C:N:Si:P Ratio in the waters of the Middle and South Adriatic

by

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Abstract

This paper gives the ratios of the anorganic forms of the main nutrient salts in the Adriatic waters. They are higher than the standard oceanographic ratios. This is caused by the minimal quantities of P, which makes us conclude that P is the factor that governs the biological productivity in the Adriatic.

Résumé

Dans ce travail sont présentés les rapports des formes anorganiques de sels nutritifs principaux dans les eaux de la mer Adriatique. Les rapports trouvés sont plus élevés que les rapports normaux dans l'océan. Cet état de choses est produit par les quantités minimales de phosphate trouvées, ce qui nous permet de conclure que P est le facteur qui dirige la productivité biologique dans l'Adriatique.

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Introduction

Among the elements that are indispensable for the life of the sea organisms the main role have C, P, N, and Si. The process of passing of these salts from the sea into the organisms develops in the euphotic layer of the sea. The reverse process of regeneration can develop at any depth. The distribution of these biologically active elements is caused by the physical processes of mixing. According to the Liebig's law of minimum these elements govern the production, and, sometimes, they can limit it completely. The ratio between the C,N,Si and P quantities in the sea waters and organisms is of particular interest and importance. This is why the study of these elements in the sea has been undertaken. CICATELLI - SCACCINI M., [1967], MC GILL [1965], STOJANOSKI([1973], VUKADIN [1973], and BULJAN & *al.* [1974], studied this problem in the Adriatic.

Method

Standard automatic methods were used to determine the nutrient salts.

Results

The experimental data include one year's cycle (July, 1973-June, 1974). The distribution of the stations under investigation was planned so that we could inspect two large Adriatic basins (the waters of Middle and South Adriatic) and a coastal station. Sampling was conducted monthly at stations (9) and (25) and seasonaly at the stations (3) and (15). The results are represented in the next table N° 1.

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Tab. N° 1. C:N:Si:P ratio in the area under investigation (by atoms) :

Station	N° of analyses	C	N	Si	P
(25)	48	27×10^3	34	81	1
(9)	24	28×10^3	38	75	1
(3)	12	27×10^3	31	82	1
(15)	16	29×10^3	32	110	1

According to REDFIELD *et al.*, the ratio of these salts in the " average " oceanic waters is about 1017 :15 :16 :1. This ratio varies very often and is usually lower in the coastal area, and it also shows seasonal changes. COOPER [1937, 1938] has found exceptionally high values of this ratio in the waters of the Mediterranean. From the above able it can be seen that the Adriatic waters are very rich in the C contents in relation to the other elements examined. The ratio of C/other elements is much more stable and it keeps within the boundaries of 27-29 $\times$ 10^3. These deviations per seasons are almost minimal as well as it is the fluctuation with depths, so it can be concluded that C can not be the factor that could govern the biological production according to the Liebig's law.

The seasonal changes of the Si : P and P ratios at all the stations are much more unstable, this refers especially to the Si : P ratio whose values are from 30-135 :1. The lower values of that ratio are found at all the stations in the spring and summer months, which is probably caused by the " blooming " and the increase of Phytoplankton, at that period of time of diatomeae in the first place. The higher values of this ratio in the autumn and winter months are caused by the regeneration of Si from the material on the sea bottom.

At all the stations the seasonal changes of the N:P ratio show considerably smaller oscillations than the Si:P ratio. The maximal value of that ratio is found in the late spring month (March and April), which is caused by the increase of NH_4^+ - ions at all the stations under examination.

In the vertical distribution of the C:N:Si:P ratio the C:P and N:P ratios show smaller deviations with depth while the Si:P ratio shows considerable changes. The increase of that ratio at the station (25) is caused by Si that increases considerably bottomwards (the coastal station- submarine springs -" vrulje "). The minimal values of the Si:P ratio at the station (9) (the waters of the Middle Adriatic) are found on the 20-30 m level, i.e. in the euphotic layer. This is particularly well expressed at the stations of the Middle and South Adriatic, i.e. at the stations (3) and (15).

In that layer of these two stations we can find distinct minimal values of the C:P, N :P ratios. Here we can also find higher deviations for the Si:P ratio than for the C:P and N:P ratios.

By observing the yearly averages of the C:N:Si:P ratio we can see that there are no significant differences of that ratio between the stations. It is important to mention that these ratios are greater in the Adriatic than in the oceans. The increase of this ratio is probably caused by the very low quantities of P in whole area under investigation so we taking ni high risk, can conclude that P is that minimum factor which governs the biological production in the waters of the Middle and South Adriatic.

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Discussion

Questions

1. Which of the 4 parameters is most stable over the season? (E. DUURSMA, *Monaco*)
2. How the author explains the different values of N/P found by SCACCINI in Fano waters (very high values)? VUKADIN's values are small. (M. BULJAN, *Yugoslavia*).

3. I suggest that further investigations must be conducted mainly concerning kinetic parameters (uptake rate, grazing and excretion rate etc.) in order to define exactly the limiting function of each nutrient. (B. CESCON, *Italy)*.
4. Is it possible to take the ratio between elements as the characteristic parameter, because of great variations of values? (A. ŠKRIVANIĆ, *Yugoslavia)*.
5. Is the P value limited in surface and bottom waters? (N. FRILIGOS, *Greece)*.

Answers :

1. Carbon.
2. May be that it is the influence of inshore waters.
3. I agree.
4. See the discussion of M. BULJAN.
5. Yes, the P value is the limiting factor both in surface and bottom water.