BENTHIC FLUXES OF NUTRIENTS IN THE MIDDLE AND SOUTHERN ADRIATIC SEA

G. Kuspilic[1]*, A. Baric[1], S. Matijevic[1] and M. Branica[2]

[1] Institute of Oceanography and Fisheries, Split, Croatia

[2] Institute "R. Boskovic", Center for Marine Research, Zagreb, Croatia. kuspe@izor.hr

Abstract

Benthic fluxes of nitrogen-, phosphorus- and silica salts were determined during the period June 1997 – October 2000 in the area of middle and south Adriatic Sea. The established fluxes (mmol m^{-2} day^{-1}) were in the range from 0.16 to 1.97 for silicate; -0.038 to 0.215 for phosphate and –1.50 to 2.88 for the sum of nitrate, nitrite and ammonia. Temporal and spatial flux variation showed increased values both in the coastal zone and during the warm period of year.

Keywords: Adriatic Sea, Benthic-Pelagic coupling, Geochemical cycles

Introduction

In the last decades benthic nutrient fluxes have been intensively studied in major oceans as well as in many coastal areas of the world. On a global scale continental slopes have been found to be the major deposition centres of organic matter and areas of intensive remineralisation (1), while in coastal areas the nutrient flux can be an important source of nutrients for primary production (2). The study of benthic nutrient fluxes in the Adriatic Sea has been limited so far to the northwestern part of the Adriatic (3).

Material and methods

Flux measurements were performed during June 1997 – October 2000 at 12 stations in the Adriatic Sea: 3 stations were located in eutrophic bays and estuaries (EB: 20-38 m), 5 in island channel waters (CW: 38-82 m), and 4 in the open sea area (OS: 100-1010 m). Sediment sampling (with overlying water) was performed by gravity corer (Plastic tube, i.d. = 6 cm, l = 100 cm) in triplicate, while bottom-layer seawater was sampled by a Niskin sampler. After the exchange of sediment overlying water with collected bottom water, sediment samples were incubated on board at the bottom layer temperature for 9-12 h. The development of concentration gradients above the sediment surface was prevented by water circulation using a peristaltic pump. Nutrient concentration changes during the incubation were determined by standard photometric methods using an AutoAnalyzer II (4).

Results and discussion

Obtained average nutrient fluxes (J) and related standard deviations (SD) for the investigated areas are given in Table 1. Total nitrogen (ΣN) in Table 1 denotes the sum of inorganic nitrate, nitrite and ammonia fluxes. From Table 1 it is obviously that the silicate and ΣN fluxes increase from the open sea area to the coastal zone, while the phosphate flux is approximately equal in all the areas studied. Comparing the values obtained with established fluxes in other regions, fluxes in the Adriatic are in the same order of magnitude or lower than elsewhere.

Table 1. Average nutrient fluxes in different areas of the Adriatic Sea.

Area	J ± SD (mmol m^{-2} day^{-1})		
	SiO_4^{4-}	PO_4^{3-}	ΣN
EBE	1.45±0.65	0.027±0.051	0.15±0.64
CW	1.02±0.53	0.030±0.054	0.22±0.70
OS	0.87±0.47	0.026±0.050	-0.09±0.59

Temporal changes in benthic fluxes were also evident in all areas, but the most prominent are in the EB area. By spliting a year into the warm period from May to October (WPY) and the cold period from November to April (CPY), the ratios of J_{CPY} : J_{WPY} for this area are 1 : 1.30 for silicate, 1 : 1.19 for phosphate and 1 : 2.64 for the ΣN - flux. The spatial and temporal variations of benthic flux can be explained by an existing trophic gradient from the open sea to the coastal zone (5) as well as by temporal fluctuations of particulate organic matter density in the water column.

Measurements of redox conditions in the sediments showed the strong influence of redox potential on the phosphate flux. Extreme situations were found at two coastal stations where the phosphate flux from sediments with positive Eh values was tenfold lower than the flux from sediments with negative redox potentials. This phenomena probably can be explained by the buffering properties of Fe (III) hydroxides in oxidized surface sediments (6). Beside an increase from the open sea to the coast (Table 1), the ΣN flux also showed a changing composition of nitrogen species (Fig. 1).

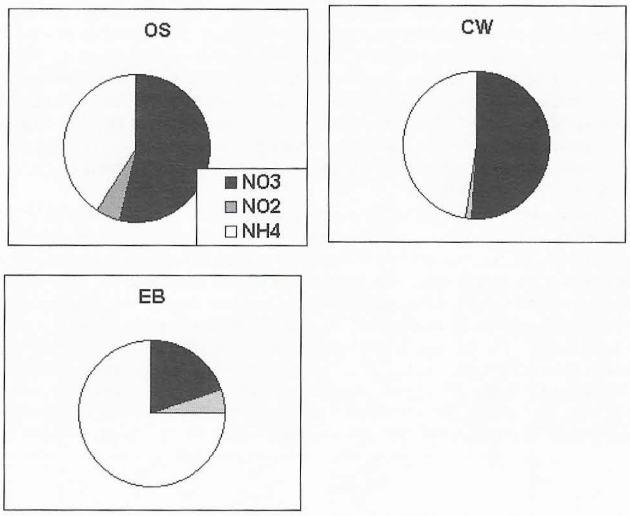

Figure 1. Partial nitrate, nitrite and ammonia flux in different areas of the Adriatic Sea during the warm period of year

In the open sea area (OS) the nitrate flux dominates in the ΣN-exchange throughout the year, while in the coastal zone (EB, CW) the ammonia flux is more important, especially during the warm period of year. As for the reason for nitrate dominated ΣN-exchange in the open sea area (100 – 1010 m), it is assumed that, due to reduced oxygen saturation in the bottom layer, nitrate in this area is an important electron – acceptor for the oxidation of organic matter in the sediment.

References

1. Walsh J.J., 1991. Importance of continental margins in the marine biogeochemical cycling of organic carbon and nitrogen. *Nature,* 350: 53-55.
2. Hopkinson C.S.Jr., 1987. Nutrient regeneration in shallow-water sediments of the estuarine plume region of the nearshore Georgia Bight, USA. *Mar. Biol.*, 94: 127-142.
3. Giordani P., Hammond D.E., Berelson W.M., Montari G., Poletti R., Milandri A., Frignani M., Langone L., Ravaioli M., Rovatti G. and Rabbi E., 1992. Benthic fluxes and nutrient budgets for sediments in the Northern Adriatic Sea: burial and recycling effencies. *In:* Vollenweider R.A., Marchetti R., and Viviani R. (eds.), Marine Coastal Eutrophication. Sci. Tot. Environ. Supplement, Elsevier, Amsterdam, pp.251-275.
4. Grasshoff K., 1976. Methods of Seawater Analysis. Verlag Chemie, Weinheim, 307 p.
5. Krstulovic N., Solic M. and Marasovic I., 1997. Relationship between bacteria, phytoplankton and heterotrophic nanoflagellates along the trophic gradient. *Helgoländer Meeresuntersuchs.*, 51: 433-443.
6. Sundby B., Gobeil C., Silverberg N. and Mucci A. 1992. The phosphorus cycle in coastal marine sediments. *Limnol. Oceanogr.* 37, 1129-1145.