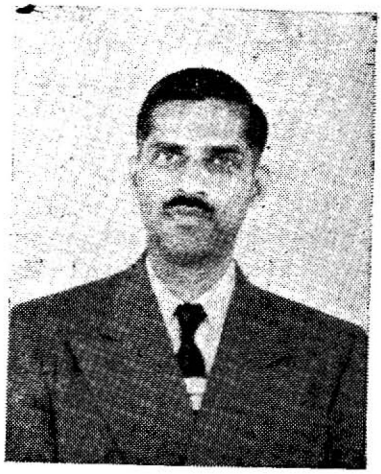
Fishes and Their Environment



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THE concept of environment, so necessary in all fishery biological investigations, is well recognized. Marine biological and oceanographic investigations have yielded very interesting information on the relationship between the forms of organisms, their structures and modes of life and many factors in their milieu. In studies of this nature we now recognize the concept of adjustment between the organism and its surroundings. But "the correlations we call adaptations are certainly of far too great a complexity for any postulate of casual connections, for the organism and the environment are two enormously complicated conceptions." This law of ecological solidarity between an animal species and its specific environment has been found to have great practical applications in fisheries.

Environmental factors are of two types. The animate or biological factors (relationship of the organism to species or types other than its own) and the inanimate or non-biological which include physical, chemical and meteorological factors. Some examples of these two types of factors influencing or affecting the fisheries along our coast are known but rather insufficiently. While some are of beneficial nature others are detrimental. For any large scale development and/or management of our marine fishery resources a better understanding of the ecology of the species is inescapable.

Biological Factors

Amongst the biological factors affecting fish and fisheries plankton has the greatest influence because the successful survival of fish larvae would largely depend on the availability of proper food at the proper time and in proper quantities. Plankton forms the food not only of the larvae but of many adult fishes also. Hence in the

food budget of the sea plankton plays a vital role. The investigations carried out along the Malabar and South Kanara coasts indicate that the landings of fish along this region are directly proportional to the quantity of plankton, the fishery in general coinciding with the major peak in plankton production thus indicating the direct relationship of plankton as food of fishes. More specific observations showed a close relationship between the standing crop of phyto - and zoo-plankton and the total quantity of fish landed particularly the landings of the oil sardine and the mackerel both of which are plankton feeders. Areas of high plankton production are invariably associated with high yield of fish. A comparison of plankton production of such areas in the Arabian Sea with the quantity of fauna and other pelagic fisheries reveals the significant fact that congregations of these fishes take place mostly in regions where plankton is most abundant.

While plankton has an immediate and direct relation to pelagic fisheries, there are a few links between plankton and the demersal fisheries and so in the latter case the relationship may not be easily discernible. The bottom fauna, on the other hand, will show a more direct relation to the demersal fisheries. But it should be remembered that the enrichment of the bottom is to a large extent dependent on the richness of the overlying waters. Considerable quantities of planktonic organisms fall slowly from the pelagic region, either as living or dead organisms, and reach the sea bottom. Detritus other than that of planktonic origin may also contribute to the particulate matter in the depths but most of the primary food matter sustaining the bottom animals are ultimately derived from the plankton.

Plankton also has adverse effects on fish populations and marine fauna in general. The sudden and localised appearance of an almost monospecific bloom of diatoms, flagellates and blue green algae are common in our coastal waters. When such blooms occur they are known to affect the pelagic fisheries of the area. Thus, the swarming of flagellates like *Hornellia marina*, *Noctiluca miliaris* and *Gonyaulax* and the blue green algae *Trichodesmium erythraeum* have been reported to cause abrupt setbacks in fisheries and sometimes cause mass mortality of marine fauna in general. Although these adverse effects on marine fauna have been known, the causes and the mechanism have not been understood fully. It is believed, however, that choking of the gills of fishes by the organisms, effects of the ectocrines or the external metabolites of these organisms and the oxygen depletion due to the decay of the enormous quantity of sinking, dead planktonic organisms are some of the causes responsible.

Non-biological Factors

Under this category are a large number of factors such as winds, currents, tides, nature of bottom, light, temperature, oxygen saturation, salinity, pH, nutrient salts, etc. The profound influence of the monsoons by providing the energy required for the dynamic processes in the Indian Ocean is well-known.

The influence of the south-west monsoon on the sea surface is manifested in the vertical circulation

(upwelling) developed in the waters off the west coast of India especially along the southern half. The intensity of upwelling is directly related to the intensity of the monsoon. Recent investigations have, however, indicated that the generally accepted idea that the monsoon intensities and associated vertical circulation provide better conditions to the pelagic fishes in the coastal waters has to be revised because the south-west monsoon intensities of certain higher range alone are found to create favourable conditions for successful pelagic fisheries. On the other hand, during the north-east monsoon its entire range of intensity is found to create favourable conditions for the oil sardine fisheries of the west coast.

The differences in the effect of the two monsoons are apparently due to the varying nature of the wind pattern. The south-west monsoon winds cause upwelling especially along the southern half of the west coast because of the configuration of the coastline. The upwelled waters, though rich in nutrients, are generally poor in oxygen thereby creating a condition which is somewhat unfavourable for fishes. But if the winds are sufficiently strong there will be wind-mixing which would increase the oxygen content of the surface waters. This is apparently the reason for the higher range of intensity of the south-west monsoon alone being quite favourable for a rich pelagic fishery. The north-east monsoon winds, on the other hand, are essentially offshore winds and are relatively weak. None-the-less they cause northerly drift currents along the west coast. These drift currents presumably help the north-ward migration of pelagic fishes like the oil sardine and mackerel along the coast. Currents and nature of circulation of water masses thus influence the fishery resources particularly pelagic fisheries. Currents vary widely in their position and strength and these variations are reflected in fisheries as they greatly influence the location of fishing grounds. The particular pattern of circulation in the region of Laccadive seas is believed to help to keep the fish eggs and larvae in the highly productive waters thereby providing them with favourable environment.

The monsoons not only affect the pelagic but also the ground fisheries. For example, the south-west monsoon seems to influence the fisheries of the Wadge Bank where there is a noticeable increase in the catch during the monsoon season. Of paramount importance, however, in good demersal or ground fisheries will be physical, chemical and biological (food supply) nature of the ground. Owing to the narrow continental shelf (up to 200 m) particularly along the east coast of India the ground fish fishery resource is somewhat limited. Even in this shelf region the ground is far from uniformly rich. Some regions especially along the west coast are highly productive while others are comparatively poor or almost barren. Similarly, the qualitative composition of the fish population too is dependent on the conditions of the ground.

The nature of substratum has certain amount of influence on the distribution of prawns and lobsters along our coasts. Although not very clearly understood in the case of all the commercial species of prawns, it

has been found that certain species prefer a muddy bottom while some others occupy a more or less hard sandy bottom with only a small percentage of silt. In the case of lobsters most of them inhabit the rocky patches of the coastline but at least one species is known to occur in fairly large numbers along the continental shelf in sandy grounds with some silt.

The success of the pearl oyster fishery is observed to depend to a large extent on the proper currents and drifts because if they are not conducive for the pelagic larvae at the time of spat fall, the larvae might miss the banks and perish for want of a suitable substratum. It is also believed that as the drifting larvae of pearl oysters will have to be at the mercy of very many factors such as changes in drift, lull in the monsoon, want of favourable grounds, etc., the true explanation of the irregularity of our pearl fisheries is to be sought in the geographical peculiarities of the pearl banks.

Although in tropical waters the fluctuations in temperature are not very marked, some effects of temperature on the inshore demersal fisheries have been noticed. Along the Maharashtra –Gujarat coasts the 'Dara' fishery is closely related with low temperature, the best catches being obtained when temperatures are below 24°C. On the other hand, the catch rate of 'Koth' has been highest when the bottom temperature was 27°C. Observations have further shown different, though graded, patterns of temperature distribution among the different regions and correlated with these are the differences in the trends of the fisheries. This is suggestive of the possibility of certain definite optimum temperatures limiting the abundance of the different groups of fishes even within the limited range found in our waters. In regard to the pelagic fisheries indications are that increase in the temperature affects adversely the mackerel catches while low temperature ranges exerted less pronounced effect. As for the oil sardines a close relation between the low temperatures and good fisheries was recorded along the Malabar coast.

The formation of mud banks along the Kerala coast and the associated rich fishery particularly the large sized prawns is well-known. The exact nature of relationship between these two remains yet to be elucidated. Recent observations, however, tend to suggest that the prawns and fish get concentrated in the areas of mud bank formation purely because of the calm conditions prevailing there.

The effect tides have on the local fisheries has not been properly investigated but there have been suggestions that the trawl catches tend to be better during the neap tide periods than during the spring tides.

Of all the chemical factors directly influencing the fishery, the oxygen content of sea water would rank first. A direct correlation between the bottom oxygen concentration and the trawl catch has been observed in some regions. Along the west coast of India from 08° to 15°N water of low oxygen content is brought up during the south-west monsoon season. As a result of this demersal fishes along the south-west coast have been found to disappear from a rather broad belt parallel to the coast. Similarly, off

the coast of Bombay a shoreward upslope of the oxygen minimum layer was observed during the period October-December which intersected the bottom at about 15 m. This phenomenon seems to have a beneficial effect on the local demersal fishery because the bottom fish, distributed over a large area on the relatively shallow continental shelf, are forced to migrate shorewards to escape lethal low-oxygen conditions. This result in notable concentrations of fish becoming easily available to the local fishermen. The boundary of the layer of minimum oxygen seems to rise and fall with the tides which will cause corresponding up and down migrations of the fish.

Even if other conditions are favourable, low-oxygen water can adversely affect the fishery. For instance the upwelling off Bombay during the north-east monsoon causes high production of plankton. Consequent on this the pelagic fish could be expected to migrate into this area to feed on the rich standing crop of plankton but fishes like mackerel, sardine and the tunas do not come close to the coast in the area. Schools of such fish were sighted about 25 miles off the Bombay coast at this time and this is presumed to be because of the low oxygen content in the surface waters of the upwelling and mixing zones.

Salinity and pH also are known to influence fisheries. The investigations indicate that increase in salinity and pH has adverse effects on the mackerel fisheries.

Though nutrient salts do not directly influence the fishery they have an important role to play in the success or failure of fisheries. Unless adequate concentrations of nutrients are available in the photic zone production of organic matter and plankton which in turn form the food of fishes will be greatly affected. This will have serious repercussions on the fisheries. It should also be mentioned that in certain areas an inverse relationship between the bottom phosphate concentrations and trawl catches has been noticed.

The foregoing examples are but a few from our coastal waters and elsewhere there are several classical examples of the influence the environment has on the behaviour pattern of fishes. Ecological niches of the various species have been investigated and determined for locating new fishing grounds, biological indicators have been recognized as indicators of good or bad fisheries and certain oceanographic and meteorological parameters have been used for forecasting the trends in fisheries. The species, thus, cannot be considered as an entity by itself. It should be studied in relation to its environment making fishery biology a field of applied ecology.

Reprint from "SEAFOOD EXPORTER"
May, 1967 — Vol. 2 — No. 1.