Chapter 3: Distribution and habitat preference of brachyuran crabs

Introduction

Information on species composition and habitat preference of marine invertebrates is the fundamental requirement to understand the presence of difference species in benthic communities, which on the other hand provides base line information for successful conservation of the habitat and benthic fauna. Studies on the distribution and diversity of local fauna are of great importance because these studies lead to the best understanding of structure, function and problems of the local animal community (Fransozo et al., 1992; Hebling et al., 1994). Particularly, a marine ecosystem requires specific attention and understanding of ecology because it provides shelter to unique and rare animal communities (MacArthur, 1972). The marine intertidal zone is formed within the transition from land to sea and in this particular area organisms experience both marine and terrestrial conditions during high tide and low tide, respectively. Organisms living in the intertidal area have to develop different kind of adaptations because they experience a wide range of physical stresses, including fluctuations in temperature, aerial exposure, salinity, and hydrodynamic forces.

The rocky intertidal community have been studied extensively for different ecological aspects for two main reasons like easy accessibility to the habitat and rich natural resources. However, in spite of long history of various ecological studies carried out on rocky shores, several ecological questions regarding spatio-temporal distribution pattern of faunal communities inhabiting the habitat are not explained. Recent studies have identified several knowledge gaps in the understanding of rocky shore including the importance of micro habitats and zonation patterns. A systematic characterization of local fauna richness on the regional scale is very much important to know the spatio-temporal variation of local faunal community.

The occurrence and variability in the structure of local faunal community depends on their ability of colonization and adaptability to the changes occurring in the habitat at local level. The intra and inter species competition also plays an important role in the structure of macro faunal community. Amongst all the species inhabiting intertidal zone, decapod crustaceans are one of the most common groups of marine organisms. They dwell in variety of habitats like mudflat, sandy shores, mangroves and rocky shores and majority of the species occur in tropical and subtropical regions (Boschi 2000).

Materials and Methods

Zonation is the most important phenomena observed on the intertidal area. Here in the present study, different zones have been identified on the basis of presence of dominant animal community. Belt transect method was adopted for the survey of brachyuran crabs. Total 10 belt transects were laid randomly at each site. The length of the belt transect was considered from the high tide mark to the low tide mark while the width of transect (10 m) was kept constant for all the sites. The transect area was surveyed thoroughly for the presence of the crab species. On the sighting of animal, micro habitat type and zone type were recorded. Hand picking method was adopted for the collection of intertidal specimen while specimens from sub tidal or deep water zone were collected through net with the help of local fishermen. All the specimens were brought to the lab and preserved in 10% formalin for further study and deposition in the Department of Zoology museum. The specimens were identified to the species level using different identification keys and monograms (Chhapgar, 1957a, b; Sethuramalingam and Ajmal Khan, 1991; Jeyabaskaran et al., 2002). For further confirmation of species, all the specimens were examined and compared with the photographs and identification information available on Marine Species Identification Portal website (www. speciesidentification.org) and NIO marine fauna information website (Jeyabaskaran et al., 2002). The classification of brachyuran crabs was adopted from WORMS website (www. marinespecies.org). A Bray-Curtis similarity index was calculated for similarity of distribution in different micro habitats.

Results

Total 30 species of brachyuran crabs belonging to 22 genera and 11 families were recorded from different zones of the study area. Families like Xanthidae which is dominantly found on the rocky shores contributed 5 genera and 8 species to the species account. Family Portunidae also contributed 4 genera and 8 species to the species list. Family Eriphiidae, also typically found on the rocky shores, contributed 3 genera and 3 species. Family Majidea and Dromidae contributed 2 species belonging to 2 different genera to the species list. Family Pilumnidae contributed 2 species belonging to single gnera. Families like Grapsidae, Ocypodidae, Matutidae, Plagusidae and Parthenopidae contributed one species belonging to one genus to the species list. Crab species like *Ocypode ceraptothelma, Atergatis ocyroe, Leptodius exaratus, Etisus laevimanus, Charybdis annulata, Thalamita crenata Menippe rumphi* and *Pilumnus vespertilio* were recorded from all the four study sites while few crab species like *Atergatis roseus, Leptodius affinis, Plagusia squamosa, Matuta planipes, Hyastenus diacanthus, Schizophrys aspera, Dromia dormia, Conchoecetes artificiosus* and *Cryptopodia angulata* were recorded from only single study site of the entire study area. Maximum number of species were recorded from Sutrapada (30 species) followed by Dhamlej (19 species), Veraval (13 species) and Kodinar (11 species) (Table 11).

No.	**Family/species**	**Study sites**			
		Veraval	**Sutrapada**	**Dhamlej**	**Kodinar**
	Xanthidae				
1	*Atergatis intergerrimus*		√	√	√
2	*Atergatis ocyroe*	√	√	√	√
3	*Atergatis roseus*	√	√		
4	*Leptodius affinis*		√		
5	*Leptodius exaratus*	√	√	√	√
6	*Macromedaeus crassimanus*		√	√	
7	*Etisus laevimanus*	√	√	√	√
8	*Demania baccalipes*		√	√	
	Portunidae				
9	*Portunus pelagicus*	√	√		
10	*Portunus sanguinolentus*	√		√	
11	*Scylla serrata*		√	√	
12	*Scylla tranqubarica*		√		
13	*Charybdis feriatus*	√	√	√	
14	*Charybdis lucifera*	√	√	√	

15	*Charybdis annulata*	√	√	√	√
16	*Thalamita crenata*	√	√	√	√
	Eriphiidae				
17	*Epixanthus frontalis*		√	√	√
18	*Eriphia smithii*		√	√	
19	*Menippe rumphii*	√	√	√	√
	Pilumnidae				
20	*Pilumnus vespertilio*	√	√	√	√
21	*Pilumnus longicornis*		√	√	
	Majidae				
22	*Schizophrys aspera*		√		
23	*Hyastenus diacanthus*		√		
	Dromidae				
24	*Dromia dormia*		√		
25	*Conchoecetes artificiosus*		√		
	Grapsidae				
26	*Grapsus albioneatus*		√	√	√
	Ocypodidae				
27	*Ocypode ceratophthalma*	√	√	√	√
	Matutidae				
28	*Matuta planipes*		√		
	Plagusidae				
29	*Plagusia squamosa*		√		
	Parthenopidae				
30	*Cryptopodia angulata*		√		
Total	**30**	**13**	**30**	**19**	**11**

Table 11: Brachyuran crab diversity at different study sites.

As stated earlier, evident zonation pattern was observed at each study site. Brachyuran crabs also showed preference to difference zones as they fulfil their requirements of microhabitats to perform different activities. Only one species of brachyuran crab *Ocypode ceraptothelma* was observed in sandy shore or zone. The species utilizes sandy shore habitat for feeding and burrowing. Peculiar pattern has been observed in burrow distribution on sandy shore in which high density of burrow with large openings were observed on the upper part of the zone while density and opening diameter of burrows decrease drastically as one goes towards lower part of the zone.

Total 19 species were recorded from gastropod zone which makes it most preferable by brachyuran crabs. The gastropod zone also consist of different kinds of micro habitats like shallow tide pools, deep tide pools, rock boulders and rock crevices and these micro habitats provide shelter to different brachyuran crab species. Family Xanthidae was dominantly observed in the gastropod zone (6 species) followed by family Portunidae (5 species), Eriphiidae (3 species) and Pilumnidae (2 species). Families like Grapsidae, Matutidae and Plagusidae contributed 1 species each to the species diversity inhabiting gastropod zone. Zoanthus zone was mostly utilized by carnivore crabs and family xanthidae was observed to be the dominant with 6 species followed by family Pillumnidae (2 species), Portunidae (1 species) and Eriphiidae (1 species). Genus *Atergatis* was observed to be dominant contributing three species. Sub tidal zone was mostly utilized by deep sea species. Total 10 species belonging to families like Portunidae, Xanthidae, Majidae, Dromidae and Parthanopidae were recorded from sub tidal zone (Table 12).

No.	**Family/species**	**Intertidal zones**			
		Sandy shore	**Gastropod zone**	**Zoanthus zone**	**sub tidal**
	Xanthidae				
1	*Atergatis intergerrimus*		√	√	
2	*Atergatis ocyroe*		√	√	
3	*Atergatis roseus*			√	
4	*Leptodius affinis*		√	√	
5	*Leptodius exaratus*		√	√	
6	*Macromedaeus crassimanus*		√		
7	*Etisus laevimanus*		√	√	
8	*Demania baccalipes*				√
	Portunidae				
9	*Portunus pelagicus*		√		√
10	*Portunus sanguinolentus*				√
11	*Scylla serrata*		√		
12	*Scylla tranqubarica*		√		
13	*Charybdis feriatus*				√
14	*Charybdis lucifera*				√
15	*Charybdis annulata*		√		

16	*Thalamita crenata*		√	√	
	Eriphiidae				
17	*Epixanthus frontalis*		√		
18	*Eriphia smithii*		√	√	
19	*Menippe rumphii*		√		
	Pilumnidae				
20	*Pilumnus vespertilio*		√	√	
21	*Pilumnus longicornis*		√	√	
	Majidae				
22	*Schizophrys aspera*				√
23	*Hyastenus diacanthus*				√
	Dromidae				
24	*Dromia dormia*				√
25	*Conchoecetes artificiosus*				√
	Grapsidae				
26	*Grapsus albioneatus*		√		
	Ocypodidae				
27	*Ocypode ceratophthalma*	√			
	Matutidae				
28	*Matuta planipes*		√		
	Plagusidae				
29	*Plagusia squamosa*		√		
	Parthenopidae				
30	*Cryptopodia angulata*				√
Total	**31**	**1**	**19**	**10**	**10**

Table 12: Brachyuran crab diversity of different intertidal zones

Species belonging to families like Grapsidae, Matutidae and Plagusidae were observed only in algal zone because they utilize specific kind of micro habitats like rock crevices and deep tide pools, which are available in the algal zone only. Shallow tide pool with algal assemblage was utilized maximally by different crab species (14 species) as compared to other microhabitats. Species like *Thalamita crenata, Grapsus albioneatus, Plagusia squamosa, Etisus laevimanus, Pilumnus vespertillio, Charybdis annulata* utilized the algal assemblage for feeding and breeding grounds, while species like *Eriphia smithii, Menippe rumphii, Epixanthus frontallis* and *Atergatis ocyroe* which are carnivore in diet use shallow tide pool with algal assemble and under rock habitat as hiding site to ambush prey. The highest density of species like *Leptodius affinis, Leptodius exaratus* and *Macromedaeus crassimanus* was observed in micro habitats like under rock crevices and under rock habitat which provides them better protection against the predators. Species like *Grapsus albioneatus* maximally utilize rock crevices and feeds on the algae attached to the crevices.

Microhabitats like shallow tide pool with *Palythoa* and *Zoanthus* were utilized by 10 and 11 different species respectively. These microhabitats are maximally utilized by species like *Atergatis integerimmus, Atergatis ocyroe, Atergatis roseus, Leptodius affinis, Leptodius exaratus* and *Macromedaeus crassimanus* belonging to family Xanthidae. Species like *Thallamita crenata* and *Charybdis annulata* of family Portunidae were also observed utilizing different microhabitats available in the Zoanthuszone. *Eriphia smithii* was the only species of family Eriphiidae that was observed utilizing micro habitats available in the zoanthus zone. The deep tide pool micro habitat was maximally utilized by large species belonging to family Portunidae.

Total 10 species were observed utilizing deep water micro habitat. Species like *Portunus sanguinolentus, Charybdis feriatus* and *Charybdis lucifera* belonging to family Portunidae were reported only from pelagic habitat. These species mostly utilized sandy bottom and sea grass beds. Species like*Schizophrys aspera, Hyastenus diacanthus, Dromia dormia, Conchoecetes artificiosus, Cryptopodia angulata* and *Demania baccalipes* belonging to families like Majidae, Dromidae, Parthanopidae and Xanthidae, respectively were also reported from deep water habitat. The distribution pattern of these species varies with the depth of water (Table 13).

No.	Family/species	Micro Habitat Types							
		Sandy	STA	STP	STZ	DTP	RC	UR	DW
	Xanthidae								
1	*Atergatis intergerrimus*			√	√				
2	*Atergatis ocyroe*		√	√	√				
3	*Atergatis roseus*				√	√			
4	*Leptodius affinis*			√	√		√	√	
5	*Leptodius exaratus*			√	√		√	√	
6	*Macromedaeus crassimanus*			√	√		√	√	
7	*Etisus laevimanus*		√	√				√	
8	*Demania baccalipes*								√

	Portunidae								
9	*Portunus pelagicus*		√			√			√
10	*Portunus sanguinolentus*								√
11	*Scylla serrata*		√			√			
12	*Scylla tranqubarica*		√						
13	*Charybdis feriatus*								√
14	*Charybdis lucifera*								√
15	*Charybdis annulata*		√	√	√		√	√	
16	*Thalamita crenata*		√	√		√	√	√	
	Eriphiidae								
17	*Epixanthus frontalis*		√					√	
18	*Eriphia smithii*		√	√	√		√	√	
19	*Menippe rumphii*		√				√	√	
	Pilumnidae								
20	*Pilumnus vespertilio*		√	√	√		√	√	
21	*Pilumnus longicornis*		√	√	√		√	√	
	Majidae								
22	*Schizophrys aspera*								√
23	*Hyastenus diacanthus*								√
	Dromidae								
24	*Dromia dormia*								√
25	*Conchoecetes artificiosus*								√
	Grapsidae								
26	*Grapsus albioneatus*		√				√	√	
	Ocypodidae								
27	*Ocypode ceratophthalma*	√							
	Matutidae								
28	*Matuta planipes*		√						
	Plagusidae								
29	*Plagusia squamosa*					√	√		
	Parthenopidae								
30	*Cryptopodia angulata*								√
Total	**31**	**1**	**14**	**11**	**10**	**5**	**11**	**13**	**10**

Table13: Microhabitat preference of brachyuran crabs (STA- Shallow tide Pool with algal assemblage, STP- Shallow tide pool with *Palythoa*, STZ- Shallow tide pool with *Zoanthus*, DTP- Deep tide pool, RC- Rock crevices, UR- Under rock, DP- Deep water)

Bray- Curtis similarity percentage was calculated to find out similarity in species diversity between different kinds of micro habitat. Results revealed that the similarity in species composition between different microhabitats ranges from 86% to 0%. There are major three group formed by different microhabitats. First group is formed by micro habitats like STA, STP, STZ, RC, UR and DTP. The second group is formed by DW joining with first group and third group is formed by Sandy habitat joining rest of the groups. Maximum similarity (86%) in terms of species composition was observed for microhabitats like RC and UR forming a separate group. Second group is formed by STP and STZ microhabitats with 85.5 % similarity in species composition. This group joined with the former group with similarity of 69.5 %. STA joined with the group formed by micro habitats like STA, STZ, RC and UR with 55% similarity. DTP showed similarity of 18.5% with the former large group of micro habitats. The DW micro habitat formed a separate group and joined the first group with 4% similarity. Micro habitat like sandy beach formed a third group with 0% similarity with other microhabitat because only *Ocypode ceratophthalma* utilizes this microhabitat and it is not found to use other micro habitats (Fig. 73).

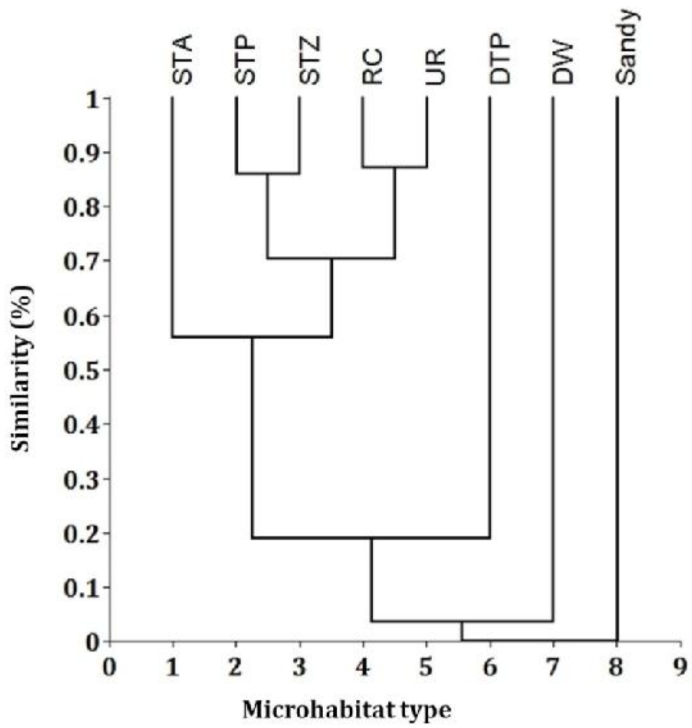

Figure 73: Bray- Curtis similarity indices for brachyuran crab diversity of different microhabitats

Discussion

Rocky shore environment play an important role as a feeding and breeding ground for various crustaceans, fishes and mollusca. The populations of different faunal groups living in the intertidal area are considered as an open population due to larval transport and recruitment from separate populations. This phenomenon produces variation in recruitment which when combined with different abiotic factors create medley of spatio-temporal variation of different intertidal fauna at the local scale (Stephenson and Stephenson, 1972)

The intertidal area of Saurashtra coast is narrow due to its steep slope still it harbours unique kind of marine diversity. Earlier studies carried out along the coastal Saurashtra on the distribution of marine benthic macro fauna reported a total of 127 species which include groups like coelenterate, mollusca, crustacea, echinodermata etc. (Joshi, 2010; Vaghela, 2010). The area also shows good coral diversity, total five species of hard corals were recorded from the area but their distribution and population is very sparse (Raghunathan et al., 2004). However, the brachyuran crab diversity of the concerned area has not been studied in detail. Rocky intertidal areas are known for their brachyuran crab diversity. Kumaralingam et al., (2012) recorded 51 species of brachyuran crabs belonging to 20 genera and 5 families from Ritchieo's Archipelago of Andoman Nicobar Islands and Kumar and Wesely (2010) have recorded 47 species of brachyuran crabs from Laamu Atoll of Maldives. In the present study, total 30 species of brachyuran crabs belonging to 22 genera and 11 families were recorded from different zones of the study area which is comparatively less in number of species but in case of genera and family diversity, the area is very diverse as compared to the above studies.

The rocky intertidal zonation has been studied in detail by many researchers and the results revealed that seasonal fluctuation cause effect on the abundance of marine organisms of different zones (Stephenson and Stephenson, 1972). The intertidal zonation pattern was studied in detail for marine invertebrates like barnacles, mussels, snails and limpets (Chavanich and Wilson, 2000) but only few studies are available on the zonation pattern of brachyuran crabs (Joel et al.,1985; Lohrer et al., 2000 and Pohleet al., 2011). In present study, specific pattern was observed for the intertidal zonation pattern of brachyuran crabs.

The gastropod zone has maximum coverage on intertidal area and harbours maximum diversity of brachyuran crab due to availability of different kinds of microhabitats. In the gastropod zone few brachyuran crab species like *Eriphia smithii, Leptodius exeratus* and *Leptodius affinis* utilize the under rock and rock crevices to ambush the prey species like gastropods, small shrimps and fishes. During the month of November and December, the entire gastropod zone is covered by algal growth (Joshi, 2010). The algal growth provides feeding ground for many herbivore crab species. The algal growth also provides best camouflage environment for many carnivore species. The smaller species belonging to family Portunidae is occurring in high densities in algal assemblage while the larger species of the family mostly prefer deep tide pools. Species belonging to families like Plagusidae and Grapsidae occurs in high density in microhabitats like rock crevices and under rock boulder. These micro habitats provides the species hiding sites from the predators as well as the algae growing on the surfaces of crevices provide best feeding ground. These factors make the gastropod zone more suitable for many brachyuran species to inhabit the zone.

The Zoanthid zone is mostly utilized by many carnivore and poisonous crab species. Zoanthid are known to release specific kind of toxins in to the adjacent environment (Reimer et al., 2006). Species belonging to family Xanthidae were observed occurring in high density in this particular zone. So, it may be possible that the crab species of family Xanthidae might have developed some mechanism to cope up with the toxins released by the zoanthids. *Atergatis ocyroe* belonging to family Xanthidae was the common species inhabiting zoanthid zone. The crab species most possibly associate with *Palythoa* sp. because the colour of the zoanthid species provide best camouflaging environment.

The deep water habitat and pelagic zone is mostly occupied by the specific crab species which are not found in other zones. The distribution and species diversity of the brachyuran crab species varies with the depth of the water. The brachyuran crab species like *Portunus sanguinolentus, Charybdis feriatus, Charybdis lucifera, Schizophrys aspera, Hyastenus diacanthus* and *Cryptopodia angulata* are mostly found in the sea grass beds. The species belonging to family Portunidae utilize sea grass beds as a feeding ground while species belonging to family Majidae and Parthenopidae utilize the sea grass beds as a hiding ground. Species belonging to family Dromidae like *Dromia dormia* and *Conchoecetes artificiosus* are mostly found in the areas where sponges are dominant. The species have symbiotic association with the sponges in which the sponge provides camouflage to the crab while the sponge uses the locomotion of the crab to search new feeding ground (Ng et al., 2008). *Demania baccalipes* belonging to family Xantidae inhabits sub tidal zoanthid beds or coral beds. The species is sometime observed in the lower intertidal zone where the zonathids are abundant.

In the present work, it was observed that the availability of various micro habitat have immense impact on the brachyuran crab diversity of the particular area. The loss of particular micro habitat can create adverse impact on the population of the crab species inhabiting that habitat. Further studies are needed to find out the variation in the abiotic and biotic properties of specific micro habitat on the species in habiting that micro habitat.