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Studies on species dominance of mollusca in rocky-muddy coast of Gopnath, Gulf of Khambhat, Gujarat, India

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Abstract
Species Dominance of molluscs was studied from January 2020 to December 2021 on the basis of the prevalence of muddy and rocky substratum, a single station, Gopnath was chosen and subdivided into three sites (Site-A, Site-B and Site-C). On a monthly basis, 30 Quadrates (1m x 1m) were applied at random to each location. There is a total of 61 species of molluscs, distributed across 23 families. 21 families of molluscs were shared by all 3 sub sites. However, site-A had a greater diversity (H'=2.756), evenly distributed (0.6845) and rich (5.352) of molluscs. Site-A (D=0.9105), Site-B (D=0.8998) and Site-C (D=0.888) all showed greater number of dominant species, indicating that there is an approximate 90% chance of obtaining a distinct species with each random sampling attempt. In contrast, Cerithidae emerged as the dominant and most abundant gastropod family along the littoral of Gopnath followed by Trochidae.

Keywords: Mollusca, species dominance, rocky-muddy coast, Gulf of Khambhat

Introduction
The exertion of a major controlling influence of one or more species upon all other species by virtue of their number, size, productivity, or related activities, would be the concept of ecological dominance (United Nations 1997) [27]. The many fields, such as anthropology and palaeontology (Clapham *et al*. 2006), [3] have an interest in ecological dominance (Flinn *et al*. 2005) [9]. According to Hillebrand *et al*. (2008), [14] dominance in ecology is the contrary of ecosystem evenness, and as a result of their competitive superiority, dominant species are traditionally the most numerous members of natural communities. These species can assemble communities based on the species involved, their diversity, biomass, spatial arrangement, and occupancy. Furthermore, dominant species frequently act as ecosystem engineers or bioengineer species (Jones *et al*. 1994, 1997, Nilsson & Wardle 2005) [15, 16, 18] as they control the distribution and abundance of other species and provide habitat for them. Certain levels of environmental stochasticity (such as disturbance), which maintain stable levels of species diversity and hierarchy, may be necessary for the persistence of dominant species (Connell 1978, but see Fox 2013) [4, 10]. And thus, ecosystem stability and levels of functional diversity may be determined by dominant species and disturbance taken as a whole (Loreau *et al*. 2001, Smith & Knapp 2003). [17, 23] This is especially noticeable in shallow subtidal and rocky intertidal ecosystems, where dominance is frequently attained by one or a few suspension-feeding species (e.g. Dayton 1971, Paine 1971, Sousa 1979, Paine *et al*. 1985, Underwood *et al*. 1991, Castilla *et al*. 2000) [19, 20, 24, 26, 2]. Dominant suspension-feeders are ecosystem engineer species (Wright & Jones 2006) [29] and are existent in most marine ecosystems worldwide (Jones *et al*. 1994, Crooks 2002, Gutiérrez *et al*. 2003). [15, 5, 13] Ecological dominance is strongly correlated with competitive ability (Dayton 1975; Steneck *et al*. 1991; Baird & Hughes 2000, [7, 25, 1] among others), which is frequently thought to have an adverse affect on species richness as competing species attempt to completely eradicate one another. It's necessary to highlight that competition can take many different forms in order to comprehend how ecological dominance can influence the whole community structure. Theoretically, competition only emerges if a particular resource is in limited supply, and it can take the form of exploitation or interference competition when it comes to rivalry over food or space (Schoener 1983, Yodzis 1989). [22, 30] Gastropods at Gopnath are currently in a highly dominant state. Consequently, it is necessary to create a database. The goal of this study was to ascertain the species diversity, frequency, and density of molluscs along Rocky-muddy coast Gopnath.

Material and method
1. Study site
According to the Government of India's Department of Ocean Development's Integrated Coastal and Marine Area Management from May 2002, The Gulf of Khambhat is a south to north penetration of the Arabian sea on the western shelf of India between the Saurashtra peninsula and mainland of Gujarat state. The gulf is only 5 km wide at its mouths, and it widens to its maximum south of Gopnath point. Due to the high tidal amplitude and the heavy load of suspended sediments directed through the perennial rivers emptying into the Gulf, the Gulf of Khambhat in Gujarat is extremely turbid (Raghunathan *et al*., 2003). Gopnath is located at 21° 21'03"44° N, 72° 10'94"36° E and it was chosen as the study site, as it is a significant rocky habitat with sparse mud patches on rocks and inside tide pools and puddles, and it was further divided into three comment section based on the presence of rocky and muddy substratum (Figure 2). A random shell collection within the sampling site was conducted to assemble information on number of species and economic importance. Samples were continuously collected at random along the intertidal zone using a 1 m x 1 m quadrat. There were 30 sampling units in total, which surveyed the entire intertidal area.
All live molluscs found inside each quadrat were photo graphed, identified, counted, and listed on the field

notebook. Representative specimens of species were collected and preserved for future possible uses if needed for further identification. Surveys were carried out from January 2020 to December 2021 at the lowest tide of the day. For mapping purposes, the GPS coordinates were obtained using a mobile GPS location

Fig 1: Map of Study Site

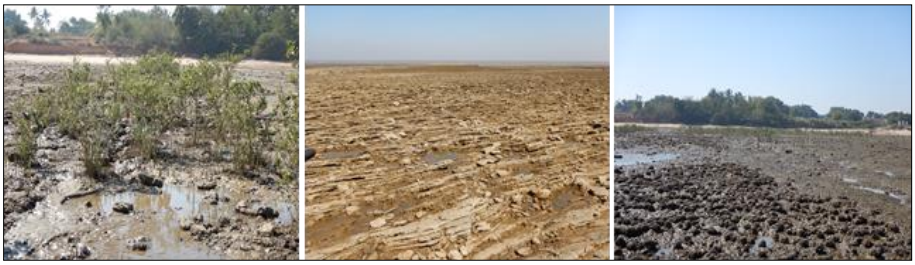

Fig 2: Study Site

Fig 3: Representative photographs of macrofauna

2. Data analysis

The following formulae were used in the analysis of data using Past (version-4.03):

1. The species diversity was computed using Simpson's Diversity (Simpson, 1949) Index

D = Σn (n-1)/N(N-1)

Where,

n = number of individuals of the species.

N = total number of individuals in the sample.

2. Shannon-Weiner index (H') (Species Diversity) For the species diversity assessment Shannon- Weiner index was used (Shannon, 1949).

$H= \sum_{i=0}^{n} pi \ lnpi$

pi = proportion of total sample represented by species

S = number of species or species richness

3. Margalef richness index (D_{Mg}) and Menhinick richness index (D_{Mn}), it is used to investigate the species richness of the community based on Margalef (1958) and (Harper (1999). It is also help for the measurement of total number of species in a provided number of individuals.

D_{Mg} = (S-1)/lnN

$D_{Mn} = S/\sqrt{N}$

Where,

S = number of individuals of one species

N = total number of all individuals in the sample

4. Species Abundance (Misra, 1968).

Ab= N/Q

Where,

N= Total number of individuals recorded

Q= Total number of sample plots where the individuals occurred

Result and discussion

1. Species dominance

Total 61 species of Molluscs distributes among 23 families within the Rocky-muddy shore of Gopnath, Gulf o Khambhat, India (Table-1). 21 families of molluscs were common with all three-sub site. However, site-A had shown most diverse (61 species), evenly distributed and Rich of molluscs. Dominancy assessed with Simpson's index, where all the three sites showed greater number, Site-A (D=0.9105), Site-B (D= 0.8998) and Site-C (D= 0.888) which means there is approximately 90% chances to get different species at each attempt of random sampling (Figure.4). However, for gastropod, Cerithidae emerged as the dominant and most abundant (43%) species along the Gopnath coast followed by the Trochidae family (Table-1).

Table 1: Molluscs found in rocky-muddy shore of gopnath

Class	Family	Sr.no.	Species
Gastropoda	Tellinidae	1.	*Tellina planata* (Linnaeus, 1978)
	Laternulidae	2.	*Laternula anatina* (Linnaeus, 1758)
	Ostreoidea	3.	*Saccostreacucullat*a (Born, 1778)
	Arcidae	4.	*Arcagranosa* (Linnaeus, 1758)
	Donacidae	5.	*Donaxfaba, Plebidonax deltoids (Lamarck, 1818)*
	Cerithidae	6.	*Cerithiumsp –I*
		7.	*Cerithiumsp - II*
		8.	*Cerithiumcaeruleum* (G.B. Sowerby II, 1855)
		9.	*Cerithiumscabridum*
		10.	*Cerithiumlutosum* (Menke, 1828)
		11.	*Cerithiumvulgatum* (Bruguiere, 1792)
		12.	*Cerithiumatratum* (Born, 1778)
		13.	*Cerethiumenchinatum* (Lamarck, 1822)
		14.	*Cerithiumlividulum* (Risso, 1826)
		15.	*Cerithiumcoralium* (Kiener, 1841)
		16.	*Clypemorus pellucida* (Hombron & Jacquinot, 1848)
		17.	*Clypeomorusbifaciata* (Sowerby, 1855)
		18.	*Clypeomorusbatillariaeformis* (Habe&Kosuge, 1966)
	Nassaridae	19.	*Nassariuslivescens* (Philippi, 1849)
		20.	*Nassariusdorsatus* (Roding, 1798)
		21.	*Nasaariusstolatus* (Gmelin, 1791)
		22.	*Nassarius sp.*
	Tegulidae	23.	*Tectusconus* (Gmelin, 1791)
	Trochidae	24.	*Halistyluscolumna* (Dall, 1890)
		25.	*Calliotrochusmarmoreus* (Pease, 1861)
		26.	*Trochusniloticus* (Linnaeus, 1758
		27.	*Umboniumvestiarium* (Linnaeus, C., 1758)
		28.	*Calliostomazizyphinum (Linnaeus, 1758)*
		29.	*Trochus radiatus* (Gmelin, 1791)
	Muricidae	30.	*Indothaislacera* (von Born, 1778)
		31.	*Muricopsisbombayensis* (Melvill, 1893)
		32.	*Semiricinulatissoti* (Petit de la saussaye, 1852)
		33.	*Thais luteostoma* (Holton, 1803)
		34.	*Chicoreusbrunneus* (Link, 1807)
	Turridae	35.	*Lophiotoma indica (Roding, 1798)*

		36.	*Turricula javana* (Linnaeus, 1767)
	Naticidae	37.	*Nerita sp.*
		38.	*Nerita undata* (Linnaeus, 1758)
		39.	*Nerita chamaeleon* (Linnaeus, 1758)
	Turbinidae	40.	*Turritella terebra (linnaeus, 1758)*
		41.	*Astralium rhodostomum (Lamarck, 1822)*
		42.	*Astralium semicostatum* (Kiener, 1850)
		43.	*Astralium stellare* (Gmelin, 1791)
		44.	*Turbo brunneus* (Roding,1791)
	Ranellidae	45.	*Gyrineum natator* (Roding, 1798)
	Littorinidae	46.	*Planxis sulcatus* (Born, 1778)
		47.	*Littoraria scabra* (Linnaeus, 1758)
		48.	*Littoraria undulata* (Gray, 1839)
		49.	*Littoraria intermedia* (Philippi, 1846)
		50.	*Littorariaarticulata* (Philippi, 1846)
	Nacellidae	51.	*Cellana rota* (Gmelin, 1791)
		52.	*Cellana karachiensis* (Winckworth, 1930)
	Potamididae	53.	*Pirenella cingulata* (Gmelin, 1791)
	Chitonidae	54.	Chiton peregrinus (Thiele, 1909)
		55.	Ui
	Haminoeidae	56.	*Haminoea galba* (Pease, 1861)
	Assimineidae	57.	Assiminea *sp.*
	Onchiddidae	58.	*Onchidium verruculatam (Cuvier, 1830)*
		59.	*Onchidium sp.*
	Octopodidae	60.	*Octopus vulgaris* (Cuvier, 1797)
	Buccinidae	61.	*Cantharus spiralis* (Gray,1839)

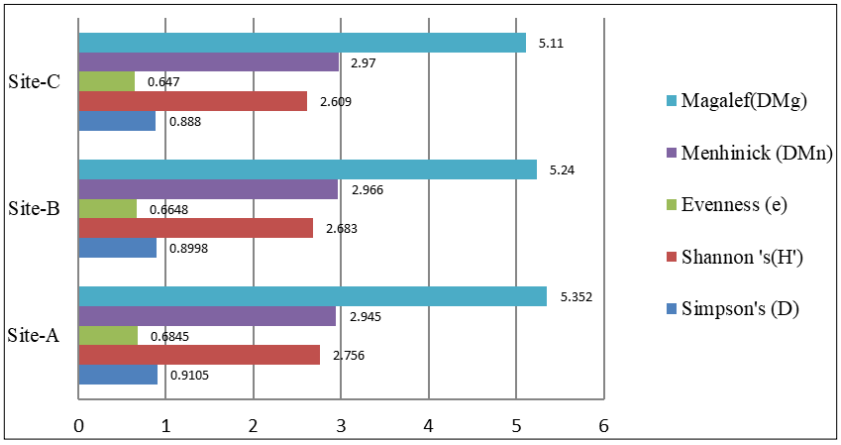

Fig 4: Dominance, Diversity and Evenness of Molluscs with in the Gopnath coast

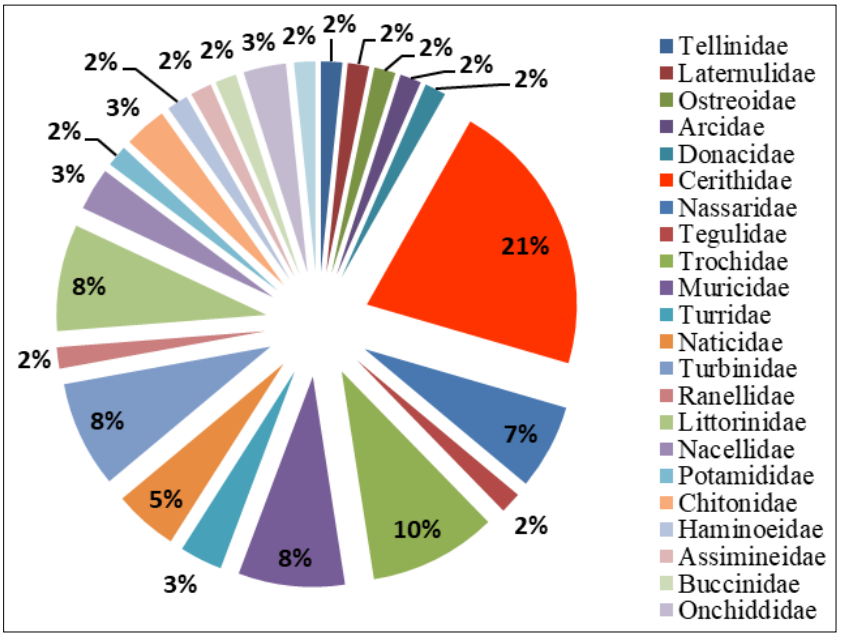

Fig 5: Percentage of Molluscs within the Gopnath Coast

Conclusion

At Gopnath shore, the available intertidal area is predominantly rocky so the macrofauna receives a large substratum to attach to. In particular, the diversity and abundance of molluscs have reached a very high level. Since the entire intertidal zone is characterized by a high degree of diversity and abundance, the Cerithidae family in particular has experienced rapid expansion (Figure-5). Even though Site-A has distinguished itself as a remarkably rich, diverse and evenly distributed area for the Mollusca (Figure-4).

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