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HEAVY METAL CONCENTRATIONS IN WATER, SEDIMENTS AND FISH IN KAŠTELA BAY (SPLIT AREA)

SADRŽAJ TEŠKIH METALA U VODI, SEDIMENTU I ORGANIZMIMA KAŠTELANSKOG ZALJEVA

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Samples of water, sediment and fish *(Mullus barbatus)* collected in Kaštela Bay, which is in the central part of the Adriatic coast near the town of Split, were analysed for Zinc, Copper, Cadmium, Lead and Nickel by AAS. The values obtained showed no significant heavy metal pollution in the studied area, in comparison with values found for an open sea station (Stončica) and with literature values for trace metal concentrations in other parts of the world.

INTRODUCTION

Kaštela bay receives a considerable amouit of industrial, agricultural and natural runoff from the River Jadro and from the town of Split. The Bay is a very important part of the coast for tourism and is also a fishing ground for trawl, pelagic and reef fish.

Heavy metals are introduced into the marine environment via effluents and by river drainge, and may be concentrated by marine organisms have not previosly been determined in this area, although the concentrations of Zn, Cd, Pb, Cu in these waters were studied by M. Branica *et al.* (1978) and by J. Štirn *et al.* (1974) using an ASV method. Therefore since few data on the concentration of trace metals in Kaštela Bay are available, this survey was undertaken to initiate routine monitoring of heavy metals in the area. Trace metal concentrations were determined in water, sediment and fish samples.

MATERIALS AND METHODS

Nearshore samples of water and sediment were collected at the stations shown in Fig. 1. Fish samples were taken from catches near the town of Split and also at an open sea station (Stončica) near the island of Vis.

Water samples: seawater samples (10 1)were collected in PVC Nansen water bottles. The water for determination of Zn, Cd, Cu, Pb and Ni was filtered through 0.45 μm membrane filter immeditely afer sampling to minimize pos-

sible adsorption of the metals onto the containers. Each sample was then passed through a glass column containing ion-exchange resin (Chelex-100) and treated according to the method outlined by Riley and Taylor (1972). The resulting solutions were then analysed by AAS (Varian 1250 A).

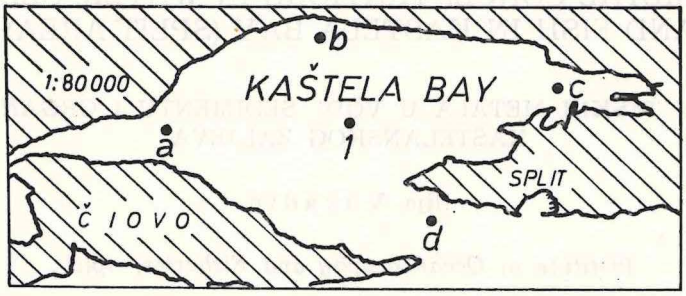

Fig. 1. Sampling location (.) in Kaštela Bay waters and sediments

Analysis of the filters showed that only small quantities of trace metals were adsorbed. The blanks were determined on stripped seawater i. e. seawater which had been passed through the Chelex-100 resin. The values of the blanks were below the limit of detection. The measured trace metal concentrations are presented in Table I.

Sediments: Samples of sediment were collected either with a grab or with a corer. Each sample was oven-dried at 110°C for 24 hours, and ground in a mortar. Zn, Cd, Pb, Cu, Ni and Fe were determined using the combined acid--reducing technique of Chester and Hughes (1971). Concentrations were measured by AAS.

Fish: Samples of homogenised fish tissue were oven-dried at 110°C for 24 h. The dry material was weighed in a Teflon vessel and digested with concentrated HNO_3 at 130°C. The dry residue was diluted to 25 ml with 0.1 M HNO_3 and analysed by AAS.

All analyses of sediment and fish were carried out at least in duplicate. Blanks and standards were prepared using the same procedure as that for the samples. The measured trace metal concentrations are shown in Tables II and III.

RESULTS AND DISCUSSION

Water: The preliminary results presented here are simlar to previous results in Adriatic waters, except for Pb where the concentrations were found to be an order of magnitude higher than those previosly reported. The data show that only slight variations occur in these waters, most of the values being close to the overall mean given in Table I.

The higest values for Zn (17.32 ppb), Cu (3.83 ppb), Cd (0.33 ppb), Pb (0.109 ppb) and Ni (1.42 ppb) in Kaštela Bay were found either in surface samples or in samples from 35 m depth. There hight concentrations of trace elements

Table I. Trace metal concentrations in water of Kaštela Bay (ppb)

Station	Depth	Zn	Cu	Cd	Pb	Ni
Kaštela	0	6.64	3.83	0.54	0.027	1.42
Bay	20	7.13	—			
IX 77	35	17.32	1.79		0.013	0.87
	0	9.29	2.36	0.16	0.115	0.80
III 78	20	—	2.19	0.33	0.109	0.95
	35	6.82	1.14	0.30	0.084	1.05
Open sea	0	8.89		0.13	0.020	
(I. Vis)	50	—		—	0.021	
	100	8.75		0.29	0.018	
Mean $\bar{x}$		9.27	2.26	0.29	0.050	1.02
Standard deviations		3.71	0.99	0.15	0.04	0.24
% Coefficient of variation		40	41	50	88	24
Standard error		1.51	0.50	0.07	0.02	0.12
Adriatic Sea Brancia M. (1978), Štirn *et al.* (1977)		9,4	0,9	0.07	0.02	0.12
Metierranean Roth I. and H. Horung (1977)		1.0—256	0.1—38.3	06—2.9	2.1—11.4	2.0—5.4
nglish coast Abdullah *et al.* (1971)		1.8—11.8	0.3—1.5	01—0.18	0.02—0.36	

could be attributed to elevated trace metal concentrations in industrial effluent and sewage from Split.

Sediments: The heavy metal concentrations in the sediments are presented in Table II. A comparison of these results with data from other authors shows that the concentrations of Zn and Pb are considerably higher. The presence of high levels of these elements in near-shore sediments may be an early stage in the accumulation of these elements, which could therefore increase if pollution continues. The highest values for Zn (111.2 ppm), Cu (1.23 ppm), Pb (19.5 ppm), Ni (13.12 ppm) were found at station No. 1 in the middle of Kaštela Bay. The presence of high concentrations could be explained by the proximity of domestic and industrial sewage outfalls.

Fish: The concentrations of five heavy metals (Zn, Cu, Cd, and Pb) in the edible muscle tissue of *Mullus barbatus* are summarised in Table III.

Althoughe there are few data available for marine organisms, similar values may be found in the literature. The values found for Zn in Kaštela Bay are somewhat higher than for organisms collected at the open sea station. Unfortunately we have no open-sea data in Table III for the other trace metals. The values found here do not exceed the tolerance levels for human consumption recommended by WHO (The World Health Organistion).

Table II. The concentrations of heavy metals (ppm dry weight) in sediments

Station		Zn	Cu	Cd	Pb	Ni
	1	111.2 49.5	1.23	0.58	—	3.12
Kaštela Bay	1a	114.5	1.14	0.64	19.5	2.24
	1b	41.2	1.06	—	25.4	—
	1c	31.9	0.84	—	18.2	1.38
	1d	47.9	1.22	—	9.11	
	S—1	17.7 8.10	1.23	0.64	—	—
	S—3	14.3 49.5	1.22	0.59	11.7	—
Open sea		22.2 15.3	0.48	—	19.0	3.0
Mean $\bar{x}$		43.6	1.13	0.61	16.8	2.25
Standard deviation s		35.5	0.14	0.03	6.50	0.87
% Coefficient of variation		76	12	5	39	39
Standard error		16.2	0.46	0.35	8.44	0.62
Mediterranean Roth I. and H. Horung (1977)		2.1—18.2	0.3—2.9	0.3—2.2	3.9—19.7	2.3—9.3
English coast Portman J. E. (1972)		17.2—42.0	2.4—7.6	0.2—0.7	21.3—65.7	4.2—15.0
Atiantic Ocean Riley, J. P. and Taylor (1972)		—	—	—	16.0—35.0	55

Table III Trace element in ppm dry weight in fich *(Mullus barbatus)*

Station	Zn	Cu	Cd	Pb
Kaštela	71.3			
Bay	17.7		0.64	
III 78	13.2			
Split	28.91	1.78	0.25	0.13
Area	25.05	3.22	0.28	0.29
III 78				
Open sea	9.5			
III 78	20.6			
Mean $\bar{x}$	26.62	2.50	0.39	0.21
Standard deviation (s)	20.79	1.02	2.22	0.10
% Coefficient of variation	78	41	56	47
Standard error	8.49	1.02	0.16	0.10
Mediterranean Roth, I. and Horung, H (1977)	18.4	5.3	0.5	2.3
England* Portman J. E. (1972)	4.4—6.6	0.5—1.8	0.05—0.16	0.5—1.0
N. Atlantic Windom H. *et al.* (1973)	8.0—20 0	1.5—3.2	0.1—2.1	

* Wet weight

CONCLUSION AND RECOMMENDATIONS

From a comparison between the data presented in this paper with the data found in the literature, we can conclude that the area (Kaštela Bay) is still relatively unpolluted. It is recommended that the monitoring of heavy metal concentrations be continued in order to improve our undersanding of their cycling in the marine environment.

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KRATAK SADRŽAJ

Uzorci vode, sedimenata i organizama sakupljeni su u Kaštelanskom zaljevu, srednji Jadran, koji se nalazi blizu grada Splita.

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