

THE NITROGEN CYCLE IN THE NORTHERN ADRIATIC

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Summary

Seasonal changes in the inorganic nitrogen content of the Northern Adriatic are related to the biological cycle. Contribution of the rivers increases the rate of the processes, which control the nitrogen cycle in the western part of the investigated area. Significant nitrogen quantities could be removed from the Northern Adriatic by water masses exchange.

Résumé

Les fluctuations saisonnières de la teneur de l'azote inorganique de l'Adriatique septentrionale ont une relation avec le cycle biologique. La contribution des fleuves accélère les processus, lesquels contrôlent le cycle de l'azote dans les régions occidentales étudiées. Quantités significantes d'azote peuvent être transportées de l'Adriatique septentrionale par les courants.

Introduction

The inorganic nitrogen cycle was studied during 1972 and 1973 at 20 stations in the Northern Adriatic (Gilmartin et al, 1972), which is one of the most productive regions of the Mediterranean.

Materials and methods

Ammonia, nitrite and nitrate analyses were performed by standard methods, most of them immediately aboard the ship. Samples were taken with plastic Van Dorn samplers. Standard oceanographic parameters were, also, determined (Gilmartin et al., 1972).

Data from each station were integrated for the water column and for the whole investigated area, as well as for three characteristic regions: I - region under the direct influence of the Po river waters; II - the southeastern region, under the influence of the middle Adriatic waters; III - the central and northern region, with transient characteristics. These regions were identified from the hydrographic data distributions.

Results

Seasonal changes of the inorganic nitrogen in the three regions, as well as in the whole Northern Adriatic, were similar in quality. Those changes are characterized by a period of higher (fall and early winter) and lower (late winter to summer) concentrations. However, the mean concentrations were different, being higher in the region I, in comparison to the regions II and III, as shown in Table 1.

Region	NH ₄		NO ₂ ($\mu\text{g-at/l}$)		NO ₃	
	I-VII	VIII-XII	I-VII	VIII-XII	I-VII	VIII-XII
I	0.7	2.4	0.1	0.7	0.5	4.8
II	0.3	1.1	0.1	0.2	0.3	0.7
III	0.5	1.4	0.1	0.3	0.3	1.3

Individual concentrations, at some stations in the western region, were occasionally two orders of magnitude higher than in the other regions. That was related to unusual conditions as are Po river floods, or resuspension of sediments during a very heavy storm.

The ratio of the inorganic nitrogen forms also varied seasonally. Concentrations of ammonia, nitrite and nitrate in winter time were found to be of the same order of magnitude. In other seasons, especially in summer, the nitrite content was much lower than ammonia and nitrate. In fall the ammonia concentration was lower than the nitrate one. In spring and summer, the opposite ratio was observed.

Discussion

The inorganic nitrogen cycle of the Northern Adriatic is influenced by several factors, and characterized by a high variability in concentrations.

On this basis of the collected data, and the results from literature the rate of nitrogen input and loss was estimated, and compared with the observed changes in inorganic nitrogen for monthly intervals. Although some of the estimates are approximate, it is possible to conclude the following:

1. The biological cycle is mainly responsible for the observed seasonal changes in the nitrogen content of the Northern Adriatic. In fall and winter regenerative processes are predominant, but in spring and summer there are, alternatively, assimilation and zooplankton excretion.
2. In the region where the influence of the Po river nitrogen contribution, is significant, the rate of the process (assimilation, regeneration, excretion, water transport loss, sink in the sediment), which are controlling the nitrogen cycle, is increased, with respect to the rest of the studied area.
3. Significant quantity of nitrogen, which is not used for assimilation in fall and winter, is probably removed from the Northern Adriatic by water mass exchange.

The mechanisms which control the nitrogen cycle in the Northern Adriatic are not yet fully quantified. More investigations are needed, especially in the context of the studies related to the protection of the Northern Adriatic ecosystem, which is becoming an actual and pressing problem.

References

- Gilmartin, M., Kveder, S., Degobbis, D., Revelante, N. and Smodlaka, N., 1972 - Hydrographic data collected during approximately bi-weekly cruises in the Northern Adriatic. July-December 1972, *Thalassia Jugosl.* 8 : 149-213.

Degobbis, D. and Gilmartin, M.

"The nitrogen cycle in the Northern Adriatic"

Paper presented by D. Degobbis (Yugoslavia)

Discussion

A. Crusado: The NH_4/NO_3 ratio shows minimum values in the fall, just when runoff is largest. Is this caused by the NH_4/NO_3 ratio of the Po water?

D. Degobbis: The NH_4/NO_3 ratio of the Po waters is lower than the ratio is generally encountered in the Northern Adriatic. Since it has been shown that in fall the inorganic nitrogen contributed by remineralization is significantly higher than that contributed by river, the observed ratio is most probably due to fast ammonia oxidation and/or preferential ammonia uptake by phytoplankton.

A. Škrivanić: Have you observed differences in the processes of the nitrogen cycle when prevail longitudinals and when there are transversal current in the Adriatic?

D. Degobbis: The dispersion of inorganic nitrogen by currents could be an important factor affecting the intensity of the processes controlling the nitrogen cycle in the subregions of the Northern Adriatic. Examples of nitrogen distribution for spring and fall were shown. In spring the gradients are more

developed toward the Istrian coast. However, phytoplankton activity rather than current transport, is considered responsible for minimizing regional differences in nitrogen concentration as observed in spring and summer.

Ballester: Perhaps you can look at the data in order to know the vertical distribution of N-compounds and the salinity distribution.

Have you any information about the N/P ratio in the same area?

Degobbis: - The processes which control the vertical distribution of nutrients in the Northern Adriatic, the N/P ratio, and other relationships between nutrients and physico-chemical parameters (salinity, dissolved oxygen, etc.) are under study.