CHAPTER 5: REEF ASSOCIATED FAUNA AND FLORA

Introduction

Associated Flora and Fauna

Inter-relationship

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5.1 INTRODUCTION:

Marine intertidal zone is the most dynamic environment. Tropical intertidal rocky zones have been a topic of interest for all marine ecologists and are being intensively studied since a few decades (Little and Kitching, 1996). This area provides shelter to diverse fauna from invertebrates to vertebrates. There is intense variation in the benthic environment and therefore a continuous monitoring is essential to assess the changes affecting the local organism community. Abundance and the relative distribution are a tool to understand the changes in the assemblages of organisms (Dayton, 1970; Underwood *et. al.*, 2000). Interactions between the abiotic and biotic factors along with spatio-temporal variation in the fauna has been given an importance recently (Danielson, 1991; Kleacher *et. al.*, 2001). Micro-environment around zoanthids provides a perfect habitat to various organisms and in majority the molluscs to lay eggs.

The zoanthids are in associated relationship as epizoic organisms (Perez *et. al.*, 2005). Associations with crustaceans, molluscs and polychaetes have been reported previously (Wirtz *et. al.*, 2009; Martinez *et. al.*, 2012). However a few studies by far document the major benthic fauna belonging to Phyla: Mollusca, Annelida and Arthropoda. Benthic organism's viz., corals, sponges, tube worms, nematodes and zoanthids are found occupying same substratum and therefore space competition is observed. 519 species of sponges have been reported by far from India. Of these, 34 species were coral boring, from Gulf of Mannar and Islands (Thomas, 1996). The

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cnidarians reported from India are approximately 842 as described by Venkatraman and Wafar (2005). The distribution of macro benthic fauna as reported by Joshi (2010) and Vaghela (2010) include a total of 127 species from Coelenterate, Mollusca, Arthropoda, and Echinodermata etc. Amongst those organisms which are sessile and found associated with zoanthids were phoronids, sponges and scleractinians and those free living were crustaceans. Major studies on Phyla Mollusca and Arthropoda are reported from the Coast of Saurashtra. Apart from that, few live corals too have been reported (Raghunathan *et. al.*, 2004). 30 species of Actinirians have been recorded from India, the actual classification being still unclear of the sea anemones of the intertidal area only genus level identification was done. Identification of many of the organisms is not thorough at the Saurashtra Coast of Gujarat. Actiniarians have been studied from the west coast of India but no detailed records of biodiversity are available from Gujarat coast. At all the four sites, the association seen was different. Zonation patterns as described in the previous chapter are distinct and thus, the association is also seen to be different. Major zonation patterns are dependent upon the abundance of a particular species in that particular zone. Major seaweed association was observed at Veraval and Sutrapada and molluscan association at Okha and Dwarka. Percentage cover of macrobenthic fauna is described in Figure 5.1.

Zoanthids are known to be symbiotic with dinoflagellates and occurs as endosymbionts in many marine invertebrates. Zooxanthellae transfer up to 98% of their photosynthetic products to complete host's energetic

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requirements. Similar to Scleractinians, Zoanthids also expel the *Symbiodinium* in unfavourable circumstances. As previously observed by Kaladharan *et. al.* (2011) at Kerala coast, *Zoanthus sociatus* was seen to revive bleaching in a time span of 67 days. This observation was also made here in *Palythoa tuberculosa*and only one observation was made in *Zoanthus sansibaricus* colony. Therefore, detailed studies are required to understand complete physiology of these organisms and their climate related issues.

5.2 ASSOCIATED FLORA

(Table 5.1)

Amongst the flora observed, Ulva spp. were seen to be highly associated with the Zoanthids and *Zoanthus sansibaricus* in particular. 43 other species of marine seaweeds were reported from the coast of Okha and Dwarka and around 50 from Veraval and Sutrapada. Species level identification was carried out from Okha and Dwarka and Genus level identification from Veraval and Sutrapada. Most of the seaweeds were common with many not present in Okha and Dwarka. The red coralline algae were largely found under the zoanthid.

5.3 ASSOCIATED FAUNA

(Table: 5.2-5.4) (Plates: 5.6)

Of the 30 species of Jelly fishes reported from India, only one observation was made in the present study at Veraval, although species level identification was difficult. Hydrozoans viz. *Physalia physalia, Velella velella and Porpita porpita* were recorded from the study sites at Sutrapada and Okha (Pandya *et. al.*, 2013). Of the Actinirians, only four were identified till

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Genus level and rest were similar to those found in the temperate regions. Phoronid tubes were in clustered pattern around *Zoanthus sansibaricus* colonies in Sutrapada's intertidal zone. Diversity of Corallimorpharia includes about 10 species along the Indian coast of which *Rhodactisspp*. has been reported form Dwarka coast (Dave, 2011; Pandya *et. al.*, 2014).

Of the 225 Scleractinian species recorded from Gujarat, live coral coverage is comparatively less in Saurashtra Coast, and therefore two major species were recorded and five other observed to be present. Of the total scleractinian species, *Porites lutea* and *Siderastrea siderastrea* were the major associates and competition for space was observed. As described by Pandya *et. al.* (2013) it was by means of three methods, the zoanthids were seen to be competing for space with the corals. It has also been mentioned in literature that Zoanthids prefer spaces where coral coverage is less favourable (Fautin, 1989).

Swain and associates (2010, 2011) have described Sponge-Zoanthid symbioses in the genus *Parazoanthus* and *Epizoanthus.* As described in their study, host sponge depends on the sponge morphology. Here also, we recorded three types of sponges associated with the Zoanthids. Demosponge *Tethya sp.* acted as base for the growth of Zoanthid species. Also, many Syconoid sponges were observed to be growing in between *Zoanthus sansibaricus* colonies.

Molluscs are the motile organisms in the intertidal zone and are often seen to be associated with many other sedentary organisms, viz., sponges and

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other cnidarians. They were observed to be embedded within the Zoanthid colony for food and shelter. Egg masses of Nudibranchs and gastropods was also observed surrounding the *Zoanthus sansibaricus* and *Palythoa mutuki* colonies. Maximum association was observed with phylum Molluscs (48%), also described by Perez et. Al from Brazil in 2005, followed by Poriferans, other Cnidarians, Arthropods, Annelids, Pisces were observed (Pandya *et. al.*, 2014). Of all gastropods, *Turbo intercostalis*, was found to be the most dominant species at all sites (Pandya *et. al.*, 2014) followed by *Cerithium caeruleum* (Gohil and Kundu, 2013). *Crassostrea sp*. was recorded from Okha, Dwarka and Veraval's rocky intertidal zone. Most abundant of other gastropods were *Chiton sp*. and *Cellana sp*. found in supra to mid littoral zones. These were observed between the *Palythoa mutuki* colonies as well, tide pools and edges of the rock areas. Site wise, between sites Okha and Dwarka total 42 different species belonging to different phyla were identified. The most abundant taxa associated to zoanthids were Mollusca (72%), Crustaceans (2.8%), Porifera (23%), Polychaeta (1.2%). Dwarka was found to be harbouring rich biodiversity associated with *Palythoa* as compared to Okha. Similarly, amongst Vewraval and Sutrapada. At Sutrapada more number of molluscan and athropoda species were observed.

Amongst the Annelids recorded during the study period, *Nereis spp*. was seen to be strongly in association with the *Palythoa mutuki, Palythoa tuberculosa* and *Zoanthus sansibaricus* colonies. Apart from Nereis, Sabellid and Serpulid worms were also observed sharing the space with the *Palythoa mutuki* and *Zoanthus sansibaricus*colonies. However, only five sightings were

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made during the entire study and mostly observed in areas with sand deposition.

In Arthropods, Cirripeds and Decapods were the next abundant organisms represented by Barnacle *Amphibalanus sp*. and 30 species of other arthropods as recorded by Trivedi and Vachhrajani (2014). Barnacle abundance in the intertidal zone pose a difficulty in assessing the intertidal zone. *Acetes sp*. and *Eumida sp*. were reported for the first time during the study period to be associated with the Zoanthids. 23 species of Brachyuran crabs have been reported from Saurashtra coast of which 8 have been recorded form Veraval and 20 from Sutrapada. Palythoa is known to release Palytoxin, a potent marine toxin, however some poisonous crabs of genus *Atergatis* and *Eriphia* were recorded from the study sites (Trivedi and Vachhrajani, 2014). Order Zoantharia and Actiniaria comprise of many organisms which are in symbiotic relationship with hermit crabs. Ates (2003) has reviewed on the Zoanthid-Crab symbiosis and reported that zoanthids survived on hermit crab shells inhabited. Dave and Mankodi (2008) reported the symbiotic relationship between hermit crab and sea anemone from Narara reef, similar observation is made during present study with in zoanthids dominated area. Phoronid tubes were in clustered pattern around *Zoanthus sansibaricus* colonies in Sutrapada intertidal zone. This indicates that most of the Molluscs and Arthropods are immune to the bioactive compounds released from these zoanthids. Similar to observations made by Perez *et. al.*, (2005). *Ophioderma appressa* and a species of star fish

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were recorded from Okha and Sutrapada as also described by Trivedi and Vachhrajani (2013)

Competition on rocky substrata has been a topic of interest and those organisms sharing the same substratum type are found to be competing for their survival (Dayton, 1971). Commensalism, mutualism and parasitic interactions between cnidarians and hydroids (Genzano, marine ecosystems and Goh -Nigel, 1999), Pennatulaceans, (Nigel, 1999) Corallimorpharians, Scleractinians, Zoanthids and sessile sponges (Suchanek and Green, 1981) have been studied previously. Zoanthid overgrowth as spatial competition was observed with barnacles and with Scleractinia by Pandya *et. al.* (2013).

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Table 5. 1: Associated Flora

Acanthophora nayadiformis	*Gelidiella sp.*
Acrosiphonia orientalis	*Gelidiopsis variabilis*
Amphiroa sp.	*Gracilaria corticata*
Boergesenia sp.	*Gracilaria dura*
Boodlea composite	*Gracilaria sp.*
Bryopsis sp.	*Grateloupia indica*
Caulerpa racemosa	*Grateloupia lithophila*
Caulerpa scalpelliformis	*Halimeda macroloba*
Caulerpa sertularioides	*Halimeda tuna*
Caulerpa taxifolia	*Halymenia sp.*
Caulerpa taxifolia	*Hydroclathrus clathratus*
Caulerpa veravalensis	*Hypnea sp.*
Caulerpa veravalensis	*Iyengaria stellata*
Centroceras clavulatum	*Laurencia sp.*
Chaetomorpha crassa	*Padina gymnospora*
Chaetomorpha spiralis	*Rhodymenia sonderi*
Chamaedoris auriculata	*Sarconema filiforme*
Champia compressa	*Sarconema scinaioides Børgesen*
Champia indica	*Sargassum johnstonii*
Champia parvula	*Sargassum sp.*
Champia somalensis	*Scinaia complata*
Cheilosporum spectabile	*Scinaia moniliformis*
Chondria armata	*Scinaia monoliformis J. Agardh*

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Chondria dasyphylla	*Sebdenia fl abellata (J. Agardh) Parkinson*
Cladophora vagabunda	*Sebdenia flabellate*
Codium decorticatum	*Sebdenia flabellate*
Codium dwarkense	*Solieria chordalis*
Corallina berteroi	*Spatoglossum asperum*
Cryptonemia undulata	*Spatoglossum* spp.
Cystoseira indica	*Udotea indica*
Dasya punicea	*Ulva fasciata*
Dictyota sp.	*Ulva fasciata Delile*
Digenea simplex	*Ulva lactuca Linnaeus*
Enteromorpha fl exuosa	*Valonia aegagropila C. Agardh*
Enteromorpha linza	*Valoniopsis pachynema (Martens) Børgesen*
Galaxaura ornata	*Veleroa karuvalensis*

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Table 5. 2: Presence of other Anthozoans at study sites

Anthozoa	Veraval	Sutrapada	Dwarka	Okha
Actiniarians				
Actinia sp.	+	+	-	-
Stichodactyla sp.	-	-	+	+
Heteractis sp.	+	+	+	+
Cerianthus sp.	-	-	+	+
Anthopleura sp.	+	+	-	-
Other species	+	+	+	+
Sclerectinians				
Porites compressa	-	+	+	+
Porites lutea	+	+	+	+
Acanthastrea sp.	+	-	-	+
Siderastrea	-	-	+	+
Favia sp.	-	-	-	+
Favites sp.	-	-	-	+
Turbinaria sp.	-	-	-	+
Corallimorpharians				
Rhodactis sp.	-	-	+	-

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Table 5. 3: Zonewise distribution of Macrobenthic Community

Zones	Organisms
Supra littoral zone	Cerithrids, Cirripedes, Actinirians, Gastropods, Crustaceans, etc.
Mid littoral	Molluscs, Arthropods, Cnidarians, Poriferans, Annelids
Infra littoral	Corals, Poriferans, Echinoderms, Pisces
Sub-tidal	Echinoderms, Tunicates, Pisces

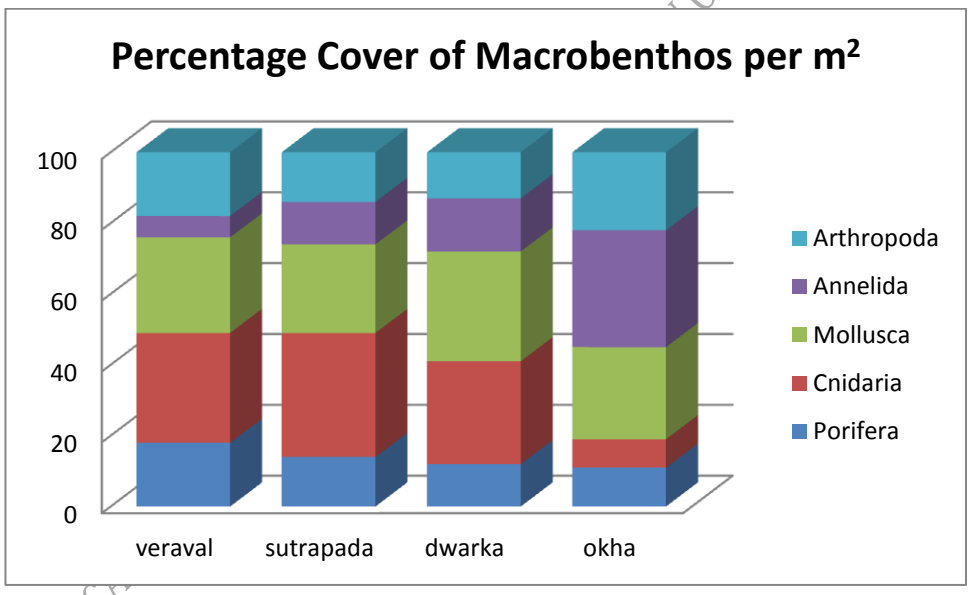

Figure 5. 1: Percentage cover of macrobenthic communities at study sites.

Table 5. 4: Site-wise associated faunal presence

Sr. No.	Phylum	Sites(+,++,+++ showing abundance, - showing absence at that site)			
	PORIFERA	OKHA	DWARKA	VERAVAL	SUTRAPADA
1	*Haliclona sp.*	+	++	++	+++
2	*Clathria sp*	+	++	+++	+++
3	*Cliona sp.*	++	+	+++	++
4	*Microciona sp.*	++	+	+	+++
5	*Oscarella sp.*	+	+	-	+
	CNIDARIA				
1	*Aequorea victoria*	+	-	-	+
2	*Porpita porpita*	-	+	-	-
3	*Velella velella*		+		
4	*Physalia physalia*				+++
5	*Actinia equina*			++	+++
6	*Actinostella spp.*			++	+++
7	*Anemonia spp.*			++	+
8	*Anthopleura elegantissima*	+	+	+++	+++
9	*Rhodactis spp.*		++		
10	*Urticina spp.*				
11	*Porites lutea*	+		++	+++
12	*Siderastrea siderastrea*		++		+++
13	*Acanthastrea hillae*			+	+
	MOLLUSCA				
1	*Astrea semicostata*	++	+++	+++	+++
2	*Isochiton*	+	++	+++	+++
3	*Ocenebra*	+	+	+	++
4	*Conus fingulinus*	++	++		++
5	*Purpura panama*	+	++	+	++

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6	*Nerita textiles*	++	+++	+	++
7	*Turbo intercostalis*	+++	+++	+++	+++
8	*Cronia subnodulosa*	++	++	+	++
9	*Cerithium scabridium*	++	+++	+++	+++
10	*Natica picta*	++	++	++	+++
11	*Nerita undata*	++	+	++	+++
12	*Onchidium verriculatum*	+	+++	+++	+++
13	*Chicoreus brunneus*	++	++	++	+++
14	*Cellena radiate*	++	++	++	+
15	*Aplysia fasciata*	+	++	++	++
16	*Thais rugosa*	+	+	+	+
17	*Lunella coronate*	++	++	+	+
18	*Pita rerycina*	++	++	+	+
19	*Olivia nebulosa*	+++	++++	+	+
20	*Monodontaaustralis*	+	+	+	+
21	*Tibia curta*	++	++	+++	+++
22	*Canthrus undosus*	++	++	+	+
23	*Cypraea turdus*	++	++	++	+++
24	*Nerita oryzarum*	+++	+++	++	++
25	*Pyrene flava*	++	+	-	-
26	*Turtitella columnaris*	+	+	++	+++
27	*Euchelus asper*	+	+	+	+
28	*Cellana karachiensis*	+	++	++	++
29	*Thais clavigera*	++	++	+++	+++
30	*Canthrusspirilis*	+	++	+	+
31	*Mitrascutulata*	+	+	++	++
32	*Lunellacoronate*	++	++	+	+
33	*Conuscumingii*	--	-	+	+
34	*Bursa granularis*	-	+	+	+

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35	*Bufonariaechinata*	-	-	+	+
36	*Erroneacaurica dracaena*	+	-	+	+
37	*Talpariatalpa*	-	-	++	+
38	*Echinolittorinainterrupta*	-	-	++	++
39	*Cerithidea cingulate*	++	++	+++	+++
40	*Neritachamaeleon*	++	+	++	+++
	ANNELIDA				
1	*Nereis*	+	+++	++	+++
2	*Eumida sp.*	+	+	-	-
3	*Serpula columbiana*	+	++	+	+++
4	*Eulalia viridis*	+	+	-	-
	ARTHROPODA				
1	*Acetes sp.*	++	++	-	++
2	*Portunus pelagicus*	+	+	++	+++
3	*Grapsus albolineatus*	++	+	+	+++
4	*Charybdis annulata*	++	++	++	+++
5	*Piluminous vespertilio*	+++	+++	++	++
6	*Petrolishthes lamarckii*	+	+	++	++
7	*Petrolishthes bosiki*	+	+	++	++
8	*Uca lactea*	+	+	++	++
9	*Clibanarius zebra*	+++	++	++	++
10	*Leptodius Spp*	+	+	+	+
11	*Atergatis integerrimus*	+	++	+	++
12	*Alpheus Spp.*	+	+	-	-
13	*Amphibalanus sp.*	++	+++	++	+++
14	*Charybdis sp.*	+	+	++	++

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15	*Clibanarius nathii*	+	++	++	++
16.	*Squilla spp.*	-	+	++	+++
	ECHINODERMATA				
1	*Ophioderma appressa*	++	+	+	+

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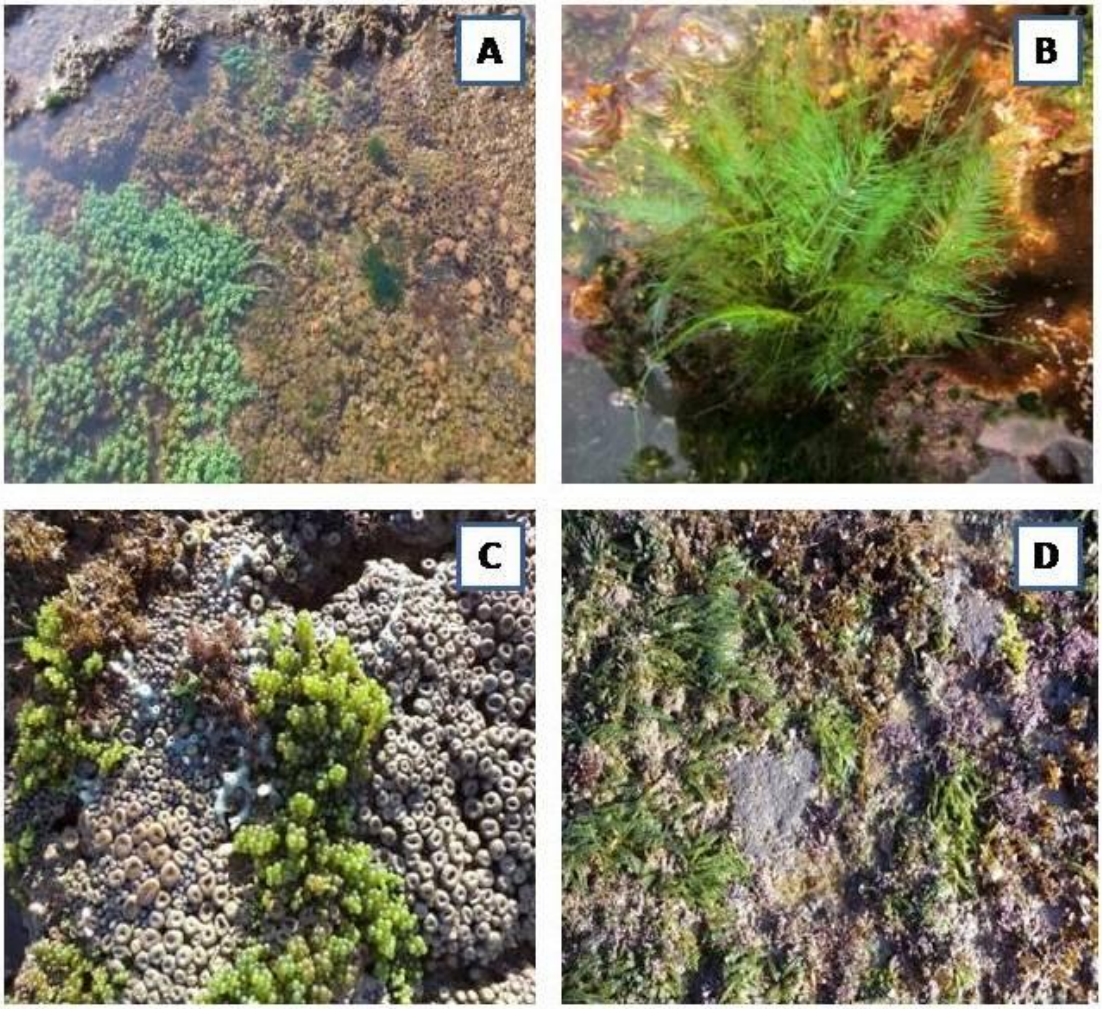

Plate 5. 1: A, C: *Caulerpa spp.,* B: *Bryopsis spp.,* D: *Ulva spp.*

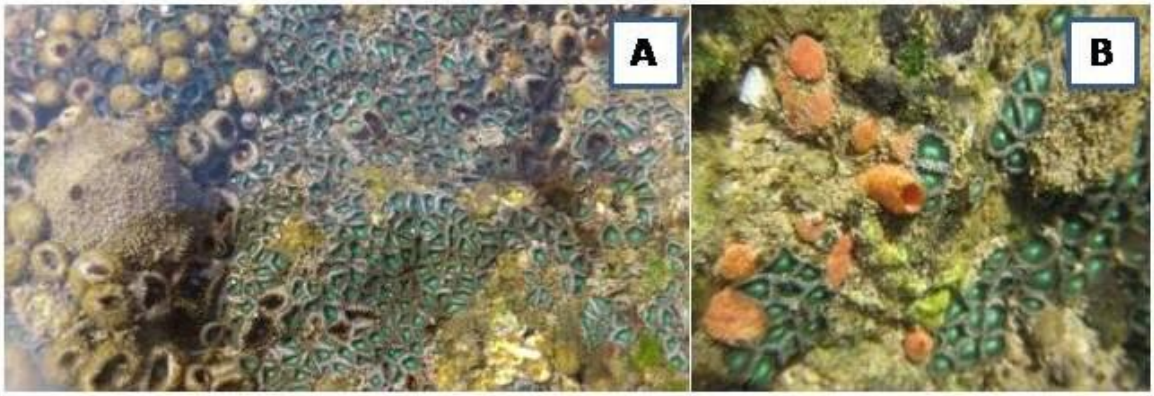

Plate 5. 2: A- *Tethya spp*., B- *Microciona spp*.

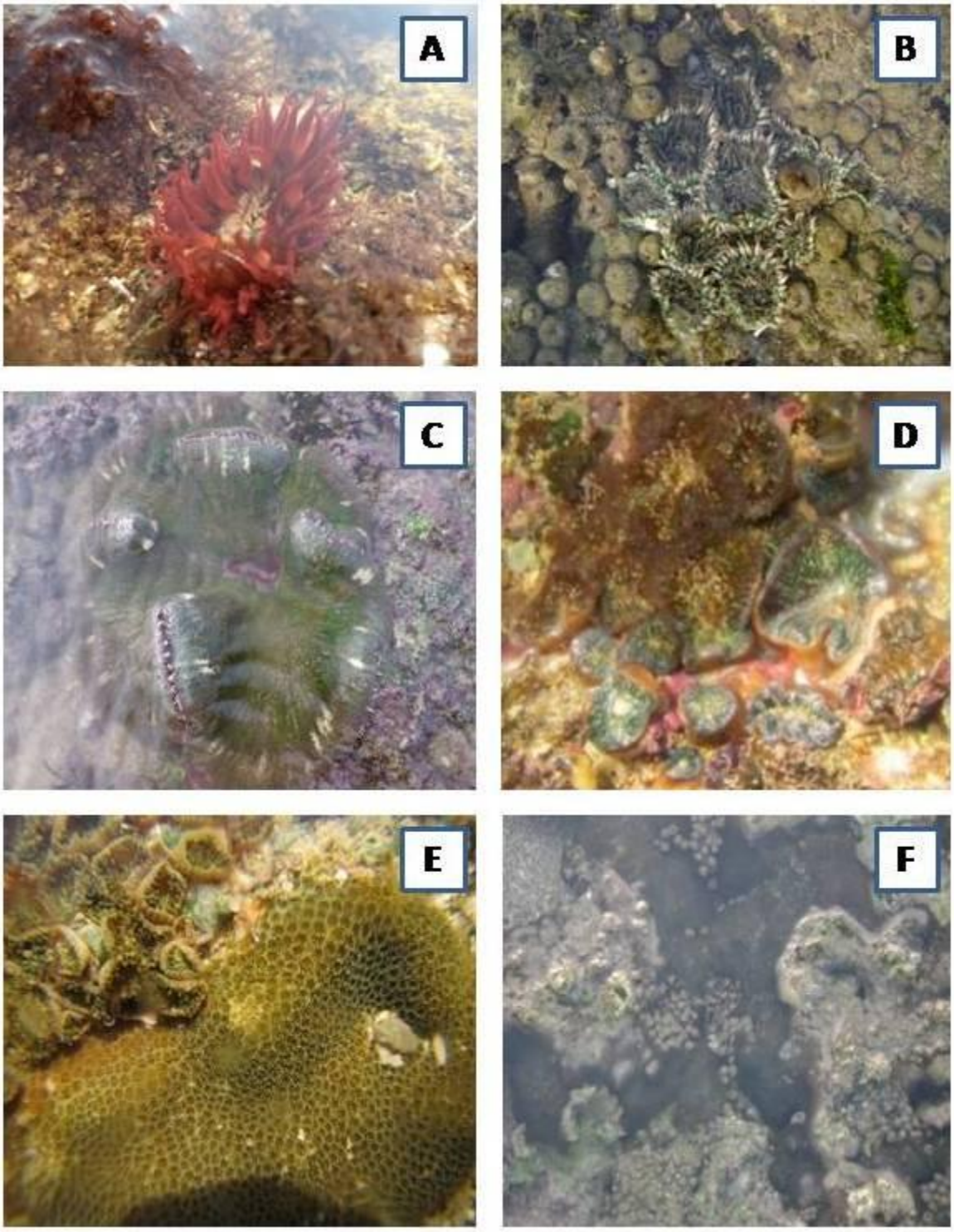

Plate 5. 3: A*: Actinia equine, B. Anthopleura spp., C: Stichodactyla haddoni, D: Rhodactis spp., E: Siderastrea spp., F: Porites lutea*

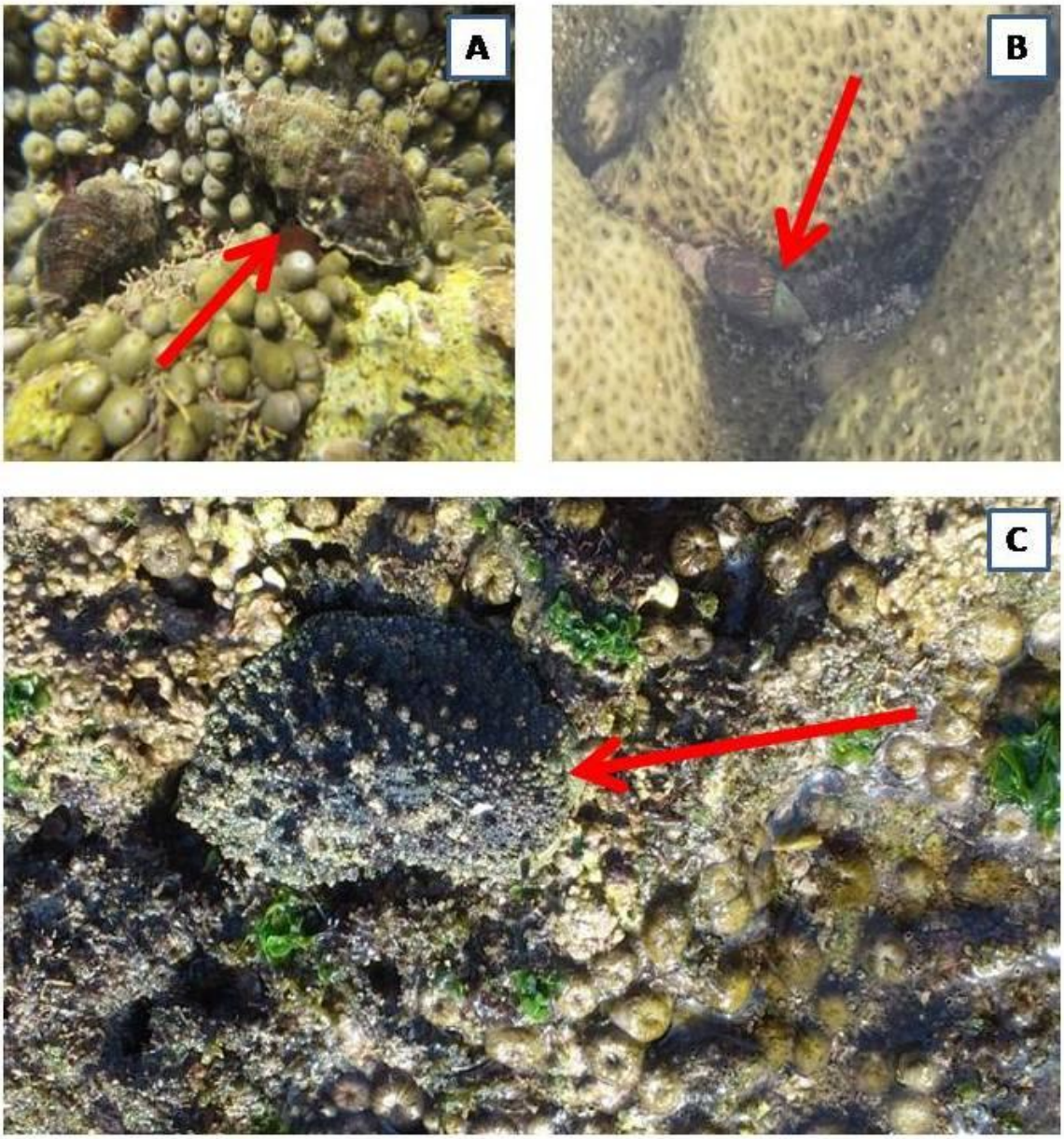

Plate 5. 4: A: *Purpura panama*, B: Gastropod, C: *Onchidium verruculatum*

ECOLOGICAL A.

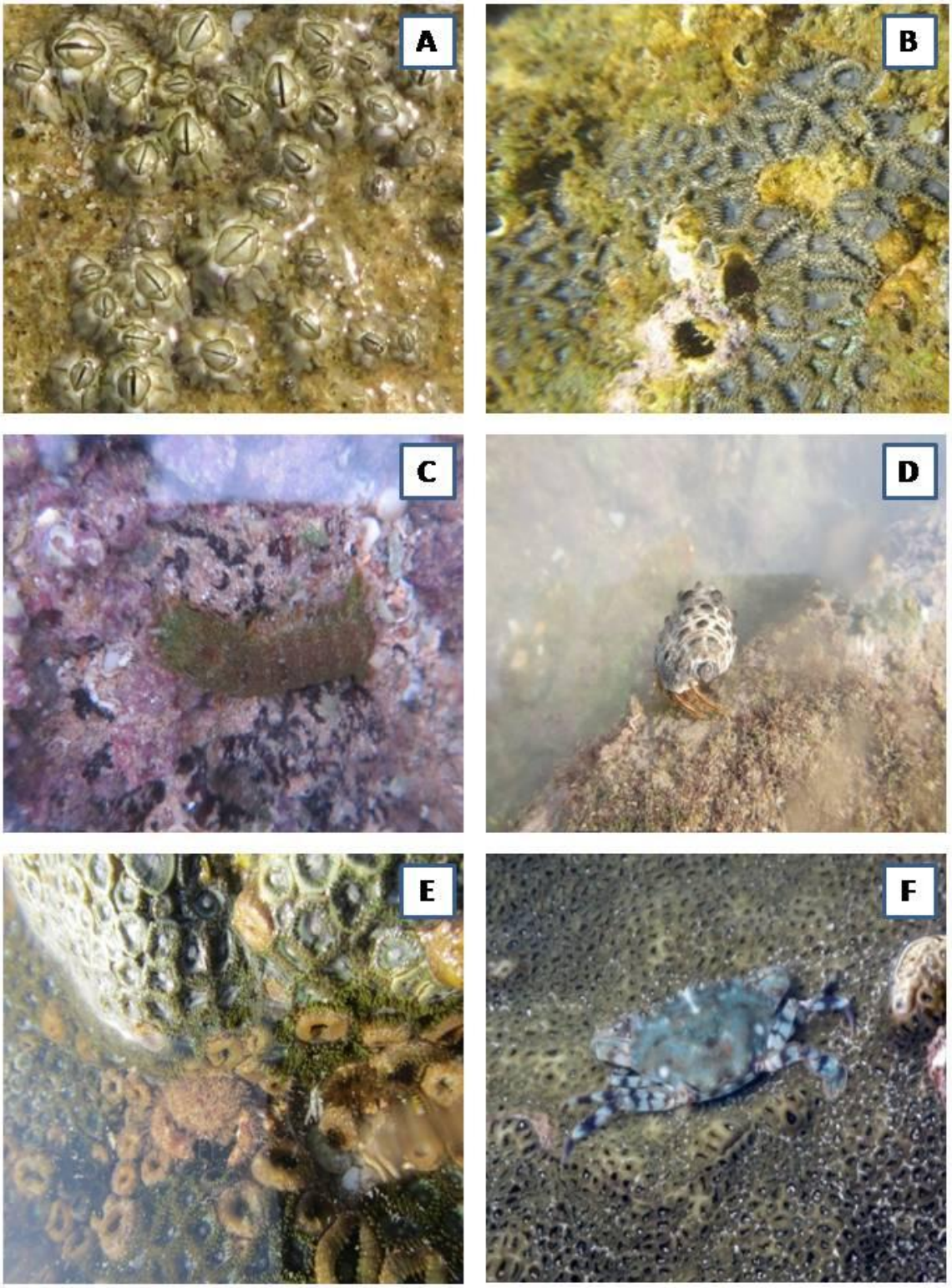

Plate 5. 5: ***A, B: Amphibalanus spp., C: Squilla, D: Clibanarius spp.E: Pilumnus vespertilo, F: Charybdis annulata***

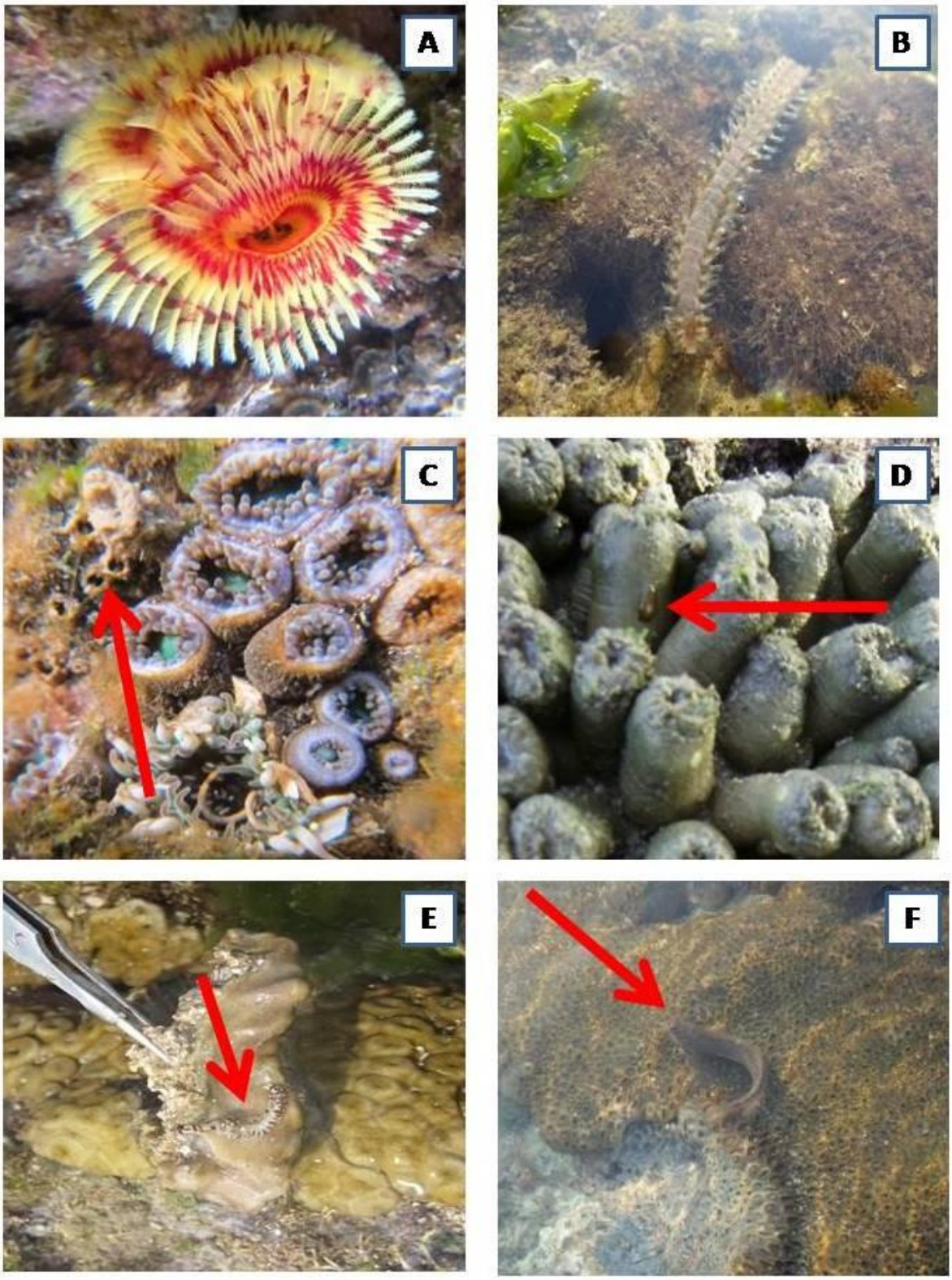

Plate 5. 6: A: *Sabella spp., B: Nereis spp.,* C: Phoronid tube, D: Unidentified spp., E: Annelid worm, F: *Gobius spp.*

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