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**Narshivudu Daggula**
Consultant in Agri -Clinics & Agri -Business Centres at National Institute of Agricultural Extension Management, Rajendra Nagar, Hyderabad, Telangana State, India

**Lakshmipathi MT**
Associate Professor, Dept. Aquatic Environment Management, College of Fisheries, Mangaluru, Karnataka

**Padmanabha A**
Senior Research Fellow, Dept. Aquatic Environment Management, College of Fisheries, Mangaluru, Karnataka, India

**Vadithe Reddynaik**
Junior Research Fellow, Dept. Aquatic Environment Management, College of Fisheries, Mangaluru, Karnataka, India

**Lingesh**
Assistant Manager in Karnataka Fisheries Development Board, Government of Karnataka, Karnataka, India

**Chalapathi Kovvuri**
Teaching Associate, Dept. Aquatic Environment Management, College of Fishery Science, Muthukuru, Nellore, Andhra Pradesh, India

**Praveen Joshi HS**
PhD Scholar in, Dept. Aquatic Environment Management, College of Fisheries, Mangaluru, Karnataka, India

**Correspondence**
**Narshivudu Daggula**
Consultant in Agri -Clinics & Agri -Business Centres at National Institute of Agricultural Extension Management, Rajendra Nagar, Hyderabad, Telangana State, India

# Distribution and abundance of intertidal organisms along the selected beaches of Mangalore coast

**Narshivudu Daggula, Lakshmipathi MT, Padmanabha A, Vadithe Reddynaik, Lingesh, Chalapathi Kovvuri and Praveen Joshi HS**

**Abstract**
The marine ecosystem is one of the richest ecosystem, in that intertidal zones are such fascinating ecosystems which have been pulled towards scientific community since many years. The intertidal, sometimes called the littoral zone, is defined as the part of the seafloor that lies between the highest high and lowest low tides. An investigation was carried out from August 2016 to July 2017 in the selected beaches of Mangaluru, to understand the spatial and temporal abundance and distribution of intertidal organisms. Regular monthly samplings were carried out at three beaches of Someshwara, Panambur and Bengre at nine selected stations over a period of 12 months between 12°47' 748" N to 12° 56' 449" N and 74° 50' 780" E to 74° 48' 207" E was studied. In the present study, in all the three beaches four phyla of invertebrates Mollusca, Arthropoda, Annelida and Echinodermata were reported among all 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. Analysis of variance revealed that organisms did not vary according to beaches though the variation was seen in different months and season. 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.

**Keywords:** Intertidal organisms, abundance, distribution, beaches, sediment texture, Mangaluru

## 1. Introduction
Mangaluru is a one of the fast growing coastal city in India. It is bounded by the Arabian Sea to its west and the Western Ghats to its east. Presently selected three beaches greatly receives pressure from industrial development in coastal areas of Mangaluru, anthropogenic activities like human settlement, pollution and coastal changes, and also tourism. Someshwara beach this 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 Chethan, N (2012) [3]. Panambur beach this 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. Bengre beach, 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 waste water and domestic sewage from fish meal plants and small industries. Dredging activities are also going on this area Amrutha and Prashanth (2010) [1].

## 2. Materials and Methods
The sampling stations were selected along the coastal beaches of Mangaluru. A total of nine stations designated as S1, S2, S3, P1, P2, P3, B1, B2 and B3 (Fig.1.). The study was carried out from August 2016 to July 2017.

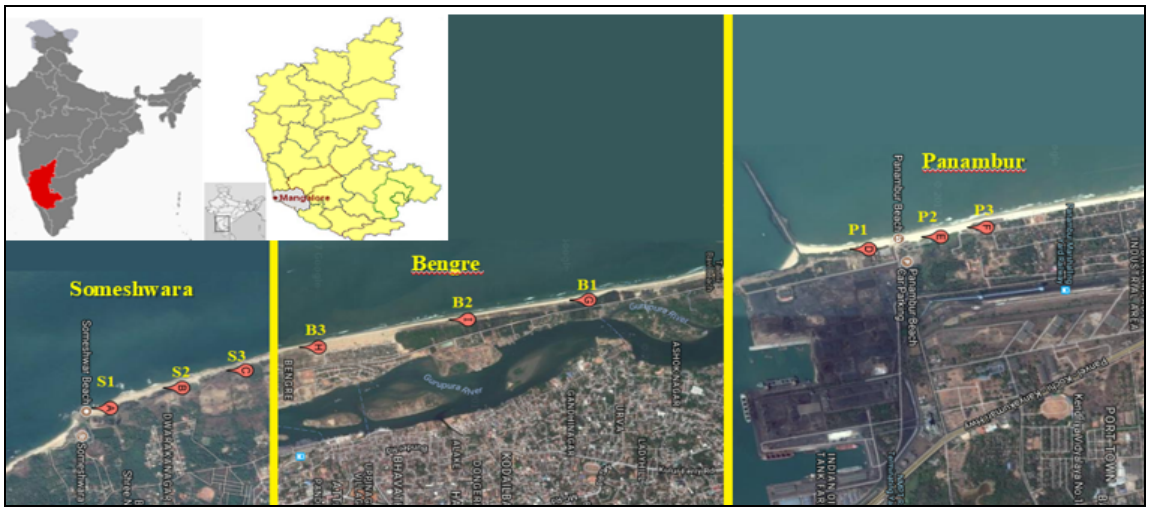


**Fig 1:** Map showing the locations of sampling station

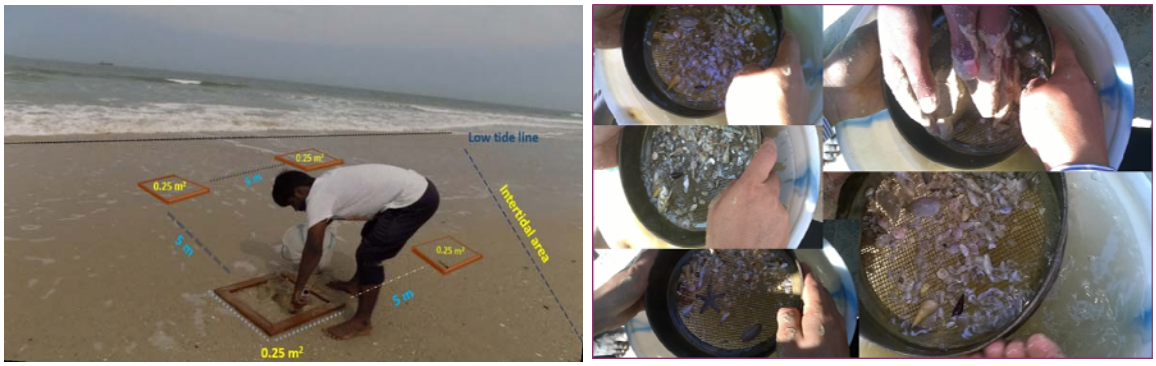


**Plate 1, 2:** Sampling design for the collection of intertidal organisms and collection of intertidal organisms and planktonic larvae.

**2(a). Intertidal organism's collection**

In each station, four selected quadrates with 0.25 $m^2$ area at an interval of 5m were sampled in every month during low tide. Thus 36 quadrates sampled in this sampling design have covered an area of 9 $m^2$ per month over the stretch of nine stations. The sample were sieved through a mesh sieve, above 1mm mesh size sieve for macro-organisms, less than 1 mm mesh size sieve for micro-organisms and 200 µm plankton net for planktonic larvae, retained organisms collected in plastic bottles and preserved in 5% formalin.

**2(b). Qualitative and Quantitative composition of Intertidal fauna**

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./$m^2$.

**3. Results**

**3A. Someshwara beach**

A total of 13 *genera* (Bivalves), 8 *genera* (Gastropods), and 2 *genera* (Scaphopods) were belonging to the phylum Mollusca. 6 *genera* (Crustaceans) belongs to Arthropod phylum. 5 *genera* (Polychaetes and Nematodes) belongs to Annelida phylum and 1 species belongs to phylum Echinodermata have been identified during the study period spatially intertidal faunal density was recorded maximum in station (S1) followed by (S2) and (S3) in Someshwara beach, seasonally higher population recorded in the post-monsoon than monsoon and pre-monsoon season.

**3A.1. Station S1**

The abundance (No./$m^2$) of intertidal organisms varied from 39 No./$m^2$ in July (monsoon) to 133 No./$m^2$ in January (post-monsoon). Intertidal organism community structure comprised of crustaceans 26.74% in June (monsoon) to 53.49% in December (post-monsoon), Bivalves 44.83% in May (pre-monsoon) to 72.29% in August (monsoon), Gastropods 18.75% in July (monsoon) to 39.69% in May (pre-monsoon), Scaphopods 4.26% in March (pre-monsoon) to 15.52% in April (pre-monsoon) were recorded under phylum Mollusca. Polychaetes 25% in July (monsoon) to 54.55% in April (pre-monsoon), Nematodes 45.45% in April (pre-monsoon) to 75% in July (monsoon) were recorded under phylum Annelida. Clypeasteroids 0% in (monsoon) to 2.75% in January (post-monsoon), miscellaneous (egg cases) 0.78% in December (post-monsoon) to 16.67% in August (monsoon) were recorded. Abundance of intertidal organisms was in the order of crustaceans 35% > bivalves 28% > gastropods 14% > nematodes 7% > Scaphopods 5% > polychaetes 5% > miscellaneous 5% > echinoids 1%.

**3A.2. Station S2**

The abundance (No./$m^2$) of intertidal organisms varied from 48 No./$m^2$ August (monsoon) to 86 No./$m^2$ January (post-monsoon) Intertidal organism community structure comprised of crustaceans 17.46% in September (monsoon) to 41.43% in November (post-monsoon) were identified under Arthropoda phylum. Bivalves 50.0% in May (pre-monsoon) to 78.26% July (monsoon), Gastropods 13.04% in July (monsoon) to 38.46% in October (post-monsoon), Scaphopods 3.85% in

October (post-monsoon) to 14.29% in June (monsoon) were recorded under phylum Mollusca. Polychaetes 20% in August (monsoon) to 69.23% in July (monsoon), Nematodes 30.77% in July (monsoon) to 68.75% in February (pre-monsoon) were recorded under phylum Annelida. Clypeasteroids 0.0% in June, July, August and September (monsoon) to 2.78% in March (pre-monsoon), Miscellaneous (egg cases) 1.39% in March (pre-monsoon) to 25.86% in June (monsoon) were recorded. Abundance of intertidal organisms was in the order of crustaceans 32% > bivalves 26% > gastropods 11% > nematodes 13% > Scaphopods 4% > polychaetes 8% > miscellaneous 5% > echinoids 1%.

**3.A.3. Station S3**

The abundance (No./$m^2$) of intertidal organisms varied from 34 No./$m^2$ in July (monsoon) to 111 No./$m^2$ in December (post-monsoon). Intertidal organism community structure comprised of crustaceans 14.71% in July (monsoon) to 32.20% in September (monsoon) were identified under Arthropod phylum. Bivalves 54.55% in September (monsoon) to 76.67% in November (post-monsoon), Gastropods 10.0% in November (post-monsoon) to 34.48% in January (post-monsoon), Scaphopods 0.0% in July (monsoon) to 13.33% in November (post-monsoon) were recorded under phylum Mollusca. Polychaetes 33.33% in December (post-monsoon) to 61.11% in November (post-monsoon), Nematodes 38.89% in November (post-monsoon) to 66.67% in December (post-monsoon) were recorded under phylum Annelida. Clypeasteroids 0.0% in June, July (monsoon) and August (monsoon) to 1.92% in January (post-monsoon), miscellaneous (egg cases) 0.90% December (post-monsoon) to 29.41% in July (monsoon). Abundance of intertidal organisms was in the order of bivalves 26% > crustaceans 25% > nematodes 17% > polychaetes 14% >gastropods 9% > scaphopods 4% > miscellaneous 5%.

**3.B Panambur beach**

A total of 16 *genera* (bivalves) 17 *genera* (gastropods) 2 *genera* (scaphopods) were belonging to the phylum Mollusca, 7 *genera* (crustaceans) belong to Arthropod phylum, 6 *genera* (polychaetes and nematodes) belong to Annelida phylum and 2 species belongs to phylum Echinodermata have been identified during the study period. Spatially intertidal faunal density was recorded maximum in station (P1) followed by (P2) and (P3), seasonally higher population recorded in the post-monsoon than pre and monsoon season.

**3.B.1 Station P1**

The abundance (No./$m^2$) of intertidal organisms varied from 117 No./$m^2$ in July (monsoon) to 252 No./$m^2$ in November (post-monsoon). Intertidal organism community structure comprised of crustaceans 23.22% in December (post-monsoon) to 38.84% in March (pre-monsoon) were identified under Arthropod phylum. Bivalves 43.82% April (pre-monsoon) to 61.19% June (monsoon), Gastropods 28.36% in June (monsoon) to 49.44% in April (pre-monsoon), Scaphopods 2.42% in January (post-monsoon) to 10.45% in June (monsoon) were recorded under phylum Mollusca. Polychaetes 35.71% in June (monsoon) to 93.75% in February (pre-monsoon), Nematodes 6.25% in March (pre-monsoon) to 64.29% in June (monsoon) were recorded under phylum Annelida. Echinoderms 0.0% in June, July (monsoon) to 8.16% in March (pre-monsoon), miscellaneous (egg cases and fish larvae) 0.51% March (pre-monsoon) to 18.80% in July (monsoon). Abundance of intertidal organisms was in the order of crustaceans 31% > bivalves 27% > gastropods 21% > nematodes 4% > scaphopods 4% > polychaetes 6% > miscellaneous 4% > echinoderms 3%.

**3.B.2. Station P2**

The abundance (No./$m^2$) of intertidal organisms varied from 117 No./$m^2$ in July (monsoon) to 215 No./$m^2$ in October (post-monsoon). Intertidal organism community structure comprised of crustaceans 27.86% in March (pre-monsoon) to 50.47% in November (post-monsoon) were identified under Arthropod phylum. Bivalves 44.23% June (monsoon) to 61.98% February (pre-monsoon), Gastropods 23.97% in February (pre-monsoon) to 50.56% in November (post-monsoon), Scaphopods 3.85% in June (monsoon) to 14.63% in December (post-monsoon) were recorded under phylum Mollusca. Polychaetes 40.0% in June (monsoon) to 80.0% in October (post-monsoon), Nematodes 7.14% in December (post-monsoon) to 60.0% in June (monsoon) were recorded under phylum Annelida. Echinoderms 1.40% in October (post-monsoon) to 7.86% in April (pre-monsoon), Miscellaneous (egg cases and fish larvae) 0.89% in February (pre-monsoon) to 16.67% in June (monsoon). Abundance of intertidal organisms was in the order of crustaceans 38% > bivalves 25% > gastropods 19% > nematodes 2% > scaphopods 4% > polychaetes 5% > miscellaneous 4% > echinoderms 3%.

**3.B.3. Station P3**

The abundance (No./$m^2$) of intertidal organisms varied from 131 No./$m^2$ June (monsoon) to 195 No./m2 April (post-monsoon) intertidal organism community structure comprised of crustaceans 24.83% in August (monsoon) to 40.0% in January (post-monsoon) were identified under Arthropoda phylum. Bivalves 33.33% September (monsoon) to 65.15% March (pre-monsoon), Gastropods 28.79% in March (pre-monsoon) to 56.67% in September (monsoon), Scaphopods 5.48% in October (post-monsoon) to 16.67% in August (monsoon) were recorded under phylum Mollusca. Polychaetes 52.0% in June (monsoon) to 90.48% in March (pre-monsoon), Nematodes 9.52% in March (pre-monsoon) to 48.0% in June (monsoon) were recorded under phylum Annelida, echinoderms 0.0% in June and July (monsoon) to 2.75% in January (post-monsoon), miscellaneous (egg cases and fish larvae) 0.76% in July (monsoon) to 6.90% in March (pre-monsoon). Abundance of intertidal organisms was in the order of crustaceans 35% > bivalves 22% > gastropods 17% > polychaetes 10% > scaphopods 5% > miscellaneous 5% > echinoderms 3% > nematodes 3%.

**3.C. Bengre beach**

A total of 15 *genera* (bivalves), 17 *genera* (gastropods) and 2 *genera* (scaphopods) were belonging to the phylum Mollusca, 8 *genera* (crustaceans) belongs to Arthropod phylum, 7 *genera* (polychaetes and nematodes) belongs to Annelida phylum and 3 species belongs to phylum Echinodermata have been identified during the study period. The intertidal faunal density recorded maximum in station (B3), (B1) and (B2) in Bengre beach. Seasonally higher population recorded in the post-monsoon than pre-monsoon and monsoon season.

**3.C.1. Station B1**

The abundance (No./$m^2$) of intertidal organisms varied from 125 No./$m^2$ October (post-monsoon) to 195 No./$m^2$ April (pre-

monsoon). Intertidal organism community structure comprised of crustaceans 20.0% in July (monsoon) to 52.46% in January (post-monsoon) were identified under Arthropoda phylum. Bivalves 42.42% October (post-monsoon) to 63.22% May (pre-monsoon), Gastropods 33.33% in May (pre-monsoon) to 50.0% in October (post-monsoon), Scaphopods 2.86% in February (pre-monsoon) to 50.0% in October (post-monsoon) were recorded under phylum Mollusca. Polychaetes 37.50% in July (monsoon) to 83.33% in August (monsoon), Nematodes 16.67% in August (monsoon) to 55.56% in May (pre-monsoon) were recorded under phylum Annelida. Echinoderms varied from 0.0% in June (monsoon) to 2.75% in January (post-monsoon), miscellaneous (egg cases, sand tubes and fish larvae) 0.72 in November (post-monsoon) to 6.30% in June (monsoon).Abundance of intertidal organisms was in the order of crustaceans 35% > bivalves 27% > gastropods 18% > nematodes 3% > scaphopods 3% > polychaetes 5% > miscellaneous 6% > echinoderms 3%

### 3.C.2. Station B2

The abundance (No./$m^2$) of intertidal organisms varied from 105 No./$m^2$ October (post-monsoon) to 183 No./$m^2$ January (post-monsoon). Intertidal organism community structure comprised of crustaceans 24.41% in June (monsoon) to 45.96% in February (pre-monsoon) were identified under Arthropoda phylum. Bivalves 47.27% November (post-monsoon) to 64.38% February (pre-monsoon), Gastropods 27.03% in July (monsoon) to 43.64% in November (post-monsoon), Scaphopods 2.90% in January (post-monsoon) to 18.52% in September (monsoon) were recorded under phylum Mollusca. Polychaetes 44.44% in May (pre-monsoon) to 84.62% in December (post-monsoon), Nematodes 11.11% in April (pre-monsoon) to 55.56% in May (pre-monsoon) were recorded under phylum Annelida. Echinoderms varied from 0.72% in November (post-monsoon) to 5.78% in March (pre-monsoon), Miscellaneous (egg cases and fish larvae) 0.0% in May (pre-monsoon) to 19.08% in August (monsoon). Abundance of intertidal organisms was in the order of crustaceans (37%) > bivalves 26% > gastropods 15% > miscellaneous 6% > polychaetes 5% > echinoderms 4% > scaphopods 4% > nematodes 3%.

### 3.C.3. Station B3

The abundance (No./$m^2$) of intertidal organisms varied from 128 No./$m^2$ August (monsoon) to 209 No./$m^2$ February (pre-monsoon). Intertidal organism community structure comprised of crustaceans 16.45% in June (monsoon) to 54.55% in October (post-monsoon) were identified under Arthropoda phylum. Bivalves 43.84% November (post-monsoon) to 63.46% February (pre-monsoon), Gastropods 28.99% in October (post-monsoon) to 51.67% in August (monsoon), Scaphopods 3.26% in May (pre-monsoon) to 51.67% in August (monsoon) were recorded under phylum Mollusca. Polychaetes 20.0% in May (pre-monsoon) to 85.71% in August (monsoon), Nematodes 14.29% in August (monsoon) to 80.0% in May (pre-monsoon) were recorded under phylum Annelida. Echinoderms varied from 0.49% in July (monsoon) to 5.41% in December (post-monsoon), miscellaneous (egg cases and fish larvae) 0.72% in November (post-monsoon) to 6.30% in June (monsoon). Abundance of intertidal organisms was in the order of crustaceans 36% > bivalves 25% > gastropods 20% > polychaetes 5% > miscellaneous 5% > scaphopods 4% > echinoderms 3% > nematodes 2%.

## 4. Discussion

### 4.1. Intertidal organisms abundance

The species abundance varied from 34 to 237 No./$m^2$. The minimum abundance was observed at Someshwara beach (S3) and (S1) was 34 and 31 July (monsoon) respectively. The maximum abundance was observed as 237, 225 and 208 No./$m^2$ in February (pre-monsoon) at Panambur beach station (P1), (P2) and Bengre beach (B3) stations respectively. The minimum species abundance was observed in the monsoon season in all selected station temporally, the intertidal organisms abundance higher during post-monsoon and lowest during monsoon followed by pre-monsoon season. 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.

### 4.2. Molluscs

In the present investigation, the Phylum Mollusca was represented by Class Gastropoda, Bivalvia, and Scaphopoda. The Molluscs comprising of Bivalvia, Gastropoda and Scaphopoda belong to different families such as Donacidae, Arcidae, Mytilidae, Ostreidae, Umbonidae, Cerithidea, Turritellidae, Trochidae and Olividae. Bivalve population included species such as *Arca spp., Anadara granosa,* Bivalve spats, *Cardium spp., Crassostrea spp., Donax faba* (Beach clam)*, Donax scortum, Dosinia spp. Meritrix casta, Meritrix spp., Paphia spp., Paphia malabarica, Pecten spp., Perna viridis* (Green mussel) and *Tellina spp.,* The Gastropods population included species such as *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. and Umbonium spp.* the percentage contribution of molluscs to the total intertidal organisms varied from Someshwara beach to Panambur and Bengre beach. The seasonal variation of molluscs revealed trimodal oscillation with greater abundance in all most throughout the post-monsoon season. In Someshwara, Panambur and Bengre beaches with lower density during monsoon and moderate density during post-monsoon season. The pre-monsoon peak consisted of molluscs in Bengre beach. *Donax faba, Dentalium spp., Turitella spp., Umbonium spp., Cerithidea spp.* and spats were highly observed in intertidal beaches of Bengre and Panambur in post and pre-monsoon season. Zacharia *et al.* (2008) [33] reported that total of 234 molluscan species were recorded belonging to 65 families and 132 genera, of which 145 are gastropods, 70 are bivalves, 16 are cephalopods, a single species of polyplacophores and two species of scaphopods recorded in coastal, Karnataka. Total 28 Molluscans species were by Pandyakhushali *et al.* (2012) [17] in intertidal zone of saurashtra coast, Gujarath. And he reported that *Turbo spp.* species was found to be the most dominant species at all his selected stations.

Similarly phylum Mollusca studies were done in Mangaluru coast by Shanthanagouda (2001), Swetha (2009) [30], Rajeshwari (2009) [20], Amrutha (2010) [1] and many researcher studied along the estuaries, brackish waters and

coastal environments along the west coast of India and they have documented grater abundance of molluscans during pre and post monsoon season.

### 4.3. Crustaceans

The class Crustacea was represented by individuals of three groups namely Copepods, Decapoda, Ocypods and mysids. Population was represented species such as *Balanus spp.,* Copepods*, Emerita spp., (*mole crab)*, Ocypode, Lepas anatifera* (goose barnacle)*,* Mysids*, Uca spp.* (fiddle crab), *Emerita spp.*, *Uca spp.*, and copepods contributed high abundance in crustacean class. *Eupagurus spp.*, *Lepas anatifera* and shrimp larvae occurred on occasions. Whereas ocypode crabs occurred more frequently with greater abundance. The abundance was more during pre-monsoon and post-monsoon season at stations of Panambur and Bengre beaches. Copepods and mole crab found to be the bulk of the class Crustacean. Seasonal distribution copepods and mole crab revealed greater abundance during pre-monsoon and post-monsoon season. The spatial distribution indicates greater abundance with fine sand in Panambur beach. It was observed that the *Emerita spp.* and copepods were responsible for bringing down the percentage of population bivalves, polychaetes and gastropods. This relationship is more evident in Someshwara beach station (S3) and Panambur beach station (P1). The percentage composition of crustaceans to the total intertidal organisms varied from season to season. However, Swetha (2009) [30], Amrutha and Prashanth (2010) [1], could not observe significant contribution of crustaceans in general and Amphipods in particular to the total macrobenthos in the Gangolli, Mangalore coastal waters and Nethravati-Gurupur estuaries respectively. Gohil and Kundu (2012) [8] four species of crabs were recorded in the intertidal zones of rocky intertidal belt at Dwarka among crabs, Hermit Crabs were present in deserted shell of gastropod molluscs in lower littoral zone. Similarly in present investigation the *Eupagurus spp.* were observed in dead shells of Mollusca at Panambur beach in post-monsoon season.

### 4.4. Annelids

Polychaete population was represented species such as *Echiurus spp., Glycera spp., Nephthys, Nereis spp.* (sand worm)*,* Polychaete larvae*, Sabellaria spp.* and Nematodes were also represented in phylum Annelida. The Polychaeta was represented by individuals belonging to families, Nephtydae, Nereidae, Glyceridae, Spionidae and Sabellaridae. Among these Nephtydae, Nerridae, Glyceridae and Sabellaridae were most dominant and present throughout the study period. The other forms occurred sporadically with few numbers. The percentage contribution of polychaetes to the intertidal organisms varied from season to season and beach to stations. The seasonal distribution of polychaetes revealed greater abundance during post-monsoon and per-monsoon seasons than that of monsoon season. The spatial distribution indicated increased abundance with increased percent of fine and medium sand. Further higher polychaete population coincided with increased silt and clay percentage in the sediment. The dominance of polychaetes during pre and post-monsoon along the estuaries of west coast of India was observed by Shanthanagouda (2001), Swetha (2009) [30], Amrutha and Prashanth (2010) [1]. However Chakraborty and Choudhury (1997) [2] observed grater abundance of polychaetes during pre-monsoon and monsoon season. In Cochin estuarine mangrove habitat studied by Sunil Kumar (2002) [28], he documented the abundance of polychaetes during pre-monsoon and monsoon season. The present observation of dominance of polychaetes during pre-monsoon and post-monsoon season is in disagreement with the works of the above two authors.

### 4.5. Echinoderms

The Echinodermata population was represented specie *Astropecten indica (star fish), Opiochoma spp.*, *Clypeasteroids* (sand dollar). *Opiochoma spp.*, *Asrtopecten indica* were the sole representatives of the Bengre and Panambur beaches. *Clypeasteroids* observed in Someshwara beach in the (pre-monsoon) season. Among others miscellaneous were also reported in present study. The miscellaneous forms included egg cases, sand tubes and juvenile fishes. The percentage contribution of these groups varied from post-monsoon to monsoon and Someshwara beach to Bengre beach. The intertidal macro-invertebrate community in the Panambur beach and Bengre beach was abundant and diverse comparatively Someshwara beach during the study period. The presence of intertidal organisms was less and irregular at Someshwara beach station (S3) and (S2) comparatively (S1) the Panambur beach stations are equally abounded with intertidal organisms in post and pre-monsoon where as in monsoon season Panambur station observed low abundance of intertidal organisms the reason could be the due to the direct connection of drainage canal with freshwater runoff in monsoon. In Bengre beach all three stations were abundant in case station 3 have been observed the highly diversified with good species abundance the reason could be the occurrence rocks and large stones. Finally observed that the number of groups/species, individuals and the diversity index values were significantly moderate condition at all selected stations of Mangaluru beaches. Several authors such as Kaiser *et al*., 2002 and 2006, [9, 10]. Lokkeborg (2011) [13] demonstrated a decrease in the abundance of some macro benthic species and changes to their community structure.

### 4.6. Statistical Analysis

Two-way ANOVVA was applied to observe the variation in the abundance of Intertidal organisms between the stations and between months. As per the result from the anova tables, research hypothesis indicating that, there is significant difference ($P< 0.05$) in the abundance of intertidal organisms between the stations and between the months. Statistical analysis showed a significant difference ($P< 0.05$) in intertidal organisms community in relation to sediment fractions, due to months and stations in the present investigation.

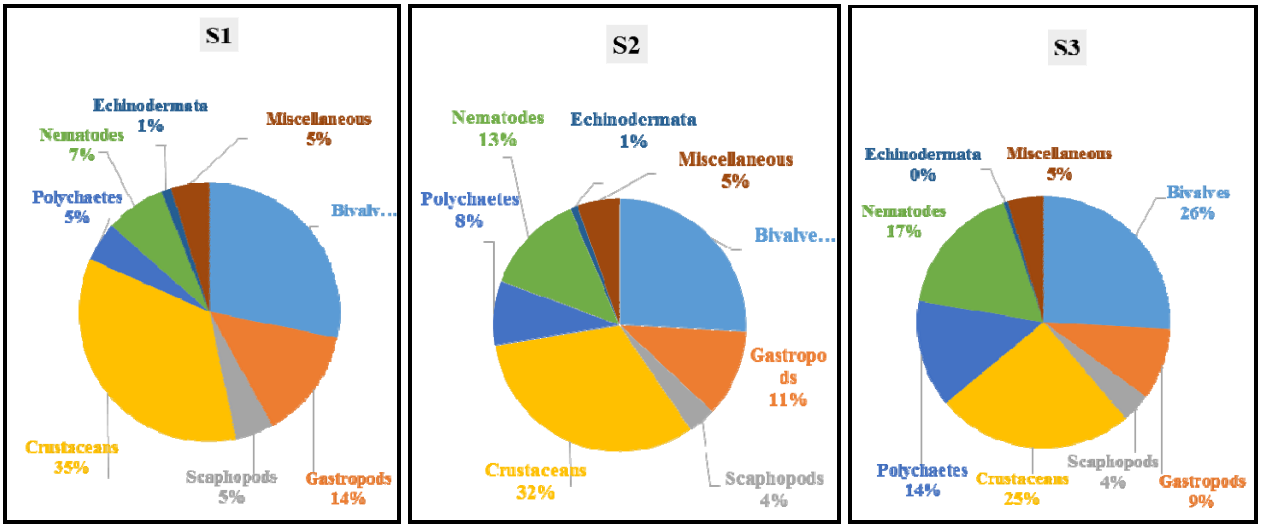


**Fig 2:** Distribution and composition of intertidal organisms (%) at Someshwara beach

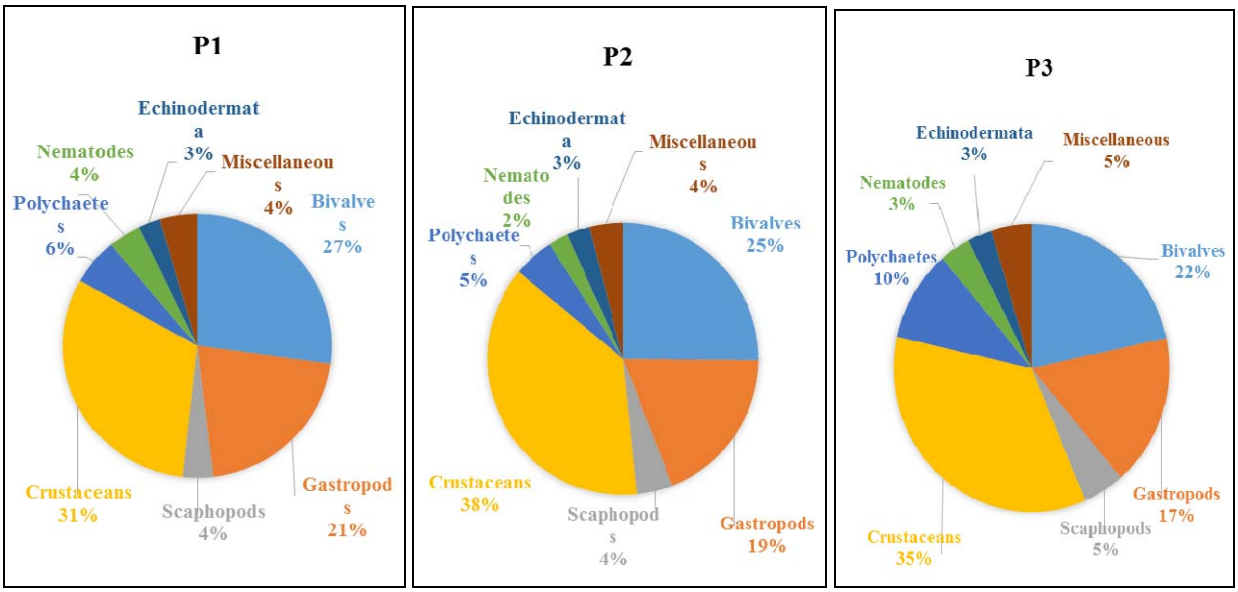


**Fig 3:** Distribution and composition of intertidal organisms (%) at Panambur beach

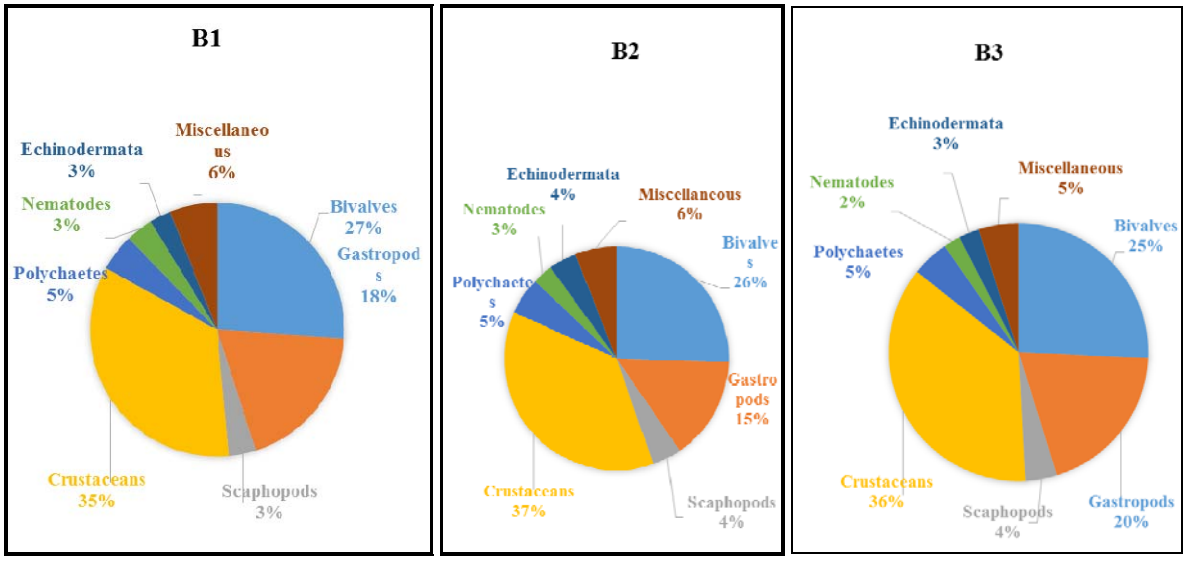


**Fig 4:** Distribution and composition of intertidal organisms (%) at Bengre beach

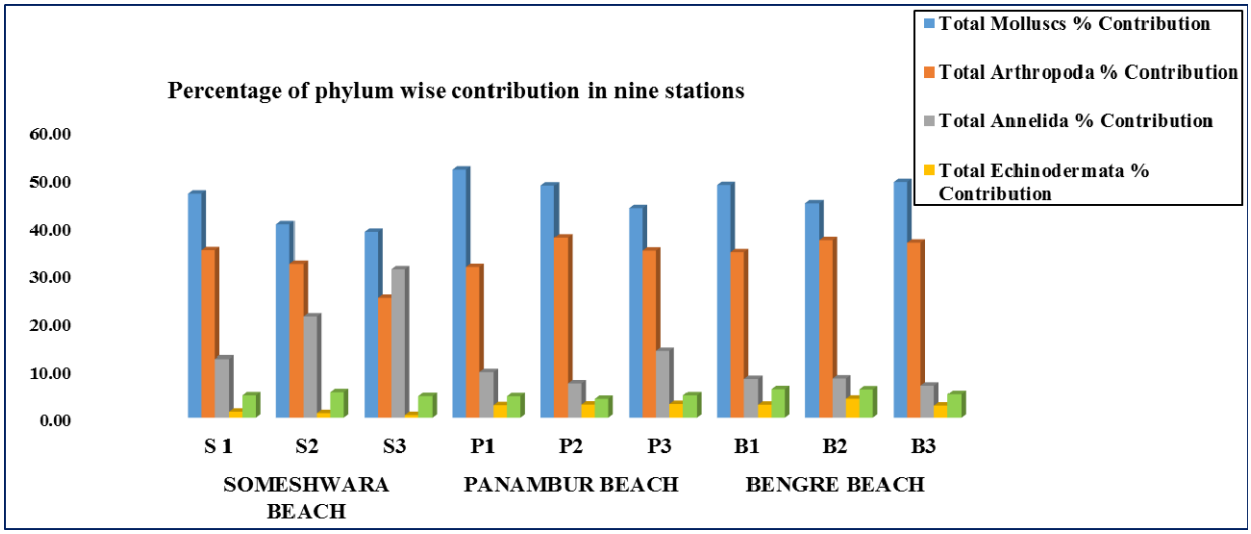


**Fig 5:** Distribution and composition percentage of intertidal organisms in selected stations

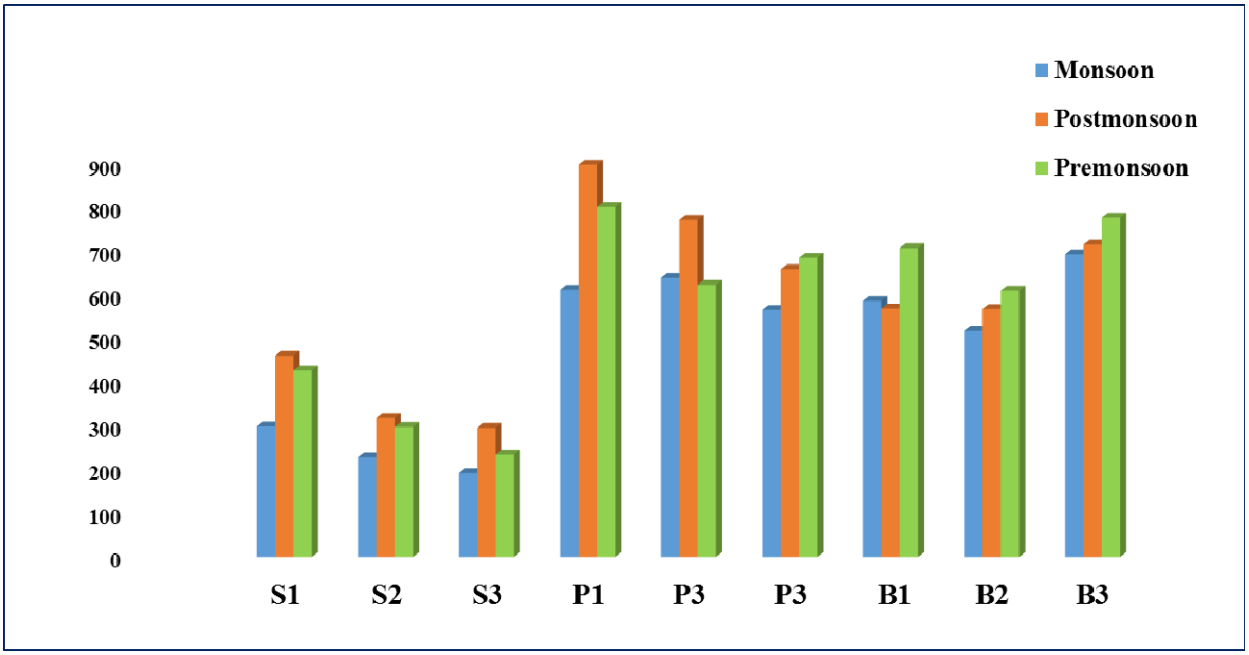


**Fig 6:** Season wise total abundance of intertidal organisms (No./$m^2$) in selected stations

## 5. Conclusion

All the nine stations were showing significant difference with seasonality in intertidal faunal composition. Beach profile, topography and grain size distribution are the most important factors in abundance and distribution of intertidal organisms Diversity indices revealed moderately diverse status of the intertidal organisms along the selected beaches of Mangaluru. 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.

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