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Relationship between grain size distribution and intertidal faunal abundance in selected stations of Someshwara, Panambur and Bengre beaches

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Abstract

The knowledge of sediment texture is important in the studies of distribution of living and non-living resources, identification of source of sediments, sediment patterns and nutrients. It is known that the macro-benthos in the aquatic environment are influenced by the texture of the sediment in which they establish themselves and live. Sediment quality guidelines are important tool for assessment of contamination in marine and estuarine sediments with biological significance of intertidal beaches. The grain size characteristics of sediments from aggrading and receding in beaches have been analyzed by several investigators, only very limited research has been done on the relationship between the intertidal faunal abundance, distribution and the sediment grain size distributions from eroding and accreting beaches of Mangaluru. Sediment variations mainly affect the species distribution, pattern of diversity, breeding, survival and other activities. The present study was carried out to determine the grain size distribution and species abundance in coastal Waters of Someshwara, Panambur and Bengre beaches along the Mangaluru, south west coast of India. The sampling of coastal water and sediment was carried out from August 2016 to July 2017 along the Mangaluru coast was studied. Spatial and temporal variations of the grain size distribution like granules, coarse sand, fine sand, and very fine sand textural components like sand, silt, clay and organic carbon percentages analyzed and correlated with intertidal species distribution, abundance in the selected stations.

Key words: Intertidal species, grain size distribution, sediment texture, Coastal beaches, Mangaluru.

Introduction

The Someshwara beach is parallel to Netravathi River, which greatly receives fresh water inflow from the river, land nutrients, municipality, and domestic sewage, decayed plant and animal matter, pesticides from agriculture activities. Panambur beach is a part of Mangaluru port area located at one end which handles high sea traffic. And another end fertilizer and oil industries and domestic sewage from coastal side fisher folk this area is highly industrialized and also one of the famous touristic spot in Mangaluru. The Bengre is a small island in Mangalore city with few of the Mangalorean population staying there located near to old Mangalore port. This beach affects mainly inflow of wastewaterand domestic sewage from fish meal plants and small industries. Dredging activities are also going on this area.

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Materials and Methods

The study have been carried out for a period of one year from August 2016 to July 2017 along the selected beaches (Someshwara, Bengre and Panambur) of Mangalore, Karnataka (Fig.1). A total of nine stations designated as S1, S2, S3, P1, P2, P3, B1, B2 and B3 (Fig.1). The sediment samples were collected by using scoop and placed in plastic cover for further analysis in the laboratory.

Sediment collection

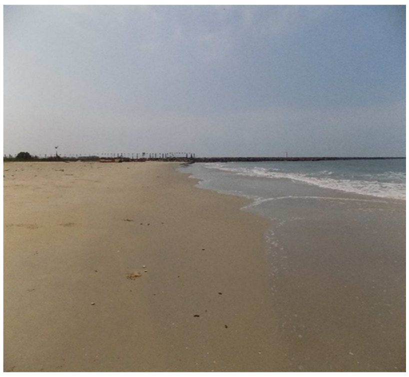
A hand corer (0.1 m^2 diameter size, depth 10 cm) was used to collect the sediment from the study area. The organic carbon content of the sediment was determined by the method given by El-wakeel and Riley (1957). The results were expressed in percentage of organic carbon in dry sediment. Clean well dried samples were first made free from molluscan shells, large stones, and dried grasses.

About 100g of dried sediment sample was weighed accurately and transferred to a 250 ml capacity beaker. The sample was made salt free by washing repeatedly with distilled water. Approximately 50 ml of 10 % sodium hexametaphosphate solution was added to the sediment and soaked overnight. Subsequently, the sample was sieved through a 62 µm size seiver. The sand fraction retained on the sieve was dried and weighed. The sediment fraction was collected in a 1000 ml beaker and transformed to a 1000 ml measuring glass cylinder and subjected to pipette analysis (Buchanan and Kain, 1971). The dried sand was sieved for size fractions analysis with the help of sieve shaker by following ASTM number (American Standards for Testing Materials).


Someshwara station S1


Someshwara station S2


Someshwara station S3


Panambur station P1


Panambur station P2


Panambur station P3


Bengre station B1


Bengre station B2


Bengre station B3

Figure1. Geographical position of stations selected for the study

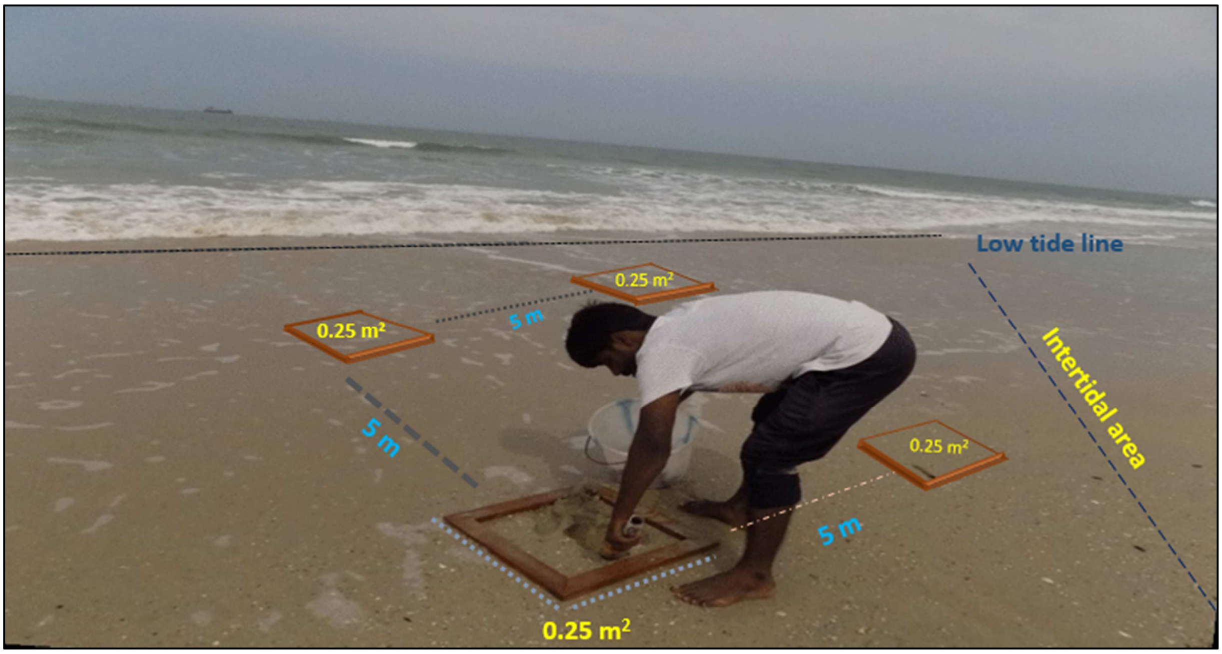


Figure 2. Qualitative and Quantitative composition of Intertidal fauna

Figure 3.Collection of intertidal organisms and planktonic larvae

In the laboratory, intertidal organisms were sorted out and identified up to generic/species level. The numerical abundance of intertidal organisms expressed in terms of No./m^2. The simple correlation was determined between various physico-chemical parameters such as water temperature, pH, salinity, dissolved oxygen, nutrients and sediment fractions.

Results and Discussion

Growth, production, survival and reproduction of aquatic organisms are influenced by physical, chemical and biological characteristics of water. The percentage occurrence and distribution of different size components of sediment (granules, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt and clay) of selected beaches of Mangaluru are depicted graphically in below figures. The different size fractions of sand contributing to the sediment components according to American Standards for Testing Materials (ASTM), granules size above the (2.0 mm), very coarse sand size from (2.00 to 1.18 mm), coarse sand size from (1.18 to 425 µm), medium sand size from (425 to 212 µm), fine sand size from (212 to 106 µm), very fine sand size from (106 to 63 µm) and silt and clay below the (63 µm). A perusal of the data presented reveals that the fractions show considerable seasonal variations in occurrence and abundance. Generally fractions of granules, slit and clay contributed to lesser degree to the total of sediment to great extent coarse sand, medium sand, fine sand showed dominant tendency in the selected beach of Mangaluru. Tropical intertidal areas are highly dynamic owing to variation in the tidal forces and energy of waves at the confluence result in a complicated sedimentary environment. Hopkison *et al.* (1999) contented that sediments play an important role in organic matter degradation and nutrient recycling in aquatic ecosystems.

Someshwara beach

Abundance of sediment fractions were in the order of coarse sand (51.21%) > medium sand (27.64%) > very coarse sand (9.98%) > fine sand (5.61%) > very fine sand (0.53%) > granules (3.50%) > silt and clay (1.50%).

Station S1 (Fig 4): Someshwara beach at station (S1) high percentage of coarse sand was recorded. The percentage of coarse sand varied from 45.33% in September (monsoon) to 80.31% April (pre-monsoon), medium sand varied from 3.88% in April (pre-monsoon) to 32.48% in July (monsoon), very coarse sand % varied from 1.21% December (post-monsoon) to 22.61% in June (monsoon), fine sand varied from 0.29% in December (post-monsoon) to 6.28% November (post-monsoon), very fine sand varied from 0.0% June, July (monsoon) to 1.30% November (post-monsoon), silt and clay varied from 0.40% in January (post-monsoon) to 2.50% in July (monsoon).

Station S2 (Fig 5): Someshwara beach at station (S2) coarse sand and medium sand percentages were high. The percentage of coarse sand varied from 32.73% in June (monsoon) to 60.05% July (monsoon), medium sand varied from 16.87% in September (monsoon) to 47.02% in June (monsoon), very coarse sand varied from 2.68% in December (post-monsoon) to 27.36% in September (monsoon), fine sand varied from 2.88% in October (post-monsoon) to 8.26% May (pre-monsoon), very fine sand varied from 0.00% July (monsoon) to 1.34% January (post-monsoon), silt and clay varied from 0.50% in January (post-monsoon) to 2.70% in July (monsoon).

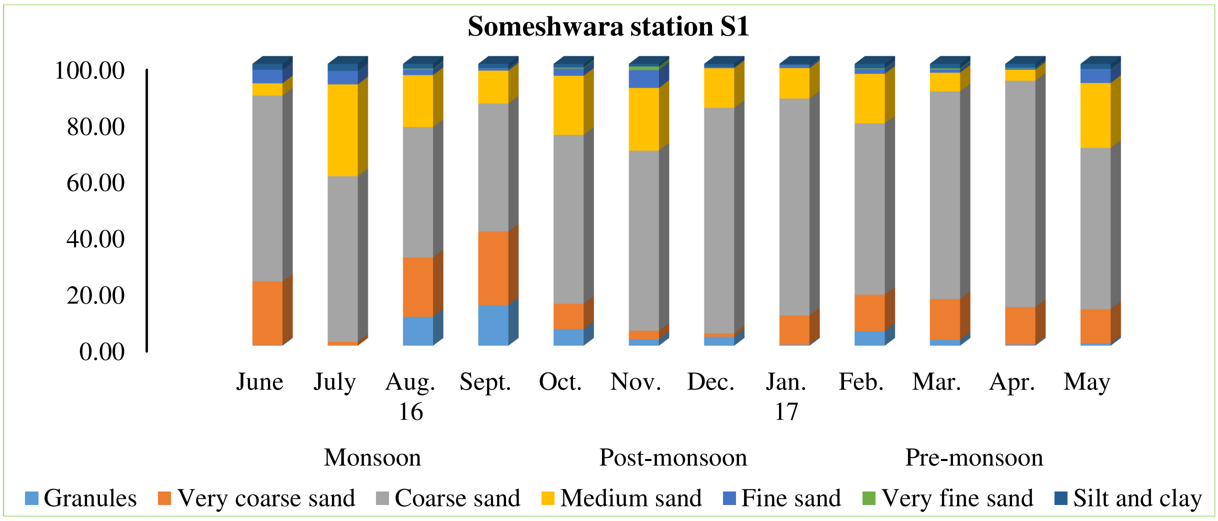


Figure 4. Percentage occurrence and distribution of different size components of sediment (granules, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt and clay) of Someshwara station Site-1.

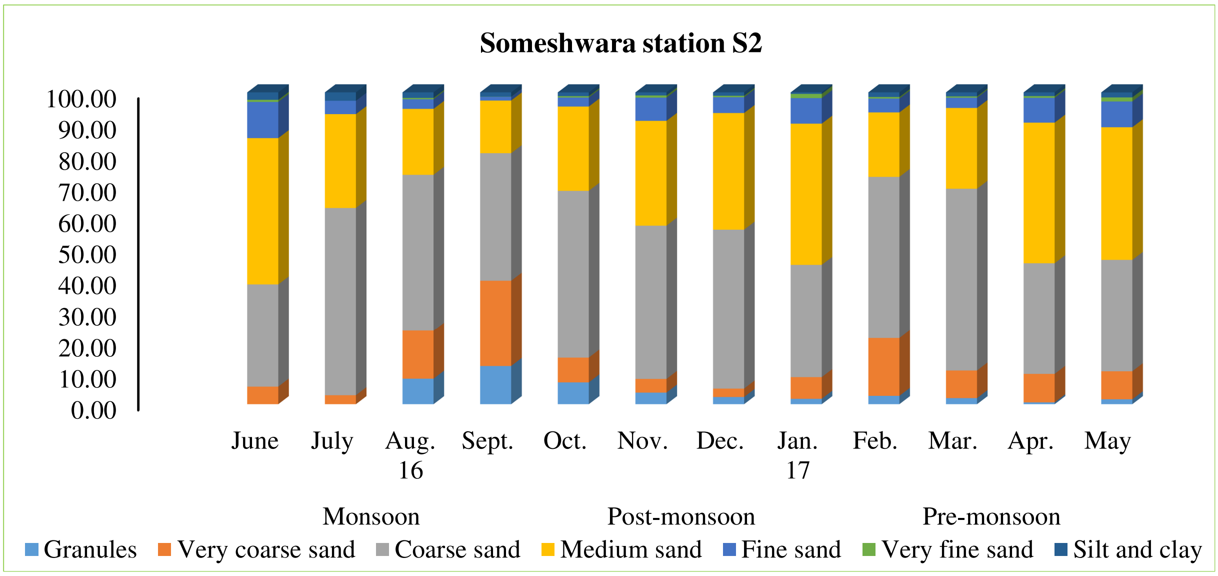


Figure 5. Percentage occurrence and distribution of different size components of sediment (granules, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt and clay) of Someshwara station Site-2.

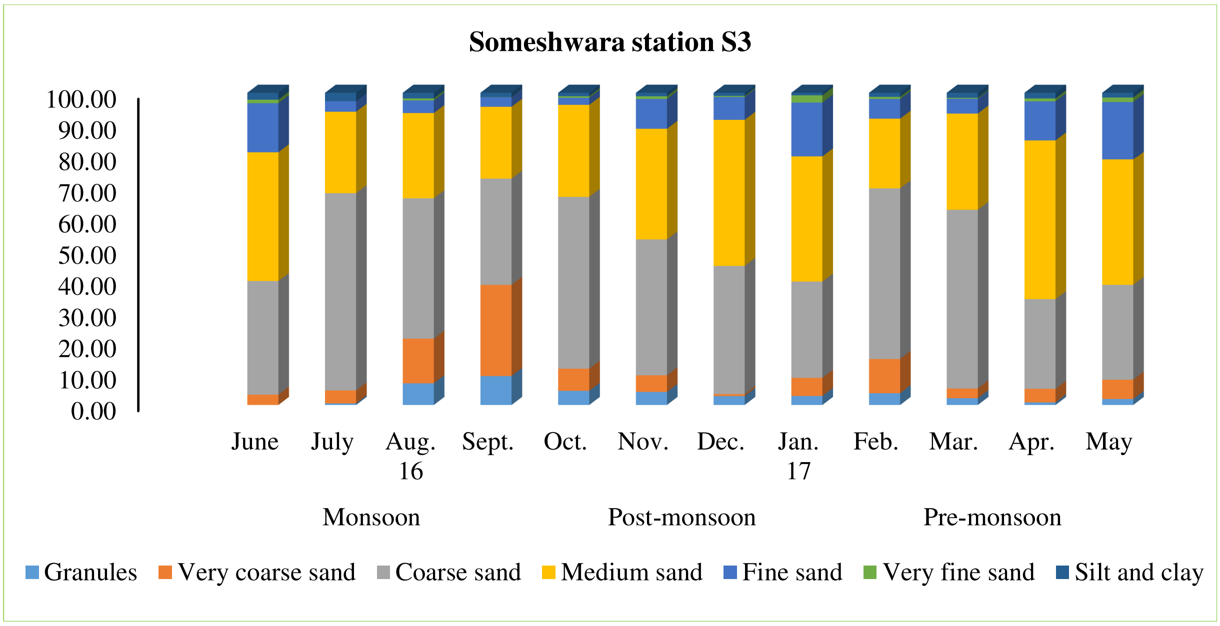


Figure 6. Percentage occurrence and distribution of different size components of sediment (granules, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt and clay) of Someshwara station Site-3.

Station S3 (Fig 6): Someshwara beach at station (S3) medium sand and coarse sand percentages were high. The percentage of medium sand varied from 22.42% in February (pre-monsoon) to 51.08% in April (pre-monsoon), coarse sand varied from 28.62% in April (pre-monsoon) to 63.14% July (monsoon), very coarse sand varied from 28.62% in April (pre-monsoon) to 55.08% in October (post-monsoon), fine sand varied from 2.22% in October (post-monsoon) to 18.45% May (pre-monsoon), very fine sand varied from 0.00% July (monsoon) to 2.32% January (post-monsoon), silt and clay varied from 0.80% in January (post-monsoon) to 2.70% in July (monsoon).

Panambur beach

Abundance of sediment fractions were in the order of fine sand (49.35%) > medium sand (31.09%) > coarse sand (9.10%) > very fine sand (7.97%) > very coarse sand (0.474%) > silt and clay (1.98%) > granules (0.003%).

Station P1 (Fig 7): Panambur beach at station (P1) high percentages of fine sand, medium sand and very fine sand were recorded. The percentage of fine sand varied from 25.70% in July (monsoon) to 66.58% in May (pre-monsoon), medium sand varied from 15.12% in April (pre-monsoon) to 53.54% July (monsoon), coarse sand % varied from 0.99% in May (pre-monsoon) to 25.04% in August (monsoon), very fine sand varied from 0.14% in June (monsoon) to 23.20% in February (pre-monsoon), very coarse sand varied from 0.07% in July (monsoon) to 0.89% in February (pre-monsoon), silt and clay varied from 0.80% in April (pre-monsoon) to 3.30% in July

(monsoon) and granules percentage was not observed in the study period.

Station P2 (Fig 8): Distribution of sediment fractions in Panambur beach (P2) are graphically depicted in Fig 8 in Panambur beach at station (P2) fine sand and medium sand percentage were high. The percentage of fine sand varied from 38.18% in July (monsoon) to 64.23% in April (pre-monsoon), medium sand varied from 19.11% in April (pre-monsoon) to 42.26% July (monsoon), coarse sand varied from 3.54% in April (pre-monsoon) to 18.13% in October (post-monsoon), very fine sand varied from 0.01% in August (monsoon) to 18.64% in February (pre-monsoon), very coarse sand varied from 0.10% in July (monsoon) to 1.09% in June (monsoon), silt and clay varied from 1.20% in November (post-monsoon) to 3.00% in July (monsoon) and granules percentage was not observed in the study period.

Station P3 (Fig 9): Panambur beach at station (P3) fine sand and medium sand percentages were high. The percentage of fine sand varied from 40.28% in July (monsoon) to 67.77% in April (pre-monsoon), medium sand varied from 10.96% in January (post-monsoon) to 40.57% in August (monsoon), coarse sand varied from 2.36% in April (pre-monsoon) to 14.11% in October (post-monsoon), very fine sand varied from 0.04% in August (monsoon) to 30.60% in January (post-monsoon), very coarse sand varied from 0.03%in September (monsoon) to 2.62% in October (post-monsoon), silt and clay varied from 1.30% in January and February (post and pre-monsoon) to 3.50% in July (monsoon) and granules percentage 0.04% in (October)observed in the study period.

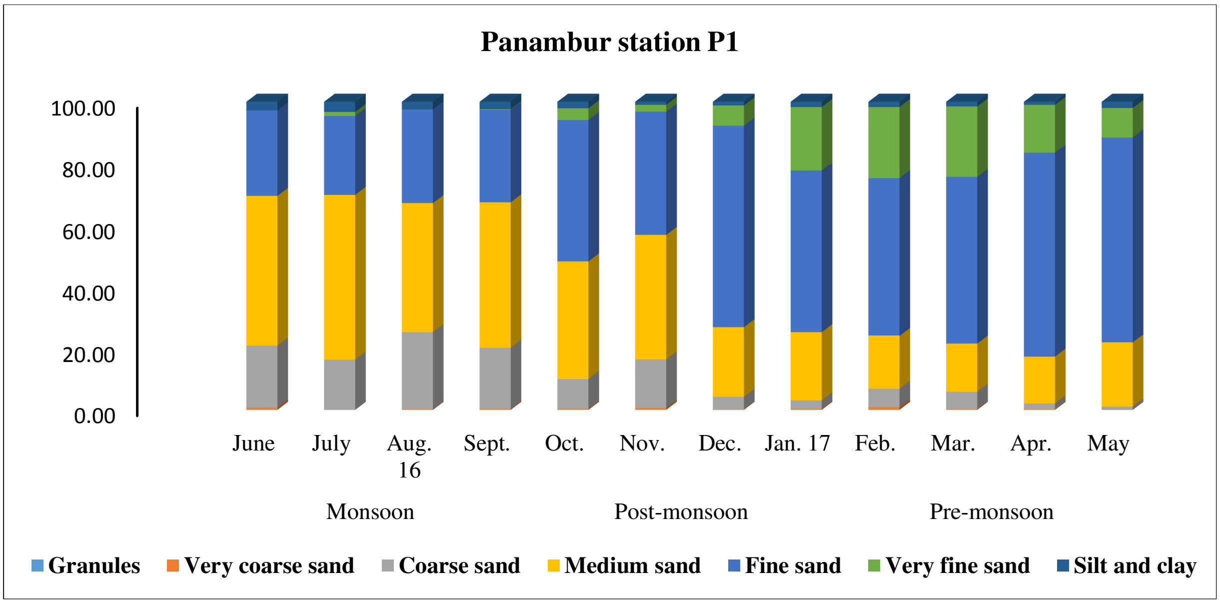


Figure 7. Percentage occurrence and distribution of different size components of sediment (granules, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt and clay) of Panambur beach Site-1.

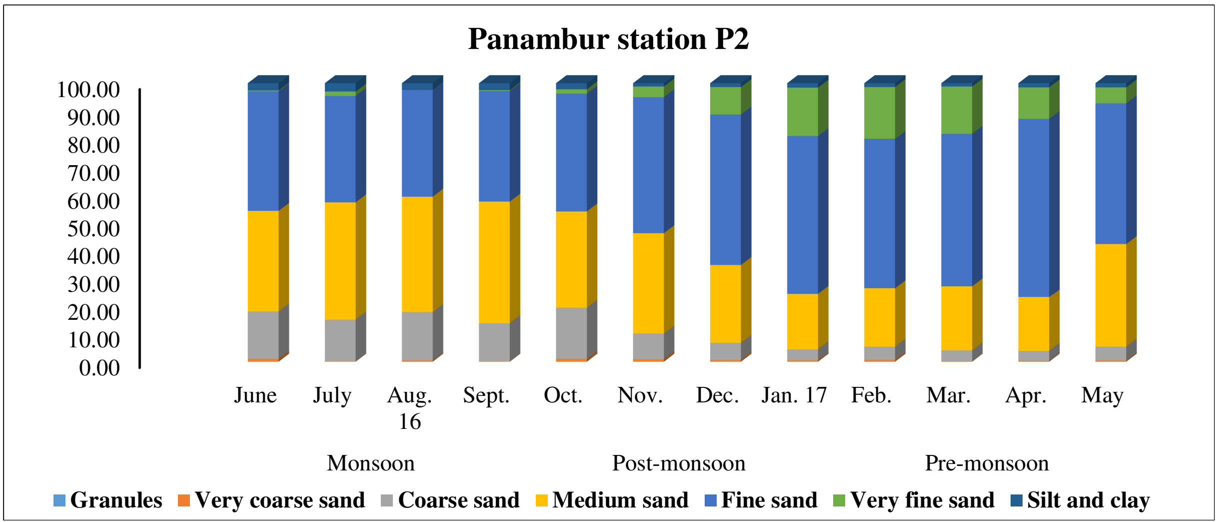


Figure 8. Percentage occurrence and distribution of different size components of sediment (granules, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt and clay) of Panambur beach Site-2.

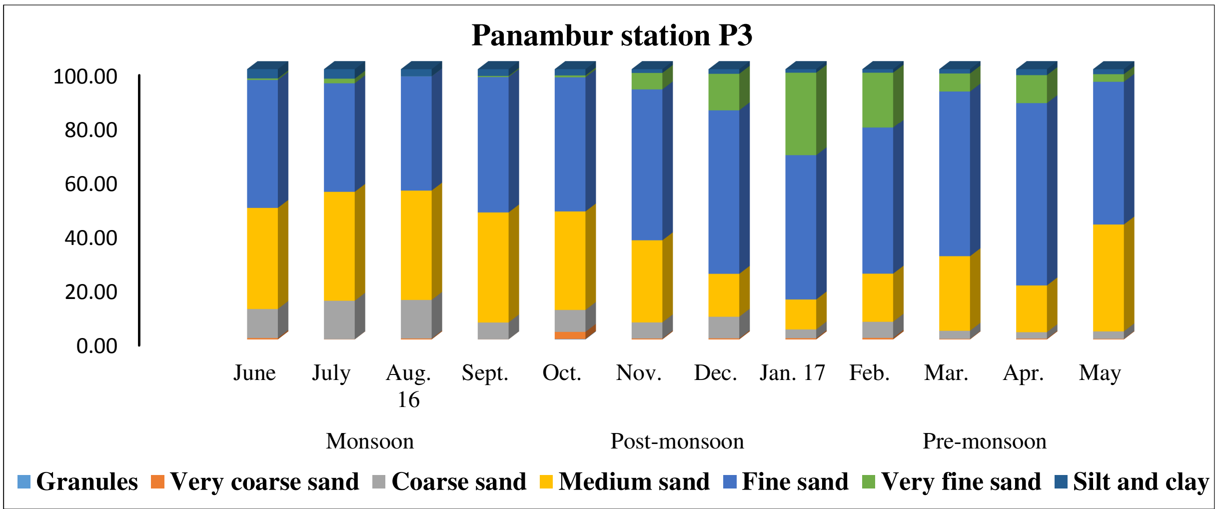


Figure 9. Percentage occurrence and distribution of different size components of sediment (granules, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt and clay) of Panambur beach Site-3.

Bengre beach

Station B1 (Fig 10): Bengre beach at station (B1), high percentages of medium sand, coarse sand and fine sand were recorded. The percentage of coarse sand varied from 1.42% in April (pre-monsoon) to 42.79% in July (monsoon), fine sand varied from 4.88% in July (monsoon) to 75.84% in October (post-monsoon), medium sand varied from 10.40% in April (pre-monsoon) to 48.23% in July (monsoon), very fine sand varied from 0.00% in July (monsoon) to 23.44% in January (post-monsoon), very coarse sand varied from 0.13% in April (pre-monsoon) to 3.33% in August (monsoon), silt and clay varied from 0.60% in October (post-monsoon) to 2.60% in July (monsoon) and granules percentage was (0.70% in post-monsoon) observed in the study period.

Station B2 (Fig 11): Bengre beach at station (B2) coarse sand, medium sand and fine sand percentages were high. The percentage of coarse sand varied from 30.36% in April (pre-monsoon) to 51.71% in July (monsoon), fine sand varied from 4.03% in July (monsoon) to 22.08% in June (monsoon), medium sand varied from 28.45% in September (monsoon) to 43.80% in November

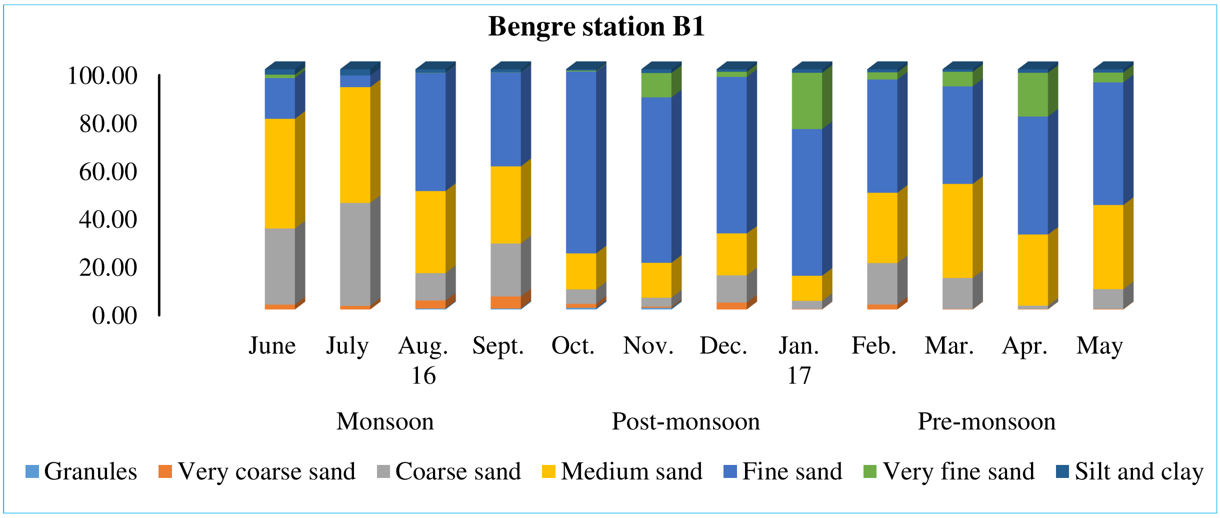


Figure 9. Percentage occurrence and distribution of different size components of sediment (granules, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt and clay) of Bengre beach Site-1.

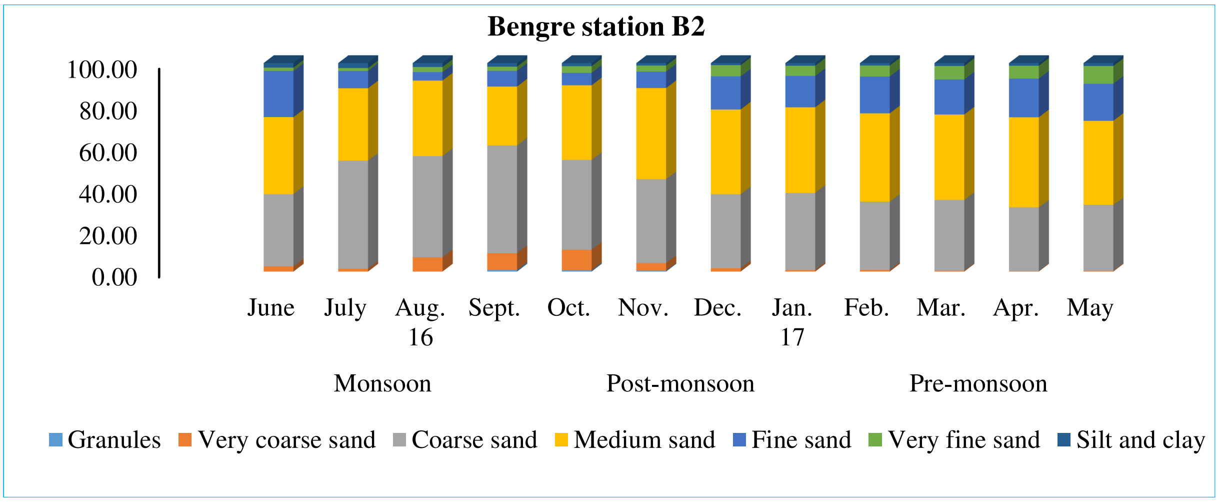


Figure 10. Percentage occurrence and distribution of different size components of sediment (granules, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt and clay) of Bengre beach Site-2.

(post-monsoon), very fine sand varied from 1.38% in July (monsoon) to 8.50% in May (pre-monsoon), very coarse sand varied from 0.19% in April (pre-monsoon) to 9.76% in October (post-monsoon), silt and clay varied from 1.00% in December (post-monsoon) to 2.40% in July (monsoon) and granules percentage was 0.63% in (post-monsoon) observed in the study period.

Station B3 (Fig 12): Bengre beach at station B3, medium sand and coarse sand percentages were high **(Fig 12)**. The percentage of coarse sand varied from 24.05% in April (pre-monsoon) to 45.28% June (monsoon), fine sand varied from 4.42% in July (monsoon) to 21.06% in April (pre-monsoon), medium sand varied from 39.43% in July (monsoon) to 50.06% in April (pre-monsoon), very fine sand varied from 1.64% in August (monsoon) to 8.40% in February (pre-monsoon), very coarse sand varied from 0.00% in April (pre-monsoon) to 6.54 in October (post-monsoon), silt and clay varied from 1.10% in December and January (post-monsoon) to 2.30% in July (monsoon) and granules percentage was (0.56% in August) not significantly observed in the study period.

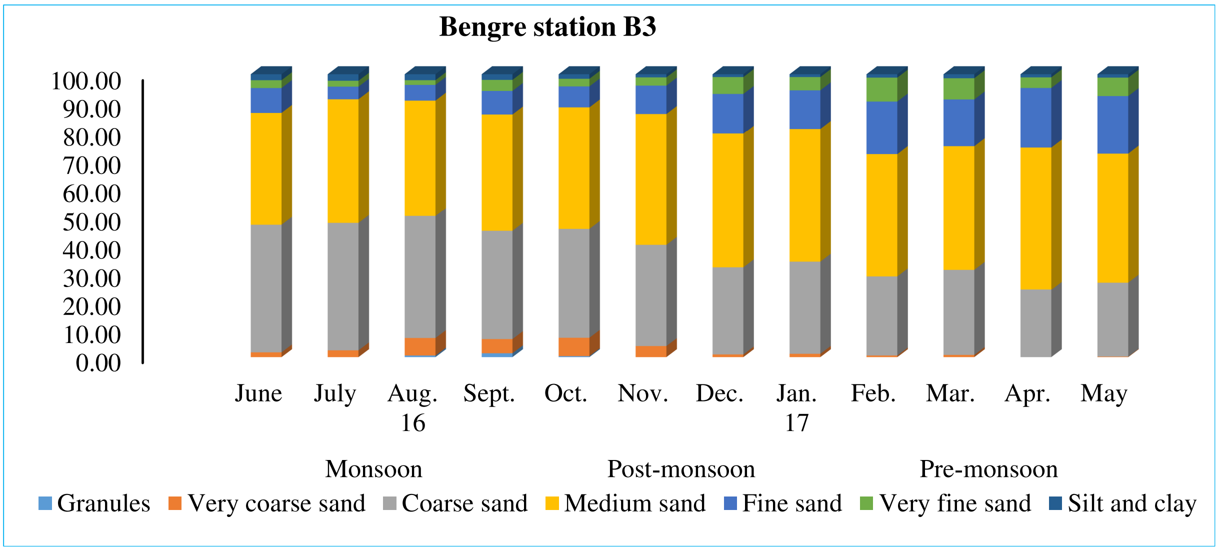


Figure 10. Percentage occurrence and distribution of different size components of sediment (granules, very coarse sand, coarse sand, medium sand, fine sand, very fine sand, silt and clay) of Bengre beach Site-3.

Over all study period the majority of sediment fractions percentage occupied by coarse sand in Someshwara, fine sand abounded in Panambur beach, equally medium and coarse sand distributed in Bengre beach and the negligible percentage of granules, silt and clay in all the selected beaches of Mangaluru. In general the Karnataka coastline has about 75% sandy beach, 11% rocky coast, and 14% mud flats, in sandy beaches three main factors that control the sediment grain size distribution: they are the sediment source, wave energy level and the general offshore slope on which the beach is constructed in coastal beaches (Komar, 1976 and Engstrom 1974). From the collected data, it was found that the sand fraction ranged from 97.88 to 99.54 % further sand fractions were analyzed high percentage of coarse sand fraction (51%) was observed at Someshwara beach compared to Panambur beach and Bengre beach. The fine sand concentration (49%) was observed at Panambur beach. Bengre beach medium sand (37%), coarse sand (30%) and fine sand (24%) were observed. granules, clay and silt concentration not in significant range at all the selected beaches. The data obtained on sediments at study sites revealed a clear cut dominance of sand over silt and clay. The sand fraction ranged from 97.88 to 99.54%. The high percentage of coarse sand fraction (51%) was observed at Someshwara beach compared to Panambur beach and Bengre beach. The fine sand concentration (49%) was observed at Panambur beach. Bengre beach medium sand (37%), coarse sand (30%) fine sand (24%) were observed. granules, clay and silt concentration not in significant range. The grain size distribution of sediment is mostly between medium to fine sand over the Mangaluru coast beaches Komar (1998). Reddy Gopala (1982) reported the dominance of sand, followed by silt and clay in Nethravati-Gurupur estuary. Ramachandra *et al.* (1984) documented the dominance of sand and equal contribution of silt and clay in the sediments of Mulki estuary. Seralathan *et al.* (1993) in the Cochin harbor observed higher percentage of sand and equal contribution of silt and clay. Chakraborty (2011) reported that considerable and continuous erosion processes have led to make the water bodies turbid and to promote unwanted accretion.

The grain size distribution ranged from 0.18 to 2.22 depicting it as very coarse to fine. However, in most of the observations the sand was found to be medium to coarse in nature. This characteristic of the intertidal sediment can be attributed to the higher wave energy regime due to local topography that prevents sedimentation of fine-grained particles. Reports by Selvaraj and Ram Mohan (2003) and Srinivasalu *et al.* (2007) from the same locality confirmed that the sediments are mainly of fine to medium grained sand similarly sediment texture analyses were done by Manjappa (1999) and Prashanth (2010). Amrutha (2010) were studied in Netravathi-Gurupura estuary. Bagadeeshwaran *et al.* (2007) observed 21.3 to 90.3% of sand 4.5 to 32.9% of silt and 2.1 to 58.3% of clay in the Arasalar estuary, Karikal, south east coast of India.

Table1. Qualitative distribution of intertidal fauna at selected stations during August 2016 to July 2017

Intertidal fauna	Someshwara			Panambur			Bengre		
	S1	S2	S3	P1	P2	P3	B1	B2	B3
MOLLUSCS									
Bivalves									
Arca spp.	+	+	+	+	+	+	+	+	+
Anadaragranosa	+	+	+	+	+	+	+	+	+
Bivalve spats	+	+	+	+	+	+	+	+	+
Cardium spp.	+	+	+	+	+	+	+	+	+
Crassostrea spp.	+	+	-	+	-	-	+	+	+
Donaxfaba	-	+	+	+	+	+	+	+	+
Donaxscortum	+	+	+	+	+	+	+	+	+
Dosinia spp.	+	+	+	+	+	+	+	+	+
Meritrixcasta	+	+	+	+	+	+	+	+	+
Meritrix spp.	+	+	+	+	+	+	+	+	+
Paphia spp.	+	-	+	+	+	+	+	+	+
Paphiamalabarica	+	+	-	+	+	+	+	-	-
Pecten spp.	-	-	-	+	+	+	+	+	+
Pernaviridis	+	+	+	+	+	+	+	+	+
Tellina spp.	+	+	+	+	+	+	+	+	+
Gastropods									
Bullia spp.	-	-	-	+	+	+	+	+	+
Bursa spp.	-	-	-	+	+	+	+	+	+
Cypraea spp.	-	-	-	+	+	+	+	+	+
Cerithidea spp.	-	+	+	+	+	+	+	+	+
Gastropod spats	+	+	+	+	+	+	+	+	+
Littorina spp.	+	+	-	+	-	-	+	-	+
Nassarius spp.	+	+	-	+	+	+	+	-	+
Oliva spp.	-	+	+	+	+	+	+	+	+
Patella spp.	+	-	-	+	+	-	-	-	+
Surcula spp.	+	-	-	+	+	+	+	+	+
Terebra spp.	-	-	-	+	+	+	+	+	+
Thais spp.	+	-	-	+	+	+	+	+	+
Tibia spp.	-	-	-	+	+	+	+	+	+
Trochus spp.	+	-	-	+	+	+	+	+	+

Turbo spp.	-	-	-	+	+	+	+	+	+
Turitella spp.	+	+	+	+	+	+	+	+	+
Umbonium spp.	+	+	-	+	+	+	+	+	+
Scaphopods									
Dentaliumoctangulata	+	-	+	+	-	-	+	+	+
Dentalium spp.	+	+	+	+	+	+	+	+	+
ARTHROPODA									
Crustaceans									
Amphipods	+	+	+	+	+	+	+	+	+
Balanus spp.	+	+	-	+	+	-	+	+	+
Copepods	+	+	+	+	+	+	+	+	+
Emerita spp.	+	+	+	+	+	+	+	+	+
Ocypode spp.	+	+	+	+	+	+	+	+	+
Eupagurus spp.	-	+	-	+	+	+	+	+	+
Lepasanatifera	+	-	-	-	-	-	-	-	+
Mysids	+	+	+	+	+	+	+	+	+
Uca spp.	+	+	+	+	+	+	+	+	+
ANNELIDA									
Polychaetes									
Echiurus spp.	-	-	-	+	+	+	+	+	+
Glycera spp.	+	+	+	+	+	+	+	+	+
Nephthys spp.	-	-	+	+	+	+	+	+	+
Nereis spp.	+	+	+	+	+	+	+	+	+
Polychaete larvae	+	+	+	+	+	+	+	+	+
Sabellaria spp.	-	+	+	+	+	-	+	+	+
Nematodes	+	+	+	+	+	+	+	+	+
ECHINODERMATA									
Astropectenindica	-	-	-	+	+	+	+	+	+
Clypeasteroids	+	+	+	+	-	-	+	+	+
Ophiocoma spp.	-	-	-	+	+	+	+	+	+
MISCELLANEOUS									
Egg cases	+	+	+	+	+	+	+	+	+
Fish larvae	-	-	-	+	+	+	+	+	+
Sand tubes	+	+	+	+	+	+	+	+	+

In the present investigation, four major phyla were recorded, belonging to Mollusca, Arthropods, Annelida, Echinodermata and other miscellaneous were found at all nine stations of three selected beaches. A total 135 no. of species belonging to 8 phylum, 19 classes, 52 orders and 102 families were documented intertidal benthic macrofauna of a brackish water coastal lagoon Chilika lake on east coast of India by Debasish mahapatro *et al.* (2015) An intertidal environment provides the best study area to observe the seasonal changes of physico-chemical process in relation to its inhabitants since a maximum of fluctuation is met in an estuaries and coastal ecosystem. important studies have been carried out on the macrobenthic ecology of various estuaries worldwide studied by Alogi (1990), Carvalho *et al*. (2001), Herman *et al.* (2001), Ysebaert *et al*. (2002), Bosire (2004), in India studied by Harkantra (1975), Ansari *et al.,* 2004, Khan *et al.,* 2004. A total of 60 different invertebrate macrofaunal species were identified from the intertidal regions of the Kathiawar Peninsula, Gujarath by Poonam Bhadja *et al.* (2014). The impact of environmental deterioration on the intertidal fauna has been studied by Datta *et al.* (2010), Chakraborty (2008), Jaiswar (2005) and Venkataraman (2005) in intertidal beaches of Mumbai coast.

Seasonal variations in species distribution

In present investigation intertidal organisms population varied between season to season and relatively high number of intertidal fauna recorded during the post-monsoon followed by pre-monsoon and monsoon season. High abundance of species observed in post and pre-monsoon may be high percentage of organisms also responsible for higher Margalef richness index throughout the study period at Panambur and Bengre beaches. Shannon's diversity index also indicated highly diverse community in respective beaches Pielou's evenness and Shannon's diversity indices revealed high evenness of the distribution except in the months of heavy monsoon (June and July) and the present investigation highest intertidal Abundance, distribution and diversity was recorded during post and pre-monsoon in Panambur and Bengre beaches the reason could be due to abounded fine sand and very fine sand substrate which shows the strongest correlation in post and pre-monsoon season with intertidal organisms according to Chakraborty *et al.* (2008) seasonal variations in the environmental factors and biological properties of organisms (breeding, gonadal maturity etc.) influence the occurrence of organisms in the intertidal region.

Table 2. Showing Someshwara beach sediment faunal Correlation (S1, S2 & S3)

Someshwara beach sediment faunal Correlation (S1, S2 & S3)								
Parameters	**Granules**	**Very coarse sand**	**Coarse sand**	**Medium sand**	**Fine sand**	**Very fine sand**	**Silt and clay**	**Faunal abundance**
Granules	1.000							
Very coarse sand	0.996	1.000						
Coarse sand	0.969	0.943	1.000					
Medium sand	-0.958	-0.928	-.999*	1.000				
Fine sand	-0.990	-.999*	-0.926	0.909	1.000			
Very fine sand	-1.000*	-.998*	-0.963	0.951	0.993	1.000		
Silt and clay	-0.262	-0.348	-0.016	-0.027	0.393	0.285	1.000	
Faunal abundance	0.990	0.974	0.994	-0.988	-0.962	-0.987	-0.126	1.000

Table 3. Showing Panambur beach sediment faunal Correlation (P1, P2 & P3)

Panambur Correlation (P1, P2 & P3)								
Parameters	**Granules**	**Very coarse sand**	**Coarse sand**	**Medium sand**	**Fine sand**	**Very fine sand**	**Silt and clay**	**Faunal abundance**
Granules	1.000							
Very coarse sand	0.231	1.000						
Coarse sand	-0.972	-0.455	1.000					
Medium sand	-1.000*	-0.256	0.977	1.000				
Fine sand	0.936	0.559	-0.993	-0.945	1.000			
Very fine sand	-0.191	-.999*	0.418	0.216	-0.524	1.000		
Silt and clay	0.983	0.051	-0.913	-0.979	0.857	-0.010	1.000	
Faunal abundance	-0.738	-0.827	0.877	0.755	-0.928	0.803	-0.604	1.000

Table 4. Showing Bengre beach sediment faunal Correlation (B1,B2 and B3)

Bengre Correlations (B1,B2 and B3)								
Parameters	**Granules**	**Very coarse sand**	**Coarse sand**	**Medium sand**	**Fine sand**	**Very fine sand**	**Silt and clay**	**Faunal abundance**
Granules	1.000							
Very coarse sand	-0.627	1.000						
Coarse sand	-0.426	0.972	1.000					
Medium sand	0.074	0.730	0.871	1.000				
Fine sand	0.261	-0.915	-0.984	-0.944	1.000			
Very fine sand	0.387	-0.961	-.999*	-0.891	0.991	1.000		
Silt and clay	-0.721	0.992	0.934	0.638	-0.857	-0.918	1.000	
Faunal abundance	0.892	-0.207	0.029	0.517	-0.204	-0.072	-0.329	1.000

Table 4. Correlation coefficient (significant at 99% and 95%) between Sediment fractions and intertidal organisms of the selected beaches of Mangaluru.

Sediment fraction Correlation with intertidal faunal Abundance								
Parameters	**Granules**	**very coarse sand**	**coarse sand**	**Medium sand**	**fine sand**	**very fine sand**	**silt and clay**	**Faunal abundance**
Granules	1.000							
very coarse sand	.970**	1.000						
coarse sand	.823**	.916**	1.000					
Medium sand	-0.452	-0.468	-0.225	1.000				
fine sand	-.745*	-.825**	-.961**	-0.045	1.000			
very fine sand	-.906**	-.939**	-.936**	0.200	.911**	1.000		
silt and clay	-0.518	-0.607	-.735*	-0.090	.760*	.771*	1.000	
Faunal abundance	-.916**	-.858**	-.721*	0.278	.686*	.885**	0.518	1.000

Simple Correlation

Simple Correlation (Pearson's) was carried out for different physico-chemical parameters of water and sediment fractions to understand their interrelationships, which finally governs the productivity of the intertidal ecosystem. There was a significant positive correlation between air, water and sediment temperature at all three beaches and the statistical relationship indicated that the strong relationship between intertidal organisms and fine sand, whereas the organisms abundance negatively correlating with granules, very coarse and coarse sand.

Conclusion

Intertidal fauna abundance was observed with relation to the sediment fraction and physico-chemical parameters in Someshwara beach, Panambur beach and Bengre beach. Comparatively the percentage of fine sand was found to be more in Panambur and equally medium sand and coarse sand percentage was found to be dominated at Bengre beach where as Someshwara beach abounded with coarse sand percentage which is negatively correlating with intertidal fauna. In all the three beaches four phyla of invertebrates were recorded in which phylum Mollusca was dominated. Total bivalves (14genera), Gastropods (16 genera), Scaphopods (2 genera), Crustaceans (6 genera), Polychaetes (7 genera), Nematodes, Echinodermata (3 genera) were recorded in the present study. The statistical relationship indicated that the strong relationship between intertidal organisms and fine sand whereas the organisms abundance negatively correlating with granules, very coarse sand and coarse sand. All the nine stations were showing significant difference with seasonality in physico-chemical parameters, sediment fractions and intertidal faunal composition Beach profile, topography and grain size distribution are the most important factors in abundance and distribution of intertidal organisms. The study concludes that though these beaches are moderately disturbed due to anthropogenic activities, they still support a rich intertidal biodiversity which needs immediate attention for protection and conservation. The present baseline information is useful for the further ecological monitoring and assessment along the coastal beaches.

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