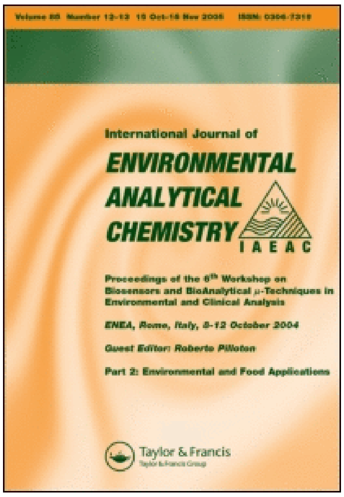

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THE CONCENTRATIONS OF Pb, Cd, Cu, Zn, AND V IN *ADAMUSSIUM COLBECKI* FROM TERRA NOVA BAY (ANTARCTICA)

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Trace element (Pb, Cd, Cu, Zn, and V) concentrations have been measured in 25 samples of *Adamussium colbecki* collected in Terra Nova Bay, Ross Sea, Antarctica. The mean concentration for lead is 0.64±0.77 µg/g dry weight, for cadmium 28.5±6.9 µg/g d.w., for copper 6.5±4.5 µg/g d.w., for zinc 88±14 µg/g d.w., and for vanadium 1.0±0.3 µg/g d.w. Results obtained are consistent with data reported in the literature for the same species, with the exception of the lead which showed, for most samples, lower concentration. The samples analysed were collected in five different years, but no significant temporal trends are evident for the elements considered.

Keywords: Antarctica; bivalves; trace elements

INTRODUCTION

Bivalve molluscs have frequently been used as bioindicators to monitor trace elements in the coastal environment because they are filtering organisms with a limited mobility. The accumulation of trace elements by bivalves is greatly affected by a series of environmental (e.g. metal concentration in water and/or sediments, salinity, temperature,...) and biological (e.g. metabolism) parameters, rendering any comparison between different species meaningless. Nevertheless, differences in trace element concentrations from site to site or from time to time at a given site for a given species may give a good indication of the relative levels in the environment. This sentinel organism approach is derived from the "Mussel Watch" program, which started in the U.S.A. in 1976 using common mussel and

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various oyster species to evaluate chemical contamination because marine bivalves are widely geographically distributed, they are sedentary organisms, they may concentrate many chemicals and especially their bio-available forms[1].

Adamussium colbecki (Smith, 1907), known as Antarctic scallop, is a filter feeding bivalve, living on soft or mixed bottoms, tipically between 4 and 805 meters depth. It is very common and widely distributed around the Antarctica. It is able to swim by clapping its valves showing a relative mobility[2]. The shell, reddish-purple to brown, is thin and fragile and reaches 8.5–9 cm of length. Studies on the growth rate for *Adamussium colbecki* indicate that a shell length of 7 cm stand for a 6–7 years old organism[3] and a shell length of 8 cm for about 12 years[4].

In the past years, samples of *Adamussium colbecki* have been collected and analysed for total mercury, organic mercury and selenium[5,6]. Part of the samples were stored for future studies. In this work the elements lead, cadmium, copper, zinc, and vanadium have been considered, because scarce data[7,8] are available in the literature for bivalve samples collected in remote areas, and in order to obtain baseline trace elements concentrations for the area interested by the Italian Base in Antarctica.

MATERIALS AND METHODS

All samples of *Adamussium colbecki* were collected near the Italian Base in Antarctica (74°42′S, 164°07′E, Terra Nova Bay, Ross Sea), in the framework of the Italian National Programme for Researches in Antarctica (PNRA) during the austral summers: 1988–89, 1989–90, 1990–91, 1991–92 and 1993–94. The samples were shipped to Italy stored at −25°C in polyethylene bags. After recording the biological parameters (length of the shell, weight of the soft parts, and sex), the soft parts of each individual were freeze-dried and homogenised. By weighing the samples before and after freeze-drying, the fresh weight/dry weight ratio was calculated.

All analyses were carried out with spectrometric methods (atomic absorption and atomic emission) after decomposition of the samples with nitric acid. The mineralisation of the biological tissue (0.2 – 0.3g dry weight) was carried out with 5mL of 65%(m/m) nitric acid (Suprapur, Merck) in closed Teflon PFA vessel heated in a microwaves oven (mod. MDS 2000, CEM). After cooling the solution was transferred into 25mL volumetric flask and brought to volume with ultra pure water (Specific Resistivity >18 Mohm·cm, Elgastat UHQ, Elga). All the operations were carried out in a Class 100 laminar flood hood (Gelair, HF 48) in order to avoid any contamination from the atmosphere of the laboratory. All the glassware used was washed with 1–2 M nitric acid and rinsed with ultra pure water.

Lead concentrations were determined by graphite furnace atomic absorption spectrometry (GFAAS) using a Perkin-Elmer 1100B spectrometer equipped with a Perkin-Elemr HGA-500 graphite furnace and a Perkin-Elmer AS-1 autosampler. Graphite furnace equipped with L'vov platforms and a matrix modifier containing phosphate and magnesium[9] were used for all determinations. Calibration was carried out by addition of the standards to the matrix solution. The detection limit (3σ) of the method for lead was 0.03 μg/g dry weight. All the other elements considered (Cd, Cu, Zn, V) were measured by atomic emission spectrometry with an inductively coupled plasma torch (ICP-AES), using a Jobin-Yvon J.Y. 24 equipped with a Type C Meinhard concentric pneumatic nebulizer. Calibration was done with standard solutions. Detection limits (3σ) of the method found for cadmium, copper, zinc and vanadium were 0.9, 0.2, 2 and 0.2 μg/g dry weight respectively. A quality control program was carried out by means of: (i) blank analysis in order to detect any possible contamination, (ii) analysis of an appropriate Certified Reference Material (CRM), and (iii) by repeating all the analyses twice. The CRM was a lobster hepatopancreas homogenate (TORT-2) from the Institute for Environmental Chemistry, National Research Council of Canada (Ottawa, Canada). A good agreement between the concentrations found and the certified data was observed (Table I).

TABLE I Quality control. Results obtained (6 replicates) on the Certified Reference Material: TORT-2 Lobster Hepatopancreas, Institute for Environmental Chemistry, National Research Council of Canada, Ottawa, Canada. Concentrations are given in μg/g dry weight (d.w.). Mean values are reported together with the confidence interval at p=0.05

	Pb μg/g d.w.	*Cd μg/g d.w.*	*Zn μg/g d.w.*	*Cu μg/g d.w.*	*V μg/g d.w.*
Certified	0.35 ± 0.13	26.7 ± 0.6	180 ± 6	106 ± 10	1.64 ± 0.19
Found	0.41 ± 0.04	27.0 ± 1.6	183 ± 5	103 ± 10	1.7 ± 0.2

RESULTS AND DISCUSSION

Five specimens of *Adamussium colbecki* were analysed for each of the years considered, choosing samples with shell lengths between 67 and 82mm (soft part's weight between 12.4 and 31.8g) so as to make comparison possible even for elements which exhibit bioaccumulation. The results obtained for the 25 specimens analysed are reported in Table II. For each sample the concentrations of lead, cadmium, zinc, copper, and vanadium are given in µg/g dry weight, together with the biological parameters (length, weight, and sex), and the year of sampling. The fresh weight/dry weight ratio (FW/DW) is also indicated in order to enable the report of concentrations on a fresh weight basis. Data reported for the concentrations in Table II are mean values of two determinations. The concentrations of mercury (total and organic) and selenium in *Adamussium colbecki* from Terra Nova Bay have already been published[5,6].

TABLE II Results obtained on *Adamussium colbecki* samples. collected at Terra Nova Bay. near the Italian Antactic Base (Ross Sea. Antarctica). All concentrations are expressed in µg/g dry weight (d.w.) and are the mean of two determinations. The length reported is the distance (mm) between the ventral margin of the shell and the umbo; the weight is the soft part's weight (g). The fresh weight/dry weight ratio (FW/DW) is also reported

Sample	*Year*	*Length* *mm*	*Weight* *g*	*Sex*	*FW/DW*	*Pb* *µg/g*	*Cd* *µg/g*	*Zn* *µg/g*	*Cu* *µg/g*	*V* *µg/g*
AC22	1988–89	78.0	13.6	M	5.53	0.36	22.5	71	4.6	1.2
AC32	1988–89	70.0	15.6	M	5,19	0.18	29.3	117	2.8	0.7
AC37	1988–89	72.0	12.8	F	5,31	0.40	25.3	80	3.9	1.3
AC41	1988–89	75.0	16.9	F	5,05	0.16	28.0	73	3.6	0.8
AC43	1988–89	79.0	15.0	F	5,15	0.27	30.4	69	3.2	0.9
AC1/10	1989–90	69.0	12.4	F	5,99	1.14	39.5	102	14.4	0.5
AC1/11	1989–90	73.0	14.5	?	5,62	1.39	23.2	85	12.2	0.7
AC1/12	1989–90	76.0	14.7	F	6,87	2.63	31.9	84	19.6	0.8
AC1/16	1989–90	82.0	17.0	F	6,57	3.18	19.4	95	14.5	1.2
AC1/18	1989–90	67.0	17.8	?	5,19	1.34	18.0	79	14.2	0.1
AC45	1990–91	74.0	27.4	M	6,09	0.76	29.2	89	4.4	1.4
AC51	1990–91	80.0	31.7	F	6,55	0.28	28.7	86	4.5	1.0
AC53	1990–91	72.0	24.3	F	6,63	0.34	21.8	91	4.6	0.9
AC55	1990–91	70.0	31.8	M	6,62	0.22	22.6	84	5.3	1.3
AC59	1990–91	77.0	23.9	F	6,31	0.46	26.2	101	6.0	1.4
AC84	1991–92	79.0	24.8	F	6,70	0.34	23.2	95	3.4	0.9
AC87	1991–92	75.0	18.9	F	6,95	0.33	22.6	110	5.6	1.2
AC88	1991–92	79.0	18.9	F	7,20	0.45	27.5	88	3.4	1.2
AC90	1991–92	74.0	19.6	M	6,34	0.32	21.8	107	4.2	1.1
AC97	1991–92	72.0	19.1	?	6,74	0.32	36.6	71	5.6	1.4
AC101	1993–94	72.0	23.2	F	5,70	0.14	36.9	99	4.6	0.9
AC102	1993–94	74.0	24.1	M	5,92	0.30	33.6	71	4.6	1.0
AC105	1993–94	71.0	17.2	?	5,98	0.27	44.7	99	5.8	1.2
AC114	1993–94	79.0	29.5	M	6,28	0.28	30.3	67	3.8	1.7
AC115	1993–94	76.0	31.5	F	5,95	0.16	39.3	96	4.4	1.2

For all elements considered no temporal trend is observed. This is clearly shown in Figure 1, where the mean concentrations measured are plotted against the sampling year. However the number of samples and the period of time considered are too small to establish a solid conclusion, and data reported are to be considered as baseline data for future researches. Actually the Italian Base in Terra Nova Bay started operation during the 1985–86 austral summer, and the data reported can be considered as representing the early stage of human activity in the area.

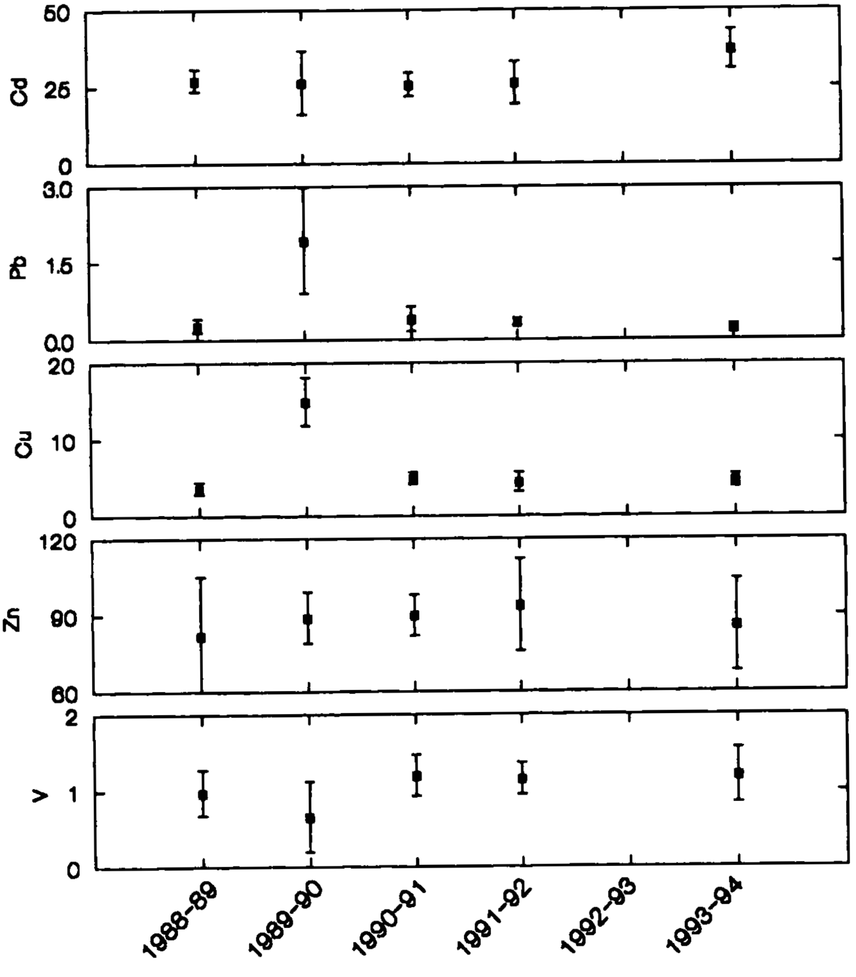

FIGURE 1 Mean concentrations of cadmium, lead, copper, zinc and vanadium, and 95% confidence intervals in *Adamussium colbecki* for each of the sampling year considered. Concentration are expressed in μg/g dry weight

Figure 1 also shows that copper (15 µg/g dry weight) and lead (1.9 µg/g d.w.) concentrations are significantly ($p<0.01$) higher for specimens sampled in 1989–90 as regards to all the other years (mean values 6 µg/g d.w. and 0.6 µg/g d.w. for copper and lead respectively). For 1989–90 too, vanadium concentration (0.7 µg/g d.w.) resulted lower (at $p=0.02$) than the average concentration (1.0 µg/g d.w.). The cadmium concentration (37.0 µg/g d.w.) for samples collected during the 1993–94 campaign is significantly ($p<0.01$) higher than the average (28.5 µg/g d.w.) for the other years.

Concentration ranges, mean values and standard for metals considered are compared with available data from the literature (Table III). The data set is rather coherent for all metals except for lead, being the mean concentration found lower than the one reported by Honda et al.[7]. However, in this case, if the data for the 1989–90 campaign are considered, the difference disappears, being the mean value 1.9 µg/g dry weight, with data ranging from 1.1 to 3.2 µg/g dry weight. No comparison is possible for vanadium (1.0 µg/g d.w.), but, since this metal may indicate contamination originating for fossil fuel combustion, it can be interesting to monitor vanadium concentration over a long term period.

TABLE III Comparison between data found in literature for *Adamussium colbecki* and those obtained during this work. All concentrations are expressed in µg/g dry weight (d.w.). The mean values ± standard deviation and range (between brackets) is reported, together the number of samples considered (n)

Reference	*n*	*Pb* (*µg/g d.w.*)	*Cd* (*µg/g d.w.*)	*Zn* (*µg/g d.w.*)	*Cu* (*µg/g d.w.*)	*V* (*µg/g d.w.*)
[7]	27	2.51 (1.00 ÷ 3.15)	34.0 (26.0 ÷ 49.0)	83.7 (40.0 ÷ 105)	10.6 (5.5 ÷ 14.6)	---
[8]	20	----	31.6 ± 7.0	80.7 ± 20.8	5.6 ± 1.4	---
This work	25	0.64 ± 0.77 (0.14 ÷ 3.18)	28.5 ± 6.9 (18.0 ÷ 44.7)	88 ± 14 (67 ÷ 117)	6.5 ± 4.5 (2.8 ÷ 19.6)	1.0 ± 0.3 (0.1 ÷ 1.7)

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References

[1] J.W. Farrington, E.D. Goldberg, R.W. Risebrough, J.H. Martin and V.T. Bowen, *Environ. Sci. Technol.*, **17**, 490–496 (1983).

[2] W. Fisher and J.C. Hureau (eds.), 1985. FAO species identification sheets for fishery purposes. Southern Ocean (Fishing areas 48, 58 and 88)(CCAMLR Conservation Area). Prepared and published with the support of the Commission for the Conservation of Antarctic Marine Living Resources, Rome, FAO, Vol 1:1–232, Vol 2:233–470.

[3] R. Ralph and J.G.H. Maxwell, *Mar. Biol.*, **42**, 171–175 (1977).

[4] W.L. Stockton, *Mar. Biol.*, **78**, 171–178 (1984).

[5] R. Capelli, V. Minganti, F. Fiorentino and R. De Pellegrini, *Annali di Chimica*, **81**, 357–369 (1991).

[6] V. Minganti, R. Capelli, F. Fiorentino, R. De Pellegrini and M. Vacchi, *Intern. J. Environ. Anal. Chem.*, **61**, 239–248 (1995).

[7] K. Honda, Y. Yamamoto and R. Tatsukawa, *Proc, NIPR Symp, Pol, Biol.*, **1**, 184–197 (1987).

[8] P.A. Berkman and M. Nigro, *Mar. Poll. Bull.*, **24**, 322–323 (1992).

[9] W. Slavin, Graphite Furnace AAS. A source book. (The Perkin-Elmer Corporation, Norwalk, CT, U.S.A., 1984), 230pp.