SEASONAL VARIATIONS OF METALS IN ZOOPLANKTON IN THE COASTAL WATERS OF THE SOUTH ADRIATIC SEA

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In various studies it has been demonstrated that the zooplankton is responsible for removal and transport processes of trace metals from the oceanic surface layers to the sediments due to its ability to accumulate the metals in relatively high quantities (MARTIN & KNAUER, 1973; CHESTER & ASTON, 1976).

The data reported concerned the seasonal variations of some metal concentrations in zooplankton collected along the coast of Apulia in the months of June, October, December 1993 and February, April and May 1994. The samples were collected out of the port of Bari along a transect situated at 2 km from the coast. The zooplankton was sampled in horizontal hauls with a "Bongo 20" net with 235 µm mesh size. In the last three months, samples of waters, sardine (*Sardina pilchardus*) and mackerel (*Scomber scombrus*) specimens were also collected.

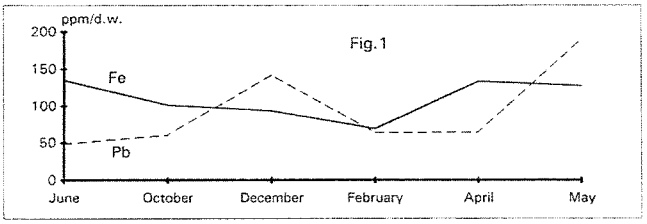
The zooplankton samples were filtered and dried and then the quantitative determination of metals was calculated by spectrophotometry in A.A. after organic matrix disgregation. The same chemical procedure was used to determine the metals in the dorsal muscle of the fishes, while the metals from the sea water samples were quantitatively extracted by solid phase extraction using SPE-phenyl for Hg, Cd, Pb, Cu, Fe, Ni and SPE-amino for Cr. The analytical data obtained show evident seasonal variations in the quantities of most metals found in the zooplankton. Pb and Fe had the highest concentration (tab.1). Pb levels were particularly high in December (142 ppm/d.w.) and May (190 ppm/d.w.) (fig.1) and comparable to those found in polluted areas of the North Adriatic Sea (CRISETIG *et al.*, 1984). These values are particularly elevated compared to metal levels found in the waters and fish samples. The highest concentrations of Fe were obtained in late spring and summer (134 ppm/d.w.).

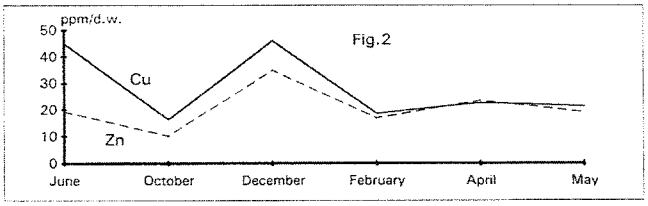
The levels of Cu and Zn throughout the seasons are very similar (fig.2). The highest concentrations of Zn were observed in December while for Cu in June and December. A certain correlation can be seen, however it does not reach significative levels ($P > 0,1$). This correlation has not been observed in other coastal areas of West Mediterranean where the levels for these metals in zooplankton are even higher (HARDSTEDT & LUMOND, 1980). The Cd levels, which present two peaks in June (8,77 ppm/d.w.) and April (6,23 ppm/d.w.), are comparable to those found in polluted waters of the North Adriatic Sea. For Hg, whose highest levels are observed in December (fig.3), concentrations have similar levels to those found in coastal waters of the Middle Adriatic Sea (CRISETIG *et al.*, 1982). Sn and Se reach higher levels in the summer-spring period. As concerns the levels of metals in sea water, the highest values were observed for Sn (max.9,8 µg/l) and Fe (4,5 µg/l).

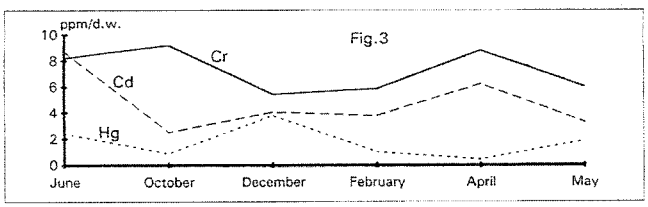
In the fishes, the concentrations of Cr, Cd, Cu and Ni were slightly higher in the sardines whereas in the mackerels higher levels were observed for Zn, Hg, Fe, Sn, As and Se. The greatest difference was found for Zn.

Metals	Pb	Cr	Cd	Cu	Zn	Hg	Fe	Sn	As	Se	Ni
sea water	1,18	0,14	0,15	0,86	-	0,13	2,93	6,36	-	-	0,54
zooplankton	94,95	7,24	4,77	28,32	20,63	1,74	109,91	18,20	7,45	14,67	20,03
S. pilchardus	2,79	1,45	0,75	7,16	0,59	1,07	19,96	6,56	5,81	3,56	0,17
S. scombrus	2,72	1,12	0,50	5,15	1,24	1,50	20,97	6,70	8,35	5,12	0,11

Table 1. Average values of metal concentrations in seawater (µg/l), zooplankton and fishes (ppm/dry weight)







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TRACE METALS CONTAMINATION IN SEDIMENTS FROM THE KISHON RIVER, ITS DRAINAGE BASIN AND ESTUARY, MEDITERRANEAN COAST OF ISRAEL

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The Kishon river, which empties into the Haifa Bay is regarded as the most polluted coastal river in Israel. The river runs through the largest industrial area in the country and is subjected to considerable inputs of organic and trace metal contaminants from oil refineries, petrochemical and fertilizer plants, a sewage treatment plant, intensive agriculture in the recharge area and other sources (COHEN *et al.*, 1993; KRUMGALZ *et al.*, 1990). Except during rainy winters (particularly such as 1991/92), the flow along the lower river system is dominated by the effluents from industries and the sewage treatment plant.

Surficial sediment samples (~ 3 cm top layer) from the Kishon river, its drainage basin (stream sediments), harbors and estuary were collected by grab or with a plastic scoop. Trace element concentrations in the samples were analyzed according to HERUT *et al.* (1993). The sampling was carried out once after the winter and again after the summer. The metal concentrations were normalized by Al as a conservative element in order to minimize grain size variations. Sediments from the upper river system and its drainage basin showed relatively low metal/Al ratios while high peaks of the polluted trace metals were recorded along the entire lower river system (Fig. 1). These normalized ratios decrease in the estuary sediments, from the Fishing Harbor seaward. For elements derived mainly from natural environment, such as Fe, Ce, Mn and Eu, no major differences were detected along the entire Kishon - Haifa Bay complex. Although contaminants are trapped in the sediments of the lower Kishon river system, river-borne contamination was also evident in the southern part of Haifa Bay deriving from bottom transport of sediment particles, suspended matter and disposal at sea of dredge spoils from the river harbors.

The interrelations between trace, minor and major elements in the Kishon system reveal the existance of two main situations : (1) during the winter, when relatively clean sediments from the drainage basin are contaminated in the lower river system by trace metals contained in industrial effluents, and close to the harbors area where the organic matter plays a major role in the accumulation of part of these metals; (2) during the summer, when due to low energy conditions, most trace metals sink directly and via scavenging by organic matter along the entire lower river system. Thus, the scavenging of trace metals from the Kishon waters seems to be controlled by two main factors : (a) the amount of organic matter input and (b) the hydrological regime of the river.

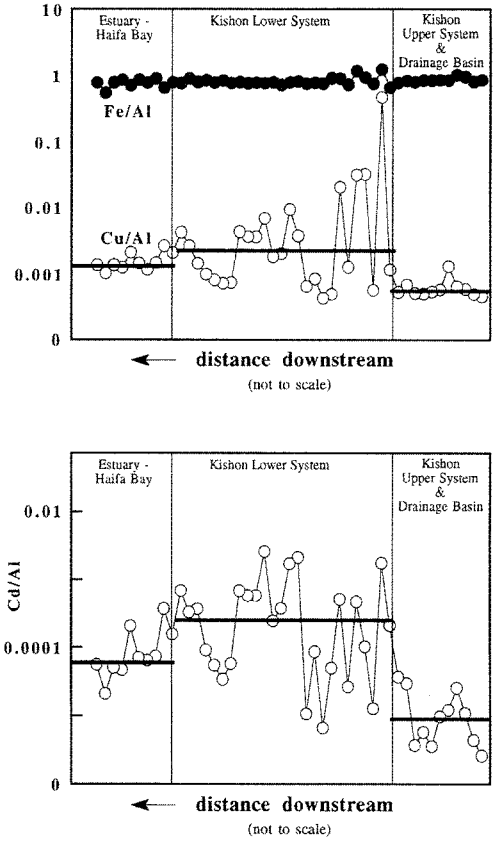

Fig. 1: Selected metals/Al ratios (wt./wt.) along the entire Kishon system. Horizontal lines represent the median values in each sub-system.

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