Journal of Critical Reviews

ISSN- 2394-5125 Vol 3, Issue 4, 2016

Review Article

A REVIEW ON BENTHIC STUDY ALONG ODISHA COAST, EAST COAST OF INDIA: A NEGLECTED RESEARCH

SATYABRATA DAS SHARMA*[1,2], LAKSHMAN NAYAK[1], CHITTA RANJAN PANDA[2], MITALI PRIYADARSINI PATI[1], SUBHALATA SAMANTARAY[1]

[1]Department of Marine Sciences, Berhampur University, Odisha, India, [2]CSIR-Institutes of Minerals and Materials Technology (IMMT), Council of Scientific and Industrial Research, Bhubaneswar, Odisha, India
Email: sbdsharma1984@gmail.com

Received: 16 May 2016 Revised and Accepted: 03 Sep 2016

ABSTRACT

The purpose of quantifying macrobenthos in the sea follows the rationales that the early workers were searching for exploitable fisheries or the importance of benthos for nourishing demersal fish stock. However in more recent years, studying on macrobenthic communities living in the coastal regions proved useful to follow changes in the biological diversity, ecosystem processes, evaluating marine pollution, accessing the demersal fishery resources as well as the environmental monitoring program. Benthic research has long been carried out both in spatial and temporal scale on the distribution, species diversity, community structure and abundance. In India, plenty of works has been reported especially both in East Coast and West Coast including Islands. Benthic studies in the coastal region of India are very few and at the primary stage as compared to other countries of the world. Likewise, the benthic studies of Bay of Bengal along the east coast of India are few as compared with the Arabian Sea along the west coast of India. While we consider about Odisha coast, it is negligible. India has nine maritime states which have been contributed their marine benthic research continuously except Odisha. Very few works have been reported along this coast during last few decades. So realizing the importance of benthic study, the present work is aimed to review how much work has actually made along Odisha Coast, East Coast of India during last few decades (1990-2015).

Keywords: Benthos, Multi-decadal review, Odisha coast, Neglected research, East coast of India

DOI: http://dx.doi.org/10.22159/jcr.2016v3i4.12876

INTRODUCTION

Ocean with their large area and volume covering 71% of the total earth surface are the most important and largest environmental compartment of global significance to man comprising an inexhaustible reservoir of both living and nonliving resources. The marine environment is divided into two regions namely pelagic and benthic region. The pelagic region refers to the total water mass or water column. The benthic region consists of rocks, stones, gravel, sand, mud that make up the sea floor from the extreme high water mark of spring tides to the deepest abysses of the open ocean [1]. The benthic region is consists of three major zones such as intertidal, subtidal, and deep sea environment.

The living resources of marine environment refers to the marine organisms, which can be conveniently categorized into benthic, nektonic or planktonic depending on the area they customarily inhabits. Those organisms that live in or near the seabed during their life cycle constitute the benthos [2-4]. Most of the pelagic organisms living in the marine environment have benthic form in their life cycle [5]. Based on the habitat the benthic organisms can be divided into two major groups namely soft bottom benthos and hard bottom benthos. The hard bottom benthos refers to the organisms, which are found in rocky shores. The majority of hard bottom benthos are represented by firmly attached forms of the rocky substratum. The soft bottom benthos are generally found on soft substrates like sand and mud present, and the soft bottom communities have higher proportions of infaunal species composition [5].

According to size, the benthic organisms are divided into microbenthos, meiobenthos and macrobenthos. Microbenthos is much smaller organisms whose body size falls below 43 µm. The meiobenthos is comparatively larger than microbenthos, whose body size ranges between 43 µm to 500 µm. The organisms which are larger than 500 µm are referred as macrobenthos [6, 7]. Macrobenthic animals are large enough to be seen with naked eye. These are greater than 0.5 mm size, resides in sea bottom sediments performing varieties of ecological function. Macrobenthos exhibit variety of body shapes, feeding styles and reproductive modes comprise the critical link in marine food chain [8]. The macrobenthic organisms can be analyzed from a high index of biological diversity. These are represented by a large number of animals' phyla, while dominated groups are represented by polychaetes, crustaceans, mollusk and echinodermata. Among these polychaeta worms are represent an important component of benthic community in term of abundance, species richness and diversity in most part of the world ocean [9, 10]. These are represented by numerous tube-dwelling and borrowing species. The dominant crustaceans include isopods, tanaids, mysids, amphipods, ostracods and few small sized decapods. Molluscs are mainly represented by a variety of borrowing bivalves and a few gastropods that live in or on the surface. Echinoderms include brittle stars, sand dollars, sea cucumbers, starfish and heart urchins.

The global estimation of macrofaunal species ranges from 500000 to 10000000 [11], as most of these species are undescribed, diversity patterns are poorly understood. The distribution of macrobenthos varies considerably both in spatial and temporal scale due in great part to the patchiness of species occurrence and overall heterogeneity of the benthic habitat [12, 13]. This heterogeneity in the distribution of macrobenthos has also been attributed to climatic irregularity and non-induced perturbation [13, 14]. When compared the soft bottom macrobenthic community of tropical and temperate regions, it was suggested that abundance and biomass of tropical regions is low as compared to temperate region [15].

The community structures of macrobenthos are mainly decided by several phisico-chemical and biological factors [16-19]. The important physicochemical factors involved for macrobenthic community structure are depth, temperature, amount of light available, turbidity, the turbulence of water, circulation, tidal exposure, substratum, sediment grain size, the salinity of the water, oxidation-reduction state, organic content, availability of elements and dissolved oxygen as well as nutrients. Beside these, the important biological factors includes

food availability, feeding activities, prey-predator relationship and species removal, reproductive effects on breeding, spawning, dispersal and settlement behavioral effects which induce movement and aggregation, the presence of symbiotic organisms, growth, and mortality.

Macrobenthos apart from the difference in size, have a series of distinctive ecological and evolutionary characteristics which suggest different mechanisms for diversity maintenance [20]. Macrobenthos in marine sediments play an important role in ecosystem processes such as mineralization, promoted and mixing of sediments, the flux of oxygen into sediments, nutrients cycling, dispersion and burial and secondary production [21]. The macrobenthos provides key linkage between primary producers and higher tropic levels like larger consumers, fish, and seabirds [22]. The benthic production is useful to assess the fishery production of a particular area [23]. The dynamics of each component of the benthos may also differ depending on the environmental conditions and tropic state [24]. The purpose of quantifying macrobenthos in the sea follows the rationales that the early workers were searching for exploitable fisheries or the importance of benthos for nourishing demersal fish stock. However in more recent years, studying on macrobenthic communities living in the coastal regions proved useful to follow changes in the biological diversity, evaluating marine pollution effects especially assessing long-term changes and detecting input from diffuse sources [25, 26]. Due to the sensitiveness of benthos towards environmental changes, the macrobenthic organisms are serving as biological indicator species, which are used for monitoring marine environment [25, 27].

The coastal region is highly diverse with rich varieties of macrobenthic communities due to adaptations of organisms, diversity and abundance of food resources [28]. The macrobenthos of coastal regions is mainly deposit feeders or browsers or filter feeders [2]. In turn, the benthos of coastal region supports a large population of demersal fish and other predators [1]. The coastal environment provides an excellent opportunity to study on the effect of the physicochemical factors on distribution, abundance, diversity of macrobenthic organisms. In recent years, most of the study has given emphasis on to known about ecosystem processes, evaluating marine pollution, accessing the demersal fishery resources of a particular area as well as the environmental monitoring program, because of macrobenthos act as an indicator to any environmental changes.

The coastal region refers to the intertidal region, which are most dynamic environment governed by a large number of physicochemical factors leaded by the tide as a principal factor. Though intertidal regions are a highly productive region, the primary production available for benthos consumption is limited in the intertidal region. The organisms depend mostly on the deposition of materials from above, washed out the land, sinking of phytoplankton and zooplankton from upper layers of the water columns and its subsequent decomposition [29].

World review

The distribution of macrobenthos along coastal region has been well documented in many parts of the world (Grassle and Maciolek [11]; Mendes [12]; Lizarralde [17]; Austein [27]; Yokoyama [28]; Dahl [30]; Whitlatch [31]; Holtman and Groenwold [32]; Ysebaert [33]; Degraer [34]; Ricciardi and Bourget [35]; Woodin [36]; Meurer and Netto [37]; Barbiero [38]; Mohmed [39]; Parameswaran [40]. Most of the studies are emphasized on the distribution, abundance and species diversity of macrobenthos. In recent years the benthic studies largely focus on the use of benthos as an indicator species to known environmental changes, pollution effect, monitoring programs [27]. Limited benthic studies have been carried out in the tropical regions when compared with higher latitudes [41]. It is important to establish a very clear database for tropical regions and improve our understanding on abundance, biodiversity, distribution and other behavior of macrobenthos in marine environment [42].

Indian review

India is a tropical peninsular country having a coastline of about 8129km and an extensive Exclusive Economic Zone (EEZ) of about 2.02 million km^2. Various investigations on macrobenthic study have been carried out in coastal regions of India (Magdoom [3]; Kundu [7]; Anbucheghian [8]; Ansari [13]; Kumar [23]; Alongi [41]; Ansari [43]; Ingole [44]; Raghunathan [45]; Elakkiya and Manivanan [46]; Hedge [47]; Ravinesh and Bijukumar [48]; Shivanagouda and Bhat [49]; and Thomas [50] and many more. The macrobenthic studies in the coastal region of India are very few and at the primary stage as compared to other countries of the world. Likewise, the benthic studies of Bay of Bengal along the east coast of India are few as compared with the Arabian Sea along the west coast of India [51].

Review of Odisha coast

Odisha has a long coastline consisting of more than 9 coastal belts around 480 km forming a major coastline of India. The coastal belts are Gopalpur, Rushikulya, Chilka, Puri, Konark, Paradip, Mahanadi, Dhamra and Chandipur. The major rivers flowing in Odisha state are Mahanadi, Dhamra, Subarnarekha, and Rushikulya. The coastal water of Odisha has been receiving appreciable amounts of wastes from domestic, agricultural, industrial and aquacultural sectors. There are many mines exploiting different types of ores and related mineral beneficiation plants and industrial units manufacturing steel, ferroalloys, fertilizers, paper, chemicals, cements etc. situated upstream of these rivers which drain their effluents into the water bodies that ultimately find their way into the Bay of Bengal. There are some major (Paradip) and minor (Gopalpur and Dhamra) ports, where movement of ships and fishing trawlers, handling of ores, crude oil, coals, fertilizers, etc. contribute to the coastal pollution. The effluents and wastes discharged to the coastal water by different sources may pose a serious threat to the marine living resources.

Thousands of works on the distribution, species diversity, community structure, abundance of macrobenthos and effect of pollution on macrobenthos with respect to environmental parameters have been carried out worldwide. In India, a number of works have been done since 1960 especially East Coast and West Coast including Islands. Among nine maritime states, eight have been contributed their marine research in a large scale except for Odisha coast. Only a limited works have been reported on benthos especially on macrobenthos by Satapathy [29]; Nayak [52]; Ingole [44]; Ingole [53]; Pati [54]; Sahu [55]; Mahapatro [56]; Mahapatro [51]; Behera and Nayak [4]; Pati [57]; Mahapatro [58] and Raman [59]. Most of the study has emphasized on the macrobenthic community of Chilka Lake by Ingole [44]; Sahu [55]; Mahapatro [56]; Mahapatro [58]. Other studies have also been focused on estuarine regions by Nayak [52]; Pati [54] and Behera and Nayak [4].

So realizing the importance of benthic study for evaluating the status of pollution in an aquatic environment, the present work is aimed to study how much work has been carried out along Odisha Coast, East Coast of India during three decades (1990-2015).

Satapathy [29] has studied on some aspects of the macrobenthos of Gopalpur Creek during Dec. 1985 to May 1988 at a depth of about 0.3 to 3.2m. He has reported that the surface salinity of the creek varied from 1.8-39.22‰, dissolved oxygen (DO) from 3.92-12.48 ml/l, sediment temperature 23.0-31.0 °C and sediment p^H from 6.48-8.78. Also in the creek, the sand varied from 17.7-100%, silt from 0-62.5%, clay from 0-38.7%, sediment nitrogen from 48.5-1837 µg/g, sediment phosphorus from 0.61-1545 µg/g and organic carbon from 0.10-4.7% during the period of investigation. About 31 species were recorded belonging to 5 major groups namely coelenterate, polychaete, gastropods, bivalves, and crustaceans. Bivalves were dominant in the sandy substratum. The gastropods were dominant in sandy silt substratum; *Nereis chilkensis, Littorina subgranosa* and *Donax scrotum* were present in higher density in the creek. *Hydrodia ulvae* were abundant in monsoon. The population density of the macrobenthos varied from 20nos/m^2 to 4468 nos/m^2. The maximum benthic population density of benthos was recorded in post monsoon due to more availability of nutrients and organic carbon; whereas the minimum density was recorded in monsoon.

Nayak [52] described on the oyster resources of Bahuda estuary, southeast coast of Odisha. He was observed oysters belonging to a single species i.e., *Crassostrea madrasensis* exist along with *Meretrix* sp. in the estuary. There are three oyster beds in the Bahuda estuary.

The first oyster bed was found near the mouth of the estuary. The second bed was situated in the middle portion of the estuary. The total area of the three oyster beds in the estuary was about 5 hectares. The density of Oyster in the three beds was quite variable with a range of 23-235 per sq. m. The highest densities of 180-220 or 235 sq. m have been recorded in some patches. The population of the oyster beds estimated to be about 2,400,000. The largest numbers of oysters were present in the first bed. The size of the oysters ranged from 30 g-280 g with an average of 105 g. Meat weight varied from 2 g–17.5 g with an average of 4.5 g. The data collected on the temperature, salinity and dissolved oxygen content of the Bahuda estuary over the three oyster beds varied greatly. The lowest temperature recorded was 26.5 °C in the month of August and the highest temperature recorded was 35 °C during April. The lowest and highest salinity observed were 7.3 ‰ and 35.05 % during August and May respectively. The dissolved oxygen content showed a range of 1.2 ml/l in June to 7.58 ml/l in February.

Ingole [44] studied on the increased macrobenthic density and diversity: Indicators of recovery of Chilka Lake from environmental degradation. He has reported that the Chilika Lake is boasted with a wealth of flora and fauna. However, Chilika has been facing with some natural and manmade problems, particularly frequent shifting of the mouth region reduced seawater inflow, siltation, and encroachment. Impacts of the developmental activities, on the lake environment were evaluated by a detailed monitoring study conducted during September 1999 to February 2001. Results of his investigation were part of the monitoring program and describe the effect of dredging activity on the macrobenthic assemblages. Data on the abundance of macrobenthic fauna (density and biomass) were collected from 30 different locations from across the entire stretch of Chilika. A spatially replicated before-after design was used. Sampling was conducted during three occasions (before dredging, during dredging and after dredging). The increased values of species diversity in post dredging phase suggested that opening of new lake mouth in November 2000 has not only enhanced the quantity of incoming seawater and facilitated an immediate recovery of macrobenthic communities.

Ingole [53] described on biodiversity of benthic polychaetes from the coastal waters (sub-tidal) of Paradip, India, (lat. 20 ° 05'-20 ° 20'N and long. 86 ° 35'-86 ° 60' E) in the Bay of Bengal. He investigated by deploying van-veen grab at 17 stations in 10-30 m water depth. He has reported that the subtidal sediment off Paradip coast was predominantly of fine to very fine particles and rich in organic carbon (mean=1.59+0.85%, n=17). The diversity of macrofauna was higher at offshore (deeper) stations whereas, density was higher at near-shore (shallower) stations. The lower polychaete diversity at near-shore was due to the persistent physical disturbance (dredging activity). The macrobenthic community was rich and diverse comprising of annelid worms and small crustaceans. The composition of macrobenthos differed considerably between the seasons. The abundance (density and biomass) of macrofauna was higher at a shallower depth (near-shore stations) mainly due to the dominance of polychaetes. A total of 79 macrofaunal invertebrate species belonging to 13 phyla and 45 families were identified. The fauna was mainly composed of polychaetes (41.3%), crustaceans (20.6%), molluscans (15.4%), echiurid worms (7.2%) and echinoderms (2.7%). The contribution of polychaetes in soft sediment macrofauna was almost 50%. Out of 20 tops ranked polychaete species, *Nephthys* sp. was the important in terms of Biological Index of Dominance (BID), whereas *Cossura longocirrata* was the most abundant. Both these species had the wider distributional range and contributed over 27% to the polychaete density.

Pati [54] worked on the mollusca of Rushikulya estuary, east coast of India. He has reported 25 species of mollusca contributing 17 species of gastropods and 8 species of bivalves. About 128,000 species of molluscas present in the world. In total 5070 species (3619 species of gastropods, 1181 species of bivalves, 40 species of polyplacophorans, 20 species of scaphopods) were reported from India, but out of which 3400 species are exclusively marine.

Sahu [55] had reported on the distribution and abundance of benthic macrofauna in Nalaban Island, Chilika, Odisha. They have found 5 major macroinvertebrate groups comprising gastropods, pelecypods, isopods, amphipods, and polychaetes. Gastropods account 75.7% and the most abundant group of macrobenthos followed by pelecypods (16.9%), isopods (4.9%), polychaetes (0.35%) and amphipods (0.07%). This species diversity index indicating a stable benthic community with the absence of environmental stress and the community structure didn't show any significant spatial variation in species composition. A significant correlation was also noticed between gastropods and isopods.

Mahapatro [56] had studied on the influence of the monsoon on macrobenthic assemblage in the outer channel area of Chilika lagoon, east coast of India. They have reported a total of 27 species of macrobenthic organisms which were collected during the different season of the study period. The crustacean emerged as the most dominate group representing 9 species followed by polychaetes with 8 species while 5 species belonged to bivalvia and 3 species to gastropoda. The other group in the study area included nematodes and echiurids. The mean density of macrobenthos was 378 organism m^{-2} and 392 organism m^{-2} in 2007 and 2008. The biomass was measured as and biomass 0.525 g m^{-2} and 0.575 g m^{-2} during 2008 and 2007. Mean values of diversity indices like Margalef's richness index was 2.7 in 2007 and 3.0 in 2008. While Shannon's H' was 1.7 of 2008 and 1.8 in 2007. The Evenness J was calculated as 0.76 in 2008 and 0.94 in 2007. The result of the study showed that hydrographical parameters like temperature, pH and Salinity had a modest relationship with population density and biomass. The preference of macrobenthic organism to any specific parameter couldn't be established clearly, and this would be due to the presence of more opportunistic filters feeders than the deposit feeders. The opening of a new outlet connecting with the sea had a good influence on species richness and population density.

Mahapatro [51] have studied on the macrobenthos of shelf zone Dhamra estuary, Bay of Bengal. They have observed that the total of 1870 individuals of macrobenthic organisms per square meter during the study period. Population density and species diversity increased when a depth increases. Polychaeta emerged as the most dominant macrobenthic group. Among dominant benthic macroinvertebrates *Nereis, Nepthys, Capitella, Owennea, Prionospio, Gammarus ampelisca, Tellina, Donax, Dentalium* and *Echinus* were predominant in the study region. Environmental parameters like Salinity, p^H and DO exhibited a strong correlation with a population density of macrobenthic organisms.

Behera (2013) have studied on the macrofaunal diversity of Bahuda estuary Odisha, east coast of India. They have reported 16 species of mollusca, out of which 8 species were gastropods and 8 species were bivalves.10 species of crustaceans, out of which 3 species of the penaeidae family, 3 species of ocypodidae family and 4 species of the portunidae family. Total 25 numbers of fish species were observed. Out of those 6 orders come under 18 families. The species diversity was showed a wide range of higher number of fish (615), followed by mollusk (549), crustaceans(257) and polychaetes (27) in different stations indicating a stable benthic community with moderate environmental parameters with less polluted waters.

Pati [57] has reported on the faunal biomass associated with the Seagrass and Seaweed bed from Chilika lagoon during 2014. Out of seven classes of Molluscan group, two classes were found from the seagrass and seaweed bed. Four species were recorded from gastropoda (*Telescopium telescopium, Cerithidea cingulata, Oliva oliva and Conus virgo)* and other two species were encountered from Bivalvia (*Modiolus striatulus and Donax scortum)* which were associated with the seagrass and seaweed. Among different species of Gastropoda, *Cerithidea cingulata* was abundant and dominant species which was contributed maximum biomass (79%) associated with *Holophila ovalis*, whereas this species was counted very less (9%) in the grass bed of *Holodule uninervis* within the same area. The dominant species in the grass bed of *Holodule uninervis* was *Modiolus striatulus* which was contributing maximum biomass (82%). This is the unique feature in its distribution. However, *Modiolus striatulus* is rarely available in *Holophila ovalis* but more abundant in the seaweed beds of *Gracillaria verrucosa*.

Mahapatro [58] has studied on the assessment of physiochemical parameter and its influence on macrobenthic community of a brackish water coastal ecosystem-the Chilika lagoon, east coast of India, during April 2011 to March 2011 across four ecological sector of Chilika lagoon to monitor ecosystem health. They have reported Salinity and DO showed significant spatiotemporal variation. The lake p^H was found near neutral (6.4) to alkaline (10.4). Salinity was primarily governed by tidal mixing between fresh water and seawater and DO and pH were mostly influenced by the aquatic vegetation such as seagrass and submerged macrophytes. Molluscan representatives were observed throughout the lagoon. Among 30 molluscan species, 16 from bivalves and 14 from gastropods were reported during the study and distribution was not uniform.

Raman [59] has studied on macrobenthos relative to the oxygen minimum zone (OMZ) on the East Indian margin, Bay of Bengal. He had carried out his research on macrobenthos relation to oxygen minimum zone [OMZ–DO (dissolved oxygen), concentration<0.5 ml. l-1] at 110 stations off the North East Indian margin (160 and 200 N) featuring coastal, shelf and slope settings (10–1004 m). Composition, abundance and diversity were studied in relation to variations in depth, dissolved oxygen, sediment texture and organic carbon. Under OMZ core sites (depth 150–280 m; DO 0.37 ml. l-1) that exhibited dense populations of surface-feeding polychaetes (mean 2188 ind. m-2) represented by spionids and cossurids (96%). Molluscs and crustaceans were poorly represented except for ampeliscid amphipods. The lower OMZ sites (DO>0.55 ml. l-1) supported a different assemblage of polychaetes (cirratulids, amphinomids, eunicids, orbinids, paraonids), crustaceans and molluscs, albeit with low population densities (mean 343 ind. m-2).

Benthos used as a tool for assess coastal pollution monitoring

Biological parameters are used for assessing the impact of pollution by urbanization, industrialization, and varieties of anthropogenic changes. Pollution effects can loosely be separated into two categories: disturbance and stress. By disturbance, it means an effect whereby individuals are physically destroyed or removed from the area. Stress, on the other hand, results in the productivity of an individual being reduced. Under highly stressed conditions, the change in species density and diversity, as well as bioavailability of toxic substances in benthic tissues, is more sensitive in order to identify and quantify the pollution. Among the biological parameters, benthos has a good history as a bonafide community of environmentally disturbed ecosystems. Among the diverse from of life in the ocean, the benthos, because of their sedentary and sessile lifestyle, are considered as the best indicator of marine as well as estuarine environmental quality. The macrobenthos community may prove an ideal tool for probing an environment under stress.

Benthic invertebrates providing a more accurate understanding of changing aquatic conditions and also play an important role in aquatic community consist of involving in mineralization, mixing of sediments and fluxing of oxygen into sediments, cycling of organic matter and to assess the quality of coastal water. Macrobenthos has shown a great deal of variation in population density and biomass consequent to environmental disturbances caused by human activities. Heavy metals are continuously released into the aquatic environment via natural and anthropogenic influx. High environmental levels of heavy metals cause metal accumulation by aquatic organisms. Study of heavy metal accumulation by bottom organisms and metal toxicity in the biota is part of the study of pollution effects on aquatic ecosystems.

Benthos is the major functional components of the biota in the bottom sediments. Benthos appears to respond in a characteristics manner with distance from the source of pollution. The introduction of sewage pollution increases the organic input to sediment, which may result in stress condition and affect mortality of benthic community. There is lowering in species diversity in proximity to the point source of pollution. The effects of toxic metals, petroleum hydrocarbon, and industrial effluents have shown negative responses on the tropical benthic community.

CONCLUSION

These papers deals with an extensive review on macrobenthos along the coast of Odisha during last three decades. Some of the research work has also been emphasized on meiobenthos but still the number is on the finger tip. The fig. 1 and 2 shows year and coastal area wise research (limited to macrobenthos only during 1990-2015) publication along Odisha Coast. However, thousands of work has already been done along Bay of Bengal and Arbian sea but if we concentrate to regional level then a number of questions arise. After a great ecological significance, research has been neglected in Odisha coast. This article highlights how much we are serious about to do the benthic work. When we will discuss the benthic research among the world scenario, we are having a least. If we concern about Odisha Coast, maximum work has restricted to only Chilika Lagoon as compared to another coastal part. Hence at the last, we should concern and improve our coastal research on most neglected but highly ecological implication species the “Benthos”.

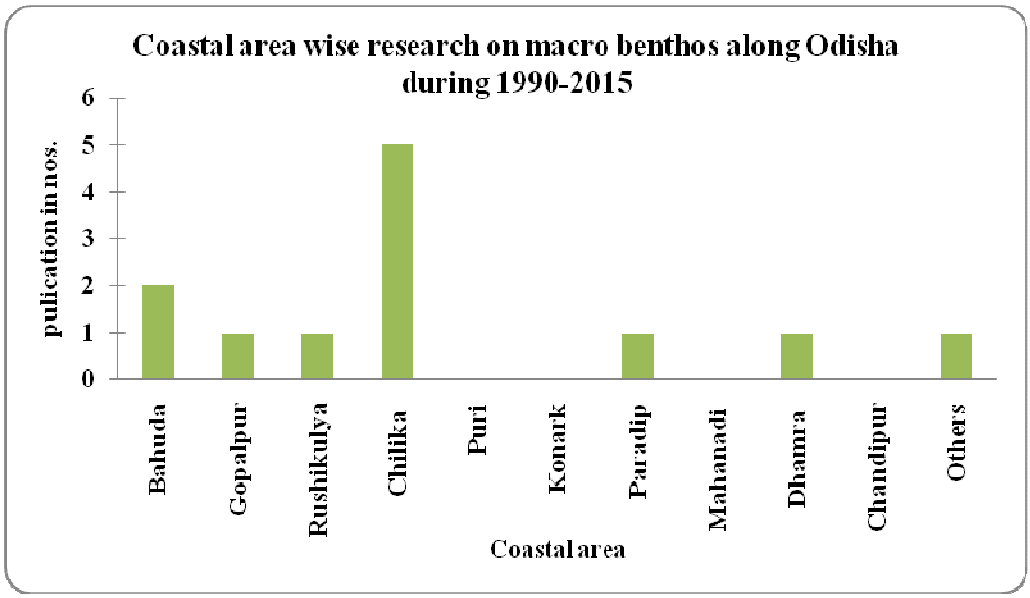

Fig. 1: Coastal area wise research on macrobenthos along Odisha, East Coast of India

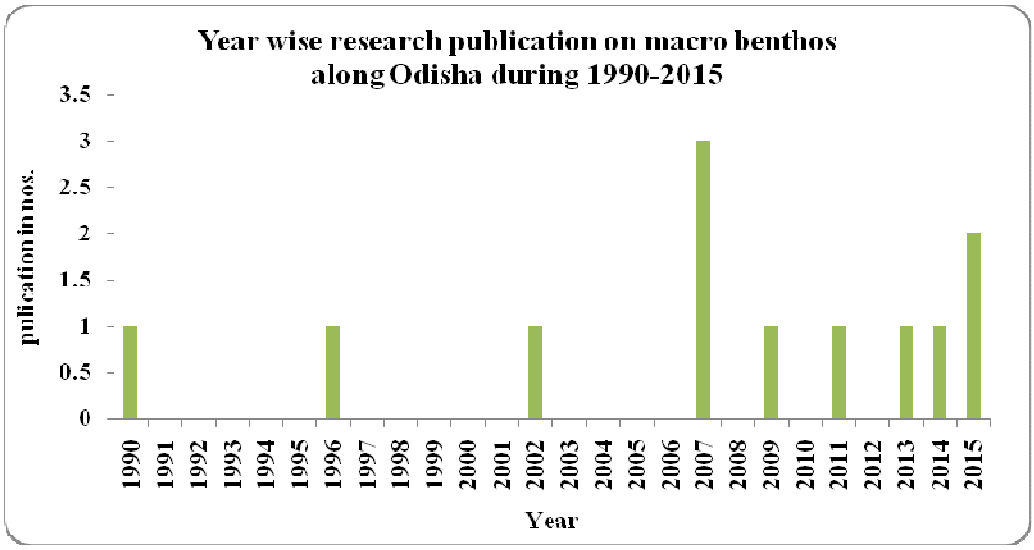

Fig. 2: Year-wise research publication on macrobenthos along Odisha Coast, East Coast of India

CONFLICT OF INTERESTS

Declared none

REFERENCES

1. McLusky DS, McIntyre AD. Characteristics of the benthic fauna of continental shelves; 1988. p. 131-54.
2. Govindan K. Marine benthos-A future perspective. A national seminar on creeks, estuaries and mangrove. Pollution and conservation; 2002. p. 28-30.
3. Magdoom BK, Kalaiselvam M, Balasubramanian T. Status of seasonal distribution of macrobenthos from Gulf of Mannar (south-east coast) of India. Curr Res J Biol Sci 2010;2:53-8.
4. Behera DP, Nayak L. A checklist on macrobenthos diversity of Bahuda estuary, Odisha, east coast of India. Int J Ecosyst Ecol Sci 2013;3:172-6.
5. Lalli CM, Parson TR. Benthic communities. Biol Oceanography Introduction 2006;8:196-247.
6. Ansari ZA, Ingole BS, Parulekar AH. Benthos of the EEZ of India. India's Exclusive Economic Zone; 1996. p. 78-83.
7. Kundu S, Mondal N, Lyla PS, Khan SA. Biodiversity and seasonal variation of macrobenthic community in the inshore water of Parangipettai coast. Environ Monit Assess 2010;163:67-79.
8. Anbucheghian RM, Rameshkumar G, Ravichandran S. Macrobenthic composition and species diversity in the costal belt of Thondi, South East Coast of India. Global J Environ Res 2009;3:68-75.
9. Knox GA, Lowry JK. A comparison between the benthos of the Southern Ocean and the North Polar Ocean with special reference to the amphipods and polychaeta, in polar oceans. Edited. Dunbar MJ. Arctic Institute of North America, Calgary; 1977. p. 423-62.
10. Arntz WE, Brey T, Gallardo VA. Antarctic zoobenthos. Oceanography Marine Biol Annual Rev 1994;32:241-304.
11. Grassle JF, Maciolek N. Deep-sea species richness: regional and local diversity estimate from quantitative bottom samples. Am Nature 1992;139:313-41.
12. Mendes CLT, Soares Gomes A, Tavares M. Seasonal and spatial distribution of sublittoral soft-bottom mollusk assemblages at Guanobara Bay, Rio De Jenerio. Brazil J Coastal Res 2004;39:1877-81.
13. Ansari ZA, Furtodo R, Badesab S, Mehta P, Thwin S. Benthic macroinvertebrate community structure and distribution in the Ayeyarwady continental shelf, Andaman Sea. Indian J Geo-Mar Sci 2012;41:272–8.
14. Mistri M, Fano EA, Rossi G, Casselli K, Rossi R. Variability in macrobenthos communities in the Vallidi Camacchio, Northern Italy, a hyper-eutrophized lagoonal ecosystem. Estuarine Coastal Shelf Sci 2000;51:599-611.
15. Jayaraj KA, Jayalashmi KV, Saraladevi K. Influence of environmental properties on macrobenthos in the North West Indian shelf. Environ Monit Assess 2007;127:459-75.
16. Thrush SF, Pridmore RD, Hewitt JE, Cummings VJ. Adult infauna as facilitators of colonization on intertidal sand flats. J Exp Marine Biol Ecol 1992;159:253-65.
17. Lizarralde ZI. Distribución y abundancia de *Tellina petitiana* (Bivalvia, Tellinidae) en cerro avanzado, chubut, argentina. Physis 2002;60:7-14.
18. Veloso VG, Caetano CHS, Cardoso RS. Composition, structure and zonation of intertidal macroinfauna in relation to physical factors in micro-tidal sandy beaches in Río de Janeiro State. Brazil Sci Marina 2003;67:393-402.
19. Defeo O, McLachlan A. Patterns, processes and regulatory mechanisms in sandy beach macrofauna: a multiscale analysis. Mar Ecol Prog Ser 2005;295:1-20.
20. Warwick RM, Dashfield SL, Somerfield PJ. The integral structure of a benthic infaunal assemblage. J Exp Mar Biol Ecol 2006;330:12-18.
21. Snelgrove PVR, Butman CA. Animal-sediment relationships revisited: cause versus effect. Oceanography Marine Biol Annual Rev 1994;32:111-67.
22. Edgar GJ, Shaw C. The production and trophic ecology of shallow-water fish assemblages in southern Australia. Diets of fishes and trophic relationships between fishes and benthos at the western part, Victoria. J Exp Mar Biol Ecol 1995;194:93-106.
23. Kumar RR, Edward JKP, Jaykumar M. Macrobenthic community structure on tuticorin coastal waters, Gulf of Mannar, South-east coast of India. World J Fish Mar Sci 2010;1:70-7.
24. Danovore R, Fraschetti S, Belgrano A, Vincx M, Curini-Galletti M, Allbertelli G *et al.* The potential impact of meiofauna on the recruitment of macrobenthos in the subtidal coastal benthic community of the Lingurian Sea (North Western Mediterranean): a field result. XXVIII EMBS, Hersonissus, Creta; 1995. p. 115-22.
25. Ansari ZA, Ingole BS, Benerjee G, Parulekar AH. Spatial and temporal change in benthic macrofauna from Manodovi-Zuari estuaries of Goa, West coast of India. Indian J Mar Sci 1986;15:223-9.
26. Gray JS. Is the deep sea really so diverse? Species diversity from the Norwegian continental shelf. Mar Ecol: Prog Ser 1994;112:205-9.
27. Austein MC. Natural nematode communities are useful tools to address ecological and applied questions. Nemato Monogra Persp 2004;2:1-17.

28. Yokoyama H, Tamaki A, Koyama K, Ishihi Y, Shimoda K, Harada K. Isotopic evidence for phytoplankton as a major food source for macrobenthos on an intertidal sand flat in Ariaka Sound, Japan. Mar Ecol: Prog Ser 2005;304:101-16.
29. Satapathy D. Studies on some aspects of macrobenthos of Gopalpur Creek. Ph. D thesis submitted to Berhampur University; 1990. p. 1-185.
30. Dahl E. Some aspects of the ecology and zonation of the fauna on sandy beaches. Oikos 1952;4:1-27.
31. Whitlatch RB. Seasonal changes in the community structure of the macrobenthos inhabiting the intertidal sand and mud flats of Barnstable harbour, Massachusetts. Biol Bull 1977;152:275-94.
32. Holtman SE, Groenwold A. Distribution of zoobenthos on the Dutch continental shelf. The Western Frisian Front, Brown Bank and Broad Fourteens (1992/1993). Netherland institutes for sea research. NIOZ-report; 1994.
33. Ysebaert T, Meire P, Coosen J, Essink K. Zonation of intertidal macrobenthos in the estuaries of Schelde and Ems. Aquatic Ecol 1998;32:53-71.
34. Degraer S, Mouton I, De-Neve L, Vincx M. Community structure and intertidal zonation of the macrobenthos on a macro tidal Ultra-dissipative sandy beach; Summer-Winter comparison. Estuaries 1999;22:742-52.
35. Ricciardi A, Bourget E. Global patterns of macro invertebrate biomass in marine intertidal communities. Mar Ecol: Prog Ser 1999;185:21-35.
36. Woodin SA. Shallow-water benthic ecology. A North American perspective of sedimentary habitats. Australian J Ecol 1999;24:291-301.
37. Meurer AZ, Netto SA. Seasonal dynamics of benthic communities in a shallow sublittoral site of Laguna estuarine ecosystem (south, Brazil). J Aquatic Sci Technol 2007;11:53-62.
38. Barbiero DC, Macedo IM, Mais B, Zalmon IR. Comparative study of the estimated sample size for benthic intertidal species and communities. Latin Am J Aquatic Res 2011;39:93-102.
39. Mohmed Maew, Madkour HA, El-Taher A. Recent benthic foraminifera in the saline pool and its surrounding areas at Ras Shukier and Gulf of Suez, Egypt. Indian J Geo-Mar Sci 2013;42:293-9.
40. Parameswaran UV, Abdul JKU, Sanjeevan VN, Anthony PJ, Elizabeth J. Benthic polychaetes off edward VIII plateau in the continental shelf of east Anarctica. Indian J Mar Sci 2014;46:915-9.
41. Alongi DM. The ecology of soft-bottom benthic organisms. Oceanography Marine Biol Annu Rev 1990;28:381-496.
42. Warwick RM, Hyuni R. Comparative study of the structure of some tropical and temperate macrobenthic communities. Mar Biol 1987;95:641-9.
43. Ansari ZA, Rodrigues CL, Chatargy A, Parulekar AH. Distribution of meiobenthos and macrobenthos at the mouth of some rivers of the east coast of India. Indian J Mar Sci 1982;11:341-3.
44. Ingole B. Increased macrobenthic density and diversity: an indicator of recovery of Chilika lagoon from environmental degradation. Proc. The national seminar on Creeks, Estuaries and Mangroves pollution and conservation; 2002. p. 213-5.
45. Raghunathan C, Tewari A, Joshi HV, Kumar VGS, Trivedi RH, Khambhaty Y. The impact of turbidity on intertidal macrofauna at Gopinath, Mahuva and Verval coasts (West coast of ndia). Indian J Mar Sci 2003;32:214-21.
46. Elakkiya P, Manivanan V. Recent benthic foraminifera from off the coast of Arkattuthurai (Near Nagapattanam). Southeast coast of India. Indian J Geo-Mar Sci 2013;42:877-87.
47. Hedge MR, Padate VP, Velip DT, Rivonker CU. An updated inventory of new records of coastal macrofauna along Goa coast, west coast of India. Indian J Geo-Mar Sci 2013;42:898-902.
48. Ravinesh R, Bijukumar A. Comparison of intertidal biodiversity associated with natural rocky shore and sea wall: A case study from the Kerala coast, India. Indian J Geo-Mar Sci 2013;42:223-35.
49. Shivanagouda SN, Bhat UG. Study on abundance and distribution of subtidal macrobenthic diversity in near-shore waters off Kutch, Gujurat, India. Res J Mar Sci 2013;1:1-5.
50. Thomas S, Dineshbabu AP, Sasi kumar G. Gastropod resource distribution and seasonal variation in trawling grounds off Konkan Malabar region, eastern Arabian Sea. Indian J Geo-Mar Sci 2014;43:384-92.
51. Mahapatro D, Panigrahy RC, Naik S, Pati SK, Samal RN. Macrobenthos of shelf zone off dhamara estuary, the Bay of Bengal. J Oceanography Mar Sci 2011;2:32-42.
52. Nayak L. Oyster resources of Bahuda estuary, Southeast coast of Orissa, Sustainable Aquaculture; 1996. p. 212-7.
53. Ingole B. Biodiversity of benthic polychaetes from the coastal waters of paradip, the bay of Bengal. Bionano Frontier 2007;1:32–45.
54. Pati SK. Studied on mollusks of Rushikulya estuary, East coast of India. M. Phil. Dissertation in Marine Biology, Berhampur University; 2007. p. 10-3.
55. Sahu P, Sethy PGS, Siddiqui SZ. Distribution and abundance of benthic macrofauna in Nalaban Island, Chilka, Orissa. Indian J Fish 2007;54:251-8.
56. Mahapatro D, Panigrahy RC, Panda S, Mishra RK. Influence of monsoon on macrobenthic Assemblage, In Outer Channel Area of Chilka Lagoon, East Coast of India. J Wetlands Ecol 2009;3:56-67.
57. Pati MP, Nayak L, Sharma SD. Studies on biomass of seagrass, seaweed and its associated fauna from Chilika lagoon. Int J Environ Sci 2014;5:423-31.
58. Mahapatro D, Barik SK, Rastogi G, Samal RN, Muduli PR, Nail G, *et al*. Assessment of physiochemical parameter and its influence on the macrobenthic community of a brackish water coastal ecosystem-the Chilika lagoon east coast of India. Res Gate 2015;65-73. DOI:10.13140/2.1.1712.9764
59. Raman AV, Damodaran R, Levin LA, Thiruchitrambalam G, Rao YKV, Nanduri Sateesh, *et al.* Macrobenthos relative to the oxygen minimum zone on the East Indian margin, Bay of Bengal. Mar Ecol 2015;36:679–700.

How to cite this article

- Satyabrata Das Sharma, Lakshman Nayak, CR Panda, Mitali Priyadarsini Pati, Subhalata Samantaray. A review on the benthic study along odisha coast, East coast of India: a neglected research. J Crit Rev 2016;3(4):27-32.