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CADMIUM, LEAD, COPPER AND ZINC CONCENTRATIONS IN *MESIDOTEA ENTOMON* IN THE GULF OF FINLAND (SOUTHERN COAST)

Introduction

In the evaluation of the pollution level of marine environment an important role is played by the investigation of sea organisms in relation to harmful substances (trace metals included). The organisms may concentrate metals directly from water, particulate matter, sediments or indirectly via food. Therefore, it has been suggested that several ecologically different species should be used in the investigation in order to assess the contamination level.

Isopod *Mesidotea entomon*, due to its wide distribution, representative part in the macrobenthic communities and long life period (about 8—9 years) is proposed as an indicator of trace metals and is included into the Baltic Monitoring Program. Besides, it serves as an important food item for many commercially used fishes (cod, flounder, eel).

The present study estimates the trace metals (cadmium, lead, copper and zinc) content in *M. entomon* sampled at the southern coast of the Gulf of Finland and attempts to reveal any areal, seasonal or size differences in metals uptake.

Material and methods

The samples were taken on board the r/v "Arnold Veimer" in May, July and August 1988 in three areas situated near the Bays of Kunda, Käsmu and Kakumäe. The positions and some hydrographical conditions of the sampling sites are shown in Table 1.

Table 1

The locations and hydrographical conditions of sampling sites

Site	Date	Station	Depth, m	Salinity, ‰	Temperature, °C
Kunda	May	K1	55	7.3	1.8
59°34′5″	July	K10	30	6.3	1.8
26°25′6″	August	K14	55	6.2	2.0
Käsmu	May	K4	55	7.2	1.6
59°39′4″	July	K8	35	6.7	10.5
25°55′6″	August	K16	41	6.2	5.6
Kakumäe	May	K5	30	6.7	2.0
59°28′3″	July	K11	30	7.1	2.2
24°3′7″	August	K17	25	6.1	16.0

Table 2

Concentrations of Cd, Pb, Cu and Zn (μg/g dry matter) in *Mesidotea entomon* from the different sampling sites

Site	Size, mm		Cd	Pb	Cu	Zn
Kunda						
K1	10—20	AVG	0.92	1.45	21	74
		SD	0.05	0.12	8	4
	20—30	AVG	1.24	1.34	89	86
		SD	0.07	0.05	1	1
	30—40	AVG	1.34	1.44	98	92
		SD	0.10	0.20	11	3
	40—50	AVG	1.34	1.53	113	99
		SD	0.05	0.14	10	1
	>50	AVG	1.14	1.58	122	120
		SD	0.28	0.09	8	9
K10	10—20	AVG	0.87	2.34	63	98
		SD	0.05	0.22	2	1
	20—30	AVG	1.14	3.38	75	106
		SD	0.06	0.41	7	6
	30—40	AVG	1.66	2.41	85	108
		SD	0.01	0.15	6	3
	40—50	AVG	1.63	2.63	117	124
		SD	0.05	0.08	11	2
	>50	AVG	1.28	2.50	100	131
		SD	0.03	0.06	10	4
K14	>50	AVG	0.88	4.06	113	175
		SD	0.03	0.20	5	3
Käsmu						
K4	30—40	AVG	0.60	2.07	72	87
		SD	0.03	0.25	7	4
	40—50	AVG	0.44	1.63	100	103
		SD	0.04	0.04	15	7
K8	10—20	AVG	0.95	1.81	95	84
		SD	0.01	0.31	13	3
	20—30	AVG	1.07	2.29	104	88
		SD	0.03	0.07	15	5
	30—40	AVG	1.17	1.73	122	102
		SD	0.05	0.14	8	5
	40—50	AVG	1.30	1.82	159	116
		SD	0.10	0.05	6	4
	>50	AVG	0.96	1.32	206	144
		SD	0.07	0.29	5	2
K16	30—40	AVG	1.59	1.03	143	83
		SD	0.05	0.19	5	1
	40—50	AVG	0.90	1.02	157	122
		SD	0.06	0.17	6	1
Kakumäe						
K5	10—20	AVG	0.91	3.46	76	100
		SD	0.01	0.26	1	0
	20—30	AVG	1.03	3.65	94	125
		SD	0.08	0.17	13	35
	30—40	AVG	1.11	2.13	111	178
		SD	0.10	0.19	10	5
	40—50	AVG	1.18	2.15	96	215
		SD	0.09	0.06	14	3
	>50	AVG	1.28	2.17	104	215
		SD	0.05	0.10	10	3
K11	10—20	AVG	1.08	1.76	100	85
		SD	0.10	0.23	1	2
	20—30	AVG	1.32	1.35	114	89
		SD	0.03	0.25	24	4
	30—40	AVG	1.32	1.45	133	93
		SD	0.04	0.11	3	1
	40—50	AVG	1.39	1.48	141	97
		SD	0.08	0.06	18	1
K17	30—40	AVG	0.87	1.61	108	80
		SD	0.00	0.16	9	3

The organisms were sampled with a Van Veen grab and dredge. They were kept in surface water to remove gut content and other foreign matter. After that they were deep-frozen in plastic bags. Prior to the analysis the specimens were measured, sorted out into 5 size groups (10—20; 20—30; 30—40; 40—50 and >50 mm), dried at 105°C, homogenized in an agate mortar. Aliquots of samples were digested by concentrated nitric acid (suprapure). Whenever possible, four parallel samples were prepared and analyzed for each size class. The analyses were carried out by means of atomic absorption (AAS-5000, Perkin-Elmer). For Cd, Pb and Cu determination flameless technique with the Zeeman background correction was used (HGA — 500). Zn was determined by flame mode (standard burner head, air-acetylene flame). The results are expressed in μg/g dry matter.

Results

The average concentrations of Cd, Pb, Cu and Zn in *M. entomon* are presented in Table 2.

When comparing the content of trace metals in different size classes of *M. entomon* only data from stations K10, K8, K5, K1 and K11 were used, as the specimens collected there represented all size classes.

Positive correlation between Cu, Zn, Cd content and size of the organisms was found ($r=0.575$; $r=0.565$; $r=0.420$, respectively, $P=0.01$). The mean concentration of Cd increased up to maximum in 40—50 mm specimens and decreased for the largest specimens. A somewhat higher Pb content was registered in smaller individuals (Fig. 1). However, no significant correlation between the Pb content and specimens size could be observed.

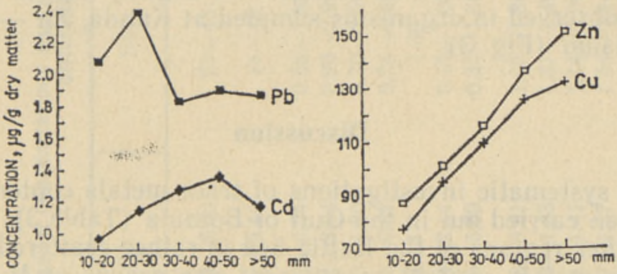

Fig. 1. Trace metal concentrations in different size groups of Mesidotea entomon.

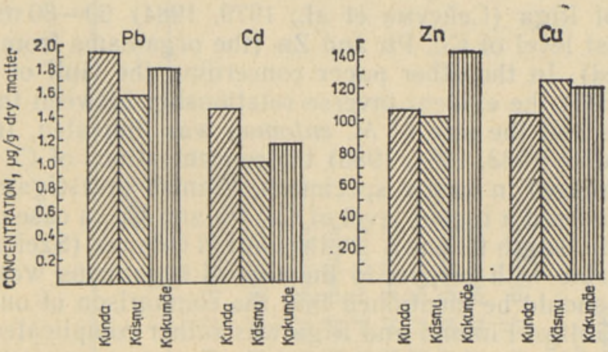

Fig. 2. Trace metals in *Mesidotena entomon* sampled at different time.

Investigations of seasonal and areal trends in trace metals accumulation by *M. entomon* were carried out on middle-sized specimens (30—50 mm) as they were sampled practically at all the stations (except for K14). The Cu mean concentration tended to increase from May to August, whereas Zn at the same time showed a slight decrease (Fig. 2). But only the lower Cu content in May and Zn — in August were statistically significant (by means of Student *t*-test). Somewhat higher Pb and Cd concentrations were detected in July (Fig. 2). However, only in case of Cd it was statistically significant.

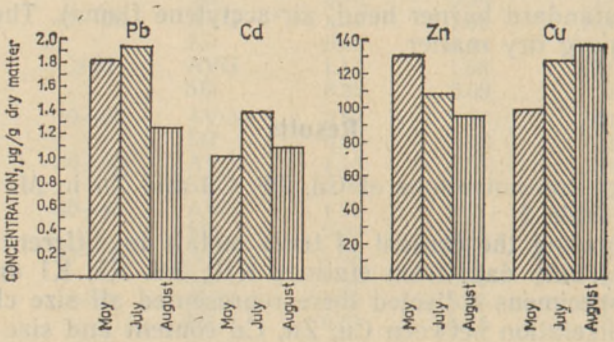

Fig. 3. Trace metal concentrations in *Mesidotea entomon* sampled in different areas.

No explicit differences in the trace metals content in *M. entomon* sampled in different areas were revealed. A slightly higher content of Pb and Cd was observed in organisms sampled at Kunda, Zn — at Kakumäe, Cu — at Käsmu (Fig. 3).

Discussion

The most systematic investigations of trace metals content in *M. entomon* have been carried out in the Gulf of Bothnia (Table 3). The information about other regions of the Baltic Sea is rather scattered.

The trace metals content in different size groups of *M. entomon* has been examined in all relevant works (Tervo et al., 1980; Sandler, 1983, 1984; Сейсума et al., 1979, 1984; Szefer, 1986). The variation of metals content with size of the organisms has been mentioned in all the papers. In the Gulf of Riga (Сейсума et al., 1979, 1984) 60—80 mm specimens had the highest level of Cd, Pb and Zn (the organisms from 40 to 90 mm were examined). In the other paper concerning the Gulf of Riga (Куликова et al., 1985) the evident inverse relationship between the Zn, Pb, Cd concentrations and the size of *M. entomon* was indicated. In the Gulf of Bothnia (Sandler, 1983, 1984, 1986) the concentrations of Cd and Cu were somewhat increased in larger specimens. Finnish investigators (Tervo et al., 1980) registered a higher level of Cd, Pb and Cu in case of one largest specimen (body length 92 mm). In the Gulf of Gdansk (Szefer et al., 1986) the most variable with respect to the size of organisms was the Zn concentration. It should be mentioned that the comparison of our results and those for the Gulf of Finland and Riga was rather complicated: the studies in the latter regions were carried out on larger organisms than ours, especially in the Gulf of Riga. It is known that male *M. entomon* are

Table 3

Trace metal concentrations (μg/g dry matter) in *Mesidotea entomon* from different Baltic Sea areas

Area	Cd	Pb	Cu	Zn	References
Gulf of Gdansk	0.22—0.60	23—45	9—26	26—95	Szefer, 1986
Gulf of Riga	1.32—5.44	14—48	110—170	68—167	Сейсума et al., 1984
Gulf of Bothnia	1.42—4.54	0.68—7.89	79—261	68—120	Voipio et al., 1977
Gulf of Bothnia	0.91—3.04	0.90—2.96	122—240	69—114	Voipio et al., 1977
Gulf of Bothnia	1.30—1.80	0.70—2.50	65—206	108—154	Häkkilä, 1980
Gulf of Bothnia	0.66—0.81	0.74—0.82	164—174	70—93	Tervo et al., 1983
Gulf of Bothnia	1.15	1.36	258	62	Tervo et al., 1983
Gulf of Bothnia	0.14—2.41	0.15—1.05	75—293	38—96	Sandler, 1983
Gulf of Bothnia	0.16—0.69	0.31—1.66	86—178	61—93	Sandler, 1986
Gulf of Finland	0.88—0.91	1.05—1.86	121—126	73—131	Voipio et al., 1977
Kunda	1.29—1.63	1.37—2.49	86—120	92—120	Present study
Käsmu	0.61—1.41	1.14—2.00	91—159	88—116	Present study
Kakumäe	0.97—1.37	1.44—2.14	98—142	86—200	Present study

larger than the female ones (Haahtela, 1962). So the differences in trace metal concentrations in shorter and larger specimens might also be due to sexual differences. Evidently, in future studies on trace metals in *M. entomon* sexual differences should also be taken into account.

Besides, the investigation of trace metals content in *M. entomon* is directly connected with moult process scrutiny. First of all the moult process is caused by the growth of organisms, whereas the younger specimens moult more often than the older ones due to their intensive growth and metabolism processes (Haahtela, 1962). The moult is also influenced by the environmental conditions. Considering also that some metals (e. g. Cd and Pb) accumulate mainly in exoskeleton, and redistribute between exoskeleton and other tissues before moult, as it occurs for Ca (Кусакин, 1979), our lower values obtained for small organisms could partially be explained by moult.

In such case we could propose that the smallest *M. entomon* specimens (10—20 mm) are not suitable for the investigation of trace metals and for environmental monitoring purposes because of the difficulties in data interpretation.

The trace metal concentrations in *M. entomon* collected in different Baltic Sea areas are, in general, of the similar level and show small variability (Table 3). Some investigators explain this situation by the regulating ability of organisms. It is assumed that decapod crustaceans are able to control the uptake of some elements, e. g. Cu and Zn (Bryan, 1967, Sandler, 1984). It might be supposed that some other elements uptake could also be regulated up to some level. However, the problem what are these elements and to what extent can organisms control their uptake needs more detailed investigation.

In future studies special attention should be paid to the following problems:

— trace metals accumulation into the exoskeleton of *M. entomon*;
— elements redistribution between exoskeleton and other tissues before moult;
— effect of high concentrations of metals in the environment on the ability of *M. entomon* to regulate metals uptake.

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Cd, Pb, Cu, Zn SISALDUS SOOME LAHE LÕUNARANNIKU *MESIDOTEA ENTOMON*'IS

On määratud raskmetallide (kaadium, plii, vask, tsink) sisaldus *Mesidotea entomon*'i erineva suurusega isendeis Soome lahe lõunaranniku lähedal.

On leitud, et suuremais *M. entomon*'i isendeis on vaske, tsinki ja kaadiumi rohkem kui väiksemais isendeis. Statistiliselt usaldusväärne on vähene vase sisaldus mais kogutud proovides ja tsingi sisaldus augustis kogutud proovides.

Keskkonna seisundi hindamisel raskmetallide suhtes ei sobi ilmselt väiksemad *M. entomon*'i isendid (10—20 mm), sest sagedaste kestumiste tõttu on raskendatud tulemuste interpreteerimine. Edaspidi tuleb pöörata tähelepanu raskmetallide kogunemisele eeskätt eksoskeletti, nende ümberjaotumisele eri kudede vahel enne kestumist, aga samuti biokontsentreerimisele suhteliselt suure raskmetallide sisalduse korral keskkonnas.

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СОДЕРЖАНИЕ Cd, Pb, Cu, Zn В *MESIDOTEA ENTOMON*, ОТОБРАННЫХ В РАЙОНЕ ЮЖНОГО ПОБЕРЕЖЬЯ ФИНСКОГО ЗАЛИВА

Определялось содержание тяжелых металлов (кадмия, свинца, меди и цинка) в различных размерных группах *Mesidotea entomon*, отобранных в районе южного побережья Финского залива весной и летом 1988 года.

Было обнаружено, что содержание Cu, Zn, Cd в крупных особях *Mesidotea entomon* выше, чем в мелких. Получено статистически достоверное низкое содержание меди в пробах, отобранных в мае, и цинка в пробах, отобранных в августе.

Использование мелких особей *Mesidotea entomon* (10—20 мм) для наблюдения за содержанием тяжелых металлов и для целей мониторинга состояния окружающей среды в отношении тяжелых металлов, по-видимому, нецелесообразно из-за перераспределения металлов между различными тканями, вызванного частыми линьками. Интерпретация результатов в этом случае сильно усложняется.

В дальнейших исследованиях следует обратить внимание на следующие проблемы: накопление металлов в экзоскелет *Mesidotea entomon*; перераспределение металлов между различными тканями перед линькой; влияние высоких концентраций металлов в среде на способность *Mesidotea entomon* регулировать процесс поступления металлов в организм.