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# A PRELIMINARY INVESTIGATION INTO THE COMMUNITY STRUCTURE AND COMPOSITION OF INTERTIDAL FAUNA ALONG THE EAST COAST OF INDIA

P. Jasmine[1], Jayeeta Dey[1], Samir Hansda[1], Aswani K. Ghosh, B. Tripathy, A.K. Mukherjee[1], K Venkataraman[1]

*Zoological Survey of India, M Block, New Alipore, Kolkata-700053*

Corresponding author: jasbose@gmail.com

## INTRODUCTION

Coastal ecosystems are biologically and economically productive and at the same time they are the places of dynamic change due to natural and anthropogenic pressures. These changes are directly or indirectly affecting the community structure of the organisms and essentially reflect ecological quality of the habitats (Vladica and Snezana, 1999). India is having a large coastline of 8000 km, along the west and east coasts, which include many biotopes such as estuaries, lagoons, backwaters, mangroves, salt marshes, coral reefs etc. The east coast coastline encompasses almost all types of intertidal habitats such as rocky intertidal zones, salt marshes, mud flats, sea grass beds and sandy beaches, sharing this coastline to different extents. The shape and the sediment characteristics of the coastal ecosystems are highly sensitive to oceanographic forcing, wave energy, near shore wave transformation, wave setup, storm surge, erosion, tides and near shore circulation (Kumar *et al*., 2006 and Krishnamurthy and Subbramaiah, 1972). These habitats provide a transition zone between terrestrial and marine ecosystems and are vulnerable to human impacts from both land and ocean based activities, including coastal development, urban run-off, marine pollution and recreational activities. The organisms in these zones become specially adapted to survive the rapid and significant changes in temperature, salinity, moisture, pH, dissolved oxygen, and food supply that occur on a daily basis due to the movement of the tides (Levington, 1995). The Intertidal zones also provide food not only for humans, but also for marine species and migrating birds. Thus intertidal ecosystems are valuable sites for investigation of relationships between biodiversity and the coastal ecosystem function (Vaghela *et al*., 2010).

The studies on the species diversity of intertidal fauna in the coastal ecosystem of India were very limited and few (Ganapati and Rao, 1962, Rao and Ganapati, 1968, McIntyre, 1968, Venkataraman, 2005, Biju Kumar and Ravinesh, 2011, Ravinesh

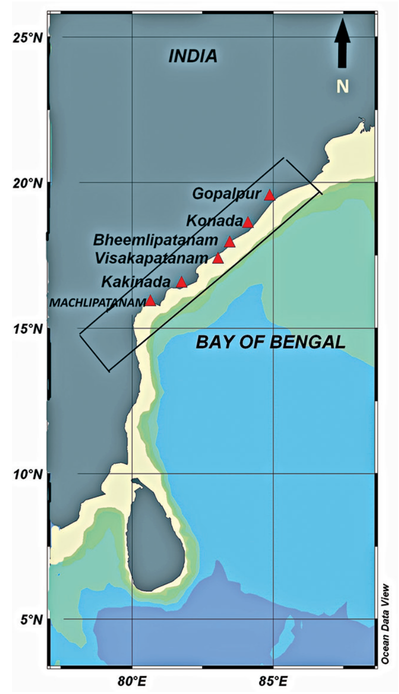


**Fig. 1.** Map showing the study sites (red dots) from Gopalpur (Southern Odisha) to Machilipatanam (Northern Andhra Pradesh coast).

and Biju Kumar, 2013, Gadi and Rajashekhar, 2007), Particularly information on the intertidal fauna in the east coast of India too was very few and most of them are related to the seaweeds and sea level changes (Kumar *et al*., 2006, Kumar *et al*., 2010). The present study deals with the diversity of organisms in the intertidal zone along the east coast of India from southern Orissa to Northern Andhra Pradesh, during summer monsoon period.

## MATERIALS AND METHODS

The intertidal faunal composition along the different regions of Gopalpur and Andhra Pradesh coast, were studied during the summer monsoon period (May, 2013). The survey was conducted from southern Odisha (Gopalpur, 19˚N; 84˚E) to Northern Andhra Pradesh (Machlipatanam, 16˚N; 81˚E) of East coast of India (Fig. 1). This region is characterised as sandy and muddy with high anthropogenic activities, whereas the coastal belt of Andhra Pradesh is characterised with more rocky shores and sandy shores. The intertidal biodiversity was surveyed based on the tidal structure by using 1m x 1m quadrat from 6 sampling sites and two quadrat samples were taken from each locality. The quadrats were placed randomly at two locations in the intertidal area, from upper limit of high tide mark to lower limit of the low tide mark, and the faunal elements collected. The collected specimens were preserved in 5% formalin and once brought to the lab were identified up to species level. The faunal diversity associated with each region was identified up to species level. The Molluscan specimens were identified based on the works of Abott and Dance, 1982, Subba Rao and Dey, 1984 & 1986, Dey, 2006, Ramakrishna and Dey, 2003 and Gray, 1997. The sea water samples collected at each sampling locations were analysed for physiochemical parameters, such as Temperature, pH, Salinity, DO and nutrients.

## RESULTS

Habitat surveys revealed that the intertidal area of Visakhapatnam was characterized by a relatively high percentage cover of rocky substratum compared to other sites in the Andhra Pradesh coast. The intertidal area of Machlipatanam was composed of soft muddy shore and Gopalpur region of Orissa with a sandy shore. The temperature ranged between $27^0$C to $33.5^0$C and pH varied between 7.9 and 8.13 in between all the sites, but remained almost constant within each site during the entire study period. Salinity ranged between 34 to 34.8, but remained same in Konada and Kakinada (Table. 1).

Higher macro faunal biomass was recorded at the intertidal region of Konada than that of other study sites. A total of 516 specimens were recorded from all the six study sites (25 crabs, 1 sponge, 1 annelid, 18 barnacles, 3 corals, 6 hermit crabs, 1 sea anemone, 1 sea urchin, 1 lobster larva, 127 gastropods and 326 bivalves (Fig. 2). The Bivalves represented by 15 species formed the major element in all the intertidal zones, followed by gastropods (12 species) and crustaceans. Comparison of diversity of intertidal fauna in all the six study sites shown that the intertidal habitat of Konada in Andhrapradesh coast represented a greater number of 205 taxa (5 crabs, 119 bivalves, 72 gastropods, 1 coral, 6 hermit crabs,) followed by Machlipatanam region representing about 177

**Table 1.** Description of the study area, temperature and characteristics of the intertidal area

| Intertidal Location | Latitude (˚N) | Longitude (˚E) | Temp ($^0$C) | Characteristics of the coast | Salinity |
|---|---|---|---|---|---|
| Gopalpur | 19˚ 25' 57''N | 84˚ 90' 47''E | 29°C | Sandy with Coarse grain | 34 |
| Konada | 18˚ 01'30''N | 83˚ 57' 24''E | 27.08° C | Sandy & Muddy, Lagoons | 34.2 |
| Bheemlipatanam | 17˚ 89'35''N | 83˚ 45' 32'' E | 29.33° C | Sandy & rocky | 34.0 |
| Vishakhapatanam | 17˚ 71' 39''N | 83˚ 31' 56''E | 33.5˚C | Sandy with Coarse grain | 34.80 |
| Kakinada | 17˚ 02' 09''N | 82˚ 29' 25''E | 32.5˚C | Sandy | 34.20 |
| Machilipatanam | 16˚ 24' 29''N | 81˚ 24' 30''E | 31.05˚C | Muddy | 34.87 |

taxa (4 crabs, 4 gastropods, 169 bivalves).Whereas Bheemlipatnam and Kakinada was supported by 95 taxa (7 crabs, 13 bivalves, 49 gastropods, 18 barnacles, 1 sponge, 1 sea anemone, 1 sea urchin) and 18 taxa respectively (14 bivalves, 2 gastropods, 1 coral, 1 lobstar larva). In comparison with other intertidal habitats, Visakhapatnam and Gopalpur coastal regions were represented by a less number of taxa (16 and 5). In the intertidal regions of Gopalpur, Visakhapatnam & Kakinada, annelids formed the dominant taxa followed by crustaceans and with very less number of other taxa (Fig. 2). Highest molluscan diversity was observed in Konada and Machlipatanam region of Andhra Pradesh coast with a percentage composition of 87.3% and 91.06% respectively.

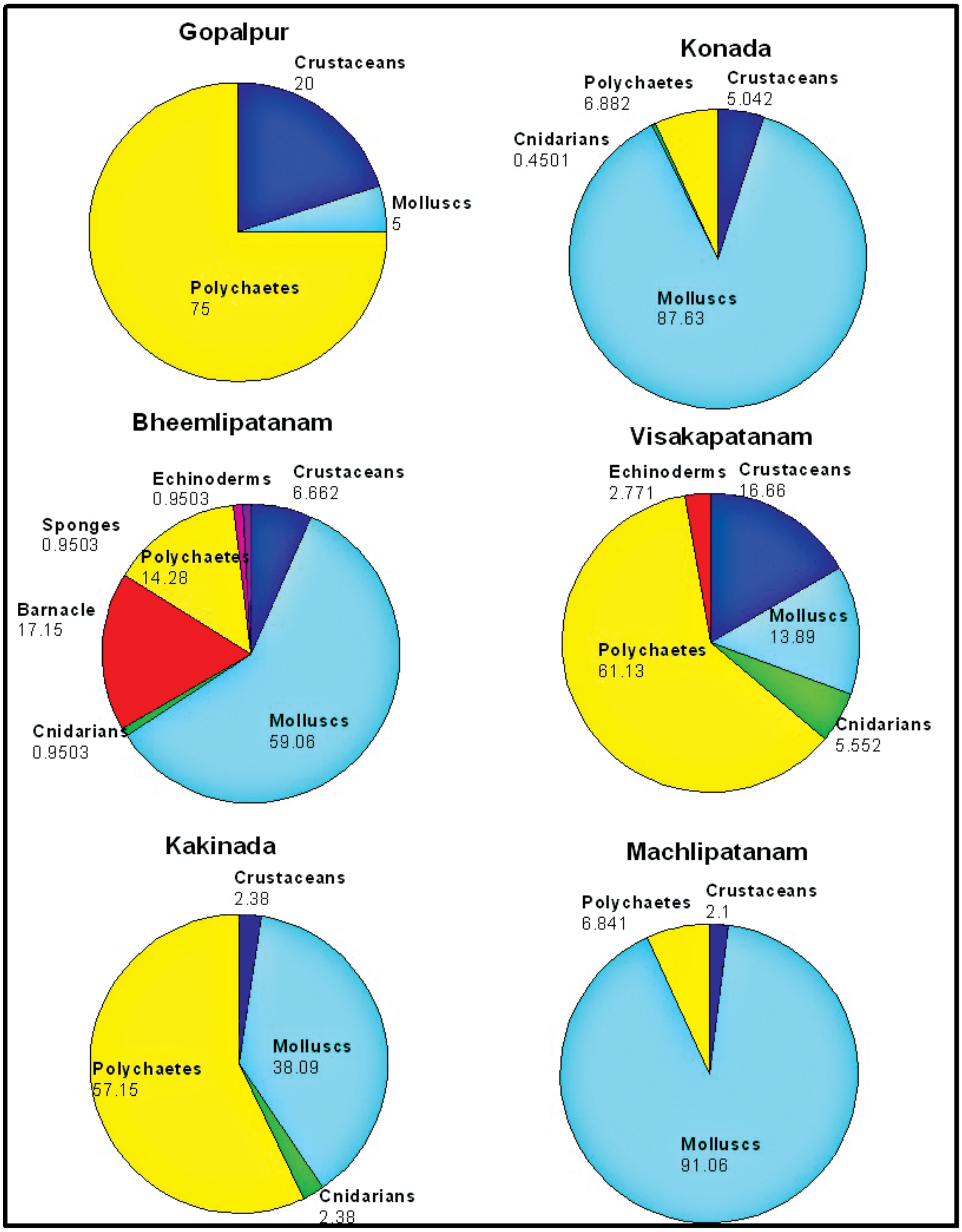


**Fig. 2**. Percentage composition of intertidal fauna of different coastal regions from southern Odisha (Gopalpur) to northern Andhra Pradesh (Machilipatanam) of East coast of India.

Twenty seven molluscan species were recorded in total from all the six study sites. The Molluscan families best represented were the Veneridae (four species), Ostreidae (two species) and the Muricidae (three species). Fifteen bivalve species were recorded and the abundance of bivalves was low at Gopalpur and Visakhapatnam (Table. 2). A summary of the molluscan species diversity were shown in Table 2. Among Mollusca *Tegillarca rhombea* was the dominant species in Konada region, *Tenguella granulata* was the dominant species in Machlipatanam region, where as the *Meretrix* sp. were common throughout the intertidal belts. The coastal region of Konada was observed with rich biodiversity of flora and fauna compared to all other study sites.

## DISCUSSION

In recent days, the conservation of marine biodiversity is a daunting task, as the decline in biodiversity is mainly due to industrialisation, extraction of natural resources, sea port formation. In India, studies on intertidal regions were mainly restricted on the marine shoreline studies related to wave energy and geography (Kumar *et al*., 2006 and 2010). Foraminifera diversity (Gadi and Rajashekhar, 2007) and very few studies were about intertidal invertebrates, mostly from some protected areas or from the west coast (Venkataraman, 2005, Ravinesh and Biju Kumar, 2013, Rao and Umamaheswara, 1986). In the present study, 516 taxa were recorded from six different intertidal areas of northern Andhra Pradesh and southern Odisha. Highest estimates of macro faunal biomass were recorded at the intertidal region of Konada than any of the other study sites. The study revealed that the macro invertebrate biomass and diversity in the rocky shores (Bheemlipatnam) were higher than that of sandy shores (Gopalpur). There are significant differences in the presence of certain species, found dominant in one zone were either not found in other zones.

In all the sampling locations, bivalves represented by 15 species formed the major element in all the intertidal zones, followed by gastropods (12 species) and crustaceans. Molluscs are the dominant group in the marine environment and the estimated diversity of molluscs comprises up to 60% of total biodiversity (Gosliner, *et al*., 1996). Some ecologists have already reported that the topological heterogeneity is a major factor regulating species abundance and distribution of community (Floater, 2001). It was also observed that the Gopalpur beach in Odisha having fewer slopes and always exposed with high wave energy, and quick exposure by the incoming tide, where as in Konada coastal belt is characterised with a wide shore line and the influence of lagoon and estuarine ecosystems. In Konada and Machilipatnam the coastal areas are much more sandy muddy. In this type of dissipative beaches have flat slop and fine grained sands and are subjects to heavy wave action whose energy is deposited over the intertidal zone (Brown and McLachlan, 1990). Macro invertebrate biomass tends to be higher on dissipative beaches (McLachlan, 1990, McLachlan *et al*., 1993) such feature allows greater retention of organic particles for both suspension feeders and deposit feeders (Talbot and Bate, 1989). This was clearly evident from the results of higher intertidal faunal assemblage of Konada. Our results showed that the rocky shore of Bheemlipatnam was the most diverse and enriched with high intertidal fauna. Previous studies had indicated that the intertidal diversity and biomass is highest in rocky shores depending on the proportions of sand, gravel and boulders and then increases progressively smaller grain sizes toward compact fine sand and mud flats. Visakhapatnam and Gopalpur were characterised with more coarse grain sands compare to other study sites. This might be due to the coarse grain beaches tend to be too unstable to support dense macro invertebrate populations (Jaramillo and McLachlan, 1993). In addition to that profuse tourism activities and anthropogenic pressures were seen in the shoreline environment of Visakhapatnam and Gopalpur. Thus human activities, both directly and indirectly are responsible for current high rates of biodiversity loss and habitat loss of most of the intertidal fauna. Anthropogenic disturbances may affect the physiological state of the animals predicting to changes in growth rate, recruitment and mortality (Tablado *et al*., 1994, Johnston and Keough, 2002, Ng and Keough, 2003). The study confirms that the coastal geography and the effect of anthropogenic activities were clearly influencing the diversity of the intertidal faunal distribution. Further intensive study of these habitats may quite likely reveal many more species in these regions and their detailed ecology and distribution.

**Table 2.** Comparison of species diversity associated with the intertidal zone at Gopalpur (**GP**), Vishakhapatnam (**VSKP**), Konada (**KND**), Bheemlipatnam (**BPM**), Kakinada (**KKND**) & Machilipatnam (**MPM**), East coast of India. **'+'** present, **'–'**absent.

| Species | GP | VSKP | KND | BPM | KKND | MPM |
|---|---|---|---|---|---|---|
| **I. Cnidaria** | | | | | | |
| Class: Anthozoa | | | | | | |
| Order: Scleractinia | | | | | | |
| Family: Dendrophyllidae | | | | | | |
| ***Heteropsammia cochleata*** (Spengler, 1781) | - | + | - | - | - | - |
| ***Heterocyathus acquicostatus*** M. Edwards &Haime, 1848 | - | - | + | - | - | - |
| **II. Mollusca** | | | | | | |
| Class: Gastropoda | | | | | | |
| Subclass: Caenogastropoda | | | | | | |
| Family: Thiaridae | | | | | | |
| ***Stenomelania torulosa*** Brugiere | - | - | - | - | - | + |
| Super family: Architaenioglossa | | | | | | |
| Family: Viviparidae | | | | | | |
| ***Bellamya bengalensis*** Lamarck, 1822 | - | - | + | - | - | - |
| Super family: Cerithioidea | | | | | | |
| Family: Potamididae | | | | | | |
| ***Tellescopium tellescopium*** Linnaeus, 1758 | - | - | + | - | - | + |
| ***Certhidea cingulata*** (Gmelin,1791) | - | - | + | - | - | + |
| Order: Neogastropoda | | | | | | |
| Superfamily: Olivoidea | | | | | | |
| Family: Olivida | | | | | | |
| ***Oliva vidua*** Roding, 1798 | - | - | - | + | - | - |
| Superfamily:Muricoidea | | | | | | |
| Family: Muricidae | | | | | | |
| ***Tenguella granulata*** (Duclos, 1832) | - | - | - | - | - | + |
| ***Murex (Murex) trapa*** Roading, 1798 | + | - | - | - | - | - |
| ***Murex (Murex) carbonnieri*** (Jousseaume, 1881) | - | + | + | - | - | - |
| Class: Gastropoda | | | | | | |
| Subclass: Vetigastropoda | | | | | | |
| Superfamily: Seguenzioidea | | | | | | |
| Family: Chilodontidae | | | | | | |
| ***Euchalus asper*** (Gmelin, 1791) | - | + | - | - | - | - |

*Table 2. Contd.*

| Species | GP | VSKP | KND | BPM | KKND | MPM |
|---|---|---|---|---|---|---|
| Subclass: Heterobranchia | | | | | | |
| Super family: Architectonicoidea | | | | | | |
| Family: Architectonicidae | | | | | | |
| ***Architectonica laevigata*** (Lamarck, 1816) | - | - | - | - | - | + |
| Super family: Lottioidea | | | | | | |
| Family: Nacellidae | | | | | | |
| Class: Gastropoda | | | | | | |
| Subclass: Patellogastropoda | | | | | | |
| ***Cellana radiata*** (Born, 1778) | - | - | + | + | - | - |
| Infra class:Pulmonata | | | | | | |
| Order: Hygrophila | | | | | | |
| Family: Planorbidae | | | | | | |
| ***Indoplanorbis exustus*** Deshayes, 1834 | - | - | + | - | - | - |
| Class: Bivalvia | | | | | | |
| Subclass: Heterodonta | | | | | | |
| Order: Veneroida | | | | | | |
| Family: Veneridae | | | | | | |
| ***Bassina pachyphylla*** (Jonas, 1839) | + | - | - | - | - | - |
| ***Venerupis bruguieri*** (Hanley, 1845) | - | - | - | + | - | - |
| ***Meretrix meretrix*** (Linnaeus, 1758) | + | + | - | + | - | + |
| ***Meretrix casta*** (Gmelin, 1791) | + | - | - | - | - | + |
| Family: Donacidae | | | | | | |
| ***Donax cuneatus*** Linnaeus, 1758 | - | + | - | - | + | + |
| Family: Cardiidae | | | | | | |
| ***Pypyridea lata*** (Born, 1778) | - | + | + | - | - | - |
| ***Vepricardium asiaticum (***Bruguiere, 1789) | + | - | - | - | - | - |
| Family: Mactridae | | | | | | |
| ***Mactramera*** (Reeve, 1854) | - | - | - | - | - | + |
| Order: Mytiloida | | | | | | |
| Family: Mytilidae | | | | | | |
| ***Perna viridis*** Linnaeus, 1758 | - | - | - | - | - | + |
| Order: Pectinoida | | | | | | |
| Family: Placunidea | | | | | | |
| ***Placuna placenta*** (Linnaeus, 1758) | + | - | - | - | - | - |
| Order: Ostreoida | | | | | | |
| Family: Osteroidae | | | | | | |
| ***Crassostrea cuttackensis*** (Newton & Smith) | + | - | + | + | - | - |
| ***Saccostrea cuculata*** (Born, 1778) | - | - | + | - | - | - |

*Table 2. Contd.*

| Species | GP | VSKP | KND | BPM | KKND | MPM |
|---|---|---|---|---|---|---|
| Order: Arcoida | | | | | | |
| Family: Arcidae | | | | | | |
| ***Tegillarca rhombea*** (Born, 1778) | + | - | + | + | - | - |
| ***Tegillarca granosa*** (Linnaeus, 1758) | - | + | - | - | - | - |
| ***Tegillarca antiquata*** (Linnaeus, 1758) | - | - | + | - | - | - |
| **III. Annelida** | | | | | | |
| Class: Polychaeta | | | | | | |
| Order: Aciculata | | | | | | |
| Family: Nereididae | | | | | | |
| ***Nereis* sp.** | - | + | - | - | - | - |
| **IV. Arthropoda** | | | | | | |
| Class: Malacostraca | | | | | | |
| Order: Decapoda | | | | | | |
| Family: Portunidae | | | | | | |
| ***Charybdis truncata*** (Fabricius, 1798) | - | - | - | + | - | - |
| ***Portunuss sasguisolentus*** (Herbst, 1790) | | | | | | |
| Family: Ocypodidae | | | | | | |
| ***Ocypoda ceratophthalma*** (Pallas, 1772) | - | - | + | - | - | - |
| ***Ocypoda cordimana*** Desmarest, 1825 | - | - | + | + | - | + |
| ***Ocypoda platytarsis*** (H. Milne Edwards, 1855) | - | - | - | + | - | + |
| Family: Grapsidae | | | | | | |
| ***Grapsus albolineatus*** Lamarck, 1818 | - | - | - | + | - | - |
| Family: Plagusiidae | | | | | | |
| ***Percnon planissimum*** (Herbst, 1804) | - | - | - | + | - | - |

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