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DIVERSITY AND DISTRIBUTION OF INTERITDAL MOLLUSCA AT SAURASHTRA COAST OF ARABIAN SEA, INDIA

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ABSTRACT
This communication reports the diversity and population ecology of mollusca at Saurashtra coast off the Arabian Sea during August 2008 to July 2009. The study was conducted at Mangrol coast to evaluate the present status of the intertidal mollusca. A total of 28 species belonging to 19 families representing 4 different classes were recorded. Results showed that major molluscan population belonged to class gastropoda with dominating species like *Cellana radiata, Nerita albicella, Turbo coronetus, Turbo intercostalis, Trochus radiates and Rhinoclavis sinensis*. The abundance values of *Turbo coronetus* recorded maximum in upper littoral zone but during post-monsoon season high values were observed in middle littoral zone. *Turbo intercostalis* was the most abundant species and was present throughout the year. Middle and lower littoral zone had high abundance values than the upper littoral zone and showed variations in seasonal variations.

KEYWORD: Arabian Sea, Distribution, Diversity, Mollusca, Saurashtra Coast.

INTRODUCTION

The intertidal zone of any ecological area is considered as the most productive with the greatest diversity of plant and animal life. Because of its accessibility, the intertidal zone remain highly explored than any other area (Vaghela *et al*., 2010). Among the diversity of Intertidal area, the molluscs are highly successful animal group in terms of ecological adaptation and they are found in nearly all habitats ranging from deepest ocean trenches to the intertidal zone, freshwater and land where they occupy a wide range of habitats (Vaghela and Kundu, 2011). Mollusca are very abundant and form an important link in the food chains. Amongst marine products, molluscs constitute an edible group next to fish and crustanceans. Molluscs in general, have not been investigated much despite their wide distribution in marine communities (Boero and Fresi, 1986). The spatial patterns in the structure of assemblages on hard substrates have been widely documented from intertidal substrates (Benedetti-Cecchi 2001; Fraschetti *et al*., 2001). Quantitative information on distribution patterns of molluscan assemblages is mainly focused on soft substrates and coral reefs (Buhl-Mortensen and Høsæter, 1993), Antarctic Sea (Cattaneo *et al.,* 2000), Mediterranean Sea (Conti and Rossini, 1985; Milazzo *et al.,*2000) and tropical environments (Esqueda *et al.,* 2000; Bouchet *et al.,* 2002). According to a rough estimate done around three decades ago, the rocky Saurashtra coastline along with the Gulf of Kachchh supports about 210 species of marine algae, over 150 species of molluscs (Sarvaiya, 1977). However, no detailed survey of intertidal fauna especially molluscan forms is done in the Saurashtra coast. These studies have been conducted long before the commercial exploitation of the coastal area had begun and hence could be used as reference. The present study deals with the intertidal molluscan diversity of rocky intertidal area and the population ecology of two prominent molluscan species at Mangrol coast off the Arabian Sea.

MATERIALS AND METHODS

Study area

Among the eight maritime states of India, Gujarat, situated on the western coast of India, with the coastline about 1650 km long shore which comprises about 22 % coastal stretch of the total coastline of India. Gujarat coastline consist 28 % sandy beach, 21 % rocky coast, 29 % muddy flats, 22 % marshy coast. Gujarat coast could be broadly described into four regions viz., the Gulf of Kachchh, the Saurashtra Coast, the Gulf of Khambhat and the South Gujarat Coast. Presently, Saurashtra coast is especially a hot-spot for various mega industries, fisheries and more importantly the tourism is also one of the related problems on the coastal zone of Saurashtra peninsula. For present investigations, Mangrol was selected along the Southern Saurashtra coastline off the Arabian Sea (Figure 1). This site experiences high amount of pressure exerted directly by human population in terms of pollutants from both harbors and terrestrial sources and it being easily accessible in the open coast, the site was chosen. Mangrol (GPS: 21^0 07'N, 70^0 07'E) is a small hamlet and an important fishing harbor around 50 km west of Veraval with many small scale fisheries industries located along the coastline.

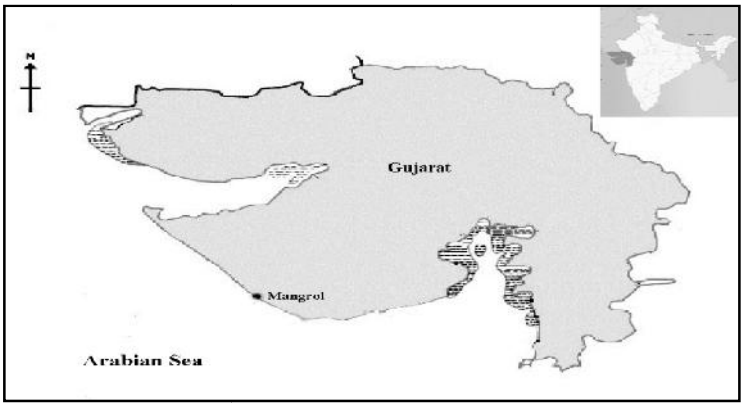

FIGURE 1. Map of the study site along the Saurashtra coast off Arabian Sea.

Data Collection

The intertidal zone of sampling site was surveyed regularly from August 2008 to July 2009 on monthly basis and all the molluscan species encountered were properly recorded during the lowest tides and later classified systematically and a checklist was prepared. The complete study was conducted in a totally non-destructive manner, involving extensive digital imagery, in which the organisms were disturbed to the bare minimum, let alone killing any. The total length of Mangrol coast is about 6 km. The intertidal area of the entire coast was divided into three sampling sites. A belt transect method was used for sampling and quadrats of 0.25 m^2 were placed randomly at about 10 m apart in the belt following an oblique direction covering maximum area of transect at almost regular occurrence. The prominent molluscan species were *Turbo cornatus* and *Turbo intercoastalis.* These species are distributed in all the three zones viz., upper, middle and lower littoral zones. Thus, role of individual zonal attributes also studied simultaneously.

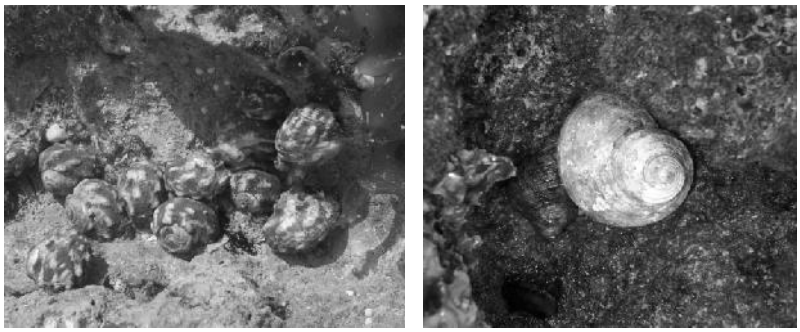

FIGURE 2 (**a)** *Turbo coronetus* Gmelin, 1791 **(b)** *Turbo intercoastalis* Menke 1846.

Analysis of data

The monthly surveys were summed up to four seasons viz., winter (December to February), summer (March to May), monsoon (June to August), post monsoon (September to November). This approach was chosen because the climatic conditions in this region do not differ much in the successive months (Misra and Kundu, 2005). Among the ecological attribute, abundance was calculated as per Misra (1968). Abundance values are used to demonstrate the evenness of the species respectively and considered the population abundance as the principal ecological factor since the distribution of the selected species was very patchy in the intertidal zone (Misra and Kundu, 2005).

RESULTS & DISCUSSION

The result deals with the diversity of Mollusca in the intertidal zones of the Mangrol coast of the Arabian Sea. Mangrol coast is directly affected by various human activities. The intertidal area under study is just besides the main center of port related activities. The Mangrol coast is constantly visited by the human population which freely performs all sorts of activities in it. The most serious consequent of these human activities is a habitat destruction which adversely and more permanently affects the coastal ecosystem. The Mangrol sampling site has been surveyed regularly and all the species of mollusca that were occurring along the entire intertidal area have been recorded during lowest tide for the present study. A total of 28 species of mollusca belonging to 19 family of 4 different class were recorded (Table 1). The major molluscan population of selected intertidal zone belongs to class gastropoda with dominating species like *Cellana radiata, Nerita albicella, Turbo coronetus, Turbo intercostalis, Trochus radiates* and *Rhinoclavis sinensis*. Raghunathan *et al.* (2004) examined that the gastropod group were the dominant comprising about 27 species followed by crab which comprises 8 species at Veraval. This trend may be due to the fact that the mollusca mainly feed on the marine algae and thus, always associated with

intertidal seaweeds (Misra and Kundu, 2005). The diversity of the mollusca at the selected shore occupy different levels of the intertidal zone, each species were dominated at the particular zone where the conditions are most favorable for them. However, the nature of substratum type such as pools, cups and channels and availability of food also play significant role for the distribution of different species. It was also suggested that the specific seaweed association of molluscs play considerable role in their abundance and distribution in the intertidal zone (Newell, 1976; Purchon, 1968; Underwood, 1992; Misra & Kundu, 2005; Vaghela *et al.,* 2010). Some species like *Octopus vulgaris, Loligo duvaucelii, Sepiella inermis* and *Mytilus edulis* were preferred mainly middle and lower littoral zone which are generally covered by water. There were another three classes recorded such as amphineura, bivalvia and cephalopoda, which comprises non gastropod species. Among them 9 species of non-gastropod mollusca were recorded during the study period. These species preferred mostly the middle and lower littoral zone except *Chiton peregrinus* and *Sunetta scripta.* In case of some non-gastropod species like *Sepiella inermis, Loligo duvaucelii* and *Octopus vulgaris* have not hard shell like such gastropod and that species mainly preferred the lower littoral zone. *Chiton peregrinus* was usually found in the upper and middle littoral zone; however it was highly diverse in the upper littoral zone on the hard substratum. On the other hand *Mytilus edulis* was found at the middle and the lower littoral zone. During the winter season the population of Mollusca was quite high than the post monsoon at almost all the selected sites. The intertidal areas with rocky and partly sand substratum provide the habitat preferred by the molluscs under study. Among that eight species of oysters, two species of mussels, 17 species of clams, six species of pearl oysters, four species of giant clams and other gastropods such as *Trochus, Turbo* as well as 15 species of cephalopods are exploited from the Indian marine region (Venkataraman and Wafar, 2005).

TABLE 1. Rocky intertidal molluscan diversity of Mangrol coast of the South Saurashtra coastline.

Class	Order	Family	Species Name
Gastropoda	Archaeogastropoda	Patelidae	*Cellana radiate* Born, 1778
		Trochidae	*Trochus radiates* Gmelin, 1791
			Monodonta australis Lamarck, 1822
			Turbo intercoastalis Menke, 1846
			Turbo coronetus Gmelin, 1791
	Mesogastropoda	Neritidae	*Nerita albicilla* Linnaeus, 1758
		Cerithiidae	*Cerethium caeruleum* G.B. Sowerby II, 1855
			Rhinoclavis sinensis Gmelin, 1791
		Cypraeidae	*Cyprea lynx* Linnaeus, 1758
		Strombidae	*Tibia insuladchorab* Röding, 1798
			Thais bufo Lamarck, 1822
		Muricidae	*Murex bruneus* Link, 1807
			Purpura panama Röding, P.F., 1798
	Neogastropoda	Buccinidae	*Cantharus spiralis* Gray, 1839
		Mitridae	*Mitra sculata* Gmelin, 1791
		Olividae	*Oliva olive* Linnaeus, 1758
		Terebridae	*Conus miliaris* Hwass in Bruguière, 1792
	Sasommatophora	Siphonariidae	*Siphoneria siphoneria* Sowerby, G.B. I, 1824
	Anaspidea	Aplysiidae	*Aplasia oculifera* Adams, A. & Reeve, 1850
Amphineura	Polyplacophora	Chitonidae	*Chiton peregrinus* Thiele, 1910
Bivalvia	Filibranchia	Mytilidae	*Mytilus edulis* Linnaeus, 1758
	Veneroida	Veneridae	*Paphia ala-papilionis* Röding, 1798
			Sunetta scripta Linnaeus, 1758
			Venus reticulate Linnaeus, 1758
			Dosinia cretacea Reeve, 1850
Cephalopoda	Decapoda	Lolignidae	*Loligo duvaucelii* Orbigny, 1848
		Sepiidae	*Sepiella inermis* Van Hasselt, 1835
	Octopoda	Octopodidae	*Octopus vulgaris* Cuvier, 1797

Gastropoda was the high occurring group among all the species of mollusca. *Turbo coronetus* and *Turbo intercoastalis,* belonging to trochidae family of group gastropoda were observed prominently in the entire littoral zone of Mangrol sampling site. Therefore, *Turbo coronetus* and *Turbo intercoastalis* were selected for detail population ecology study for their acceptability along the intertidal zone throughout the study. In the present investigation, among the ecological attributes abundance was analyzed which was also demonstrating the evenness of those species along the selected intertidal area. *Turbo coronetus,* usually occurred in clusters, therefore the abundance values were found to be high. The abundance values showed fluctuation in seasonal data. However, there was no more significant difference between zonal distributions were observed. The abundance values of *Turbo coronetus* recorded maximum in upper littoral zone but during post-monsoon season maximum values were

observed in middle littoral zone (Figure 3a). During winter and summer season abundance value was lower than the post-monsoon. From the present study, it was evident that the abundance did not follow any definite trend throughout the study period. It appears from the present study that Mangrol coast is influenced by the various human activities. *Turbo coronetus* is covered with a very hard and thick solid shell and fluctuations in physical conditions hardly brings any changes on their distribution. The distribution of this species was quite high in this rocky coastline. However, the sampling site is formed of fragile calcareous stone resembling dead coral base which could not offer sufficient smooth and wider open area for individual species. That can be a possible reason for lesser number of this group of animals. Seasonal fluctuation may be due to the change in photoperiod, wave action of the tide (Underwood, 2000). The maximum abundance values were recorded 1.52 no/0.25m^2 and 1.48 no/0.25m^2 during post-monsoon in case of *Turbo coronetus* and *Turbo intercoastalis* respectively (Figure 3a & 3b). *Turbo intercostalis* was the most abundant species and was present throughout the year, with very low in summer. Abundance values were significantly higher at middle littoral zone during most of the seasons. Middle and lower littoral zone had high abundance values than the upper littoral zone and showed variations in seasonal trends (Figure 3b). The marine animals along the intertidal have to protect themselves against high salinity, desiccation and against the predators. Thus they achieve through taking shelter under the bushy canopy of the seaweeds which grow better on the lower littoral zone (Misra & Kundu, 2005). The abundance values increased remarkably and reached at their peaks during post-monsoon season and then remained at intermediate level till the monsoon. This species preferred to dwell at the middle littoral zone but during the study this species found at all littoral zone with highly occurrence (Figure 3b). The fluctuation was more or less similar during winter and post-monsoon. The abundance values showed decline trend at all the sites studied during summer season. The results of the abundance value confirmed that *Turbo coronetus* is versatile and mobile gastropod which can rapidly migrate from adverse habitat condition to a better one (Underwood, 1998). The contrasting coast characteristics of the Saurashtra coast is reflected on the local migration of this species which is ultimately patterned the observed results.

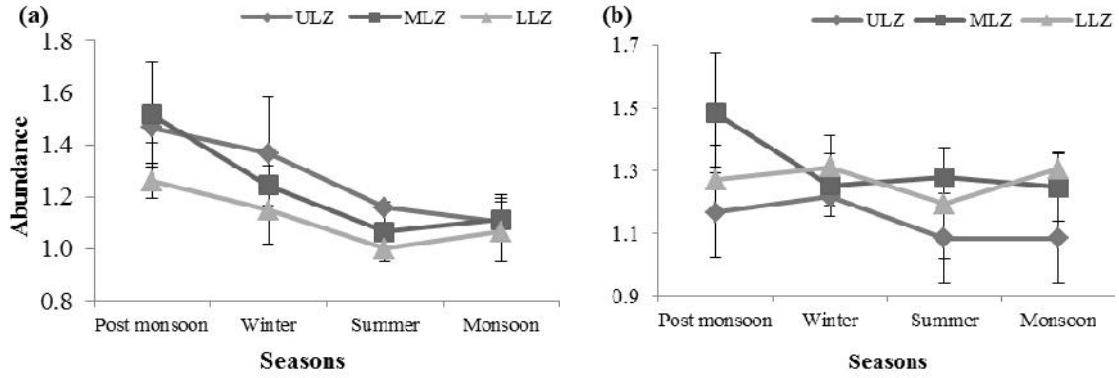

FIGURE 3. Seasonal variations in mean abundance (± SD) values (no/0.25 m^2) of **(a)** *Turbo coronetus* Gmelin, 1791 **(b)** *Turbo intercoastalis* Menke, 1846 in different littoral zones at Mangrol. (Abbreviations used ULZ, MLZ and LLZ are Upper, Middle and Lower Littoral Zones respectively).

The distribution of *Turbo intercostalis* in the intertidal belt of selected locations is uniform and solitary. As they are mostly found in the middle and lower littoral zone, getting an encounter with this group was a rare occurrence. They prefer small but deep rock pores or openings where they can fix themselves singularly either with the base or within the rock fold (Kelaher *et al.,* 2001). At the intertidal belt of Saurashtra coast, though rock condition of the upper and middle zone provides sufficient suitable holes to dwell at, still the local people use these animals as food. Gastropod species likes the hard substratum for high proliferation and they themselves are equipped with well-developed shell system and that helps them to sustain quite easily at changing condition of the atmospheric condition (Anbuchezhian *et al.,* 2009; Vaghela *et al.,* 2010).

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