

Benthic Productivity in the Indian Ocean

By

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Benthic organisms form an important link in the food chain of organisms at different trophic levels. Between the primary production and the fish production, the role of benthic organisms first as a feeder of detritus and plant material and in turn forming food of some predators like crabs and fishes is now well recognised. This concept of bottom communities received little attention until last three decades. The investigations of Belegvad (1930), Jones (1950, 51 and 56), Sanders (1956) and Mulicki (1957) have thrown new light on the importance of benthic communities. Belegvad (1930) for the first time showed a direct connection between the variations in the quantity of benthic biomass and plaice fishery in the Atlantic region.

In the Indian Ocean region the study of benthic productivity was more or less restricted to the inshore areas. In India, Annandale (1907), Panikkar and Aiyar (1937), Sheshappa (1953), Kurian (1955), Desai and Krishnankutty (1967 - a & b) and Desai (1971) have discussed the benthic productivity of nearshore areas and Indian continental shelf region. During the Indian Ocean Expedition, the Soviet ship 'Vityaz' carried out number of observations on benthic communities and excellent papers on deep sea benthos have been published by Beljaev and Vinogradova (1961) and Sokolova and Pasternak (1962).

An attempt has been made in this paper to review our present knowledge of benthic productivity in the Indian Ocean and suggest course of action to be undertaken to fill up lacunae and also measures to be taken to increase benthic productivity with an ultimate aim to increase fish yield.

Physiography and Hydrographic Conditions

The Indian Ocean is the smallest of the three great oceans covering an area of approximately 74,917,000 km². Its east-west boundaries are 20°E to 147°E i. e., from the African coast to Australia and North-South boundaries 36° North to 72° South.

The continental shelf of the Indian Ocean is somewhat narrower on the average than that of the Atlantic, ranging in width from a few hundred meters around some oceanic islands to more than 200 km off Bombay. The mean depth of the Indian Ocean is 3897 meters, the maximum recorded depth being 7437 meters.

The hydrographic conditions are very much variable in nearshore regions and have been well reported by many authors. It is desirable, however, to review briefly the conditions prevalent in the Indian Ocean in general. The temperature in February in the northern part

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of the ocean shows typical winter conditions of the sea. In Persian Gulf and Red Sea low temperatures of 15° to 17.5°C are recorded. In the southern part, however, summer conditions exist at the same time, where the water temperature recorded is 28°C or more. In May these conditions are reversed and the northern part receives maximum heating recording temperatures above 29°C.

The surface salinity in southern area is more or less uniform being 36‰ in areas such as west of Australia. In the northern part on the other hand the surface salinity is variable from place to place and in different seasons. It is extremely low in the Bay of Bengal and rather high in some parts of Arabian Sea (upto 39‰). The oxygen value is very high above 7.5 ml/L in the surface water of the Antarctic region of the Indian Ocean. Over a vast area average values of oxygen vary from 4.5 to 5.5 ml/L. In the northern areas, however, oxygen values recorded are low ranging between 2.5 to 4 ml/L. These values decrease as the depth increases and very low amount of oxygen is found near the bottom.

The nutrients like phosphates and nitrates were also recorded during Indian Ocean Expedition. Phosphates in the upper layers varied from 1.5 mg to 1.8 mg/m³ although higher values of over 2.2 mg/m³ were recorded in deeper layers. Nitrites are found only in the surface water masses in sub-Antarctic. The values are 8–10 mg/m³ but in the Northern Indian Ocean upto about 320 mg/m³ near 12° South are recorded.

Bottom Sediments

In the Indian Ocean, calcareous ooze of globigerina type occupy about 54% of the total ocean floors where depth is not excessive and in areas of warmth and very high organic productivity forming an equatorial belt from 20° North to 40° South. Red clay dominate about 25% of the total area between 10° North and 40° South, in the eastern half of the Indian Ocean away from islands and continents.

Diatom ooze occupy about 20% of total area in the subpolar region beyond 50° S latitude.

Benthos

High benthos values are characteristic of the inshore water of the continental shelf at any place and the quantity decreases gradually as the depth increases in the open ocean regions.

Sokolov and Pasternak (1962) studied quantitative bottom samples from 46 stations and trawl samples from 13 stations in the Indian Ocean. These stations were occupied in the Bay of Bengal, Andaman Sea and northern part of the Indian Ocean.

In the Bay of Bengal a benthic biomass was of 0.11–0.38 gm/m² at a depth of about 3000 meters (Beljaev and Vinogradova 1961). In the offshore area, between 1000–3000 m in the Bay of Bengal and Andaman Sea, benthos biomass was 4–6 times lower than in the Arabian Sea at the same depth. The biomass increases from the region of open seas to the interior nearshore area. Bottom animals feeding on sediment detritus prevail in the zones of active accumulation of sediments, whereas

animals feeding on suspended detritus are predominant in the zone of erosion.

In the northern part of the Indian Ocean towards the Arabian coast high benthos values 1.0 gm/m^2 are observed, such high values are also recorded on the north Indian Coast. This is followed by a wider area of ocean floor where the benthic values are from 0.5 to 1.0 gm/m^2 . This value decreases as the depth increases and in deeper waters about 0.05 gm/m^2 benthos were recorded.

Foraminifera have almost universal distribution and at greater depths these dominate the other benthic forms. Macro-benthos like annelids, molluscs and crustaceans were found more near the inshore region which really contributed to higher benthic values.

In the nearshore region especially of India, a fairly detailed observations on the benthos are available.

The benthic biomass observed on the west coast of India is richer than that of the Bay of Bengal. Such disparity is also recorded for the fishery of these two areas. The narrow width of the continental shelf on the east coast is largely responsible for this disparity. Kurian (1955) reported a high value of benthic biomass upto 18 kg/m^2 on the south west coast of India. Desai and Krishnankutty (1957) have observed biomass of 500 gm/m^2 near Cochin. Values obtained by Kurian are expressed in gross weight in wet condition, whereas those expressed by Desai and Krishnankutty represent dry body weight without shells or tubes. Cape Comorin, Vizhin-gom, Quilon, Tellichery, Goa, Bombay,

Dwarka and Okha are some of the places where high biomass values were recorded on the west coast.

Biomass values of about 45 gm/m^2 have been observed in the northern part of the Ganges Delta. These were largely due to the presence of sea urchin community. But towards the south of the Delta the benthic biomass decreases to about 5 gm/m^2 . In the shallow waters polychaetes formed the largest contributor (25%) followed by crustaceans (21%) and decapods and amphipods coming next.

The distribution of benthic organisms is patchy and even in two stations close by it is not similar. This patchiness can be attributed to the nature of shelf deposits. Each type of deposit has a fauna of its own. In areas near Cochin, Cape Comorin, Bombay, Dwarka and Okha high biomass is observed because of sandy deposits and presence of bivalve and crab community (Desai 1971).

On the muddy deposits especially in the mud bank region micro and meio-benthos are at the maximum. Ciliates, nematodes, copepods, ostracods and foraminifera occur in large numbers. The quantities of biomass vary from 0.25 gm to 35 gm/m^2 . The water in this region is highly productive and high concentrations of nutrients are recorded. Turritella, brittle stars, squilla are very common in this region.

Maximum production of benthos occurs in the zone of deposits of fine sand with mud and shell fragments. Polychaetes, crustaceans, bivalves and gastropods approximate a value of 500

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gm/m². Maximum inshore bottom fishery constituting prawns and bottom fishes also occurs in this region

The data have revealed that the nature of continental shelf is responsible for the distribution and abundance of benthic organisms. The benthic biomass on the west coast is richer than the east coast. Due to narrow width of the continental shelf total area available for benthic production is much less on the east coast and secondly the sediments on the continental shelf transported by a large number of rivers on the east coast are predominantly muddy and clayey which are not very favourable for benthic production.

It has been observed that the fauna is rather impoverished on muddy substrata as compared to the sediment constituted by fine sand and shell fragments.

Further the hydrographic conditions on the west coast of India remain more or less stable throughout the year, whereas in the Bay of Bengal wide fluctuations are observed in the salinity which has a detrimental effect on the benthic productivity. Desai and Krishnankutty (1967) have discussed this phenomenon in case of Cochin backwaters where similar changes in salinity have detrimental effect on the benthic production.

The primary source of food for the benthos in deeper waters are the plankton, terrigenous organic detritus and in shallow waters they prefer algae and plants. In most areas, plankton in overlying water masses is the chief source and high benthic productivity

depend upon their presence. Detritus and bacteria also form important food resources as they can be carried to greater distances by water currents. Sponges, pelecypods and brachiopods feed mainly on detritus. Polychaets on the other hand are main deposit feeders. They are common in mud and muddy sands, whereas the suspension feeders are more common in sandy gravel or host bed.

If we are to build a pyramid of different trophic levels, we will have to start with primary production at the base, where with the help of light and nutrients organic matter is produced which forms a food for planktonic organisms, which in active stage are eaten by the higher forms and as detritus eaten by the benthic organisms which again in turn form the food of higher carnivores. Thus, it is evident that benthos is a very important link in the food chain and any reduction in benthic productivity may adversely affect the demersal fishery. If on the other hand the benthic productivity can be increased by artificial means, i. e., by providing more nutrients in the water mass a substantial increase in the productivity can be achieved. Experimental work of this nature is highly desirable since in the nature a correlation is seen between benthos and fishery. Especially the poor prawn fishery for the last two years suggest cultivation of suitable benthic organisms like bivalves on which prawns feed. It is felt by the author that dredging of the areas near prawn beds have seriously affected the food resources, and disappearance of prawn from the normal habitat may be the result of this action, apart from other causes if any.

REFERENCES

- Annandale, N.** 1907. Fauna of the brackish ponds of Port Canning, Lower Bengal. *Rec. Indian Mus.*, **1**.
- Belegvad, H.** 1930. Quantitative investigations of bottom invertebrates in the Kattegat with special reference to plaice food. *Rep. Danish. Biol. Sta.*, **36**: 1-16.
- Beljaev, G. M., Vinogradova, M. G.** 1961. Quantitative distribution of bottom fauna in the northern half of the Indian Ocean. *Dokl. Acad. Nauk SSSR*, **133**(5): 1191-1294.
- Desai, B. N.** 1971. Dominance of Mollusca in the benthic fauna off Cochin. *J. Bom. Nat. Hist. Soc.*, **68**(2): 355-362.
- Desai, B. N., Krishnankutty, M.** 1967a. Studies on the benthic fauna of Cochin backwater. *Proc. Indian Acad. Sci.*, **65**: 123-142.
- 1967b. A comparison of the marine and estuarine benthic fauna of the nearshore regions of the Arabian Sea. *Bull. N. I. S. I.*, **38**: 677-683.
- Jones, N. S.** 1950. Marine bottom communities. *Biol. Rev.*, **25**: 283-313.
- Jones, N. S.** 1951. The bottom fauna at the South of the Isle of Man. *J. Amin. Ecol.*, **21**: 132-144.
- Jones, N. S.** 1956. The fauna and biomass of muddy sand deposits off Pool. Exin. I. O. M. *J. Amin. Ecol.*, **25**: 217-252.
- Kurian, C. V.** 1955a. A preliminary survey of the bottom fauna and bottom deposits of the Travancore Coast within 15 fathom line. *Proc. Inst. Sci. India*, **19**: 747-776.
- Mulicki, Z.** 1957. Ecology of the more important benthic invertebrates in Baltic Sea. *Pr. Norsk. Inst. rub. Gdyui*, **9**: 313-379.
- Panikkar, N. K. and Aiyar, R. C.** 1937. The brackish water fauna of Madras. *Proc. Ind. Acad. Sci.*, **6**: 284-337.
- Sanders, H. L.** 1956. Oceanography of long Island. Sound. 1952-54 X. Biology of marine bottom. *Bull. Bingham Oceanogr. Coll.* **15**: 345-414.
- Sheshappa, G.** 1953. Observations on the physical and biological features of the inshore sea bottom along the Malabar Coast. *Proc. Nat. Inst. Sci. India*, **19**: 256-279.
- Sokolova, M. N., Pasternak, F. A.** 1962. Quantitative distribution and trophic zoning of the bottom fauna in the Bay of Bengal and Andaman Sea. *Trud. Inst. Okeanol.*, **64**: 271-296.