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Distribution and diversity of Shellfishes along the intertidal rocky coast of Veraval, Gujarat (India)

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Abstract

The rocky intertidal coast of veraval harbours a good number of seaweeds and shellfish diversity. The vertical exposed coastal length of 60-70 meter were divided into three different zones from the highest high tide line. The zones were Zone-1 (0-20mt), Zone-2 (20-40mt), and Zone-3 (40-60mt). The highest density of organisms found at Zone-2, followed by Zone-3 and Zone-1. The coast inhabits 33 species of shellfishes of which 28 were molluscs and 05 crustaceans. It is also observed that the most abundant and year round species observed was *Patella radiate* followed by *Turbo intercostalis, Chiton granoradiatus, Rinoclavis sinensis* and *Cerithium* spp. of molluscs and *Balanus amphtrite* among the crutaceans. The shellfishes like *Hexaplex endivia, Pyrene versicolor, Anadara Spp., Murex tribulus* and *Chicoreus ramosus* shown rare availability at almost all the level. The seawater parameters recorded were: pH – 8.2 to 8.32, Temperature – 28 to 31^{0}C, Salinity – 34.1 to 35.5 ppt, and Dissolved Oxygen – 4.8 to 5.9 mg/l.

Keywords: Veraval, Vertical distribution, Diversity, Season

Introduction

The recent studies of biodiversity focuses on the development of best scientific practices for the conservation and sustainable utilization of the natural resources. The west coast of India represents very dynamic systems with the potential to become one of the best habitat for marine organisms. The diverse coastal area of the Gujarat characterized by its rocky, sandy and muddy intertidal zones, harboring rich and varied biota. The rocky coast of Veraval (21^{0}35‘N, 69^{0}36‘E) is of approximately 3 km, followed by sandy coast near traditional fishing village Jhaleswar. The inhabitant of the intertidal organisms due to diel changes in exposure, desiccation and submergence are known to be hardy and diverse. The intertidal diversity study focuses on the current succession ratio of native pioneer species and introduction of opportunistic species. The factors affecting on both the opportunistic and pioneer species are rapid urbanisation, industrial developments, climate change, and overfishing. The shellfishes are having a good potential for

export markets and domestic consumptions. The present study reflects the current status of shellfish diversity along the rocky intertidal veraval coast. The study on density and diversity of available intertidal organisms may help to redefine existing policies and uncontrolled growth in terms of loss of biodiversity.

Materials and methods

The study carried out for entire one year from sepmber-2013 to August-2014The vertical coastal stretch Veraval were divided into three different zones, according to tide levels. The vertical zones were zone-1, 0-20 mt from highest high tide line to the ocean, zone-2, 20-40 mt and zone-3, 40-60mt. The study was carried out by $1m^2$ quadrate method. The study was carried out in non-destructive manner. For the identification of shellfishes, they were preserved in 10% formalene. During the entire study, the selected sites were frequently surveyed at monthly interval. The observed and collected shellfishes specimens were recorded and later classified systematically. The important physicochemical parameters of seawater were also recorded.

Results and discussion

The results showed a rich habitat in terms of both quality and quantity of shellfishes along with seaweeds and other organisms. The pre-monsoon and post-monsoon studies reflected a diverse change in abundance of shellfishes. The Veraval stretch represented a dense growth of seaweeds which supports a possible potential site for the developments of shellfishes. It was suggested that the specific seaweed association of molluscs 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 shellfishes. Most of the crustaceans preferred middle and lower littoral zone to avoid desiccation and ample availability of food. The vertical stretch of 0 to 20 meter shown the abundance C*erithium Spp, Chiton granoradiatus, Mancinella bufo, Patella(Cellana) radiate, Rhinoclavis sinensis, Siphonria laciniosa, Turbo (Marmarostoma) intercostalis, Umbonium vestiarium.* The other organisms abundance is less may be due to high desiccation rate, less biomass of available seaweeds and inflush 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 has not shown the significant variations in terms of density over the year.

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 *Balanus amphitrite, cerithium spp., Chiton granoradiatus, thais purpura bufa, patella radiate* and *Rhinoclavis laciniosa.* 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 molluscs and crustaceans. Even the middle intertidal zone is with good number of pudals with sandy substratum which is not preferred by these two varieties. The pudals with sandy substratum represented abundance of *Cerithium spp, Conus acuminatus, Mancinell bufo,*and *Turbo intercoastalis.* The significant increase of turbo intercostalis, cerithum spp. among the gastropods and *Balanus amphitrite* belonging to arthopods observed along the entire coast. This zone indicates the presence of *Clibanarius clibanarius (Cancer clibanarius), Charybdis feriatus, Portunus pelagicus, Portunus sanguinolentus* among the crustacenas. The zone-3 almost shown the similar trend like zone-2 in terms of diversity but there was observable change in the abundance of shellfishes. There was

sharp decline in the density of *cerithium spp., chiton spp, Thais bufo, Patella radiate, Turbo intercostalis* and *Rhinoclavis sinensis* observed while there were significant increase observed in *Umbonium vestiatrum, Trochus radiates*and *Balanus amphitirte* observed. The zone also indicated the presence of all available crustaceans as in zone-2. The rise in size and density of seaweeds provided the better habitat to crustaceans than zone-1.

The cumulative mean values available abundance of shellfishes for year 2012-13 and 2013-14 shown that the middle intertidal zone (zone-2) supports highest number of organisms followed by Zone-1 and Zone-3. The zone-1 is with higher density of organisms but biodiversity point of view, the zone-3 is with better potential for future sites for supporting almost all kind of shellfishes.

Table 1: 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
Class - Gastropoda		
Heterostropha	Architectonicidae	*Architectonica arcana(nobilis)* Roding, 1798
Archaeogastropoda	Trochidae	*Umbonium vestiarium* Linnaeus,1758
		Trochus radiates Gmelin, 1791
		Monodonta australis Lamarck, 1822
Neogastropoda	Babyloniidae	*Babylonia spirata* Linnaeus,1758
	Buccinidae	*Cantharus undosus* Linnaeus,1758
	Conidae	*Conus acuminatus (Leptoconus locumtenens)* Bruguiere, 1792
	Muricidae	*Hexaplex endivia(Hexaplex cichoreum* Gmelin, 1791
		Mancinella bufo (Thais purpura bufo) Lamarck,1822
		Chicoreus ramosus Linnaeus,1758
		Murex tribulus Linnaeus,1758
	Mitridae	*Mitra mitra* Linnaeus,1758
	Nassariidae	*Nassarius olivaceus* Bruguière, 1789
	Olividae	*Oliva olive* Linnaeus,1758
	Magilidae	*Purpura persica* Linnaeus,1758
	Columbellidae	*Pyrene (Columbella) versicolor* Sowerby, 1832
Docoglossa	Patellidae	*Patella(Cellana) radiate* Born, 1778
Neritopsina	Neritidae	*Nerita albicilla* Linnaeus,1758
Basommatophora	Siphonariidae	*Siphonria laciniosa* Linnaeus,1758
Archaeogastropoda	Turbinidae	*Turbo intercostalis* Menke, 1843
		Turbo coronetus Gmelin, 1791
Class - Bivalvia		
Arcoida	Archidae	*Anadara Spp.*
Class - Maxillopoda		
Sessilla	Balanidae	*Balanus Amphitrite* Darwin,1854
Class - Malacostraca		
Decapoda	Diogenidae	*Clibanarius clibanarius* Herbst, 1791
	Portunidae	*Charybdis feriatus* Linnaeus, 1758
		Portunus pelagicus Linnaeus, 1758
		Portunus sanguinolentus Herbst, 1783

Table 2: Zone-wise observed density of organisms.

Average zone-wise density of shellfishes					
		species	Zone-1	Zone-2	Zone-3
	Valid	792	232	530	490
	Missing	0	560	262	302
Mean			5.7026	3.6340	2.3388
Std. Deviation			4.99977	3.59715	2.45273
Minimum			1.00	1.00	0.00
Maximum			25.00	16.00	18.00
Sum			1323.00	1926.00	1146.00
Total Species observed			22	35	35

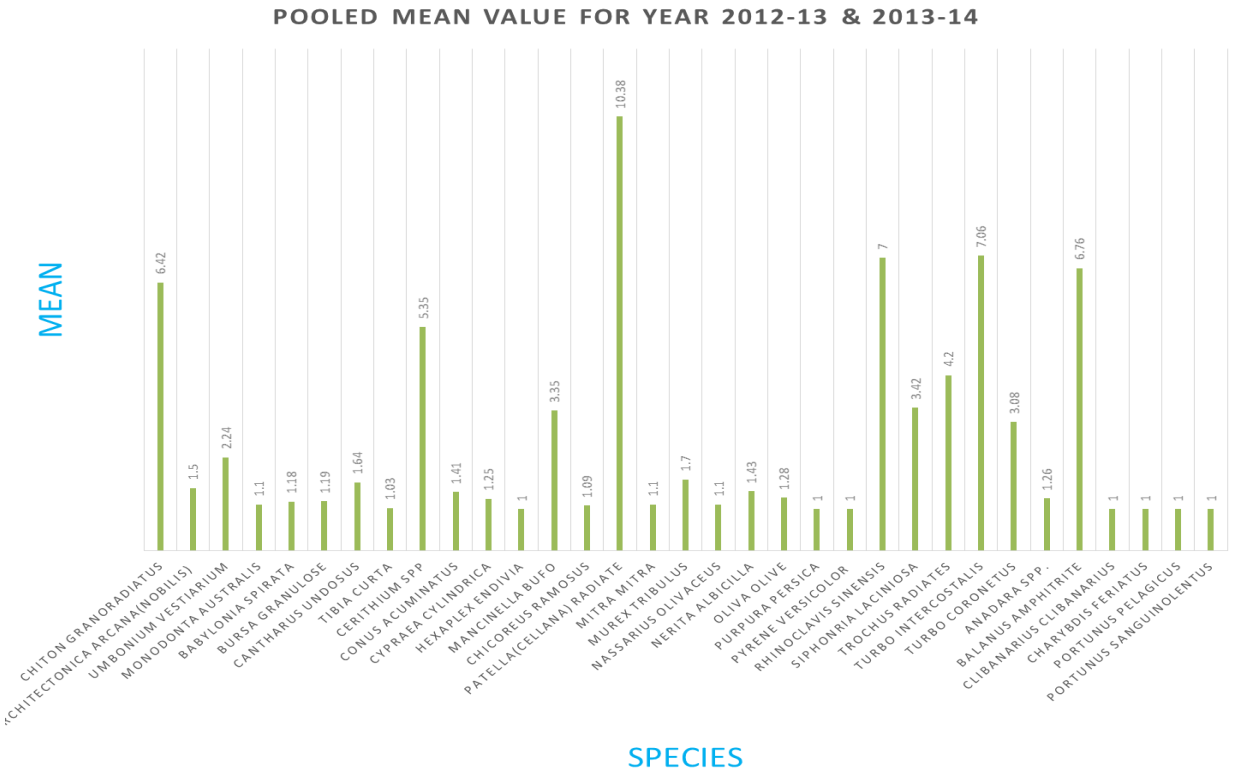


Fig. 1: Mean density values of the number of organisms present.

The species Bursa granulose, Cerithum spp, Thais bufo, Patella radiate, Oliva olive, Purpura percica, Rhinooclavis sinensis, Trochus radiates, Turbo intercoastalis, Turbo coronatus and Balanus amphitrite shown year-round availability. The shellfishes like Hexaplex endivia, Pyrene versicolor, Anadara Spp., Murex tribulus and chicoreus ramosus shown rare availability at almost all the level.

Table 3: Seasonal variation in the occurrence of shellfishes in the intertidal area.

Species	Occurrence (Seasonal)			Species	Occurrence(Seasonal)		
	Post Mon.	Sum.	Pre. Mon.		Post Mon.	Sum.	Pre. Mon.
Chiton granoradiatus	**F**	**F**	**F**	*Nassarius olivaceus*	**F**	**O**	**O**
Architectonica arcane (nobilis)	**F**	**F**	**F**	*Nerita albicilla*	**F**	**F**	**F**
Umbonium vestiarium	**F**	**F**	**F**	*Oliva olive*	**F**	**O**	**O**
Monodonta australis	**F**	**O**	**O**	*Purpura persica*	**F**	**O**	**O**
Babylonia spirata	**F**	**O**	**O**	*Pyrene versicolor*	**R**	**R**	**R**
Bursa granulose	**F**	**F**	**F**	*Rhinoclavis sinensis*	**F**	**F**	**F**
Cantharus undosus	**F**	**O**	**O**	*Siphonria laciniosa*	**F**	**F**	**F**
Tibia curta	**O**	**O**	**O**	*Trochus radiates*	**F**	**F**	**F**
Cerithium Spp	**F**	**F**	**F**	*Turbo intercostalis*	**F**	**F**	**F**
Conus acuminatus	**F**	**F**	**F**	*Turbo coronetus*	**F**	**F**	**F**
Cypraea cylindrica	**F**	**O**	**O**	*Anadara Spp.*	**R**	**R**	**R**
Hexaplex endivia	**R**	**R**	**R**	*Balanus Amphitrite*	**F**	**F**	**F**
Mancinella bufo	**F**	**F**	**F**	*Clibanarius clibanarius*	**F**	**F**	**F**
Chicoreus ramosus	**R**	**R**	**R**	*Charybdis feriatus*	**O**	**O**	**O**
Patella(Cellana) radiate	**F**	**F**	**F**	*Portunus pelagicus*	**O**	**O**	**O**
Mitra mitra	**F**	**O**	**O**	*Portunus sanguinolentus*	**O**	**O**	**O**
Murex tribulus	**R**	**R**	**R**				

Note: F = Frequent; O = Occasional; R = Rare

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

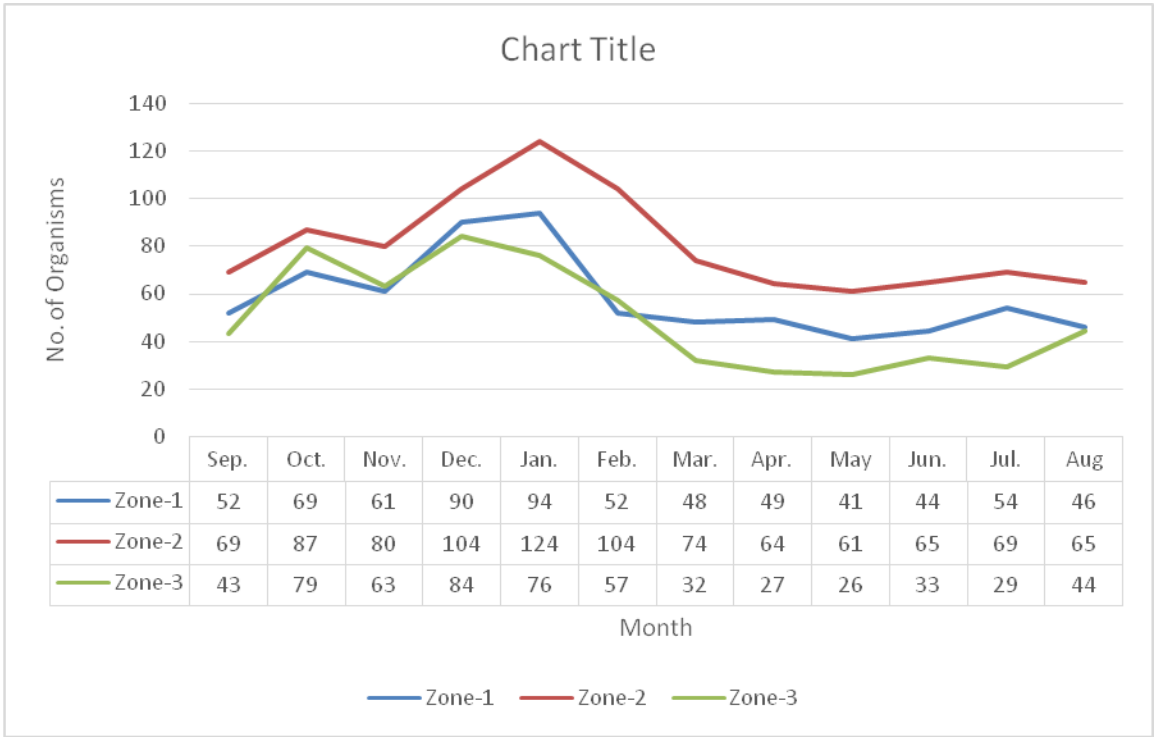
The diversity of gastropods showed a decline trend in terms of density and availability during the months of pre-monsoon. This indicated that rise of surrounding environment temperatures especially during low tides, less dissolved oxygen holding capacity of tidal seawater etc. given a direct effect over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

Table 4: Month-wise variation in the major physicochemical parameters of intertidal seawater.

Year- 2012-2013													
Sr. No.	Water Paramater	Month											
		Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
1.	Temp. (^{0}C)	30	31	29	28	28.5	29	30	31	31	29	29	30
2.	pH	8.3	8.3	8.2	8.3	8.3	8.1	8.3	8.3	8.4	8.2	8.2	8.2
3.	Salinity (ppt)	35.5	35.2	34.4	34.1	34.5	34.5	35.5	35.0	35.2	34.5	34.1	34.1
4.	DO_2 (mg/l)	5.1	5.1	5.3	5.2	5.5	5.2	5.0	5.3	5.3	5.5	5.1	5.0
Year- 2013-2014													
1.	Temp. (^{0}C)	30	29	28	28	28	30	29	30	31	30	29	30
2.	pH	8.1	8.2	8.2	8.3	8.3	8.2	8.1	8.2	8.2	8.3	8.3	8.3
3.	Salinity (ppt)	35.0	35.2	35.3	35.3	35.1	35.0	35.2	35.0	35.0	34.6	34.5	34.7
4.	DO_2 (mg/l)	5.1	5.2	5.5	5.7	5.5	5.6	5.3	5.4	5.5	5.3	5.2	5.1

	September	October	November	December	January	February	March	April	May	June	July	August
Zone-1	12	14	15	16	16	17	18	19	19	20	20	20
Zone-2	26	30	31	32	32	33	33	33	33	33	33	33
Zone-3	21	28	31	32	32	32	33	33	33	33	33	33

Fig. 2: Species richness (Species).



	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug
Zone-1	52	69	61	90	94	52	48	49	41	44	54	46
Zone-2	69	87	80	104	124	104	74	64	61	65	69	65
Zone-3	43	79	63	84	76	57	32	27	26	33	29	44

Fig. 3: Species Richness (No. of Individuals).

The above illustrated diagrams clearly indicates during the months of post monsoon at Veraval coast, i.e July, August, September and October, lesser diversity in terms of both, species and Individuals, observed. After that, there is rising up in the diversity gives indications of more favourable climatic factors and seawater parameters.

Conclusion

The intertidal habitat of the Veraval exhibits a rich biodiversity habitat. The great diversity of shellfishes and seaweeds indicated the Veraval intertidal zone as favourable habitat. The density of shellfishes shown least fluctuations during entire study indicates the diversity is less affected by anthropogenic activities. The results of physicochemical parameters of seawater and year round availability of shellfishes indicate the coast can serve as a natural shellfish species repository for further coming years.

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