SEASONAL AND SPATIAL VARIATION OF CU, CR, NI AND PB CONCENTRATIONS IN *MYTILUS GALLOPROVINCIALIS* OF SARONIKOS GULF, GREECE

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Abstract

Accumulation of Cu, Cr, Ni and Pb by the mussel *Mytilus galloprovincialis* was studied seasonally at four stations in Saronikos gulf (Aegean sea, Greece). All metals showed a significant seasonal variation with the maximum mean values occurring in winter. The observed pattern was mainly related to the biological cycle of the mussels and only secondarily to environmental parameters. Concerning the spatial distribution of metal concentrations in mussels, higher values were detected at station 2 close to the central sewage outfall than those at station 4 located further away from the source of contamination.

Keywords: metals, bivalves, Aegean sea

Introduction

In marine ecosystems, heavy metals occur in the water mass, suspended particles, sediment and biota. The use of biological indicators to monitor environmental contamination by trace metals has many advantages over the measurement of metals in water or sediment samples, since their content of pollutants is proportional to the biologically available concentration of pollutants harmful to marine life and it represents a time integrated image of the bioavailability of a pollutant which is not affected by short term fluctuations in sea water (1). The common mussel, *Mytilus galloprovincialis*, is considered to be a sentinel organism in monitoring both acute and chronic environmental pollution (2). This work deals with Cu, Ni, Cr and Pb concentrations in mussels from Saronikos gulf (Aegean sea, Greece), and has been carried out within the framework of MED-POL Monitoring Programme.

Methodology

During 1995, samples of mussel (*Mytilus galloprovincialis*) of about 5 cm length were collected seasonally from four coastal locations by scuba diving (Fig. 1). Immediately after collection, the shell was cleaned and 6 pooled samples from each station were made from the soft parts of 6 to 12 individuals which had been carefully rinsed with abundant distilled water in order to eliminate sediment and other impurities.

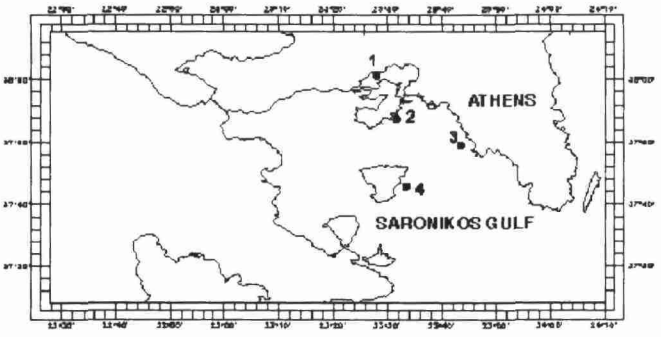

Fig. 1. Sampling stations in Saronikos Gulf.

The analysis of samples included lyophilisation, homogenisation and digestion with HNO_3 (proanalysis, MERCK) under pressure at 100°C for 12 hours. The determination of metals was performed by atomic absorption spectrophotometry with flame using a VARIAN SPECTR AA 20 Plus spectrophotometer. The quality control of the analytical methodology was carried out by analysing the reference material of BCR No 279 (*Ulva lactuca*). The data, after log transformation {log(x+1)}, were statistically treated by two-way ANOVA, in order to estimate if there are any differences among the sampling stations as well as between the different seasons (3).

Results

In total 90 samples of mussels were analysed. The mean concentrations of Cu, Cr, Ni and Pb, expressed in μg/g dry weight in the soft tissues of mussels, are summarized in Table 1. Mean values ranged from 2.62 to 15.94 for Cu, 0,80 to 27.57 for Cr, 1.61 to 12.14 for Ni and 2.09 to 11.02 for Pb. The highest concentrations for Cu and Cr were observed at station 2, for Ni at station 3 while Pb was maximum at station 1. It is important to mention that station 4 displayed the lowest concentrations for all metals.

Table 1. Mean metal concentrations in mussels from different areas of the Saronikos gulf during 1995 (in μg/g dry weight).

Station	Cu	Cr	Ni	Pb
1	7,99 ± 1.76	2,90(1.43	4,99 ± 1.09	6,14 ± 1.33
2	8,27 ± 2.37	9,32 ± 9.00	5,11 ± 2.00	5,95 ± 1.77
3	7,24 ± 3.60	3,83 ± 1.89	5,93 ± 3.81	5,90 ± 2.29
4	4,68 ± 1.57	2,55 ± 1.44	3,90 ± 1.20	4,69 ± 1.96

Seasonal mean concentrations (avg), standard deviation (sd), minimum (min) and maximum (max) values are presented in Table 2. Concerning the temporal variation in metal levels, we observe that it presents common patterns in the 4 localities where mussels were collected.

Table 2. Seasonal metal concentrations in *M. galloprovincialis* (μg/g dry weight) of Saronikos gulf (b: summer, c: autumn, d: winter).

		Cu				Cr			
Station	Season	avg	std	min	max	avg	std	min	max
	b	6,39	1,69	3,26	8,55	1,68	0,29	1,30	2,11
1	c	8,11	1,16	5,75	9,47	3,69	1,65	1,93	7,19
	d	9,47	0,58	8,55	10,15	3,32	1,02	2,07	5,28
	b	6,70	0,73	5,77	7,83	3,01	1,27	1,52	5,95
2	c	6,74	1,02	4,91	8,73	3,44	1,91	0,00	6,69
	d	11,38	0,93	10,22	13,13	21,51	3,84	17,73	27,57
	b	4,15	0,85	3,52	6,30	2,17	0,65	1,03	2,89
3	c	11,55	2,47	7,53	15,94	5,40	1,60	2,17	7,36
	d	6,95	0,84	5,92	7,87	4,81	1,12	2,92	5,73
	b	3,21	0,52	2,62	4,18	1,82	0,61	0,80	2,84
4	c	4,51	0,63	3,34	5,47	1,93	0,55	1,22	2,91
	d	6,88	0,57	6,15	7,78	4,37	1,48	3,01	7,20

		Ni				Pb			
Station	Season	avg	std	min	max	avg	std	min	max
	b	4,42	1,50	1,97	6,56	5,46	1,77	3,63	8,80
1	c	5,53	0,42	5,07	6,31	6,33	0,70	5,34	7,31
	d	5,02	0,71	4,10	6,15	6,62	1,00	4,33	7,76
	b	3,25	0,67	2,24	4,43	4,36	1,04	2,46	6,18
2	c	4,84	0,72	3,90	6,32	5,80	0,96	4,63	7,64
	d	7,23	1,73	5,54	11,49	7,70	1,34	4,85	9,68
	b	2,37	0,39	1,61	2,83	3,65	0,54	2,69	4,48
3	c	10,89	1,21	8,46	12,14	8,07	1,56	5,84	10,77
	d	5,61	0,50	5,10	12,14	7,14	0,86	5,77	8,10
	b	3,01	0,49	1,96	3,72	4,15	0,71	3,07	5,38
4	c	3,52	0,49	2,48	4,12	3,70	1,15	2,09	5,24
	d	5,52	0,80	4,36	6,58	6,74	2,41	2,81	11,02

Regarding the differences between stations and seasons, a statistically significant difference at the 95% level for the metal concentrations in mussels, for all stations and seasons, is apparent from the data in Table 3. Concerning the seasonal variation, an effect of the sampling season is recorded since mussels present higher values during the cold period of the year ($P < 0.05$). The variation in seasonal average concentration of metals in mussels from the four coastal areas of Saronikos gulf is presented in Figure 2.

Discussion

In this work the overall metal concentrations in mussels from Saronikos gulf are similar to those reported for other Mediterranean areas (4).