

A PRELIMINARY ACCOUNT OF PRIMARY PRODUCTION AND ITS RELATION TO FISHERIES OF THE INSHORE WATERS OF THE GULF OF MANNAR

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INTRODUCTION

IN the ecological studies of marine environments dynamics of production and the quantitative aspects of the relations involved have received special interest. Such quantitative studies of the various relationships have resulted in the familiar 'Eltonian Pyramid' which represents the layering of the community brought about by the feeding habits of different species. But due to the inevitable loss of materials at each level in the food chain the yield normally will be smaller than the supply. According to Clarke (1946) "the measurement of the ratio of yield to supply, and hence the efficiency of the formation of the yield, is therefore of great importance to the ecologist, to the conservationist, and to the farmer or fishermen, in order to ascertain whether the actual yield represents a needlessly low utilization or an over-exploitation of the area."

With this object in view investigations on the primary production of the inshore waters of the Gulf of Mannar were started in 1957 to ascertain the efficiency of the formation of the yield in this region. Preliminary experiments on the primary production were conducted at a station near the Central Marine Fisheries Research Station jetty (Prasad, Pillai and Nair, 1958) and later five more stations were selected at about 8 kilometres apart in the inshore region of the Gulf, parallel to the coast. The data obtained (two years' observations from the first station and one year's from the other five stations) are used to compute the general productivity in relation to the fisheries of this region extending from Dhanushkodi to Cape Comorin for a 10-mile belt which is normally exploited by the fishermen at present.

Various methods, both direct and indirect, are employed for estimating the production of an area. The pioneer work on the production of organic matter was done in the English Channel by Atkins (1922 and 1923) who used the changes in alkalinity and phosphate consumption for computing

production. The first really direct method of the estimation of organic matter using 'clear' and 'dark' bottles was introduced by Gaarder and Gran (1927). This technique with slight modifications was subsequently used by Riley (1938, 1939, 1941 *a* and 1941 *b*) in extensive plankton investigations. A review of all the techniques has been given by Steemann Nielsen (1952) while introducing the ^{14}C technique for the determination of carbon assimilation by the plankton algæ. Though at present it has been widely recognised that ^{14}C is the most valuable tool in the determination of organic production, in the present investigations the authors have used the 'light' and 'dark' bottle technique mainly due to lack of facilities for employing ^{14}C and also due to the fact that the investigations are in shallow eutrophic areas where the present technique is applicable.

METHOD

Sea-water was collected from respective stations at fixed hours in bottles thoroughly cleaned with chromic acid. Control bottles were painted dark or covered with double-layered dark cloth. Sets of such 'light' and 'dark' bottles were filled with raw sea-water from surface and depth taking care that no air-bubbles were left inside. The bottles were then suspended by 'cradles' from stands erected in the sea or from bamboo poles tied to an anchored drum. The initial and the final oxygen contents of both the bottles at the end of 24 hours were determined by a modified Winkler technique (alkaline azide method described by Dickinson as quoted by Thresh, Beale and Suckling, 1949). The difference between the oxygen content of the light and dark bottles at the end of the experimental period is the oxygen production and the difference between the initial oxygen and that of the dark bottle is the oxygen consumption of the community. The oxygen production values are converted into its carbon equivalents using a $\text{PQ} = 1.01$ based on equivalents given by Laevastu (1958, Table 5).

DISCUSSION OF RESULTS

The total annual production of carbon of the surface-waters of the first station from July 1957 to June 1958 was 88.792 gm./m³, while from July 1958 to June 1959 it was 90.750 gm./m³. The average annual production from all the analyses of the surface and depth samples from the six stations for the year 1959 was 88.730 gm./m³. Calculated on the basis of these data the total annual production of carbon is 5,184,234 metric tons for an area of about 3,900 square kilometres of the sea with an average depth of 15 metres, extending from Dhanushkodi to Cape Comorin. It should, however, be mentioned here that although the six stations from

which data have been collected do not cover a major part of the southern region of the Gulf a broad assumption that the present figures are applicable for the entire zone has been made for computing the total production of this region.* During the corresponding period the total fish landing for this zone is 15,980 metric tons. Assuming that the average protein content of fish to be 20% of which 50% could be reckoned as carbon, *i.e.*, 10% of the wet weight of fish (Vinogradov, 1953), the fish landings represent 1,598 metric tons of carbon. So the annual yield in terms of carbon is only 0.03% of the total carbon production of the area which is exploited at present by the fishermen. Subrahmanyam (1958 and 1959) estimated the phytoplankton production for a potential fishing area of 1,55,400 square kilometres on the West Coast of India and believes that the landings of the West Coast represent only 1/10 to 1/30 of that in the English Channel.

It might be of interest to note that the production of the entire hydrosphere has been estimated by Steemann Nielsen and Jensen (1957) as 1.2 to 1.5×10^{10} tons of carbon per year. According to them the annual yield of marine fishes as per the F.A.O. fishery statistics represents only 0.01% of the carbon annually fixed in the plankton algæ in all seas, whereas in eutrophic coastal areas at higher latitudes such as the North Sea, about 0.2 to 0.3% of the carbon annually fixed by the plankton algæ is taken every year by the fishermen. Steemann Nielsen and Jensen (1957) believe that a high percentage of yield is possible in eutrophic areas where plankton feeders abound. With only one link in the food chain, the percentage is bound to be high. According to this estimate it may be said that our present yield is only 1/7 to 1/10 of a possible exploitable stock, compared to the North Sea, on the assumption that the same percentage of carbon is being converted into exploitable fish stock.

ACKNOWLEDGEMENT

The authors are grateful to Dr. S. Jones, Chief Research Officer, Central Marine Fisheries Research Station, for going through the manuscript and offering helpful criticisms. They are also thankful to the Fishery Survey Section of the Central Marine Fisheries for making available the survey

* Since this paper was sent to the Press, the authors were able to conduct one set of experiments off Tuticorin at the 8-fathom area in Kuthadikkarai, on September 6, 1960. It happened to be a period of *Rhizosolenia* bloom. Sampling was done just below the surface and at 5, 10 and 15 m. Production was highest near the surface (0.458 gm.C/m²/day) which progressively diminished reaching compensation level at about 15 m. The production would thus amount to 3.435 gm.C/m²/day. This value compares well with values obtained for the six stations during similar periods of diatom blooms.

data of the concerned zone and Sarvashri D. Sudarsana Reddy and C. T. Rajan for helpful co-operation in the collection and analysis of samples.

REFERENCES

- Atkins, W. R. G. 1922 .. Hydrogen-ion concentration of sea-water in its biological relations. *J. Mar. biol. Assoc. U.K.*, **12**, 717-71.
- , 1923 .. Phosphate content of waters in relationship to growth of algal plankton. *Ibid.*, **13**, 119-50.
- Clarke, G. L. 1946 .. Dynamics of production in a marine area. *Ecol. Monogr.*, **16**, 322-35.
- Gaarder, T. and Gran, H. H. 1927 Investigations of the production of plankton in the Oslo Fjord. *Rapp. et Proc. Verb., Cons. Internat. Explor. Mer.*, **42**, 1-48.
- Lævastu, T. 1958 .. *Review of the Methods Used in Plankton Research and Conversion Tables for Recording the Data and Recommendations for Standardization*. F.A.O. Fisheries Division, Biology Branch, FB/58/T2 (Mimeo.).
- Prasad, R. R., Krishna Pillai, V. and Ramachandran Nair, P. V. 1958 A note on the organic production in the inshore waters of the Gulf of Mannar. *Curr. Sci.*, **27**, 302-03.
- Riley, G. A. 1938 .. Plankton Studies.—I. A preliminary investigation of the plankton of the Totugas region. *J. Mar. Res.*, **1**, 335-52.
- , 1939 .. Plankton Studies—II. The Western North Atlantic, May-June, 1939. *Ibid.*, **2**, 145-62.
- , 1941 a .. Plankton Studies—III. Long Island Sound. *Bull. Bingham Oceanogr. Coll.*, **17**, 1-93.
- , 1941 b .. Plankton Studies—IV. Georges Bank. *Ibid.*, **7**, 1-73.
- Steemann Nielsen, E. 1952 .. The use of radioactive carbon (^{14}C) for measuring organic production in the sea. *J. du. Cons.*, **18**, 117-40.
- and Jensen, E. A. 1957 Primary Oceanic Production. The autotrophic production of organic matter in the oceans. *Galathea Reports*, **1**, 49-136.
- Subrahmanyam, R. 1958 .. Ecological studies on the marine phytoplankton on the West Coast of India. *Mem. Indian Bot. Soc.*, **1**, 145-51.
- , 1959 .. Studies on the phytoplankton of the West Coast of India. Part I. Quantitative and qualitative fluctuation of the total phytoplankton crop, the zooplankton crop and their interrelationship, with remarks on the magnitude of the standing crop and production of matter and their relationship to fish landings. *Proc. Indian Acad. Sci.*, **50 B**, 113-87.
- Thresh, J. C., Beale, J. F. and Suckling, E. V. 1949 *The Examination of Water and Water Supplies*. London, p. 280.
- Vinogradov, A. P. 1953 .. *The Elementary Chemical Composition of Marine Organisms*. New Haven, pp. 647.