CHAPTER 4 DISTRIBUTION OF ZOANTHIDS

GENERAL DISTRIBUTION

SITE WISE DISTRIBUTION

SUMMARY

CONTENTS

CHAPTER 4 DISTRIBUTION OF ZOANTHIDS 89
4.1 GENERAL DISTRIBUTION 90
4.2 SITE WISE DISTRIBUTION 90
4.2.1 OKHA 91
4.2.2 DWARKA 95
4.2.3 VERAVAL: 97
4.2.4 SUTRAPADA: 99
4.3 SUMMARY: 103

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

4.1 GENERAL DISTRIBUTION

As it observed in natural ecosystem, the organisms are found to be moving from the areas of less favourable condition to the areas of more favourable conditions. The substratum, tidal action, salinity and the climatic conditions play a major role in distribution of the zoanthids in the intertidal zone. Zoanthids at all the four study sites were found to be present in colonies of varying sizes. As discussed in Chapter 2, marked variations were found in the type of substratum among all the four sites under investigation. Due to the same reason, the pattern in which these species were present in the intertidal zone was also different. There was a general linear pattern of distribution perpendicular to the shore line which was observed to be present at all the four study sites. The supra littoral zone of all the four sites were found to be dominated by *Palythoa spp*. Fewer colonies *Isaurus spp.* were found to be present in the supra littoral zone with lesser consistency among the sites. The mid littoral zone on the other hand was having a transition in the zoanthid colonies from *Palythoa spp*. to *Zoanthus spp*. The infra littoral zone showed abundance of the *Zoanthus spp*.

4.2 SITE WISE DISTRIBUTION

All the four sites under ecological assessment were critically examined for distribution of zoanthids with respect to ecologically demarcated zones. viz., Supra littoral zone, Mid littoral zone and Infra littoral zone. Veraval and Sutrapada showed the presence of *Isaurus spp*. where as in Okha and Dwarkathe *Isaurus spp*. was found to be absent. This might be attributed to lower tolerance limit of the

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

organism towards specific limiting parameters. It is established fact that the organisms in the littoral zone are distributed in particular micro habitats having specific set of ecological aspects. It is also found that these are widely influenced by not only by the physical gradients but also by the existing faunal and floral associates occupying the particular area (Doty, 1946; Southward, 1958; Lewis, 1964).The interspecific and intra specific competition among the community plays a major role in forming the structure of a particular ecosystem (Connell, 1961; 1972; Paine, 1974; Glynn, 1976). This was also observed at the study sites under investigation. This type of interrelation might have played a major role along with the physico – chemical parameters at Okha and Dwarka where *Isaurus spp*. was absent. Apart from the competition for food and shelter, predation is one of the important ecological aspect. Due to higher number of predatory organisms relying on a particular species negatively affects the abundance of the organism of prey.The natural prey and predator relationship are often found to be affected by the ecological tolerance limits of the prey and the predator. It is also observed in nature that the prey species are more tolerant to the environmental stresses. However, the species with lesser acclimatization capacities get removed from the niche with due course of time (Connell, 1961; 1970; Paine, 1966; 1974; Dayton, 1971; Menge, 1976).The distribution of the zoanthids at all the four sites is as follows:

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

4.2.1 OKHA

Okha, the southern tip of gulf of Kachchh was studied intensively for assessment of diversity and distribution of zoanthids. Among the three species of zoanthids under investigation, this coast showed the presence of *Palythoa spp*. and *Zoanthus*

spp., however, *Isaurus spp*. was absent which may be attributed to more specific requirements and lesser tolerance limits.Okha coast, as mentioned earlier is also having higher tidal movements and higher sediment transfer and deposits. The overall physico – chemical aspects of the Okha coast is having partially unfavourable conditions due to which nearly 40-50 % of coast was barren devoid of any biota. It was also observed in the previous research that if the substratum remains covered by the sediments, the survival of zoanthids and other benthos become difficult (Takahashi 1988, Nakai 2007).The salinity gradient and recurring mixture with freshwater from the shores may also affect the distribution as was observed in the case of Okinawa(Irei. *et al.*, 2011). Similar environmental gradient might be affecting the distribution of zoanthids at Okha. *Palythoa spp*. and *Zoanthus spp*. were almost equally distributed in the mid littoral zone. The supra littoral zone was having higher extent of *Palythoa spp*. in comparison to the *Zoanthus spp*. however, the infra littoral zone showed higher percentage coverage of *Zoanthus spp*.

In Okha coast, the zoanthid colonies were found to be distributed into various patterns. The supra littoral zone was dominated by the presence of *Palythoa spp.* Colonies of *P. mutuki* was found to be present in circular to semi – circular shapes with smooth boundaries of the colony. However, the colonies were more or less discontinuous or distinct. Distribution of *P. Mutuki* into distinct colonies was observed in the areas of emergence sizing 2 to 4 meters in diameter (Plate4.3: A and C) whereas the colonies present inside the tide pool covering the entire depression having dimensions of 3-6 meters in diameter showed a continuous distribution (Plate 4.3: B). Colonies of *P. mutuki* on the other hand were more prominently found either in the areas of submergence of emergence. A number of

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

colonies of *P. mutuki* were found to be covering the whole bottom of the tide pools; whereas they are also found on the areas which were submerged for barely 2 – 4 hours a day. It is noteworthy that *P. mutuki* is highly adapted to the reef environment and the same was seen in the current study as well. Ecologically *P. mutuki* was found to be having largest niche and tolerance limits among all the zoanthids present at the study site. It is identified that all the zoanthids have different physiological requirements and depending upon the same they have difference in their tolerance limits. However, *Palythoa spp*. is found to be having wider tolerance limits with respect to physical parameters of the coast (Reimer *et al.*, 2008). This could be one of the reasons of their continuous distribution at the site with varied micro habitats. The highest elevation of the rocky shores was left uncovered by both of the species at Okha. The mid littoral zone showed the colonies of *Z. sansibaricus* and *Z. vietnamensis* being more abundant than *Palythoa spp*. or *Isaurus spp*. These colonies were present as patches in the crevices and at the periphery of tide pools. The colonies of *Zoanthus spp*. showed a linear belt like pattern at the slopes of the crevices (Plate 4.3: D). They were having varied length ranging from 1 to 4 meters. However, the width of such belts was ranging between 15 to 50 centimetres whereas in the case of circular to semi – circular tide pools they grew on the slopes in distinct colonies ranging from 20 to 60 centimetres(Plate 4.3: E). It was also identified in the study of another tropical rocky shore that the distribution of *Z. sansibaricus* is more prominent in the mid littoral and infra littoral zone. However, there were more colonies of the species in mid littoral zone in comparison to the infra littoral zone (Irei *et al.*, 2011).The infra littoral zone also showed scatterd patches of *Z. sansibaricus* especially at the slopes of tide pools (Plate 4.3: F).The sizes of the patches ranged from few centimeters to

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

1 meter in diameter. However, they were distributed in such a pattern so that during the time of the day where solar insolation is at its peak, the oral disk of the polyps do not face the sun. Apart from the colonies of *Z. sansibaricus* in the infra littoral zone *P. heliodiscus* was randomly distributed in infra littoral zone with 10 – 12 colonies sizing from few centimetres to 2 meters. Individual colonies were also found at the transition of mid littoral zone and infra littoral zone was found. However, these colonies were present at a greater horizontal distance from each other.Though most of the Okha coast was barren in all the three zones, the Saurashtra coast was distributed with scanty colonies of Palythoa spp. and *Zoanthus spp.* (Pandya K. M. and Mankodi P. C., 2013).In current study the maximum number of colonies found at the study site were of *P. mutuki* and *Z. sansibaricus*. They were highly clustered and randomly present in all the three parts of the littoral zone. *P. tuberculosa* on the other hand showed up only in the supra littoral and mid littoral zone with smaller colonies. The physico – chemical factors of the coast were such that the total coverage of the coast by benthos was merely 50 to 60 % (Plate 4.2). Moreover, the distribution of any permanent benthic organism depends upon the attachment of the organism with the substratum at the initial stages of development (Wilson, 1952; Mathieson, 1960; De Silva, 1962; Gale, 1971; Crisp, 1974). This discontinuous and scattered distribution of the colonies may be attributed to the initial colonization of zoanthids at the coast as well. All in all, the Okha coast showed the occurrence of *Palythoa spp*. and *Zoanthus spp*. randomly distributed with varied degree of abundance in all the three parts of littoral zone. However, the third zoanthids under investigation i.e. *Isaurus spp*. was absent during the whole study period.

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

4.2.2 DWARKA

The the Dwarka coast showed similar characterstics of species distributionas observed along the Okha coast. Maximun area of the littoral zone was barren uncovered by any of the biota. Dwarka coast also showed a marked absence of *Isaurus spp*. as in the case of Okha. This might be attributed to similar substratum properties at both the sites. The supra littoral zone on the other hand was highly dominated by *Paythoa spp*. However, nearly half of the supra littoral zone was barren, devoid of other biota. The site showed a marked gradient in the distribution of zoanthids. As the supra littora zone was dominated by Palythoa spp. The mid littoral zone was identified with abundance of *Zoanthus spp.* with patchy and scattered distribution of *Palythoa spp*. However, *Zoanthus spp*. was widely distributed in the infra littoral zone at Dwarka among all the zoanthids present (Fig. 4.4).

In the supra littoral zone flat to bulbous colonies of *P. mutuki* was observed. Most of them were found to be new recruits. These colonies were continuously spread in the supra littoral zone and grew upto the extent ranging from 1 meter to 15 meters with majority of the colonies having dimentions of 8 – 10 m of an average. In this zone 30 – 40 huge colonies / clusters of *P. tuberculosa* and smaller to medium sized colonies of *P. mutuki* were observed.In some parts of the supra littoral zone the growth of *P. tuberculosa* was covering the entire depression of the tide pool(Plate 4.5:A). These were also present as patchy colonies in the supra littoral zone having sizes ranging from 2 to 5 meters(Plate 4.5:B).In previous study carried out in the Saurashtra coast has also mentioned similar type of clustered to

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

patchy distribution of *P. tuberculosa* with the presence of sporadic colonies of *P. mutuki* (Bhattji, *et al.*, 2010).

In the mid littoral zone, *Z. sansibaricus* was observed to be present in scattered manner. The colonies were ranging in size from few centemeters to 2 to 3 meters. However, it followed almost a continuous pattern of distribution with fewer colonial devided. The infra littoral zone was represented by the presence of *Z. sansibaricus*having larger colonies. The overall distribution of the zoanthids is affected by the existing ecological factors. This is pre established by previous researches which strongly suggest that the community show varied degree of responses to the currently existing factors. This also largely affects the presence or absence of a species in a particular habitat (Sutherland, 1974).Moreover, the angle of the slope of littoral zone at the Dwarka coast is low. The coast is also characterised by the uneven topography. This type of situation leads to relatively poor water circulation leading to unfavorable salinity condition at the coast. This largely affects the number of zoantid colonies in the area. The mid littoral zone was also demarcated by patchy distribution of *P. tuberculosa* (Plate 4.5: C). They were found to be sharing the sub stratum in mid littoral zone with *Z. sansibaricus* as embedded colonies (Plate 4.5: D). The mid littoral zone of Dwarka coast showed a blend of both the zoanthids i.e. *Zoanthus spp*. and *Palythoa spp*. Similar to Okha, *Isaurus spp.* was absent at Dwarka too.

The infra littoral zone of the shore showed scattered and sporadic colonies of *P. tubercuosa*. The colonies were present in circular to semi – circular shapes and highly scattered (Plate4.5: E). This may be due to the patches of favourable and unfavourable conditions scattered in the infra littoral zone. However, the colonies of *Z. sansibaricus* were found to be present at the crevices and at the slopes of the

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

tide pools (Plate 4.5: E). In similar type of colonization of *Z. sansibaricus* it was seen that a part of the colonies were present at such a topographical region where there would be little availability of insolation at right angle or near to right angle. Whereas the same species was found to be existing in such a position where the oral disks of the polyps would directly be facing the highest degree of solar insolation (Kamezaki *et al.*, 2013).This may be attributed to variation in the molecular structure of the same species (Reimer *et al.*, 2007). The overall presence and distribution of Dwarka coastline was similar to the presence and distribution of zoanthids at Okha coast with marked presence of *Palythoa spp*. and *Zoanthus spp*. and absence of *Isaurus spp*. throughout the sampling period.

4.2.3 VERAVAL:

Veraval cost is having a long rocky shoreas mentioned in Chapter 2. This makes a perfact niche for the zoanthids as well as other benthic organism. Veraval also had similar pattern of distribution of the zoanthids under investigation like Sutrapada coast. This may be attributed to the coastal characteristic similarities as both faces open Arabian sea. The supra littoral zone was dominated by *Palythoa* spp. There was a gradual shift in the zoanthid species with a change in the littoral zone. The mid littoral zone having mixed colonies of *Palythoa* spp. and Zoanthus spp. The infra littoral zone, however had most of the area covered by *Zoanthus spp.* i.e. 55 % - 57 %. Similar to Sutrapada coast, Veraval coast also has presence of *Isaurus spp.* in the supra littoral zone. This suggest that along with Sutrapada coast, the Veraval coast along with the Sutrapada coast might be having favourable ecological conditions for successful establishment and development of Isaurus spp.Among all the four sites under investigation, the environmental parameters

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

were found to be most suitable for the successful establishment of Zoanthids at Veraval coast (Vaghela *et al.*, 2010, Bhadja and Kundu, 2012). This is also supported by the results of the study which shows 50 % to 80 % coverage of littoral zone by the zoanthids (Fig. 4.6).

At Veraval coast, patchy and mat like colonies of *P. tuberculosa* and *P. mutuki* having variation in their sizes were observed. Similar to other study sites, *Palythoaspp*. showed widespread distribution in the supra littoral zone(Plate 4.7:A). This is also evident in the previous studies made. In one of the studies at the Saurashtra coast, two major types of colonies of *P. tuberculosa* were seen. Some of the colonies in the intertidal zone were massive whereas other colonies were distributed as small round agglomerations (Pandya and Mankodi, 2013).The size of these colonies at Veraval coast in the current study were ranging from few centimeters to several meters. In most of the cases they were observed as globular patches at the site. Similar to Sutrapada coast, Veraval also showed the presence of *I. tuberculatus.*It also showed sporadic colonies of *I. maculatus.*This was present at scattered colonies of 5-20 individual polyps(Plate 4.7:B).The mid littoral zone was having a mixture of the colonies of *Zoanthus spp*. and *Palythoa spp*. Patchy colonies of *P. tuberculosa* were observed inside the outgrowth of a mixture of *Z. vietnamensis* and *Z. sansibaricus* colonies(Plate 4.7:C). The *Palythoa* colonies were ranging in sizes in this zone from sporadic distribution of 15-20 centimeters to 2 meters maximum size. Though the mid littoral zone showed presence of *Zoanthus spp*. and *Palythoa spp*, colonies of *Zoanthus spp.* were observed to be dominating in the mid littoral zone. The linear belts of *Z. sansibaricus* were seen at the shaded areas of mid littoral zone. This might be the colonies of molecular variation in comparision to the ones which were present at the elevated parts of the rocky

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

shore. Such type of variation is also seen at other parts of the tropical reefs (Kamezaki *et al.*, 2013). However, a typical distribution of *P.tuberculosa* was seen on the slopes of tide pools in the mid littoral.

The infra littoral zone of the coast showed super abundance of *Z. sansibaricus* with the mat like distribution having 20 – 25 m of length and 30 – 35 m of width. Most of the infra littoral zone of Veraval coast was dominated by this speceis of Zoanthids. However, sporadic colonies of *Palythoa spp.* were also found embeded into or at the periphery of the Zoanthus colonies. A linear distribution pattern of *Z. vietnamensis* was also seen along the crevise(Plate 4.7:E).It was identified in one of the study that due to molecular variation some of the *Z. sansibaricus* were found to be growing best in full sunlight whereas some of them were found to be growing in crevices where direct insolation during the mid – day was to a limited extent (Kamezaki *et al.*, 2013). This result matches the findings of the current study where the colonies of *Z. sansibaricus* are found to be present at different parts of the littoral zone with varied pattern of distribution. The majority of the ifra littora zone was covered by the mat like colonial growth of *Zuanthus spp*. (Plate 4.7: F). The overall assessment suggests that the Veraval coast is most supportive for the survival of all the three species of zoanthids under investigation.

4.2.4 SUTRAPADA:

Unlike Okha and Dwarka, Sutrapada coast is a blend of sandy beach and rocky shore. A larger portion of the shore which is partially uplifted rocky substratum makes a suitable habitat for growth and development of zoanthids. Similar to the general distribution pattern of zoanthids a usually observed distribution pattern was seen at this study site. The supra littoral zone was highly dominated by

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

Palythoa spp. among all the zoanthids present. The trend continued in the mid littoral zone as well with nearly 55 % of the zone was covered by *Palythoa spp.*(Figure: 4.8). However, the infra littoral zone was dominated by large colonies of *Zoanthus spp.* Sutrapada shore is also characterised by marked presence of *Isaurus spp.* which was absent in Okha and Dwarka. In the previous studies on *Palythoa spp*., it was identified that they were abundant and widely distributed at the rocky littoral zones along the Saurashtra

It was also documented that during the monsoon the density of *Palythoa spp*. was reducing (Trivedi J. N. and Vachhrajani K. D., 2014). The reason behind this might be the dilution of sea water by precipitation as it would change the salinity gradient. The results of the previous studies also find a moderate degree of similarity with the current study with respect to the distribution of *Palythoa spp*. and *Zoanthus spp*. However, the particular site under observation for the current study is away from observations made in the previous study. Starting from the shoreline, the first types of zoanthids abundantly distributed were *Palythoa spp.* (Plate 4.9: A). However, patchy distribution of the *Isaurus spp.* was recorded from the supra littoral zone (Plate 4.9: B).

The mid littoral zone was found to be having blended colonies of *Zoanthus spp*. and *Palythoa spp*. (Plate 4.9: C). The colonies were found to be overlapping, however, uncertainty prevails regarding the overriding species. A distribution pattern, similar to the one found during the current study is also reported along the Saurashtra coast where the infra littoral zone was dominated by *Zoanthus spp*. (Trivedi and Vachhrajani, 2014).

In the current study, *Palythoa spp*. was highly distributed in supra littoral zone. Approximately 20-22 colonies of *P. Mutuki* were randomly distributed in a large

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

extent in the supra littoral zone marking the dominance of *P. mutuki* at Sutrapada coast. The colonies were having the size ranging from 1 to 10 meters in diameter. However, most of the colonies had amorphous pattern of distribution which can also be termed as uneven. Sporadic or clustered distribution pattern; though to a very limited extent, was seen in the case of *Isaurus tuberculatus*. *I. tuberculatus* was found to be distributed in the colonies having indefinite shape. However, the extent of growth and distribution of the colonies of *I. tuberculatus* was limited to the middle part of supra littoral zone. In most of the cases these were found to be distributed at the points in the supra littoral zone where accumulation of sea water was for 3-4 hours a day. This suggests that apart from the higher sedimentation rates, there are other ecological aspects which continuously affect the existence of *I.tuberculatus*. Due course of the research work, the average community of *I. tuberculatus* found at Sutrapada was having 20 – 40 centimetre in diameter. The mid littoral zone of the coast was highly dominated by *P. mutuki* with nearly 70 % of the zoanthid coverage. The spread of the colonies of *P. mutuki* was found to be ranging from 30 meters to 60 meters. The mid littoral zone of Veraval coast was also having marked presence of *P. tuberculosa* with 10 to 12 colonies randomly distributed at various topographical features of the rocky shore. It is noteworthy that the colonies of *Palythoa tuberculosa* were more or less present at the flat bottoms unlike the colonies of *P.mutuki* which showed presence at the uneven surfaces. However, the colonization of *P. tuberculosa* in the mid littoral zone may be attributed to the more or less flat surfaces in this zone. The colonies of *P. tuberculosa*, unlike *P. Mutuki*were in patches distinctly apart from one another. This may be considered as a random distribution pattern as none of

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

the existing ecological parameter was found to be associated with their sporadic distribution.

The mid littoral zone showed a transitional distribution pattern of *Z. sansibaricus* with 10 – 12 numbers of colonies averaging in size from 1 to 5 meters. However, scattered colonies having the length of 25 – 30 meters were also seen in the mid littoral zone. These colonies were also found to be merging into the colonies of *Z. vietnamensis*. The colonies of *Z. vietnamensis* were ranging from 5 meters to 10 meters in length having patchy distribution pattern in the mid littoral zone. Presence of circular to semi circular sporadic colonies of *P. tuberculosa* was also found in the mid littoral zone of the coast (Plate 4.9: D).

The infra littoral zone was observed to be occupied with the patchy colonies of *Z. sansibaricus* and *Z. vietnamensis*. There was a random distribution pattern with blending colonies of both the species were seen in the infra littoral zone of the Sutrapada coast (Plate 4.: E). The colonies were present on uneven surfaces and showed random distribution irrespective of any topographical variation. It is a pre - established fact that different molecular variants of *Z. sansibaricus* were present at different parts and slopes of the littoral zones receiving different levels of solar insolation (Reimer *et al.*, 2007). However, no variation in the *Z. sansibaricus* colonies was seen at the Sutrapada coast. The overall distribution pattern of zoanthids along Sutrapada coast matched the general distribution pattern observed at most of the rocky shores (Figure 4.1).

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

4.3 SUMMARY:

Following table summarises the overall distribution of zoanthids along the Saurashtra coast.

Table 4. 1: Summary of overall distribution of zoanthids along the Saurashtra coast.

Sr. no	Species	Distribution
1	*Palythoa mutuki*	Continuous mats in the supra littoral zone covering the areas of emergence as well as total submergence. linear belts and patchy distribution pattern in the mid littoral zone along the slopes of crevises and tide pools. Circular or semi circular small colonies sporadically embeded in the colonies of *Zoanthus spp.* Dominating *Palythoa* sp. at Okha, Veraval and Sutrapada.
2	*Palythoa tuberculosa*	Continuous patches similar to *P. mutuki*in the supra littoral zone. Patchy colonies along the slopes in the mid littoral zone. Globular colonies co-existing with the colonies of *Zoanthus spp*. found in infra littoral zone.
3	*Palythoa heliodiscus*	Sporadic smaller colonies present in littoral zone of Okha where as patchy discontinuous distribution is observed in the supra tidal zone of other sites.

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

4	*Zoanthus sansibaricus*	Widespread distribution in mid littoral zone and infra littoral zone at all the study sites. Distributed as patchy colonies at Okha and Dwarka.
5	*Zoanthus vietnamensis* Z. aff. *Kuroshio* *Z.* aff. *sociatus*	Present as patches in the mid littoral zone. Mat like colonial distribution in infra littoral zone. Liner growth along the slopes of crevises and at the periphery of tide pools.
6	*Isaurus tuberculatus*	Randomly distributed colonies of 5-15 polyps in supra littoral zone. Absent in Mid littoral and Infra littoral zones. Totally absent Okha and Dwarka.
7	*Isaurus maculatus*	Randomly distributed colonies of 5-15 polyps. Sporadic colonies in supra littoral zone of Veraval

In the current study carried out along the Saurashtra coast four different sites with varied degree of similarities and dissimilarities with respect to their ecological properties. Starting from the northern side of the Saurashtra coast the sites Okha, Dwarka, Sutrapada and Veraval varied in the types of physico - chemical aspects. These parameters are observed to be affecting the diversity and distirbution of benthos along the coasts. Degree of natural predation also affect the density of zoanthids as documented earlier(Randall, 1967, Ott and Lewis, 1972, Sebens K.P., 1982). While assessing all the four sites from north to south of Saurashtra coast there was an increasing trend observed in the suitability of shores for inhabitation of Zoanthids. Okha coast showed scattered and uneven distribution of zoanthid with 20 – 25 % coverage of the rocky shore. Its geomorphology and geological

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

location might have made the shore partially unsuitable for zanthids. It was observed in the previous studies that predation has lesser impact on zoanthid distribution rather than the sedimentation or sand deposition (Sebens K. P, 1982). The Dwarka coast showed comparatively larger colonies of zoanthids with mat like colonies of *P. tuberculosa*. There were also mixed colonies of *Zoanthus spp*. and *Palythoa spp.* Colonies of Zoanthus along the slope of crevices were also observed in the infra littoral zone. At the coasts of Sutrapada and Veraval, presence of *Isaurus spp.* was observed in the supra littoral zone with widespread colonies of *Palythoa spp*. in the type of distribution pattern both of the site were more or less identical and followed the general distribution pattern of zoanthids. In another study carried out at saurastra coast suggested that the littoral zone has varied percentage coverage and distribution of the zoanthids. The authors also found the *Palythoa spp*. to be most widely distributed and *Isaurus spp*. with a lesser distribution (Pandya *et al.*, 2014). In overall study it was found that Okha and Dwarka has comparatively higher similarities. On the other hand Sutrapada and Veraval showed similarity in the distribution of zoanthids. Such similarities may be attributed to the abiotic factors at all the four sites. It is already documented that the distribution pattern of zoanthids in different reef environments having similar physico – chemical and geomorphological characteristics followed a similar pattern of distribution (Irei. *et al.*, 2011).In a previous study at the Saurashtra coast a similar pattern of distribution of zoanthids were observed at different sites. However, there were seasonal variations in the colonies of zoanthids which indicate greater influence of climatic factors on zoanthids (Trivedi, and Vachhrajani, 2014). The overall distribution as observed are found to be affected by varied degrees of physical, chemical and biological parameters. Depending

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF SOME ANTHOZOANS

upon the same different types of distribution pattern were observed at all the four sites under investigation.

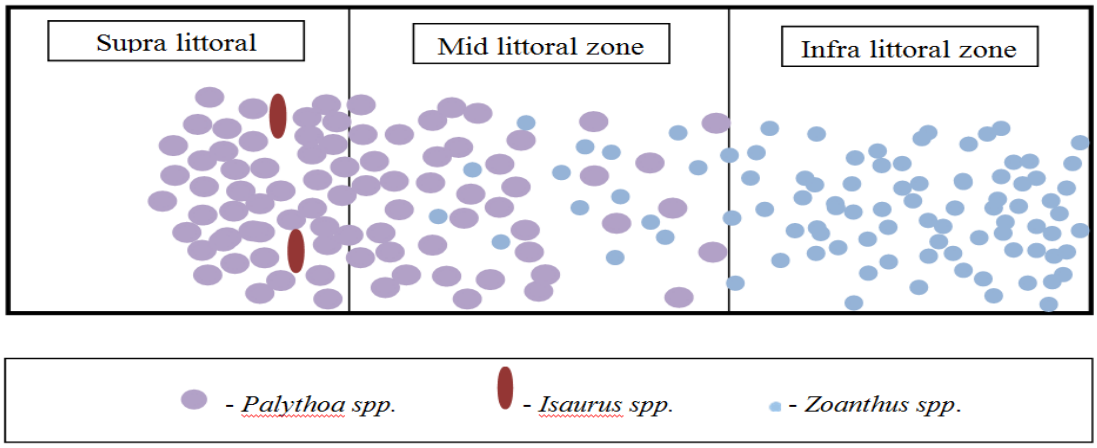

Figure 4. 1: Schematic diagram showing general distribution pattern of zoanthids in littoral zone

ECOLOGICAL ASSESSMENT AND DISTRIBUTION PATTERN OF

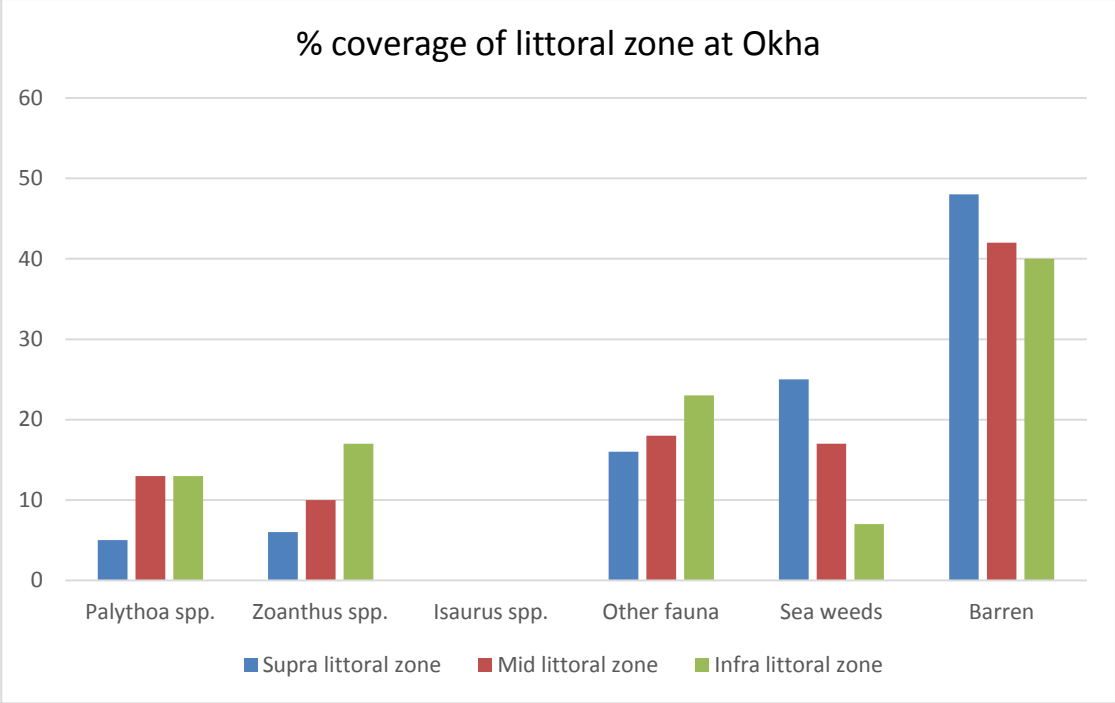

Figure 4. 2: Percentage coverage of Zoanthids at Okha

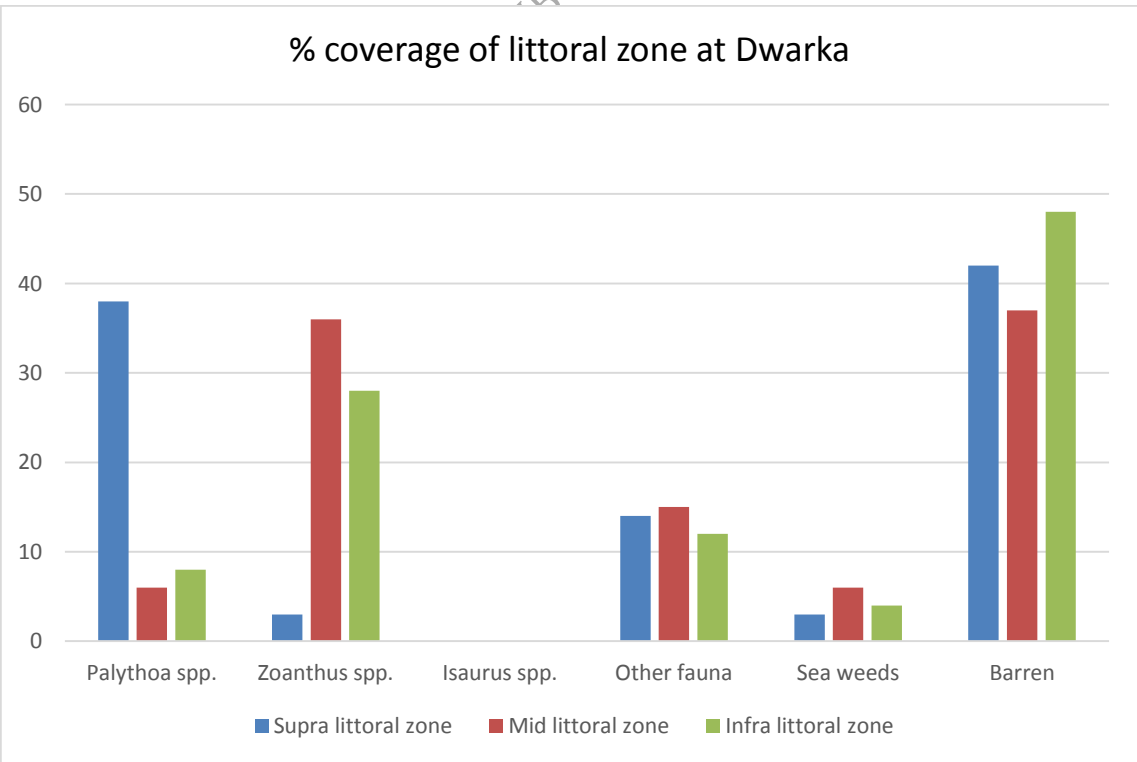

Figure 4. 3: Percentage coverage of Zoanthids at Dwarka

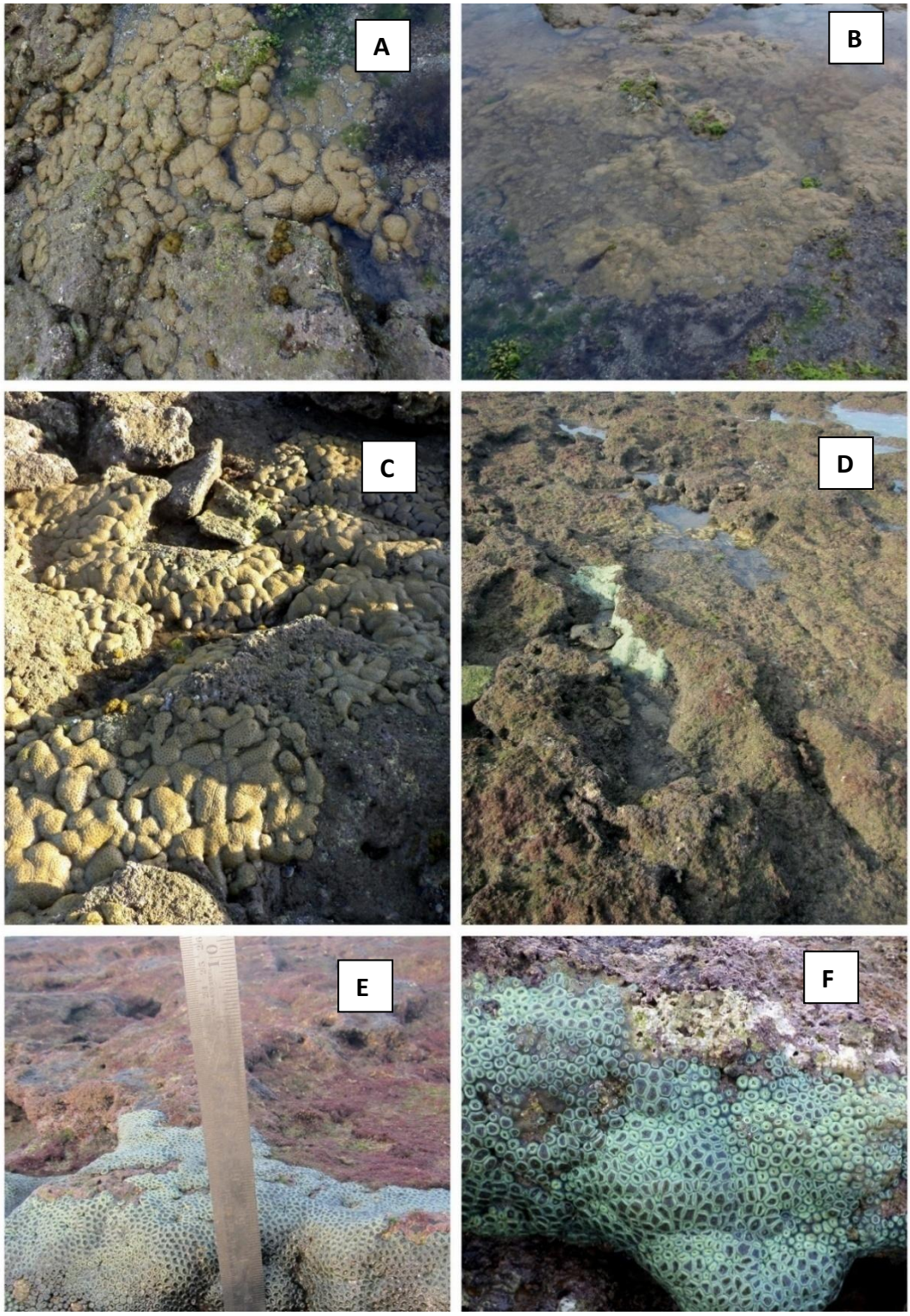

Plate 4. 1: Distribution of Zoanthids along Okha coast.

Plate 4. 2: Distribution of Zoanthids along Dwarka coast.

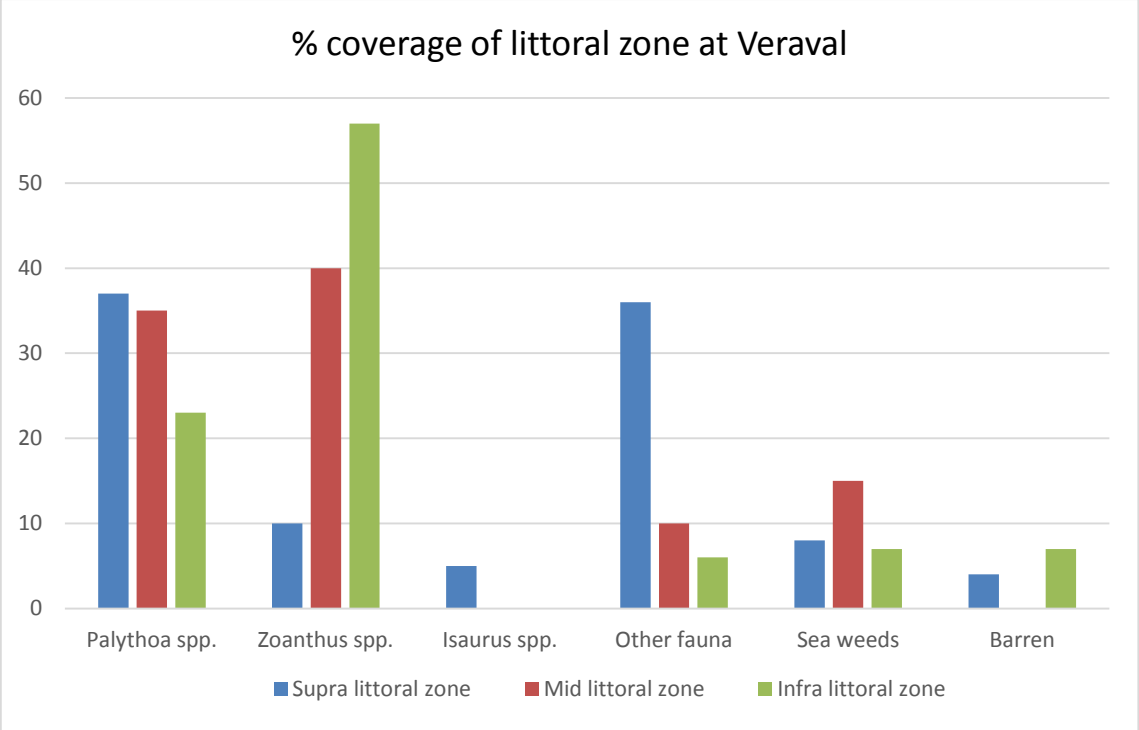

Figure 4. 4: Percentage coverage of Zoanthids at Veraval

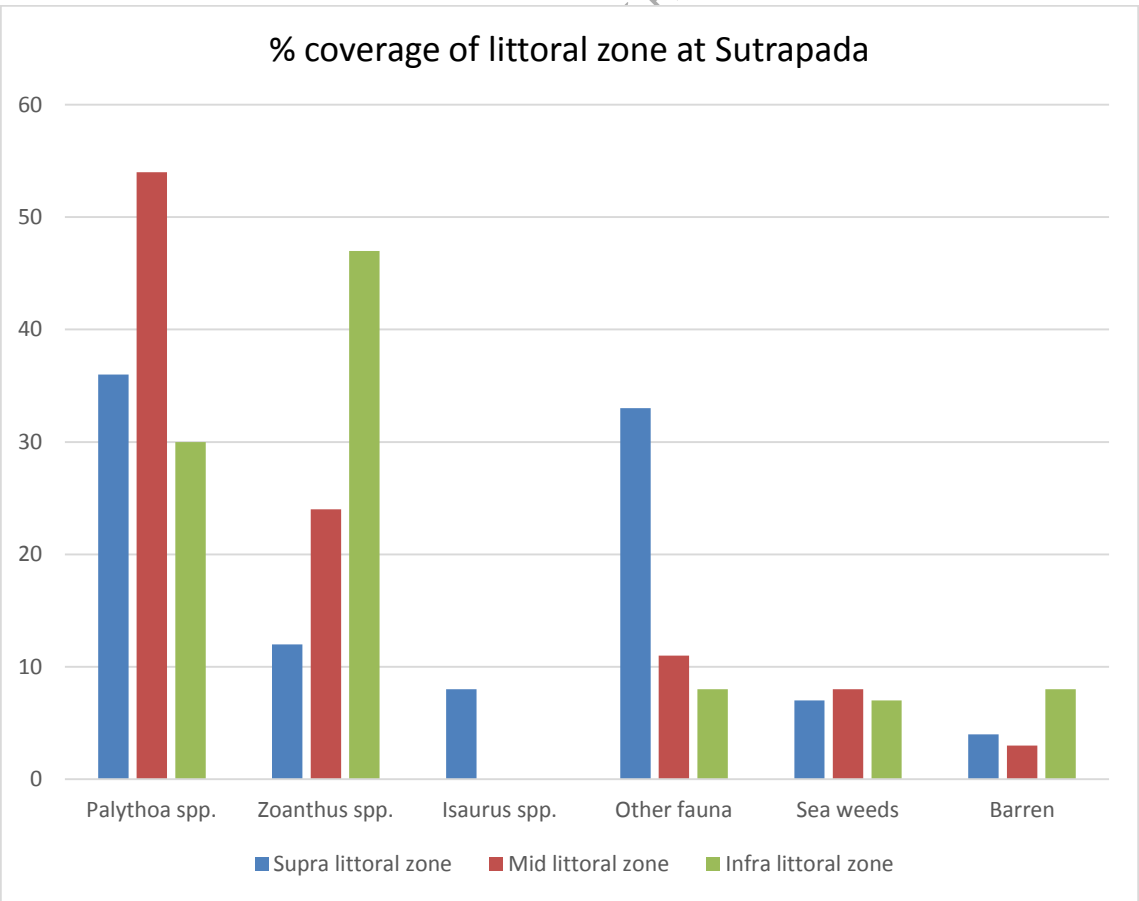

Figure 4. 5: Percentage coverage of Zoanthids at Sutrapada

Plate 4. 3:Distribution of Zoanthids at Veraval Coast

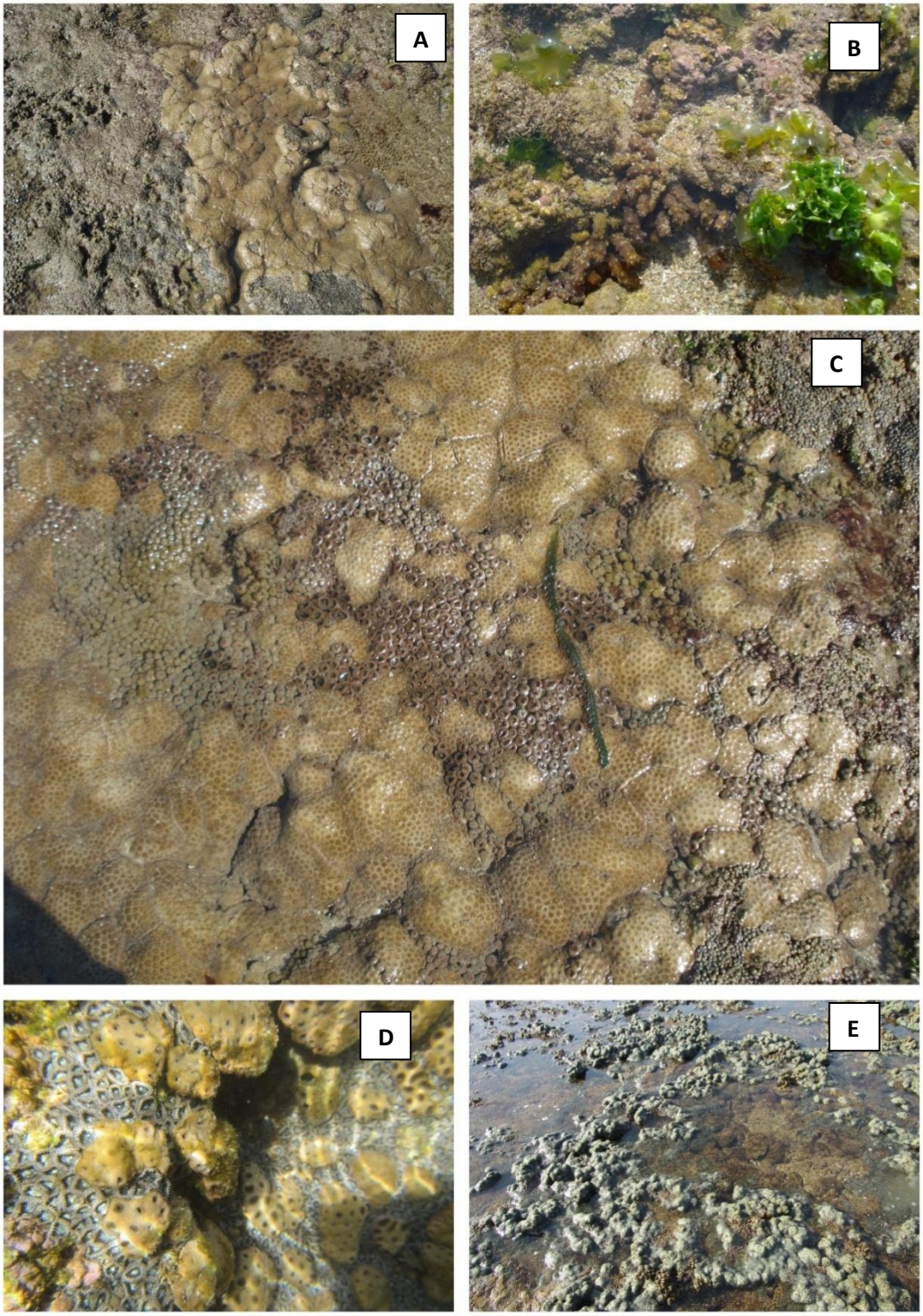

Plate 4. 4: Distribution pattern of zoanthids along Sutrapada coast

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