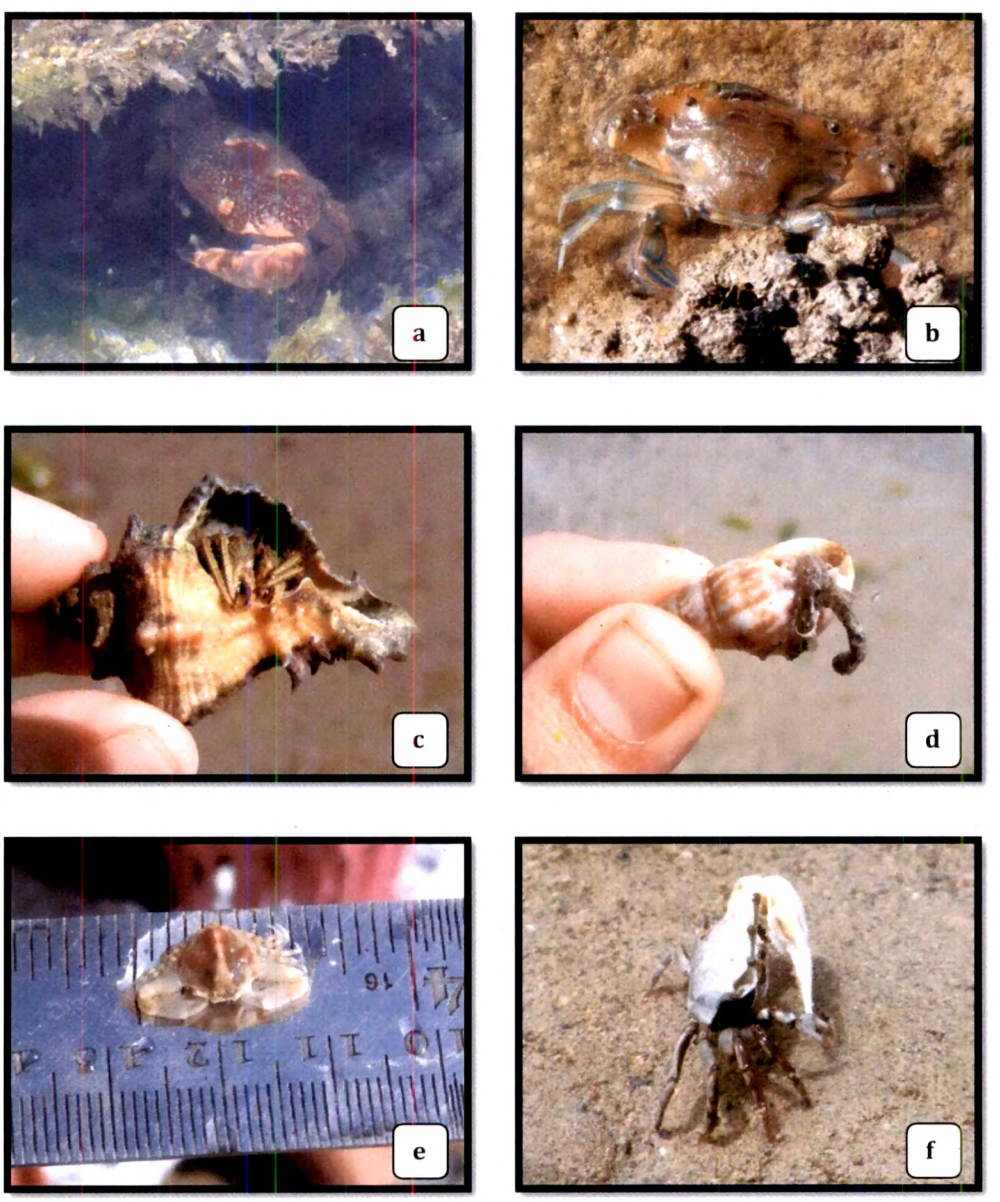
5.3.5 CRUSTACEANS:

Arthropods like isopods, amphipods and crustaceans are generally found abundant in reef environment. In this study, crustaceans which include in macro benthic associated fauna were considered for their diversity and distribution. All together 17 species of crustaceans (11 species of brachyuran crabs, 02 of anomuran crabs, 03 species of shrimps and 01 species of barnacle) were recorded from Narara reef area (Table 5.5 and Plate: 5.8, 5.9 and 5.10).

Table 5.5: Crustacean species recorded from Narara reef and their distribution on intertidal area.

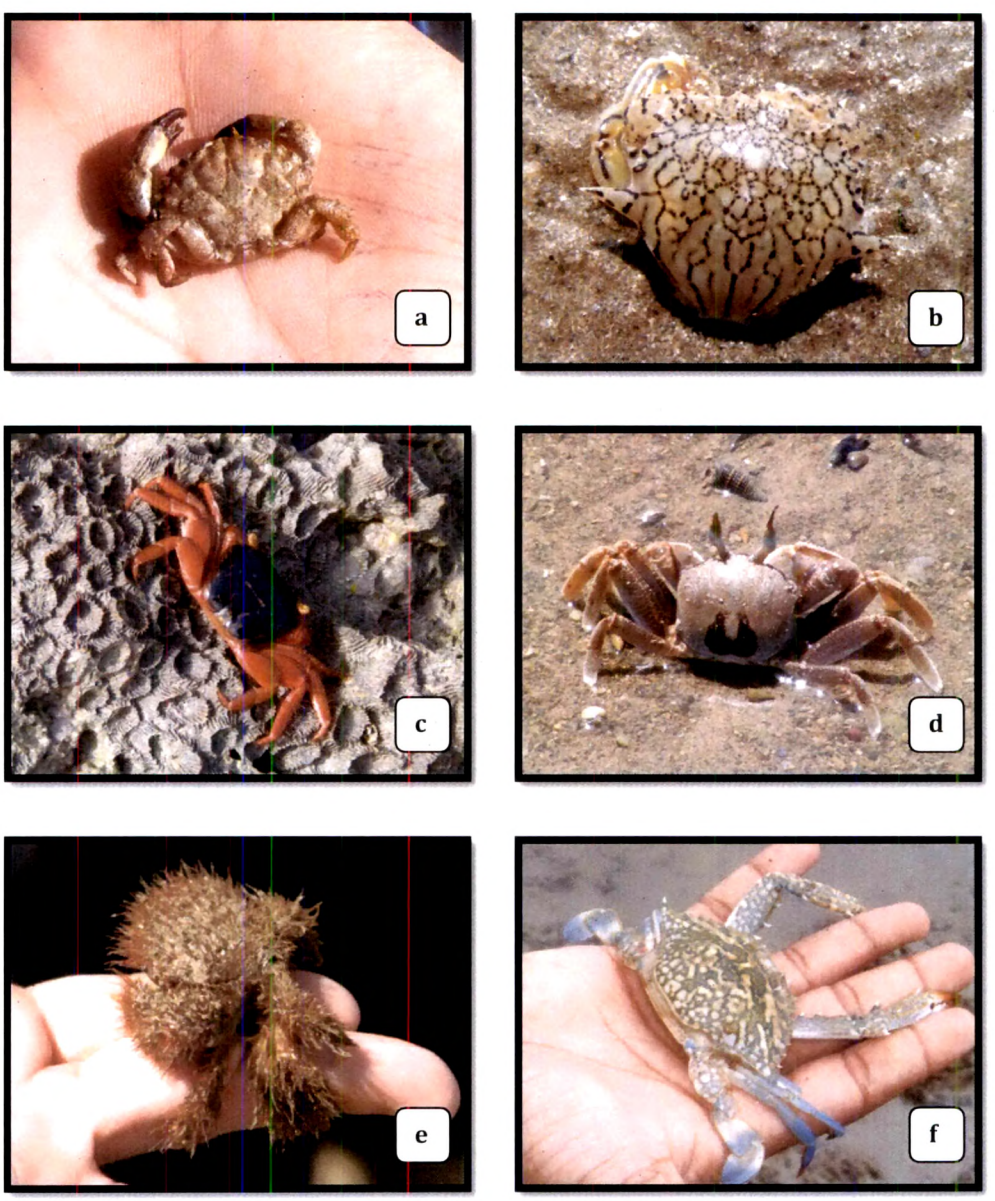
Sr. No	Species	Distribution		
		Upper	Middle	Lower
1	*Atergatis integerrimus*			+
2	*Scylla serrata*	+	+	
3	*Portunus pelagicus*	+	+	
4	*Uca sp.*	+		
5	*Matuta planipes*	+		
6	*Ocypode rotundata*	+		
7	*Pilumnus vespertilio*		+	+
8	*Leptodius euglyptus quadrispinous*	+		
9	*Charybdis sp.*		+	+
10	*Periclimenes brevicarpalis*		+	+
11	*Shrimp* (unidentified sp 1)		+	+
12	*Shrimp* (unidentified sp 2)		+	+
13	*Balanus sp.*	+		
14	*Clibanarius spp.*	+		
15	*Metopograpsus messor*		+	+
16	*Thalamita sp.*	+		

Plate: 5.8



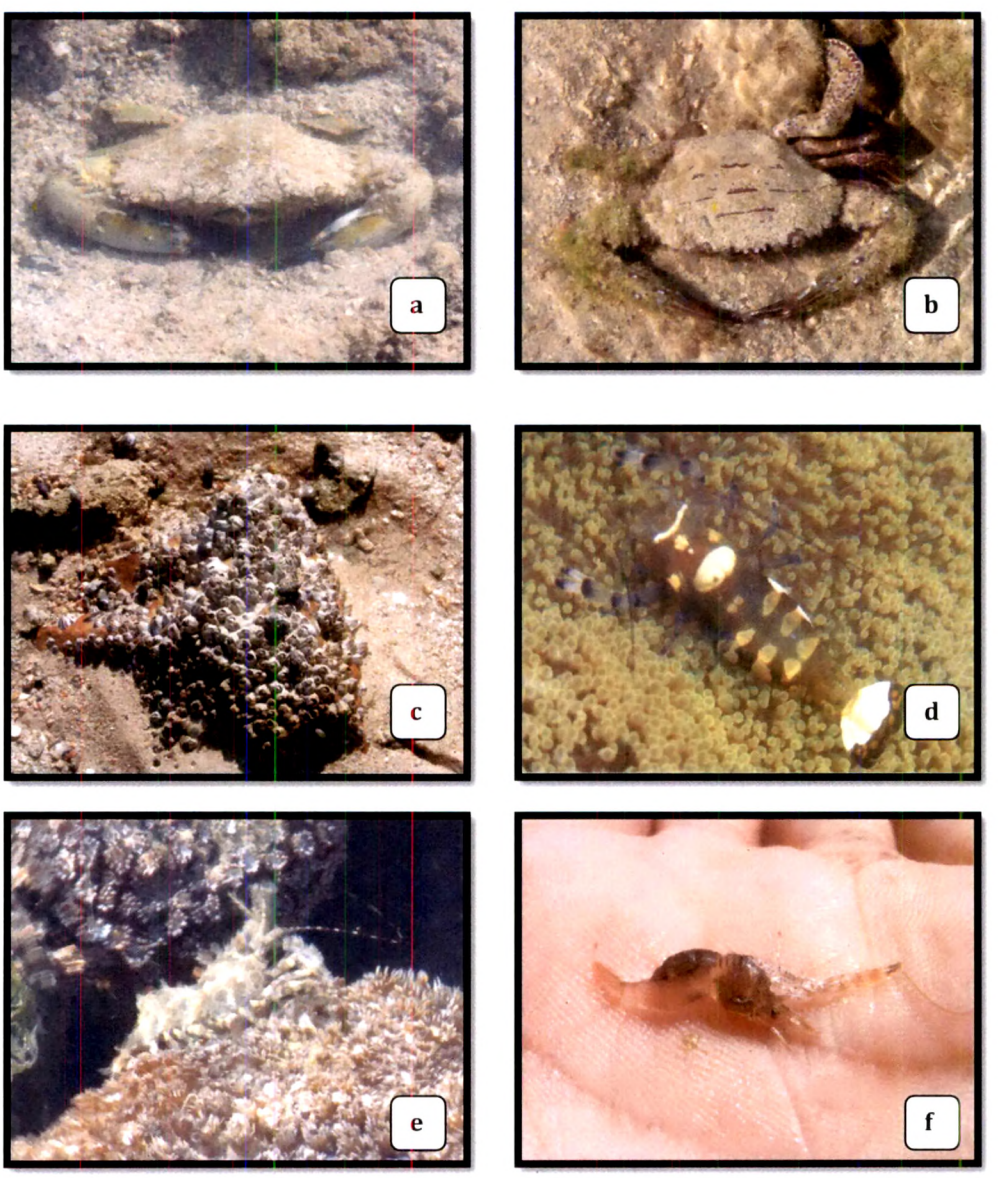
(a) *Atergatis integerrimus*, **(b)** *Charybdis sp.*, **(c, d)** *Clibanarius spp.*, **(e)** unidentified sp. of crab, **(f)** *Uca sp.*

Plate: 5.9



(a) *Leptodius euglyptus quadrispinous*, **(b)** *Matuta planipes*, **(c)** *Metopograpsus messor*, **(d)** *Ocypode rotundata*, **(e)** *Pilumnus vespertilio*, **(f)** *Portunus pelagicus.*

Plate: 5.10



(a) *Scylla serrata*, **(b)** *Thalamita sp.*, **(c)** *Balanus sp.*, **(d)** *Periclimenes brevicarpalis*, **(e, f)** unidentified shrimps.

5.3.6 ECHIURANS (PHYLUM: ECHIURA):

The echiurans, popularly known as "spoon worms" or "innkeeper worms", were represented by genus *Acanthobonellia* in Narara reef, the genus is represented by a few species worldwide. Earlier the species was reported as *Ikedella misakiensis* by (Gideon *et al.,* 1956; Gideon *et al.*, 1957) from Gulf of Kachchh. However, later on (Jose, 1964) studied the bonellid worm in detail and described it as a new species and named it *Acanthobonellia pirotanensis* because of its endemism to Pirotan Island of GoK. Subsequent studies reported distribution of the bonellid worm (erroneously identified as *Ikedella misakiensis*) from Paga reef, Bural reef, Pashu Island and Mithapur coast (Patel, 1976); Goose reef, Kalubhar Island and Chank Island (Pandey and Parasharya, 2007). During present study the *A. pirotanensis* (Plate 5.11 a) was found to occur on Narara reef, first time from mainland attached coral reef in GoK (Dave and Mankodi, 2008). Earlier during present study the echiuran was reported from sub-sites S1 and S4 only, but later on it was also found dwelling sub-site S3. It was invariably observed in the lower intertidal areas and areas below LTL up to knee deep waters. The fringe of the embayment (notch) in sub-site S4 was found to be the preferred habitat by the echiuran worms, on an average 20-30 individuals are likely to be sighted in the area anytime of the visit.

According to previous studies (Schembri and Jaccarini, 1978; Schembri, 1977), Bonellid worms cannot excavate burrow by their own, the worms occupy spaces within piles of boulders or take over abandoned burrows in the rock excavated by other animals. In sub-sites S1 and S4 nearly similar substratum was observed which was preferred by *A. pirotanensis* as their habitat. Not a single specimen was encountered from sub-sites S2, and S5 during observations.

In-spite of having similar substratum characteristics as of sub-site S4, sub-site S2 lacks the organism. This can be because of inability of the bonellids to cross the large sandy patches in-between inhabitable sites, once they settle down (Wilczynski, 1960). This type of substratum preference was also recorded for *B. viridis* (Berec *et al.*, 2005) which seem to prefer rock bordering sandy substrata, or rock with small pockets of sediment or covered by fine layers of silt.

The values of frequency of occurrence, density and abundance for sub-site S1 are 25%, 0.55/m^2 and 2.2 respectively, where as for sub-site S4 the values are 15%, 0.35/m^2 and 2.33 respectively. These data can be interpreted as the distribution of *A. pirotanensis* is patchy. At every observation they found to be occurring in a water lodged area such as tide-pools with an average water depth of 0.156 m.

5.3.7 Echinoderms (Phylum: Echinodermata):

Total 07 echinoderms were recorded from Narara reef (Table 5.6, Plate: 5.11 b-e and 5.12 a-c). All the species of echinoderms were recorded living cryptic life underneath rocks except *L. depressum* which inhabited sandy bottoms in mid intertidal area.

Table 5.6: List of echinoderm species recorded from Narara reef and their distribution.

Species	Common name	Sub-sites				
		S1	S2	S3	S4	S5
Salmacis bicolor (L. Agassiz and Desor, 1846)	Sea urchin		+	+	+	
Ophiarachnella sp.	Green Big Brittle star		+	+	+	
Brittle star A (unidentified)	Brittle star		+	+	+	
Brittle star B (unidentified)	Brittle star		+	+	+	
Asterina sp.	Starfish	+	+	+	+	+
Laganum depressum Lesson 1841	Sand dollar				+	+
Holothuria sp.	Sea cucumber	+	+	+		

The echinoderms e.g. sea cucumbers are cultured and used as food source in many parts of the world and India. However, no such practice is run in GoK. The echinoderms' distribution on Narara reef was found to be even, but only one i.g. *L. depressum* which was recorded only in the upper and middle sandy intertidal areas of sub-site S4 and S5.

5.3.8 Fishes (Phylum: Chordata):

The coral reefs are known for numerous kinds of fishes they sustain. However, during present study fishes remain within intertidal area during low tides were considered as associated fish fauna rather than surveying nearby fisher community for occurrence of fishes.

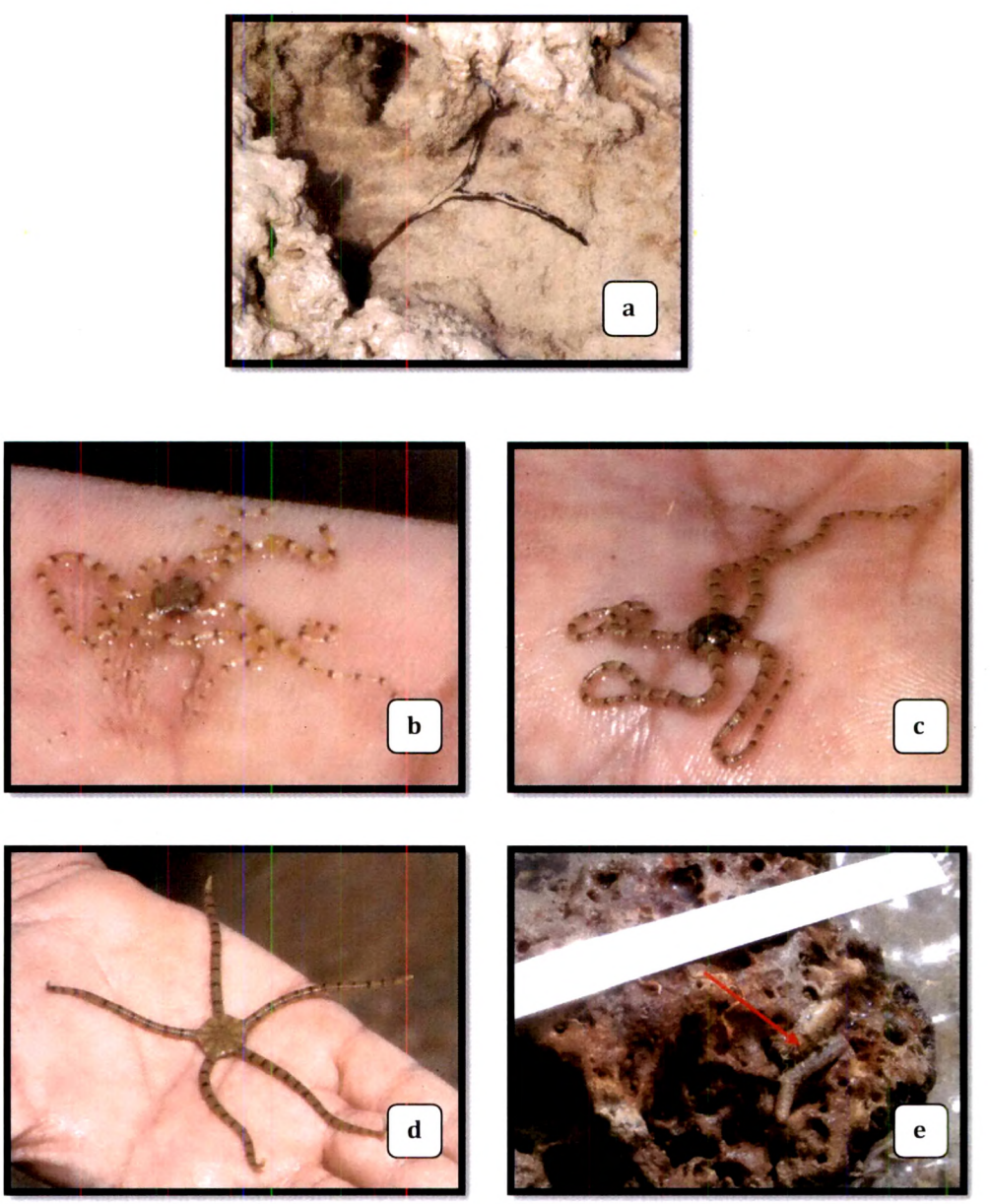
Total 04 fishes namely *Tetradon lineatus* (puffer fish), *Plotosus lineatus* (cat fish) and *Periopthalmus sp.* (mud skipper) were recorded (Plate: 5.12 d-f). Out of them, puffer fishes are of great tourist attraction among the visitors. It was common in all sub-sites except S5 due to shallower tide-pools. Mudflats in sub-site S5 were inhabited by mud skippers.

5.3.9 OTHER ASSOCIATED FAUNA

Apart from above listed fauna 1 species of flatworm - *Pseudoceros indicus* (phylum: Platyhelminthes), Nemertine worm (phylum: Nemertea) and ascidian (Order: Ascidiacea, Phylum: Urochordata) each were recorded (Plate 5.13).

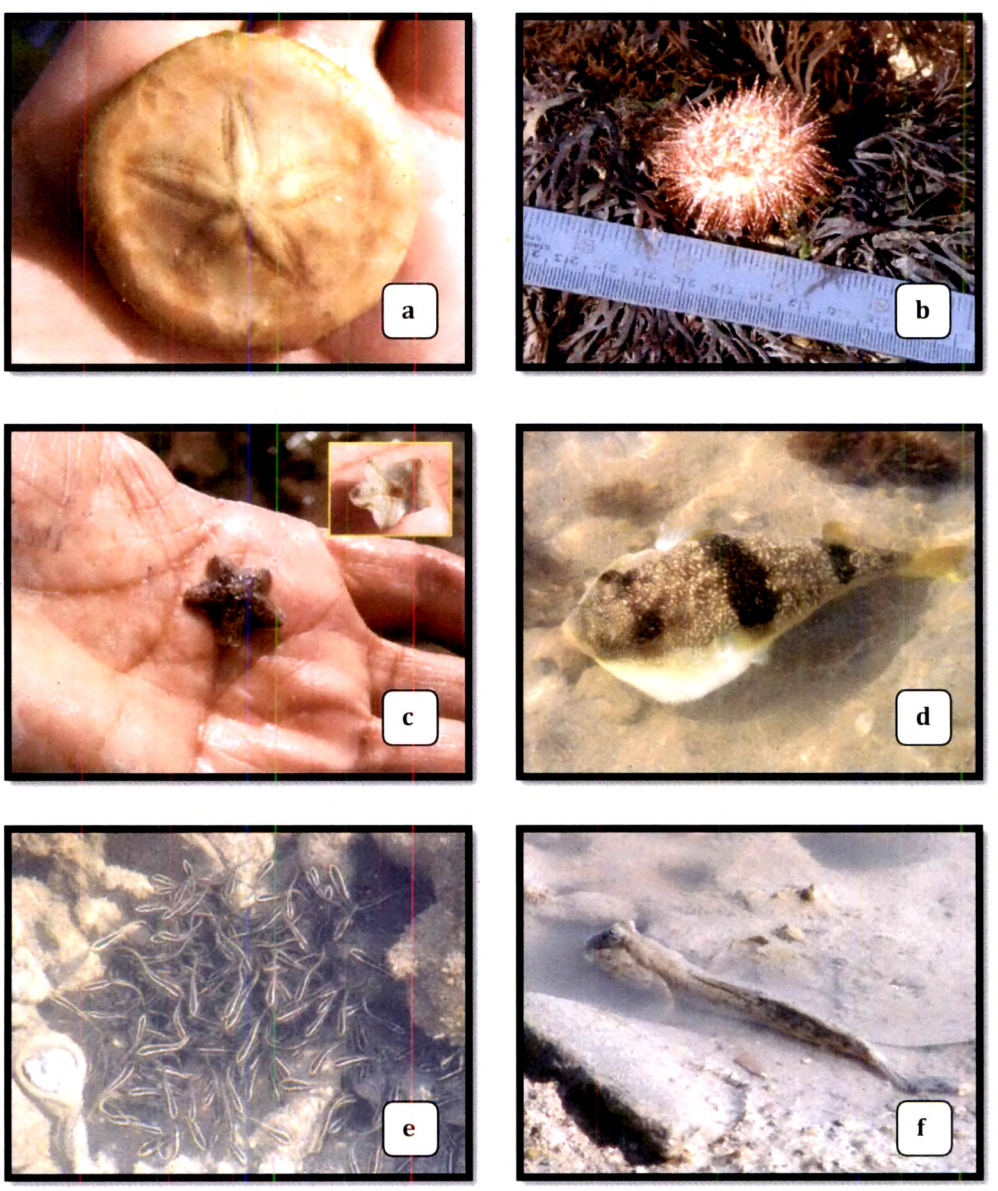
Nemertine worms and ascidians were common to observe in high tidal mudflats and underneath of rocks respectively. Whereas, the flatworm was comparatively less common and sighted only for twice from sub-site S2.

Plate: 5.11



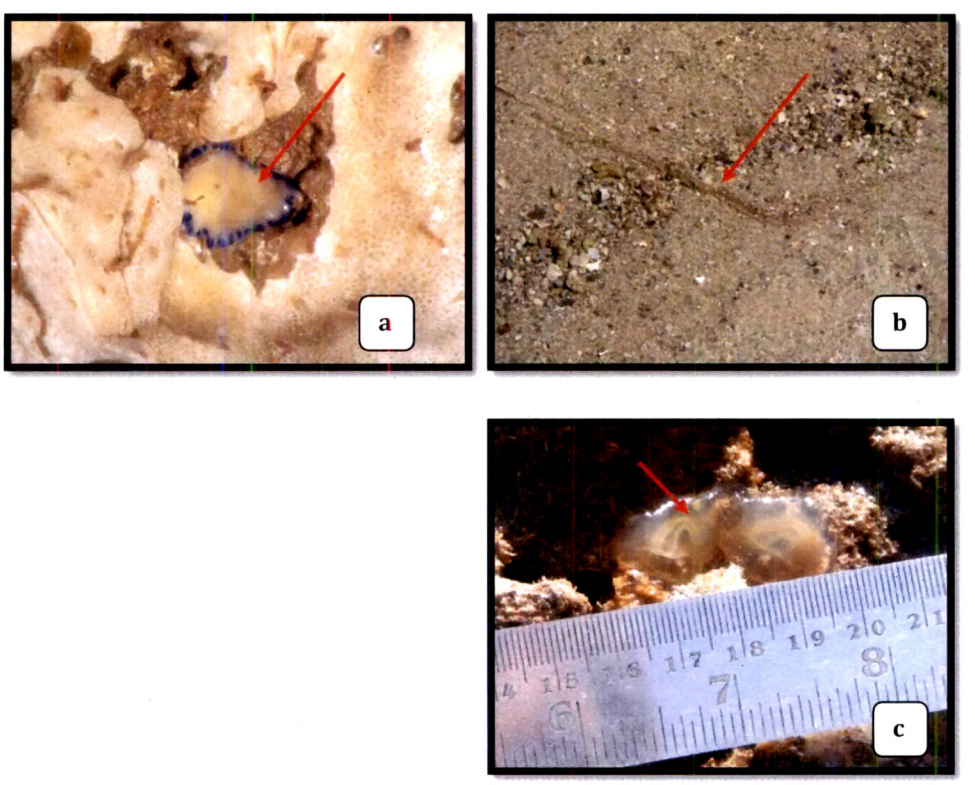
(a) *Acanthobonellia pirotanensis*, **(b, c)** unidentified species of brittle stars, **(d)** *Ophiarachnella sp.* **(e)** *Holothuria sp.*

Plate: 5.12



(a) *Laganum depressum*, **(b)** *Salmacis bicolor*, **(c)** *Asterina sp.*, **(d)** *Tetradon lineatus*, **(e)** *Plotosus lineatus*, **(f)** *Periopthalmus sp.*

Plate: 5.13



(a) *Pseudoceros indicus,* **(b)** Nemertine worm, **(c)** Ascidians.

5.4 ASSOCIATED FLORA:

In coral reef environment plants share equal important in determining the ecology. The main vegetation on reef is formed by seaweed/macro algae. The algae are classified in three main group Chlorophyta (Green algae), Phaeophyta (Brown algae) and Rhodophyta (Red algae). The algae not only serve as the main primary producers, but they are also effective indicator to assess any change in the biotic community or environment as a whole (Lefèvre and Bellwood, 2010; Mumby *et al.*, 2007; O'Connor and Bruno, 2007). Here in present study seasonal aspect of macro algae and distribution of seaweeds on the intertidal area was considered.

Previous study by National Institute of Oceanography, Goa reported 65 species of intertidal vegetation from Narara reef (Table 5.7) covering 62 species of marine algae and 03 species of sea grasses (Nair, 2002). In Narara, algae start dominating from January and remain dominated till late of April, then gradually start diminishing. During the dominating months they cover entire intertidal area. It was observed that the distribution of seaweeds on the reef flat was not in uniform manner and was found to follow specific patter from one sub-site to another.

The upper intertidal area, which is a mudflat dominating zone, start getting covered by luxuriant growth of *Ulva spp.* in the beginning of algal blooming phase. Moving from upper to lower intertidal area, a gradual shift in dominance pattern was seen shifting from *Ulva* dominated community to *Sargassum* dominated community, this was common to all sub-sites except S5 where *Ulva* was found dominating all across the intertidal area (Plate: 5.14 b). This might be because of the morphology of the sub-site due to which no sufficient water depth remain during low tides which can support erect algae like *Surgassum.* Conditions of community dominance at lower intertidal were strikingly different within sub-sites. Reef crest in sub-sites S2 and S4 was remained covered under *Sargassum* bloom (Plate: 5.14 a), where as the in sub-site S3 the area was dominated by *Scinaia sp.* (Plate: 5.14 d).

Though the seasonal change in algal dominating reef community stocks nutrients in the reef environment, such prolific blooms of marine algae is reported to harm the corals in the reef (Chandrasekaran *et al.*, 2008).

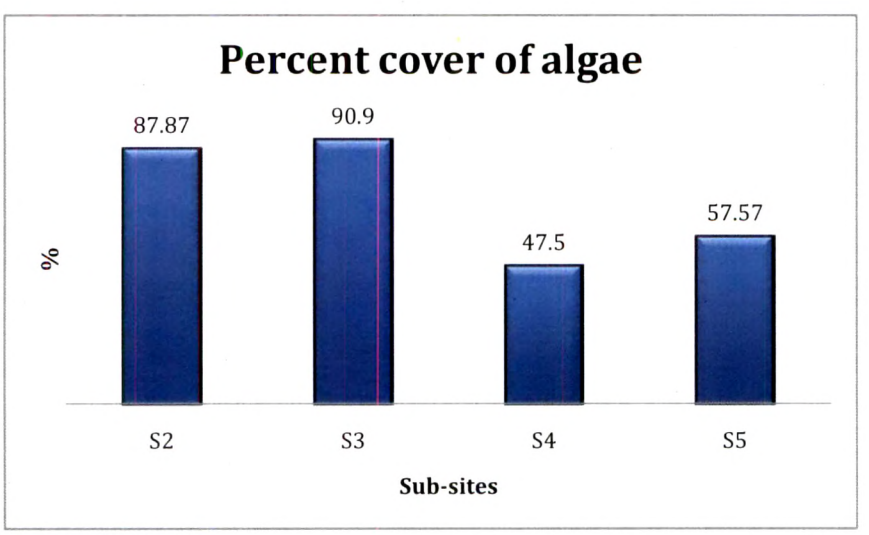


Fig. 5.4: Sub-site wise algal cover during January 2008.

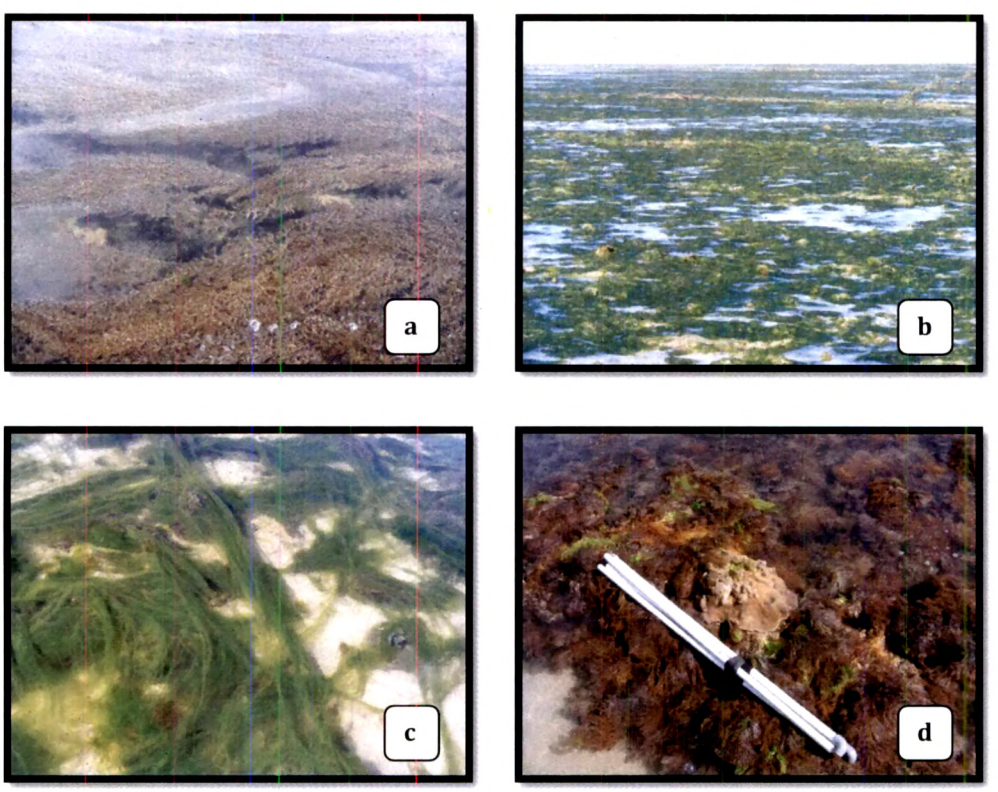
Table 5.7: Intertidal vegetation recorded from Narara Reef.

Sr. No.	Species	Abundance	Sr. No.	Species	Abundance
	CYANOPHYCEAE			**RHODOPHYCEAE**	
1	*Lyngbya majuscule*	+ +	36	*Acanthophora specifera*	+ +
2	*Microcoleus sp.*	+ +	37	*Agardhiella robusta*	+
	CHLOROPHYCEAE		38	*Ahnfelta pilicata*	+
3	*Bryojopsis hypnoides*	+	41	*Asparagopsis taxiformes*	+
4	*Caulerpa racemosa*	+ +	42	*Botrycladia leptopoda*	+
5	*C. peltata*	+	43	*Champia indica*	+ +
6	*C. sertilarioides*	+	44	*Centroceros clavulatum*	+ +
7	*C. taxifolia*	+	45	*Cheilosporum spectabile*	+
8	*Cladophora patentiramea*	+ +	46	*Dasya sp.*	+ +
9	*C. expansa*	+	47	*Galaxura oblongata*	+
10	*Cladophora sp.*	+	48	*Gelidium pussilum*	+
11	*Enteromorpha clathrata*	+ + +	49	*Gracilaria corticata*	+
12	*E. intestionalis*	+ + +	50	*G. verrucosa*	+
13	*E. flexuosa*	+	51	*Gracilaria sp.*	+
14	*Halimeda macroloba*	+	52	*Grateloupia sp.*	+
15	*H. tuna*	+	53	*Hypnea cervicornis*	+
	PHAEOPHYCEAE		54	*H. musciformes*	+ +
16	*Celpomenia sinuosa*	+	55	*H. velanite*	+
17	*Cystoseira indica*	+	56	*Jania sp.*	+
18	*C. myrica*	+	57	*Laurencia papillosa*	+
19	*Dictyota australis*	+	58	*L. pedicularioides*	+
20	*D. bartayressiana*	+	59	*L. obtusa*	+
21	*D. cervicornis*	+	60	*Polysiphonia platycarpa*	+
22	*D. dichotoma*	+	61	*Scinaia indica*	+
23	*Ectocarpus sp.*	+ +	62	*Wranglia sp.*	+
24	*Hinskia mitchelle*	+ +		**SEA GRASSES**	
25	*Iyegaria stellata*	+ + +	63	*Halodule univervis*	+
26	*Padina tetrastromatica*	+ +	64	*Halophila ovata*	+ +
27	*Rosenvingea intricate*	+	65	*H. beccarii*	+ +
28	*Sargassum sp. 1.*	+			
29	*Sargassum sp. 2.*	+			
30	*S. iliciifollium*	+ +			
31	*Swartzii*	+			
32	*S. vulgare*	+			
33	*S. tenerrimum*	+			
34	*S. johnstonii*	+			
35	*Turbinaria ornata*	+			

Very common: +++ Common: ++ Rare: +

Source: Nair (2002)

Plate: 5.14



(a) *Sargassum spp.* dominating reef crest and lagoon area in sub-site S2, S4, **(b)** *Ulva sp.* cover on sub-site S5, **(c)** sandy reef flat of sub-site S4 with fibrous green algae, **(d)** *Scinaia sp.* covering reef crest area at S3.

5.5 INTERRELATIONSHIP AMONG FAUNA:

During study total 03 apparent interrelationships between animals were observed on Narara reef. Out of the 03 interrelationships two were commensalism and one was predatory relationship.

A pair of *Periclimenes brevicarpalis*, anemone shrimp, was invariably observed dwelling between tentacles of *Stichodactyla spp.* of sea anemones (Plate: 5.15 a). The anemone shrimp being detritus feeder eats remains of sea anemone's food and lives commensalistic life. Such association between the sea anemone and anemone shrimps (*P. holthuisi, P. brevicarpalis, Thor amboinensis*) is studied in detail for the shrimps' preference for sea amemone's body parts (Khan *et al.*, 2004(Khan *et al.*, 2004). The field observations of the association also agree with the study, most of the time the pair of shrimps was recorded moving between the tentacles in the outer periphery of *Stichodactyla spp.*

In another case, a species specific relationship was observed between *Paraiptasia radiata*, a tiny sea anemone and a snail, *Nassarius olivaceus*. Here *P. radiata* lives an epibiont life on the snail and enjoys commensalism (Plate: 5.15 b). The *N. olivaceus* is a fast moving scavenger in habit with a larger shell (20 – 25 mm) and generally found abundantly on sandy upper intertidal area of Narara, therefore, it was concluded that here the stationary anemone living an epibiont life on the shell of the gastropod gets the benefit of better foraging by movement of gastropod (Dave and Mankodi, 2009a).

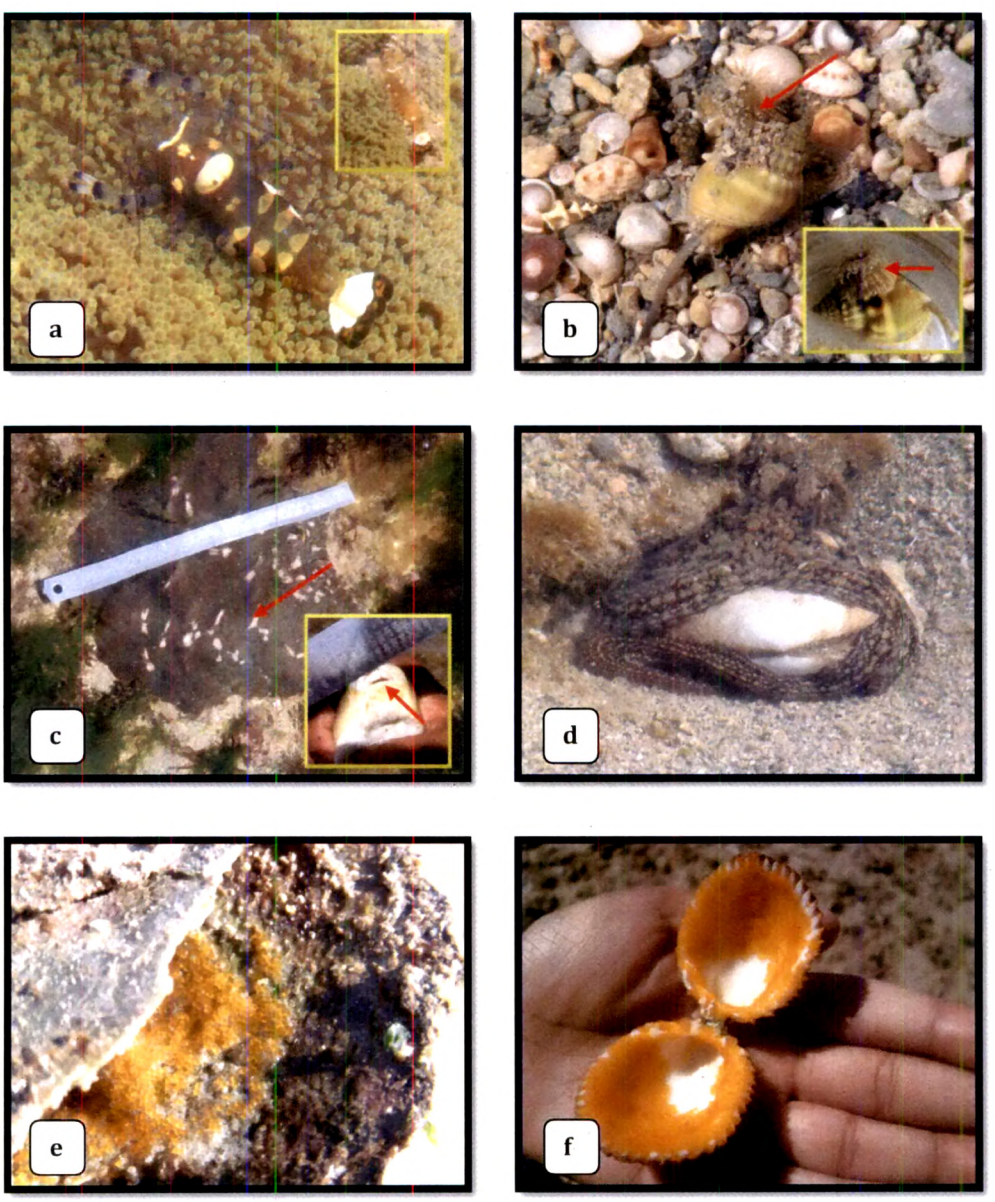
The predatory relationship was found to exist between *Porites lutea* and Puffer fish, *Tetradon lineatus*. The predation of *P. lutea*'s polyps was evident by scrap marks made by puffer fish exclusively on the coral's colonies (Plate: 5.15 c).

The *Octopus vulgaris* is carnivore cephalopod, it was observed to hunt actively for fishes, crabs and bivalves which might be preferred over the others (Plate: 5.15 d). It was found that not only alive food, the octopuses feed upon the pieces of fishable organisms entangled in the fishing nets as fish bait.

Apart from the above mentioned interrelationships between live organisms, an interesting observation was made for two empty bivalve shells and fish (unknown). The dead shells of *Pinna bicolor* and *Cardium flavum* were often seen with fish egg masses (Plate: 5.15 e, f).

All these examples explain the important of alive or dead material in the reef environment which by one or the other way serve to the other species as habitat/shelter, egg laying places, better living options etc.

Plate: 5.15



(a) *P. brevicarpalis* with *Stichodactyla spp.*, inset: female of *P. brevicarp*lais, **(b)** *P. radiata* with *N. olivaceus*, **(c)** Scrap marks on *P. lutea* colony, inset: upper jow bone ridge of *T. lineatus* with gape in mid matching with scrap mark patterns, **(d)** *P. bicolor* with fish eggs, **(f)** *C. flavum* with fish eggs.