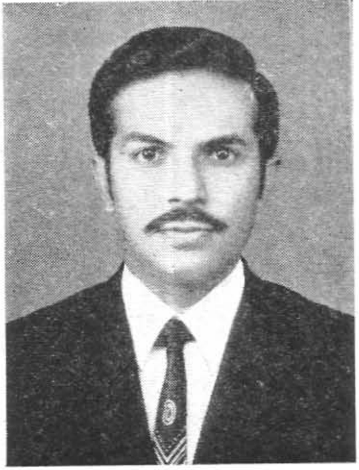

PRODUCTION AND EXPLOITATION OF LIVING MARINE RESOURCES

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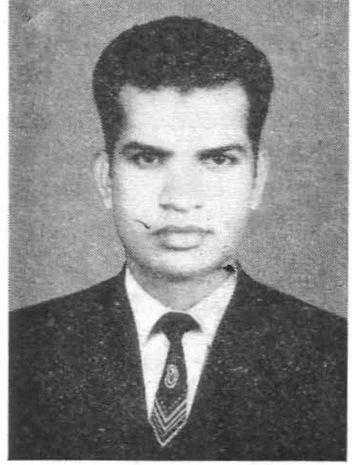


An unprecedented increase in the world population during the past few decades has made the scientists to predict that by the year 2000 A. D., the world population will increase from the present 2.7 billion to 7 billion. Agriculture and natural resources can be enhanced to sustain a population of that size, but the people, no doubt, will begin to suffer from chronic deficiency of protein and fat. This is reason why in recent years much attention has been given towards the assessment of potential of marine organisms as a source of protein food and the imperative necessity of harvesting the sea resources to a maximum level.

The basic questions which are often asked when we examine the fertility of a marine area are: What is the quantum of organisms developed within the area in a given time? What is the total quantity of organisms available in an area for harvesting? How much organisms can be exploited from the area and so on. An attempt is made in this article to answer some of these fundamental questions.

Productivity

Productivity represents the capacity of an area to produce living organisms. It is an index for evaluating the relative fertility of different areas. Extensive investigations have shown that the minute unicellular floating algae — the phytoplankton - give a measure of production. These plants are mainly constituted by diatoms, dinoflagellates. silicoflagellates, coccolithophores, blue-green algae and a variety of minute forms called nannoplankters. These tiny plants contain chloroplasts that can produce carbohydrates from carbon dioxide and water in the presence of light (photosynthesis). The plant cells then synthesize complex organic compounds from suitable inorganic substances such as phosphorus and nitrogen.

The amount of organic material synthesized by the activity of organisms in a unit time and volume is called production rate. It is evaluated in terms of gross production. A part of the gross production is used by the plants themselves. The remaining fraction is the net production. The amount of organic material, thus formed, can be expressed as 'carbon' and hence the production per unit volume of water can be reported as grams of carbon produced per square metre of surface area per day.

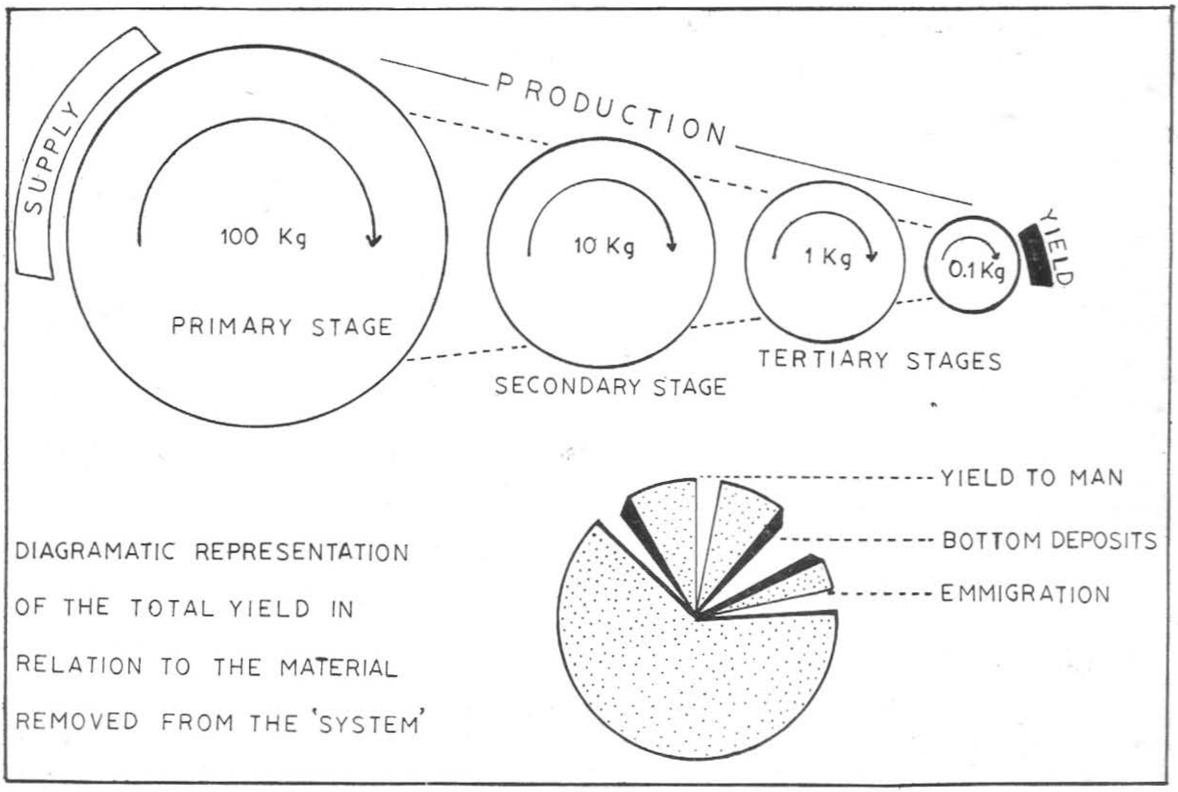
The produciion being dependent on light, takes place in the upper layers known as the euphotic zone, where penetration of sunlight is possible. Other factors that play significant role in the plant production of the sea are the availability of nutrients, trace elements and to some extent salinity and temperature of the water. The production rate has been found to be high in areas where the euphotic zone gets enriched with water from deeper levels havihg high concentrations of nutrients. Such areas in the world are associated with upwelling (lifting of water from the subsurface to the surface) or other ocesnographic phenomena that involve replenishment of the nutrients.

Estimates of primary production can be made by various methods. The rate of production can be measured either directly or indirectly by estimating the standing stock of phytoplankton. A more direct estimation can be made by measuring experimentally the rate of production by trapping a small population ef phytoplankton in bottles. The most common experimental method for measuring the production rate is the well-known light and dark bottle oxygen technique. In this method the oxygen in light and dark bottles is measured and the difference between the two gives the gross production. Another method for the estimation of production is by pigment analysis. The plant pigment content of phytoplankton (chlorophylls) assumes greater importance in studies of food chain. More recently, the radioactive carbon technique (C^{14}) has made it possibie to determine more precisely the rate of primary production and this method is being used throughout the world. Studies carried out by the Central Marine Fisheries Research Institute have shown that the production rate in coastal waters of the Indian Seas (up to 25 fathom depth) is of the order of about 3 $gC/m^2/day$ and 0.2 to 1.0 $gC/m^2/day$ in the shelf waters and about 0.2 to 0.7 $gC/m^2/day$ in the oceanic waters. Thus the estimated production for the west coast as a whole amounts to about 46×10^6 tonnes of carbon and for the east coast 15×10^6 tonnes of carbon. Scientists have theoretically estimated that "the potential harvest as derived from the yield ratio from carbon production is about 2 – 3 million tonnes of fish for both the coasts" and for the whole Indian Ocean it is 11 million tonnes.

It is interesting to point out the relationship between the microscopic plants and the animal populations of the sea. The utilization of the organic material produced by plants is done by zooplankton which includes small drifting animals and the larval stages of many higher groups. These secondary producers grow at the expense of primary food in the sea and convert the plant material into animal material to be utilized by the carnivorous forms. Herbivorous members of the animal community are dependent on the phytoplankton for their food supply and among the grazers a group called copepods is the foremost. Further along the food chain, these zooplankton serve as the food of the young ones of nearly all species of fish and some adult fishes which remain plankton feeders throughout their life (mackerel). The zooplankters feeders in turn form the major food items of large predatory fishes.

Maximum abundance (biomass) of zooplankton is usually at 75–200m depth in tropical seas and near the surface in higher latitudes. Zooplankton production follows the increase of the phytoplankton and it occurs most in areas where enrichment takes place (upwelling). The animals lose some energy, as the food consumed is converted partly into growth and partly into metabolism. The food supply become progressively reduced with depth although a small increase is seen at the bottom where unutilized organic matter and detritus finally concentrates and gets decomposed by bacteria into mineral substances (N, P, and trace elements). These are finally returned to the surface waters by physical processes.

The food value of the zooplankton varies greatly according to the type of organisms. Crustaceans have a high protein content and in colder seas they also possess a high oil content. The rate at which the plant material is converted into animal matter and in turn utilized by the predators is termed as the efficiency of conversion. This efficiency usually is of the order of 10%. However, this factor may be too conservative since recent studies have shown that in some euphausiids dominated environments the efficiency has ranged from 11–44%. The gross growth



efficiency in some copepods has been found to range from 30–45%. These findings would considerably enhance the estimates of harvestable resources in different regions.

Biomass

The standing crop of animals represents the number of individuals in a given area. Estimation of the animal crop is essential to study the rate with which the larger animals feed upon the smaller ones. Estimation of living marine resources can be made by quantitative sampling and estimation of energy flow in controlled conditions and applying the result to a natural environment.

When we consider the amount of yield available to man (commercial production) we should take into consideration several channels through which the organisms are lost from the ecologically bound 'system'. Organisms may be permanently removed from the area by winds or currents or by migration by its own power of locomotion. Dead organic matter, which gets buried in the bottom sediment is another temporary loss. Natural mortality also plays an important role. The amount of organisms harvested by man during a certain period is termed as "yield". The yield to man and the losses through the various channels mentioned above add to the total amount of material removed from the system.

No sustained yield can be maintained, if it exceed the total supply of material in the form of the various basic constituents. Usually yield is much smaller than the total supply. In order to ascertain the possibility for measuring the yield from any area, a well planned measurement of the relation of yield to supply is necessary. The maximum sustainable yield thus represents an index of animals removed from an area year after year.

Better scientific knowledge gathered during recent years has given a clear picture of the detrimental effects of environmental factors on fish populations. Man once considered these resources as inexhaustible. Much attention is being given to generate extra food resources by culturing different cultivable animals. Although the long larval life of many animals will discourage the real farming practices, some fishes, prawns, clams and mussels form excellent groups for culture operations. The proximity of primary producers (phytoplankton) and heterotrophic animals in the shallow nearshore waters and estuaries, makes the consumption and conversion of the primary food by the animals an easier process. The abundance of organic detritus in estuaries also acts as a link in the primary and secondary production levels. Moreover filter feeding animals such as oysters, clams and mussels are well known for their capacity to accumulate protein directly by feeding on phytoplankton, thus avoiding the secondary links in their food chain.

In productive marine ecosystem, little effort is required in cultivation because recycling of nutrients is automatically provided. A careful planning and exploitation of resources is required which could produce the high protein food and make it easily available to the consumer at a low cost.