

Some Aspects of Productivity and Fisheries of the West Coast of India

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THE transformation of solar energy into potential food energy by photosynthesis is the most important single factor governing the productivity of any region in the sea. This food energy is transferred through a series of consumers and ultimately is made available as fish. In the operation of this system four steps can be recognised: i. e., reception of light energy, production of organic material by phytoplankton utilising inorganic nutrients, consumption of organic material by consumers and decomposition of the organic material to inorganic nutrients. So taking all seas as a whole it may be mentioned that the replenishment of nutrients in the productive layers is the most important aspect governing the

magnitude of the annual organic production. Nature has established an equilibrium between all factors influencing production. Any change in one of the factors will normally influence the other factors as well and establish a new equilibrium. Besides the replenishment of nutrients, light, temperature and grazing by zooplankton are the other important factors that determine the magni-

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tude of production. As temperature and light are never limiting factors in our waters, it is the replenishment of nutrient salts that mostly govern the productivity.

The two important elements becoming limiting factors in the sea are nitrogen and phosphorus. In water masses located below a depth of about 500-1000 metres the concentration of inorganic phosphate and nitrate are relatively high. Therefore, when deep water is brought up to the surface and used for phytoplankton growth these two elements are exhausted simultaneously. So it is the rate of replenishment of the nutrients in the euphotic zone (the upper few metres of the ocean where there is sufficient light for photosynthesis) and not the concentration observed at a given time which determines the productivity. This replenishment is provided by the two processes of decomposition and water circulation

Regeneration of the nutrients from organic matter may be either due to the excretion by the zooplankton feeding on phytoplankton or indirectly by microbiological regeneration of organic compounds originating from digested plants and animals. This indirect regeneration takes place both in the water masses and in the top layer of sediments. In the free water masses this process is generally slow. In shallow areas the re-

generation in the sediments constitutes the most important part of total regeneration. The influence of temperature on the regeneration of nutrient salts is considerable. In coastal areas where the water masses of the euphotic zone which come in direct contact with the bottom a striking correlation between temperature and production will be found but temperature has only a limited significance on the rate of organic production. Thus the shallow coastal regions especially in tropics are found to be very productive.

On the other hand in the open part of the sea, water circulation is necessary for the replenishment of the nutrient salts in the euphotic zone. The water circulation may be horizontal whereby nutrient-rich water is brought in from neighbouring areas or vertical, of which the latter is more important. Vertical circulation may be due to upwelling or due to turbulence. In typical upwelling (something like "ploughing the sea surface") deeper water masses ascend to replace surface water carried away by wind. In typical vertical turbulence there is more or less a complete mixing of the surface water masses with deeper water masses. The rate of production is thus high in the "new" surface water and low in "old" surface water. The presence of such "new" water is responsible

or the higher production in the equatorial region of the Indian Ocean as compared to other tropical oceanic regions.

On the west coast of India, which accounts for about 80% of the total sea fishery of the country, the role played by the monsoon in the process of production of organic matter cannot be over-emphasised. The hydrographic features governing production show pronounced seasonal variations. Four seasons can arbitrarily be postulated viz., monsoon (June, July, August), post-monsoon (September, October, November), winter (December, January, February) and summer (March, April, May). The summer months exhibit stagnant conditions. During monsoon and immediate post-monsoon periods upwelling occurs along the entire west coast with regional variations in intensity. This brings up nutrients from the deeper layers and enrich the surface layers. Besides, the upwelling and divergence near the bottom between 20-30 metres along the coast north of Quilon produce vertical acceleration with the resultant lifting of bottom waters. As the bottom is composed of fine silt, this silt is lifted up which comes almost to the surface where it is kept in position in the regions of convergence resulting in the formation of the mudbanks extending from about the region of

Alleppey to the areas north of Calicut. These mud banks are the store houses of nutrients especially phosphates which in turn contribute to the rich production of plankton. The abundance of plankton food and the calm conditions prevailing within the mud banks contribute to the rich fisheries in this region.

It is also seen that a high rate of production takes place in the shallow waters at the coasts of isolated oceanic islands. This is mainly because the ocean currents sweeping an isolated island may induce some vertical mixing. Investigations conducted around the Laccadive Islands have shown that there is an anti-cyclonic motion from surface down to the thermocline and down below the circulation is reversed. These circulatory movements help to maintain the highly productive water in the vicinity of the Islands for longer time.

Thus, it may be seen that the productivity in the coastal regions of Indian waters is high practically anywhere on the shelf. Outside the shelf it is wholly dependent on the ascent of "new" water rich in nutrients from below. The open part of the Arabian Sea, especially the regions of deep water ascent, has the highest concentration of nutrients at or near the base of the euphotic zone

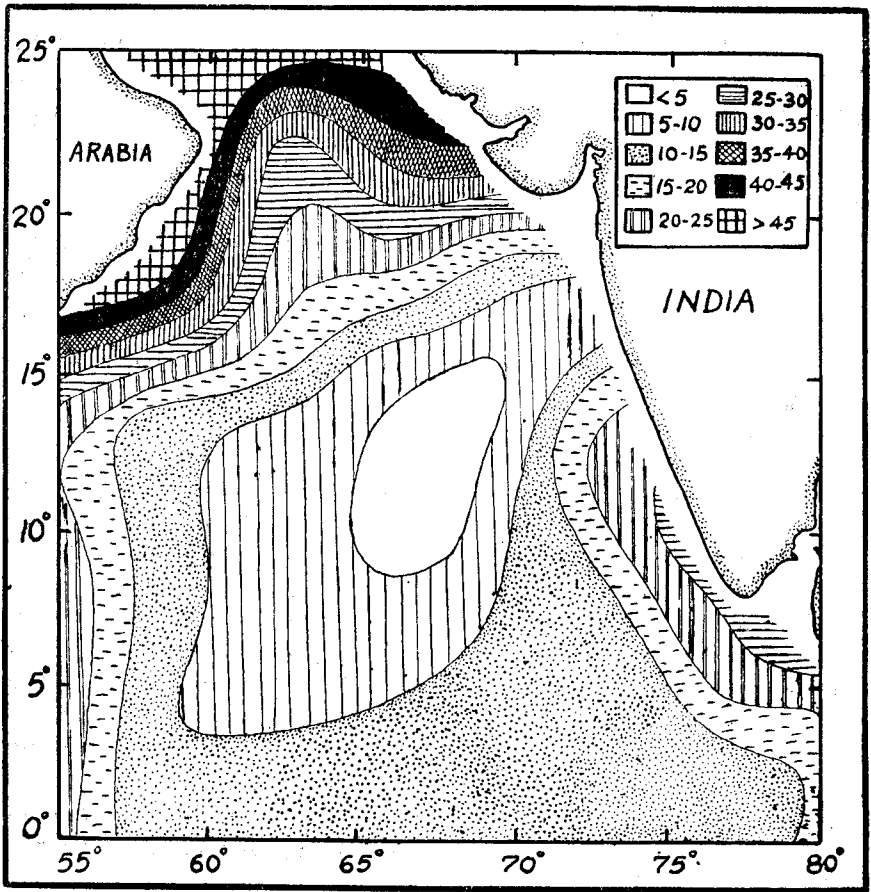


Figure showing the relative abundance of zooplankton in millilitres in the upper 200 metres of water of the Arabian Sea.

which is a potentially productive condition. But it is possible that this high productivity of the surface waters do not reach their culmination into profitable fisheries and in certain extreme cases a paradoxical situation consequent on this high production is created whereby mass mortality of fish takes places. Extensive mortality

of fish, sometimes covering enormous areas, has been reported from time to time. On the basis of recent investigations it is presumed that the presence of very high concentrations of nutrients at or near the base of the euphotic zone indicates a situation which though potentially productive is biologically unstable. Because of

he intensive phytoplankton production, zooplankton increases and fish move into these regions. Due to subsequent death and decomposition of enormous quantity of sinking plankton the already low oxygen concentration in the bottom layers get further depleted. Certain areas in the Arabian Sea have been known to be practically without life. While these are extreme cases it is fairly well-established that the waters of the Arabian Sea are somewhat deficient in oxygen which reaches a

minimum level at 200 to 500 metres. This oxygen minimum layer is subject to movements and while during certain seasons such movements may have beneficial effect in concentrating the fish populations towards the coast, it is equally possible that the opposite could happen. The shifting of the oxygen minimum layer is believed to be one of the causes for the large scale fluctuations in fisheries like the oil sardine and in extreme cases the mass mortality of fish in the open part of the sea.