

THE TIME VARIATIONS OF THE PHYTOPLANKTON AND NUTRIENTS IN THE NORTH ADRIATIC SEA

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Abstract

The paper discuss the results obtained by statistical treatments of long-time series of experimental data detected by an oceanographic boat in a fixed point of the north Adriatic sea. The area is subject to blooms of algal species in different period of the year. The spectral analysis applied to these time series shows a strict periodic variation in the structure of the nutrient -phytoplankton system as it is pointed out, under specific condition, in the simulation model of exchange dynamic.

Résumé

On présente les résultats obtenus par traitement statistique de séries à long terme de données enregistrées d'un bateau océanographique dans un site déterminé de l'Adriatique du Nord, caractérisé par la présence d'algues d'espèces différentes selon les diverses périodes de l'année. L'analyse spectrale a été appliquée à ces séries temporelles et la structure du système nutritif du phytoplancton présente une stricte variation périodique, pendant l'expérience de simulation de l'échange dynamique.

The phenomenon of eutrophication interests the coastal belt of the Emilia Romagna region on the north-western Adriatic sea.

Within the framework of research programs carried out from 1977 to 1980 along the entire Emilia Romagna coast, which aimed at outlining the spatial and temporal distribution of blooms, clarifying and focusing on the factors that concur in bringing them about, evaluating their possible health and sanitary effects and establishing the hydro-dynamic coastal conditions, a fixed sampling station has been chosen.

The survey started in June 1979 and ended in December 1980. Sampling was carried out daily employing the scientific instrumentation installed on board the oceanographic boat "DAPHNE"; the laboratory tests were carried out from the Consorzio del Centro Universitario Studi e Ricerche sulle Risorse Biologiche - Marine di Cesenatico.

The elements that determined the choice of a fixed sampling station were: the need to survey the coastal eutrophic phenomena, also within limits of time, the opportunity of studying the temporal variations of various parameters, the possibility of being able to infer from the phenomenology by means of instruments of statistical analysis applied to long period frequency distribution and the verifications of the realibility and representativity of the bi-weekly sampling carried out in control areas.

The characteristics and location of the sampling site are: a distance from the port of Cesenatico such as not to be directly influenced by the city wastes, and, at the same time, such as to be affected by the principal eutrophic coastal phenomena; a depth for the station sufficient to evaluate the variations of some parameters between the surface and the bottom under stable conditions; the knowledge of dynamic of the zone in that, during the entire investigated period there were continuously registered the current flow data.

There were ascertained various episodes of algal blooms, both in summer and in winter; differences of temperature between the surface and the bottom have proved favourable for the establishment of accentuated thermoclines; dissolved oxygen proves to be influenced by meteoric and biologic conditions and in the bottom a greater variability is found.

The most relevant contribution to the nitrogen substances is supplied by nitrates during the autumn and ammoniacal nitrogen during the summer.

Nitrates show the highest degrees of concentration in correspondence with salinity decrease, therefore deriving from the contribution from the inland.

Orthophosphates and total phosphorus do not on the average have very high concentrations but their highest values precede the phenomena of algal blooms, reactive silica shows the maximum concentration in late autumn and sharp reduction have taken place in unison with diatom blooms.

Looking for the degree of connection between variables there have been found significant ties between algal biomass and nutrient salts, in particular nitrogen complexes, during the summer period. Particularly interesting has proved to be the law between chlorophyll "a" and the flows of the Po river during the summer period, the decrease of salinity following increased river flows and above all the amount of salts

that favours the development of diatoms. The algal biomass is inversely correlated to the temperature.

All the variables have been dealt with spectral analysis and the results is that the variables that constitute the nutrient-phytoplankton system in a simple chemostat model show exceptionally pronounced peaks of power-spectra and they are similar in shape.

Recurring peaks are located at 3-3.6 days for all variables. Values marked of 6 days are found for total phosphorus. Around 6 days exceptionally marked peaks are found for nitrates and dinoflagellates. The periods of 8-9 days are present for all the variables with the exception of  $PO_4$  and  $NO_3$ , while the oscillations of 16-18 days are repeated for all the variables with the exception of nitrates and diatoms.

The existence of the time variations that oscillates in time at recurrence period of three days can be induced by many factors and the aim of further studies is to consider that the meteorological effects which could present peaks of equal periods strictly bound to phases of mixing of the vertical column.

#### BIBLIOGRAPHY

ARNOLD E.M. and VOSS D.A. (1981) - Numerical behavior of a zooplankton, 0304-3800-81 Ecological modelling, Elsevier, Amsterdam

BATH M. (1974) - Spectral analysis in geophysics - Elsevier - Amsterdam

BENNET A.S. (1976) - Conversion of in situ measurements of conductivity to salinity - Deep-Sea-Research Vol. 23 pp. 157-165 - Pergamon Press - Great Britain

BLACKMAN R.B. and TUKEY J.W. (1958) - The measurement of power spectra - 190 pp. - Dover - New York

COOLEY J.W. TUCKEY J.W. - An algorithm for machine calculation of complex Fourier series - Mathematics of computation (1965), Vol. 19, 90, pp. 297-301.

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"The time variations of the phytoplankton and nutrients in the North Adriatic Sea"

Paper presented by G. Galliani (Italy)

DiscussionM. Branica:

- a) The title of your paper is too general, because one can conclude from it that you study the whole area of North Adriatic.
- b) How many miles of the examined area is from the mouth of the river Po?

G. Galliani:

- a) This work represents part of a general one that studies the whole area from the river Po to Cattolica with about 50 sampling stations (a large area of North Adriatic)
- b) The monitoring station is about forty miles from the river Po mouth.

B. Cescon:

I think that the investigation carried out by fixed monitoring stations can suitably integrate the information obtained through continuous analysis. I can give the following suggestions:

- To choose the position of the monitoring station (s) on the ground of a more detailed spatial analysis;
- To automatize the analytical procedures including the calorimetric ones;
- To include the analysis of historical series data by using mathematical filters in order to distinguish the effects of the various periodical and aperiodical factors acting upon.