

RELATIONSHIP BETWEEN CHLOROPHYLL *a* AND COLUMN PRIMARY PRODUCTION

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ABSTRACT

Relationship between surface chlorophyll *a* and column primary production has been established to help in estimating the latter more quickly and accurately. The equation derived is Primary Production, $y = 0.54 \text{ Ln Chl } a - 0.6$. The relationship was found to be statistically significant.

Key-words : Chlorophyll *a*, Primary Production.

The last two decades have observed a tremendous increase in the rate of data collection in the oceanic and coastal areas. The data collections at sea are not only tedious but very expensive too. Hence various techniques are now being used to make the data collection more economical. These includes remote sensing of sea surface parameters, drifting and moored buoys, telemetry, etc.

Surface chlorophyll is one such parameter which can be estimated by remote sensing via satellite. Chlorophyll is an index of primary production which in turn is used for estimating the living resources in the sea. The primary production is generally measured by ^{14}C technique (Steemann Nielsen, 1952) and by measurement of oxygen evolved during the photosynthesis. The details of these methods have been described by Vollenweider (1974). While O_2 method has become obsolete, the ^{14}C technique is also said to give a low value as observed by Sheldon and Sutcliffe (1978), Gieskes, Kraay and Baars (1979), Schulenberger and Reid (1981) and Jenkins (1982).

If the surface chlorophyll upto a depth of 10m can be measured by any technique, it can be theoretically considered for estimating primary production. Relationship between chlorophyll *a* and photosynthesis at given light intensity and depth has been described by several authors (Qasim, Wellershaus, Bhattathiri and Abidi, 1969; Ryther and Yentsch, 1957 and Aruga and Monsi, 1963). In this note an attempt has been made to find out relationship between concentration of surface chl-*a* and primary production with a view to facilitate the estimation of the latter more easily.

The data from 60 stations collected by R V Anton Brunn during International Indian Ocean Expedition (Cruise 1 to 3) between latitude 19 —

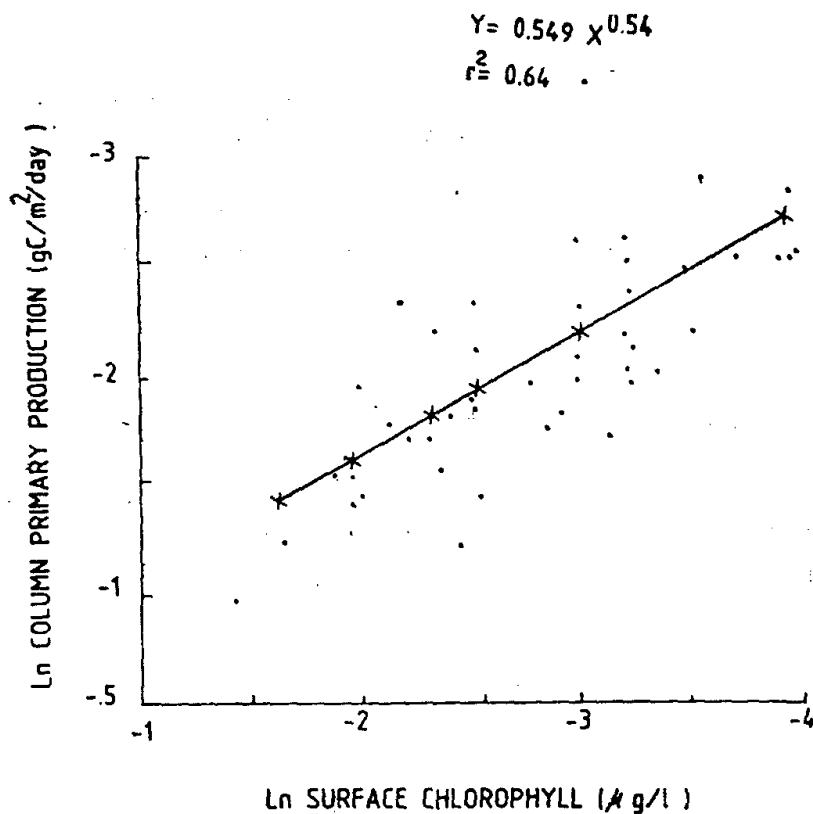


Fig. 1. Relationship between chlorophyll a and column primary production

24°N and Longitude 60 — 71°E have been used. The column primary production integrated from the values at different optical depths and the average concentration of chlorophyll a (from the 0 — 20 m depth) have been used to establish the relationship between the two parameters.

Since the maximum concentration of chlorophyll is not always at the surface but generally a little below it, an averaged value of surface and at 10 meter depth was taken and termed as 'surface chlorophyll'. The values of surface chlorophyll and the primary productivity used in this note ranged from 0.01 to 0.36 $\mu\text{g/l}$ and from 0.008 to 0.32 $\text{gC/m}^2/\text{day}$ respectively.

The relation between the two variables can be evaluated by examining the reduction in the sum of square of the dependent variable produced by the regression function. The sum of squares divided into two components — one associated with linear regression, and the other with the extent of deviation of the data from the straight line. The reduction in the total sum of squares due to linear regression is then computed and is defined as the ratio of the total variability (r^2) to the total sum of squares.

Raw data showed a non-linear relationship on linear scale and called for the transformation. Secondly an increasing values of chlorophyll (x) demanded a transformation of logarithmic type. The transformation made the error

additive and the data linear (Fig. 1). The criteria used to judge the fit of regression to the data points was coefficient of determination. The coefficient measures the fraction of the total sum of squares that can be attributed to the regression. The regression equation is $y = 0.549x - 0.54$, ($r^2 = 0.64$). As the r^2 was increasing to higher order solution, the linear regression was considered adequate. The relationship was also found to be statistically significant.

Thus from this preliminary study, it is concluded that the surface chlorophyll values can be utilized for getting fairly a good estimate of column production. However, a more detailed work is warranted to support this finding.

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REFERENCES

- Aruga, Y. and M. Monsi, 1963. Chlorophyll amount as an indicator of matter productivity in biocommunities. *Plant Cell Physiology*, **4**: 29-39.
- Gieskes, W. C., G. W. Kraay and M. A. Baars, 1979. Current ^{14}C methods for measuring primary production: Gross under estimates in oceanic waters. *Netherlands Journal of Sea Research*, **13**: 58-78.
- Jenkins, W. J., 1982. Oxygen utilization rates in North Atlantic subtropical gyre and primary production in oligotrophic systems. *Nature*, **300**: 246-248.
- Qasim, S. Z., S. Wellershaus, P. M. A. Bhattathiri & S. A. H. Abidi, 1969. Organic production in a tropical estuary. *Proceedings of Indian Academy of Sciences*, **B. 69**: 51-94.
- Ryther, J. H. and C. S. Yentsch, 1957. The estimation of phytoplankton production in the ocean from chlorophyll and light data. *Limnology and Oceanography*, **2**: 281-286.
- Schulenberger, E. and J. C. Reid, 1981. The Pacific shallow oxygen maximum, deep chlorophyll maximum and primary productivity reconsidered. *Deep Sea Research*, **28 A**: 901-919.
- Sheldon, R. W. and W. H. Sutcliffe, 1978. Generation times of 3h for Sargasso sea microplankton determined by ATP methods. *Limnology and Oceanography*, **23**: 1051-1055.
- Steemann Nielson, E, 1952. The use of radioactive carbon (^{14}C) for measuring organic production in the sea. *Journal du Conseil Perm International Exploration Mer*, **18**: 117-140.
- Vollenweider, R. A., 1974. A manual on Methods of measuring primary production. Aquatic Environments, IBP Handbook, 12, Blackwell Scientific Publications, Oxford.