

**Trace elements in *Mytilus galloprovincialis* Lmk
from Sozopol area (Bulgarian Black Sea Coast)**

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Introduction

During the period 1985-1987 trace elements (Cu, Zn, Cd, Pb, Hg) were determined in *Mytilus galloprovincialis* Lmk from Sozopol area. The study was carried out to determine the good sanitary condition of the experimental mussel culture and in accordance with a programme for biological monitoring. Modern high sensitive analytical methods were applied.

Materials and methods

The study included both cultivated (suspended culture) and bottom mussels from the same area. After preliminary processing (I) a definite quantity of the soft tissues was dried at 105°C. Then it was digested with HNO₃/H₂SO₄/HClO₄ or trace metals were extracted from the sulfate ash (heated at 500°C), in addition of HCl. The dilutions obtained were analysed through AAS - for Zn, Cu and Hg (cold vapour method) and anodic stripping voltammetry, ASV (2) - for Cu, Cd and Pb. Means of some determinations obtained are given in Table I.

Table I. Trace elements in *Mytilus galloprovincialis* Lmk, Sozopol area, 1985 - 1987

Date	Average concentrations /μg.g ⁻¹ dry weight/ Pb Cu Zn Cd Hg				
	1985/III	4.9	3.8	32.1	0.25
IV	2.9	4.3	40.3	0.17	0.017
V	2.8	1.5	35.7	0.38	0.017
X	2.6	2.6	42.0	0.22	0.018
1986/III	3.8	10.6	27.2	0.31	0.019
V	2.1	7.9	22.3	0.39	0.022
XI	2.1	8.4	12.8	-	0.020
1987/ I	2.4	1.3	22.2	0.65	0.019
IV	2.5	1.4	27.6	0.77	0.022
V	2.3	0.5	28.4	0.90	0.020
X	2.1	1.0	21.3	0.71	-

Results and discussion

AAS-determination of Cu- and Zn-concentrations in both dry ash and wet mineralized samples of *Mytilus galloprovincialis* Lmk showed good agreement with error of each determination within the method limitations. The ASV-method allows quantifying 0.1-10 ppm Cd, Pb and Cu in hydrobionts, with relative standard deviation of 8-10% (n=5).

The average values for trace elements in the cultivated mussels coincide with those for the bottom mussels. In spring (March and April) higher concentrations of Pb and Cu were determined related to the specific physiological condition and increased metabolism of mussels following the increase of sea water temperature.

Increased Cu-concentrations were determined in 1986, and Cd- in 1987, most probably due to further coastal pollution. Nevertheless the values obtained are less than those cited for similar studies along the Italian and French Mediterranean coast (3). Hg- concentrations are constant during the whole period of investigation and less than the standard Bulgarian sanitary requirements.

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ANTIMONY IN SEAWATER AND SEDIMENTS FROM SARONIKOS AND ELEFSIS GULFS, GREECE

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Antimony was determined in seawater and sediments from Saronikos and Elefsis Gulfs, Greece, by Instrumental Neutron Activation Analysis. In Saronikos Gulf, elevated concentrations of total, dissolved and particulate Sb in seawater and total Sb in the silt-clay fraction of sediment cores, were found near the Athens Sewage Outfall (ASO) and close to a Fertiliser Plant (FP) outside Piraeus Harbor if compared with those found from stations several miles offshore. In Elefsis Gulf, slightly increased levels of dissolved Sb in seawater and total Sb in sediment cores were observed. In general, at a distance of 3-5 km from the pollution sources, Sb concentrations reach those of the unpolluted pelagic waters and sediments. The predominant form of Sb in seawater is dissolved Sb (85-90% of total). The Sb vertical distribution in polluted sediment cores -very similar to that of arsenic- is evidence that redissolution and upward migration of these elements may take place in organic rich anoxic sediments.

INTRODUCTION

Antimony is one of the less studied trace elements in the Mediterranean although it is known to be solubilized from the sediments under reducing conditions and it has biological significance since it forms organometallic compounds. Saronikos and Elefsis Gulfs receive wastes from the most industrialised and heavily populated Greek regions. These wastes contain, among other pollutants, big quantities of heavy metals.

The objective of this study was to investigate the distribution of Sb in seawater and sediment cores in polluted and unpolluted areas of N. Saronikos and Elefsis Gulfs and to establish typical background values of this element in seawater and sediments of the specific marine environment.

MATERIALS AND METHODS

Sampling: Seawater samples were collected from 35 stations (Fig. 1) during March, July, October 1984, November 1986, and February 1987. Sediment cores were collected from 18 stations (Fig. 1). Details about sampling and pretreatment of samples prior to analysis are given elsewhere (Grimanis et al. 1985).
Methodology: Antimony was determined in all samples by Instrumental Neutron Activation Analysis (Grimanis et al. 1985).

RESULTS AND DISCUSSION

Seawater: Higher concentrations of antimony were found in the vicinity of ASO and FP (Tab.1). The Sb concentrations decreased with distance, reaching values that are comparable with those reported for clean coastal waters, at a distance of 3 km (Tab.1). Typical Sb concentrations for open Saronikos waters (results from the analysis of 70 samples) are: 0.29±0.11 μg/l for total, 0.26±0.10 μg/l for dissolved and 0.03±0.01 μg/l for particulate Sb. In the water Sb was found to remain constant or to decrease with depth in most cases. A slight increase in Sb levels was observed in Elefsis Gulf's waters (see Tab.1).

Sediments: Highest concentrations of Sb were found in sediments affected by the FP wastes (14-102 μg/g, 30-208 times higher than the background values). Elevated concentrations of Sb were found in the vicinity of ASO (6.6-32 μg/g, 15-65 times higher). At a distance of 3-5 km from the pollution sources, Sb concentrations reach values between 0.48-0.90 μg/g (average 0.73±0.12 μg/g), which seem to represent the inner Saronikos gulf's background values.

TABLE 1. Antimony concentrations (μg/l) in seawater. Numbers in parentheses indicate average values.

AREA	TOTAL	DISSOLVED	PARTICULATE	REFERENCE
ASO, FP	0.60-1.40 (1.0)	0.50-1.0 (0.75)	0.11-0.40 (0.25)	This work
Inner Saronikos	0.16-0.53 (0.29)	0.15-0.48 (0.26)	0.01-0.08 (0.03)	This work
Outer Saronikos	0.11-0.31 (0.23)	0.10-0.28 (0.21)	0.01-0.03 (0.02)	This work
Western Saronikos	0.15-0.44 (0.28)	0.14-0.40 (0.26)	0.01-0.03 (0.02)	This work
Elefsis Gulf	0.13-0.85 (0.37)	0.12-0.80 (0.35)	0.01-0.05 (0.02)	This work
Coastal Japan	0.16-0.60		0.01-0.03	Gohda (1975)
Saanich Inlet	0.11-0.16		negligible	Bertine & Lee (1983)
M. Adriatic	0.28-5.6			Grimanis et al. (1975)

For the open Saronikos Gulf the Sb levels were found to range from 0.30-0.60 μg/g (average 0.43±0.13 μg/g). Sb concentrations were slightly increased in sediments from the Elefsis gulf (0.53-0.96 μg/g, average 0.74±0.15 μg/g) if compared with the open Saronikos background values. In general, the antimony content of the offshore sediments was, in all cases, comparable with the values of 0.43-1.5 μg/g that have been reported for the open Aegean sea sediments (Angelidis, 1986). In contrast with other trace elements' distribution, Sb concentrations were found to increase with depth in the most polluted cores. The same distribution pattern was found only for arsenic in the same cores (Grimanis et al., 1984) and could be attributed to a redissolution and upward migration of these elements in these organic rich, anoxic sediments.

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FIGURE 1. Sampling stations.

