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Organic Production in Indian Waters

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Studies on the quantitative and qualitative distribution of the standing crop of plankton in the Indian coastal waters have been fairly extensive. But investigations on the production of organic matter which enable us to assess the relative fertility of the various regions of the sea are of recent development. Systematic measurements on the production of matter in the southeast coast of India and recent measurements from the west coast together with the information already available on the nutrient salts enable us to draw a general picture of the productivity of the Indian waters.

Taking all seas as a whole it may be mentioned that the replenishment of nutrient salts in the productive layers is normally the most important factor governing the magnitude of the annual organic production, other factors being light, temperature and grazing by zooplankton. However, temperature and light are never limiting factors in these waters as in the temperate seas.

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. It is only occasionally possible at any given time to describe one of the factors as the absolutely limiting one. The most important elements thus becoming limiting 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. The ratio between nitrogen and phosphorus (N:P) is about 16 in phytoplankton when the contents are expressed in mg. atom and is generally the same in deeper waters. Therefore when deep water is brought up to the surface and used for phytoplankton growth the two elements are exhausted simultaneously. So it is the rate of replenishment of the nutrients in the euphotic zone 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 regeneration in the sediments constitutes the most important part of total regeneration. The influence of temperature on the regeneration of nutrient salts is considerable. So in coastal areas where the water masses of the photic zone comes in direct contact with the bottom a striking correlation will be found though temperature has only a limited significance on the rate of organic

production. On the other hand in the open part of the sea, water circulation is necessary for the replenishment of the nutrient salts in the photic zone. The water circulation may be horizontal, whereby nutrient-rich water is brought in from neighbouring areas, or vertical. It is the vertical circulation that is more important. Vertical circulation may be due to upwelling or due to turbulence. In typical upwelling 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 shallow coastal regions show that they are very productive. This is a general feature of tropical waters. As mentioned before the main cause for this high rate is the regeneration of the nutrient salts due to the high temperature A strong positive correlation was observed between temperature and organic production in the shallow coastal waters of Mandapam. There are two peaks of production, one in April–May and another in October. The annual gross production in the surface waters as estimated by the light and dark bottle method comes to 75 g C/m^3. Carbon-14 experiments conducted off Tuticorin in the Gulf of Mannar also indicated a very high rate of production. In regions where the depth of the photic zone was about 45 metres, production rate exceeded 5gC/m^2/day. This is comparable with the highest rates so far observed, for example in the western part of the Arabian Sea and in the Gulf of Oman by the Indian Ocean Expedition research vessels.

On the west coast of India 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 thus enrich the surface layers 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 photic zone which is a potentially productive condition.

Near the shelf the lower boundary of photic zone as determined by light penetration is about 60 metres. The rate of production is high in the surface waters towards the coast (more than 10 mg C/m^3/hour) suggesting a constant supply of nutrients. The rate of production amounts to 2.0–4.5 gC/m^2/day near the coast off Cape Comorin. Outside the shelf the rate of production is only moderate, being less than 0.5 gC/m^2/day. In the open part of the Ocean the Expedition ships have observed high production in the zones of deep water ascent. In the equatorial part of the Indian Ocean the production rate is found to be significantly higher than tropical waters in general.

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 anticyclonic 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 a longer time. Carbon-14 experiments conducted in the waters around the Islands show that compared to the other islands the waters around Minicoy are having the highest production rates with 50.0 mgC/m^3/day in the surface waters. In the deeper regions in the vicinity of the Island, though the rate per unit volume is lower, the column production is about 0.3 gC/m^2/day which is only a little more than the rate usually found in tropical oceanic waters. On the shelf where there is no turbidity the rate of production is found to be high – upto 0.6 gC/m/day. Hence 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.

Thus organic production studies conducted extensively both on a spatial and temporal basis can provide valuable information on the possibilities of large scale fishing. Investigations conducted by the Central Marine Fisheries Research Institue for the first time in India have revealed that in some of the regions like the southeast coast of India, the rate of production is very high and comparable to the most productive regions of the world. Exploratory fishing carried out subsequently have substantiated that some of the areas like the inshore waters of the Gulf of Mannar and Palk Bay could sustain a much higher yield than at present exploited.