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SURVEY AND DIVERSITY OF INTERTIDAL MOLLUSCSALONG THE COAST OFVERAVAL (GUJARAT), ARABIAN SEA

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Abstract: The 1.6 km long rocky coastal stretch with 90 mt. vertical exposure during lowest low tide shown rich biological diversity. The study carried out in belt transect method to study abundance and density of intertidal macrofauna from Sept-2015 to Aug-2016. The zone was divided into 3 zones viz. Zone-1 (0-30mt), Zone-2 (30-60mt), and Zone-3 (60-90mt). The one square meter quadrate having 10 X 10 cm sub quadrates were employed along the line transact at every 10 mt intervals on the intertidal region perpendicular to the shoreline starting from highest high watermark to lowest low water mark at the time of the study. The highest density of organisms found at Zone-2, followed by Zone-3 and Zone-1. The coast exhibited the presence of 31 species of molluscs. It is also observed that the most abundant and year-round species observed was *Patella radiate* followed by *Turbo intercostalis, Chiton granoradiatus*, *Rinoclavissinensis* and *Cerithium*spp. The shellfishes like *Hexaplexendivia, Pyrene versicolor, Anadara Spp., Murex tribulus* and *Chicoreusramosus* shown rare availability at almost all the level.

Keywords: Veraval, Vertical distribution, Diversity, Season, Index.

INTRODUCTION

The intertidal zone is one of the most dynamic marine ecosystems for it is the crossing point between the sea and the terrestrial environment. The physical factors that include the existence of waves and the duration of exposure to sunlight are the factors that affect the life of the organisms inhabiting the intertidal zone (Datta *et al* 2009). Temperature fluctuations, intense solar radiation, and desiccation for considerable period similarly occur, that highly influence the activities of these species (Smith *et al* 2004). The distribution of organisms along this vertical gradient in a specific spatial sequence is known as littoral zonation. This pattern has long been studied (e.g. Wahlenberg, 1812; Ballesteros and Romero, 1988) and it is considered universal by some authors (Mokyevsky, 1960; Barnes and Hughes, 1999).The vertical distribution of littoral assemblages and species has been extensively studied in relation to abiotic factors (e.g. waves, wind, water clarity, temperature and ice exposure; Kiirikki, 1996; Reichert *et al.*, 2008) and the interaction between abiotic and biotic factors (Underwood and Jernakoff, 1981).

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MATERIALS AND METHODS

The study carried out for the entire one year from sepmber-2015 to August-2016. According to the coastal biodiversity survey protocols (UCSC, 2011), the coastal stretch of Veraval (Lat. 20°54' N, Long. 70°21'E) were divided into three different zones. The square meter quadrat having l0 X 10 cm sub quadrats were employed along the line transect at every 10 m interval on the intertidal region perpendicular to the shoreline starting from highest high water mark to lowest low water mark at the time of the study. However, the data was condensed for every 50m stretch of the intertidal belt. The study was carried out in a non-destructive manner. For the identification of shellfishes, they were preserved in 5% formalin. During the entire study, the selected sites were frequently surveyed at monthly interval. The observed and collected mollusks specimens were recorded and later classified systematically with standard manual. The seawater parameters were also recorded at the time of sampling. The appropriate ecological attributes Density, Relative density, Species Richness, Simpson Index, Shannon's diversity index calculated (Clarke and Warwick, 2001).

RESULTS AND DISCUSSION

The results showed a rich habitat in terms of both quality and quantity of mollusks along with seaweeds and other marine organisms. The pre-monsoon and post-monsoon studies reflected a diverse change in abundance of mollusks. The Veraval stretch represented a dense growth of seaweeds and rock substratum as attachment site which supports a possible potential site for the developments of mollusks. It was suggested that the specific seaweed association of mollusks play a considerable role in their abundance and distribution in the intertidal zone (Newell, 1976; Purchon, 1968; Underwood, 1992). The Nature of substratum such as pools, cups, channels, pudals along with seaweed diversity played a significant role in the diversity and distribution of mollusks. The vertical stretch of 0 to 30 meter shown the abundance C*erithiumSpp, Chiton granoradiatus, Mancinellabufo, Patella* (*Cellana*) *radiate, Rhinoclavissinensis, Siphonrialaciniosa, Turbo* (*Marmarostoma*) *intercostalis, Umboniumvestiarium.* The other organisms' abundance is less may be due to high desiccation rate, less biomass of available seaweeds and flush of freshwaters during the monsoon season. The zone-1 exhibited the *Patella radiate* as the most abundant gastropod followed by *Chiton granoradiatus.* The both varieties almost remain stable and have not shown the significant variations in terms of density over the year.

Table A: Availability and diversity of different species of shellfishes at intertidal area of selected sites at Veraval

Class –Polyplacophora		
Order	Family	Species
Neoloricata	Chitonidae	*Chiton granoradiatus*Leloup,1937
		Chitontuberculatus Linnaeus, 1758
Class – Gastropoda		
Heterostropha	Architectonicidae	*Architectonica arcana*Roding, 1798
Littorinimorpha	Bursidae	*Bursa granularis*Röding, 1798
		Bursa spinosa , Schumacher, 1817
		*Tibia curta*Sowerby 1842
Archaeogastropoda	Trochidae	*Umboniumvestiarium*Linnaeus,1758
		Trochus radiates Gmelin, 1791
		Monodontaaustralis Lamarck, 1822
Neogastropoda	Babyloniidae	*Babylonia spirata*Linnaeus,1758
	Buccinidae	*Cantharusundosus*Linnaeus,1758
	Conidae	*Conus acuminatus*Bruguiere, 1792
	Muricidae	*Hexaplexendivia*Gmelin, 1791
		*Mancinellabufo*Lamarck,1822
		Chicoreusramosus Linnaeus,1758
		*Murex tribulus*Linnaeus,1758
	Mitridae	*Mitramitra* Linnaeus,1758
	Nassariidae	*Nassariusolivaceus*Bruguière, 1789
	Olividae	*Oliva olive* Linnaeus,1758
	Magilidae	*Purpura persica*Linnaeus,1758
	Columbellidae	*Pyrene versicolor*Sowerby, 1832
Docoglossa	Patellidae	*Patella(Cellana) radiate* Born, 1778
		*Patella vulgata*Linnaeus*, 1758*
Neritopsina	Neritidae	*Neritaalbicilla* Linnaeus,1758
Basommatophora	Siphonariidae	*Siphonrialaciniosa*Linnaeus,1758
Archaeogastropoda	Turbinidae	*Turbo intercostalis*Menke, 1843
		*Turbo coronetus*Gmelin, 1791
	Cypraeidae	*CypraeaCylindrica*Born 1778
Caenogastropoda	Cerithiidae	*CerithiumSpp.*Bruguière, 1789
		*Rhinoclavissinensis*Gmelin 1791
Class - Bivalvia		
Arcoida	Archidae	*Anadara Spp.*

A total of 31 gastropod taxa were collected within 21families (Table - A). The richest families in the overall dataset in terms of number of species were the Trochidae and the Muricidae with 3 and 4 species, respectively, followed by the Chitonidae (2 species), Turbinidae (2 Species).

The zone-2, vertical stretch of 20-40 mt shown almost presence of all the available species along the veraval coast. The most abundant available organisms included *Balanusamphitrite,*

cerithium spp., Chiton granoradiatus, thais purpura bufa, patella radiate and *Rhinoclavislaciniosa.* The density of *patella radiate* and *Chiton granoradiatus*shown significant decrease compare to zone-1. This may be due to the presence of another varieties of mollusks and crustaceans. Even the middle intertidal zone is with a good number of pudals with sandy substratum which is not preferred by these two varieties. The pudals with sandy substratum represented abundance of *Cerithiumspp, Conus acuminatus, Mancinellbufo,* and *Turbo intercoastalis.* The significant increase of turbo intercostalis, cerithumspp. among the gastropods and *Balanusamphitrite* belonging to arthopods observed along the entire coast.

Table 1: Biodiversity Indexes

Site	Zone-1(0-30mt.)	Zone-2 (30-60mt.)	Zone-3 (60-90mt.)
Taxa_S	13.08	21.19	20.97
Individuals	62.92	44.50	43.67
Dominance_D	0.15	0.08	0.08
Simpson_1-D	0.85	0.92	0.92
Shannon_H	2.19	2.81	2.79
Evenness_e^H/S	0.69	0.80	0.80

The higher Shannon index values indicate a rich and evenly distributed gastropod diversity along the entire coast. The higher values at sublittoral zones indicates preference of habitat by gastropods communities. Since evenness and dominance are simply two sides of the same coin, their measures are complimentary. Simpson's index is based on the probability of any two individuals drawn at random from an infinitely large community belonging to the same species. The values reach 1 indicates the one of the appropriate habitat for the growth of infinite biodiversity along the coastal stretch.

The zone-3 almost shown the similar trend like zone-2 in terms of diversity but there was an observable change in the abundance of molluscs. There was a sharp decline in the density of *cerithium spp., chiton spp, Thais bufo, Patella radiate, Turbo intercostalis* and *Rhinoclavissinensis* observed while there was significant increase observed in *Umboniumvestiatrum, and Trochus radiates* observed.

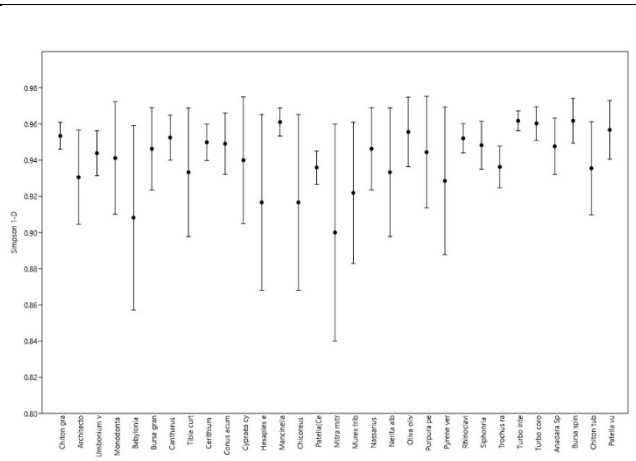

Fig. 1. The Simpson Index

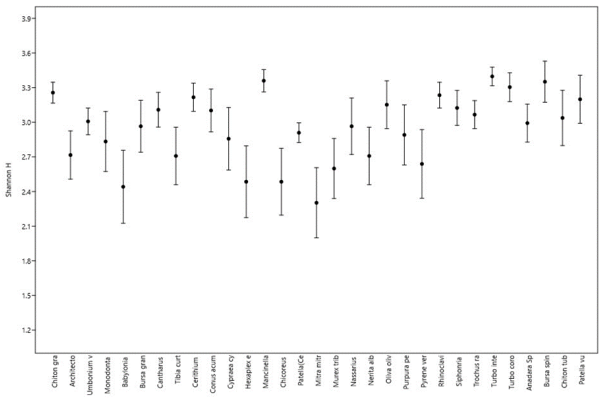

Fig.2. The Shannon's Diversity Index

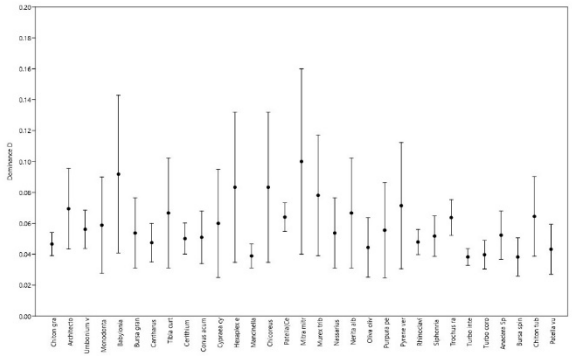

Fig. 3 The Dominance Model

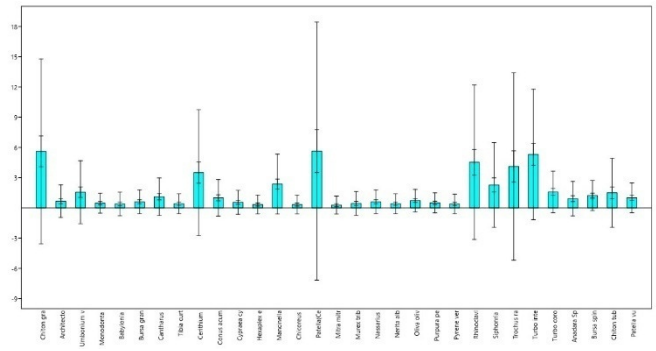

Fig.-4. The Box-Plot model

The level of the diversity of molluscs in the different horizontal stretches shown vast differences. The Statistically, T-test shows that there was a significant difference on dominance, species richness and species abundance of molluscs between the sampling sites Zone-1 and zone-2, while there was little difference between Zone-2 and Zone-3. The zone - 2 and zone-3 had shown high diversity as well as even distribution of organisms, while the zone-1 with more number of organisms but less diversity and uneven distribution of molluscans.

The species *Bursa granulose*, Cerithumspp, *Thais bufo*, *Patella radiate, Oliva olive, Purpura percica, Rhinooclavissinensis, Trochus radiates, Turbo intercoastalis, Turbo coronatus* and *Balanusamphitrite* showed year-round availability. The shellfishes like *Hexaplexendivia, Pyrene versicolor, Anadara Spp.*, *Murex tribulus* and C*hicoreusramosus* shown rare availability at almost all the level.

The *Chiton granoradiatus, Umboniumvestiarium, Cerithium Spp., Patella* (*Cellana*) *radiate, Rhinoclavissinensis, Siphonrialaciniosa, Trochus radiates, Turbo intercostalis* and

Chitontuberculatus exhibited the aggregation behaviour. The remaining species shown the Random and Regular distributional patterns, according to the cumulative data.

The physicochemical parameters of seawater shown comparatively fewer fluctuations over the year. The in the flush of freshwater during monsoon given sharp decline in Temperature and salinity at creek area but the rocky intertidal community got less affected.

The diversity of gastropods shown a declining trend in terms of density and availability during the months of pre-monsoon. This indicated that rise of surrounding environment temperatures especially during low tides, less dissolved oxygen holding capacity of tidal seawater etc. given a direct effect on the distribution and density of intertidal shellfish organisms. The monsoon months also showed less diversity and density of the organisms mainly due to inflush of freshwater, less photosynthesis due to cloudy weather.

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