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An Appraisal of Benthic Meiofaunal Diversity and Distribution along Estuaries of Peninsular India

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ABSTRACT: One of the most phyletically diverse fauna, the meiofauna of sediments is now focused for ecological monitoring, bioreactors, bioturbators and many more. Now a days meiofaunal researches are gaining popularity as a result of increasing use of aquatic ecosystems and resources, advancing collaborative, multi-disciplinary scientific studies on ecosystem dynamics, functions and processes is becoming more pertinent. Meiobenthology is gaining importance as it deals with the role of meiobenthos in ecosystem function, taxonomy, systematics and evolution of meiobenthos, use of meiobenthos within the assessment of environmental consequences and response of meiobenthos to environmental change. Meiobenthos is another widely distributed biodiversity group as it differs with environment like freshwater, estuarine and marine ecosystems and main works are mainly associated with marine as well as estuarine environments of which the studies from estuarine meiobenthic diversity and distribution are moderate from Indian subcontinent. This review attempts to compile studies on diversity and distribution of benthic meiofauna along estuaries of peninsular India using available data from internet based indexing/abstracting sources.

Keywords: Benthos, Meiobenthos, Nematodes, Biodiversity.

INTRODUCTION

Estuaries are transient ecosystems supporting high biodiversity and provide critical habitat for species that are valued commercially, recreationally and culturally. They also act as critical reproductive and nursery ground for a variety of organisms including benthic fauna characterized with fluctuating salinities, shallow depths, high turbidity and siltation, act as nutrient dumb and high productivity (Pritchard, 1967). Benthos comprises of microscopic bacteria to larger organisms residing in the bed sediments of water bodies. Traunspurger and Majdi (2017) stated that the meiofauna (or meiobenthos) are the smallest metazoans dwelling in the substratum of streams and other stationary surfaces, such as tree root wads and other large debris. Higgins and Thiel (1988) expounded meiofauna as themetazoans creatures able to pass through a 500 mm sieve, but are retained on a 40 mm sieve. They are diversified, numerically ruling community which acts as a mediator between micro- and macroscopic life forms in aquatic ecosystems (Schmid-Araya *et al.*, 2002).

At least twenty of the presently identified thirty-four phyla within the different biogeographical regions are constituted in meiobenthic fauna: Phylum Porifera, Placozoa, Cnideria, Ctenophora, Platyhelminthes, Orthonectida, Rhombozoa, Cycliophora, Acanthocephala, Nemertea, Nematomorpha, Gnathostomulida, Kinoryncha, Loricifera, Nematoda, Rotifera, Gastrotricha, Entoprocta, Priapulida, Pogonophora, Echiura, Sipuncula, Annelida, Arthropoda, Tardigrada, Onychophora, Mollusca, Phoronida, Bryozoa, Brachiopoda, Echinodermata, Chaetognatha, Hemichordata and Chordata (APHA, 2017). Nematodes are predominant group in bottom habitats, Harpaticoid copepods and Foraminiferans follows them in many environments. In a study on five Australian tropical mangrove estuaries, Turbellaria were the most dominant meiofaunal group recorded and disclosed temperature and sediment granulometry as the factors controlling zonation pattern of meiofauna (Alongi, 1987). Study from Venice reported that Foraminifera show a fast response to unforeseen changes of environmental parameters (Albaniet *et al.*, 2007). These benthic organisms forms a direct source of energy for higher trophic levels that aid in benthic-pelagic coupling linking the bed sediments with the water column by nutrient cycling (Warwick, 1987; Ellis and Coull, 1989; Coull, 1999). Schmid *et al.* (2000) manifested the negative correlation of density with body size measurements of stream communities as their consistent trait.Partihary et al. (2009) disclosed the benthic variability in the Mandovy estuary and their function in the ecosystem.

Meiofauna exists in all aquatic (freshwater, marine and estuarine), terrestrial environments and frigid zones (Giere, 2009). In marine abode, it can be noticed from splash zone to the mysterious deeper parts of the ocean and appearing in all types of sediment texture (clay to gravel) as well. Estuarine mud flats have more

meiofaunal communities and the high degree of meiofauna production in intertidal zone is attributable to high nutrient availability (Vicente, 1990). Usually the meiofauna has a patchy distribution (Vitiello, 1968; McLachlan, 1978; Findlay, 1981) and not shows similitude in a specific habitat. Moreover, season (Coull, 1985), latitude (Kotwicki *et al.*, 2005) water depth, tidal exposure, grain size (Williams 1972; Conrad 1976; Schratzberger *et al.,* 2000; 2004) and habitat (Funch *et al.*, 2002) influences their affluence. A distinct meiofaunal ecosystem framework is apparent in different habitat such as intertidal (McLachlan *et al.* 1977a; Ellison 1984), sub-littoral sandy (McLachlan *et al.* 1977b) and silty stations (Vidakovic, 1984), deep sea (Ansari and Parulekar, 1981), mangrove ecosystem (Dye, 1983; Armenteros, 2006), seagrass systems (Decho *et al.,* 1985; Fisher and Sheaves, 2003; Armenteros, 2008) salt marsh mud (Smith *et al.*, 1984), hydrothermal vents (Vanreusel *et al.,* 1997; Thiermann *et al.,* 1997) and ocean ice (Bick and Arlt 2005). Vincx (1996) manifested the capability of meiofaunal taxa to form symbiotic and commensalistic association with phytal environment. Gambi *et al.,* (2003) had been reported the decrease in the meiofaunal abundance by sediment organic matter build-up owing to the impact of microphytobenthos distribution. He also demonstrated salinity gradient as an independent variable to the case.

The works on meiofauna began during 18th century by Loven (1844) who narrated the worms under new genus. Dujardin (1851) spotted out Kinoryncha. The term 'Interstitial fauna' was proposed by Nicholls (1935) and stated as term interstitial fauna refers to the animals living in the interstitial space between all types of sediment particles. Remain (1940) put forwarded the similar term 'Mesopsammon'. 'Meiofauna', the term having Greek origin was suggested by Mare (1942) for the benthos of mud-caked substrates. Potent sampling techniques that separates the distribution of meiofauna from intertide to subtidal range was one of the remarkable change cropped up during 19th century. This constituted the development of grab for subtidal sample collection (Petersen, 1913) and dredges for sediment sampling (Mortensen, 1925). Moore and Neil (1930), Moore (1931), Rees (1940) and Weiser (1960) were some other key contributors and their works were appreciable benefactions to meiofaunal research. Over the period of 1950 to 1980, the works on the approach for ecological experiments has been done to value the meiofauna distribution from the native to lab conditions that is, tolerance capacity to different environmental parameters, life history studies, calculation of respiratory rate, etc. For collecting, handling and sorting samples Holme and McIntyre (1984) had been done an extensive analysis on the work of McIntyre (1969) and Hulings and Gray (1971). Remane (1952) reported extensive work on the distribution of Gastrotricha, Rotifer, Arachiannelida, Kinorhychna, and other taxa in the shore line of Helogoland Isles and Germany. Annandale (1907) initiated benthic work in Indian subcontinent, followed by Panikkar and Aiyar (1937), Kurien (1953; 1967; 1972), Seshappa (1953), Gnanamuthu (1954), Ganapati Rao (1959; 1962), Rao Mishra (1983) and so on.

Estuarine meiofaunal studies were an area of interest to many people. Based on the observations made at four stations from the South-west coast of India, Kutty and Nair (1966) prepared a report reflecting the impact of wave action, grain size, temperature and salinity on meiofauna and also their occurrence, seasonal abundance and the nature of distribution of the different groups on the intertidal zone. The seasonal cycles of organic matter and chlorophyll in relation to meiofaunal affluence was carried out by Panikkar and Rajan (1970) and reported that there is no correlation between organic carbon and chlorophyll. In the opinion of Dalal (1980) the muddy substratum exhibit abundant meiobenthos and was reported by Dhivya and Mohan (2013). Meiofauna found more in the finer sediments when a study was conducted by Kurien (1972) on the ecology of benthos of the Cochin backwaters. The study also mentioned that tidal change has no effect on its abundance. Ansari (1978) by his study on abundance and distribution of meiobenthos reported that 70% of the fauna obtained from Karwar estuarine environment occurred in the upper 2 cm of the sediments and depth wise their distribution is unique.

Ansari *et al.* (1982) reported that the total meiofauna ranged from 226 animals/4.5 cm^2 to 967 animals/4.5 cm^2 in the top 10 cm layer of the bottom deposits at the mouth of Krishna, Godavari, Mahanadi and Hooghly rivers. Biomass and faunal composition of benthos with respect to different environmental conditions were studied by Govindan *et al*. (1983) in four estuaries of Gujarat and revealed the prevalence of meiofauna in reference to biomass and numerical ampleness in the benthic productivity of the estuaries. The study also stated, "Wherever industrial pollution occurred benthos were badly affected". A study of Fernando *et al.* (1983) in the sandy bottom of Vellar estuary reported maximum concentration of meiofaunal communities of Nematodes, Harpaticoids. They also correlated the monitored environmental parameters and sediment characteristics to the benthic faunal abundance. John (2009) mentioned in his work, Murthy and Rao (1987) documented composition and ecological aspects of meiofauna of Gautami-Godavari estuary. A survey conducted by Kondalarao (1988) in the Kakinada Bay recorded 13 groups and 22 species of Harpacticoid copepod and the meiofauna ranged between 30.2 and 5924 no. $(10\ cm^2)^{-1}$ with relatively greater densities in a mangrove biotope.

Bhat and Neelakandan (1991) studied the distribution of meiobenthos in reference to environmental parameters in the Kali estuary of Karwar [reported by John (2009)]. In an investigation on the spatial and temporal variability in abundance and community structure of meiobenthic copepods, Ansari and Parulekar (1993) got a lower density in the monsoon period and higher in pre-monsoon period and *Stenhelia longifurca* was species common to all saline environments. An investigation of Ingole and Parulekar (1998) carried out between 1991 and 1992 in the estuarine intertidal beach at Siridao of Goa reported that mid tide level exhibit 3.6 to 211 individuals for every 3 cm^2 and is highly influenced by varying salinity. Spatially the meiofaunal affluence decreased from the lower to upper reaches of Zuary estuary of Goa when Ansari and Parulekar conducted a

survey there in 1988. The study reported that salinity and availability of food are the two factors determining horizontal distribution of the fauna and that determine vertical distribution is chlorophyll a and intertidal water. Rao and Sarma (1999) made report on the patterns of numerical abundance of meiofaunal variation with the sediment during different seasons in a tropical estuary.

Ansari *et al.* (2001) carried out study in intertidal mudflat of the Mandovi estuary, Goa and reported that Nematode was the dominant (589 to 1457 no./10 cm^2) taxa there followed by Turbellaria (259 to 336 no./10 cm^2) and harpacticoid copepod (90 to 160 no./10 cm^2). Tardigrada, Gastrotricha, Foraminifera, Oligochaeta and Crustacean nauplii were the other taxa that were available in this environment. Pillai (2001) conducted a study on some benthic polychaetes from Cochin estuary. Anila Kumari (2008) conducted a study at Poonthura estuary on the community structure of meiobenthic nematodes and noticed a positive correlation between species diversity index and the number of species. Thirty-four different variety of meiobenthic species were identified from Manakudy estuary of Kanyakumari district. In the course of 2016 a study on how meiofauna respond towards tidal exchange and domestic sewage by Janakiraman reported that their response in diversity and density may vary according to the seasonal fluctuations in various physico-chemical parameters and it was conducted in Adayar estuary of Chennai. Ghosh and Mandal (2016) published a list of about two hundred and eighty-eight species of free-living nematodes but it needs an in-depth assessment. Asha *et al.* (2016) undertaken a study to assess the eco-hydrological status of depriving Vembanad marshland and highlighted the need for restoration strategies for its effective management. Jayachandran (2017) reported the prevalence of *Nassodontainsignis* from Kodungallur-Azhikode backwater system and substantiated it over the coming year with morphological as well as molecular methods. Sugumaran and Padmasai (2019) reported meiofaunal diversity and density of Manamelkudi – an intertidal sandy beach of Palk bay, India. Sabyasachi *et al.* (2021) studied the distribution pattern of the benthic meiofaunal community along the depth gradient of the western Indian continental margin, including the OMZ and abyssal plain. Beside all these works Ansari *et al*. (1982), Rao and Murthy (1988), Sunitha and Rama (1990), Vijayakumar et al. (1991), Chatterji *et al.* (1995), and Hussain and Mohan (2001) were some other works reported from east coast of India. Devassy and Gopinathan (1970), Damodaran (1973), Ansari *et al.* (1977, 1980), Aziz and Nair (1983), Venkataswamy and Hariharan (1985), Reddy and Hariharan (1985, 1986), Ansari and Parulekar (1993), Mani *et al.* (2008), Sautya *et al.* (2021) were those reported from west coast.

CONCLUSIONS

Once, the reason for meiofaunal research being neglected was due to its small size and the perception that small organisms are hard to study and of limited ecological importance. Even though a number of studies have been emanated on meiobenthos from different part of the world, studies and literature from Indian subcontinent was comparatively less due to various reasons including demand for expertise in taxonomy of diverse invertebrate and vertebrate groups spread over different habitats like marine, estuarine and freshwater benthic ecosystems. However, in India, meiofaunal study predominantly focused Nematoda and Harpacticoida (Copepod) and some extend in Polychaeta and majority of the existing works are also not undergone to level of species. Most of the studies before 20th century on meiofaunal account were only on ecological line, in spite of it the qualitative and quantitative research works using appropriate sampling devices is comparatively recent. Unavailability of satisfactory taxonomic description was one of the challenge researchers faced. Owing to the incorrect available sources it was difficult for them to get the same organism from their study sites. Another difficulty associated with meiofaunal taxonomy was their delicate nature which makes morphological study without preservation strenuous. Hence they had to euthanize the organisms before their work. From the review it is apparent that meiofaunal research need a lot of manpower and effort must be taken to create fruitful data so that the scientific community as well as common people will be benefited.

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