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Trace Metals in Adriatic Seaweeds from the Istrian Coast

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The northern Adriatic is heavily polluted by both domestic sewage and industrial discharges. Increased concentrations of heavy metals in coastal waters were reported (Branica, 1978).

Due to high accumulation factors and ability of strong binding of metals seaweeds are valuable indicators in metal pollution studies. Metals present in algae are, however, related to the problem of water pollution monitoring.

In this study the concentrations of Mn, Zn, Cd, Cu and Pb were determined by atomic absorption spectrometry (AA 6 Techtron Varian). Samples were collected in the rocky eulittoral and sublittorally at Piran and Rovinj. Both seasonal and perennial species from differently polluted sites were studied. Differences in accumulation capacity between species and genera were considered as well as seasonal and habitat-conditioned variations in trace metal content. Five to ten paralleles were taken for each species during sampling. Results are means of three replicates and are expressed as ug.g of dry weight.

The trace metal content in the surface water at Piran during spring (April) was: 60 ug.l of Zn, 6 $ug.l^{-1}$ of Mn, > 0.5 $ug.l^{-1}$ of Cd, > 2 $ug.l^{-1}$ of Cu and > 1.5 $ug.l^{-1}$ of Pb. In spite of the fact that the concentration of Zn in seawater was notably higher than that of Mn, the concentration of the latter was two to three times higher that that of Zn, in some cases even more. The toxic metals Cd, Cu and Pb were found in low concentrations in the investigated material, with few exceptions. Looking at the algal material as a whole, results indicated that Mn concentrations in the tissue were the main distinguishing characteristic between the taxonomic groups as well as in seasonal and habitat-conditioned variations. Variations in the Zn content were less pronounced and did not always follow the same trend as the Mn content. The toxic metals showed no definite trends of variations and tended to be elevated in some taxonomic groups (representatives of the Scytosiphonales, Dictyotales Gelidiales and in some crustose corallines).

Among the brown algae the perennial *Fucus virsoides* exhibited a relatively high Mn content (ranging from 97 to 475 $ug.g^{-1}$ for the Piran material and from 28 to 44 $ug.g^{-1}$ for that from Rovinj). It increased from winter towards summer, with a peak in August and subsequent decline in autumn. Seasonal variations in Zn content were less pronounced (ranges from 40 to 74 $ug.g^{-1}$). In the Rovinj material the Mn content was lower than in that from Piran. Differences were less conspicuous regarding the Zn content. Among other fucoid species belonging to the genus *Cystoseira* a high Mn content was found in the eulittoral *Cystoseira compressa*, whereas in the sublittoral fucoids it was notably lower. It seems, however, likely that the eulittoral fucoids accumulate more Mn and also Zn that the sublittoral ones. The Cd content in the fucoid species varied between 0.3 and 0.7 $ug.g^{-1}$, that of Cu between 2 and 10 $ug.g^{-1}$ and of Pb between 2 and 6 $ug.g^{-1}$. In representatives of the Sphacelariales (*Halopteris scoparia*) and Dictyotales (*Dictyota dichotoma, Dictyopteris membranacea, Padina pavonica*) a high Mn content was notable, especially in *Padina*. Also in these samples both Mn and Zn concentrations were lower in the Rovinj material than in that from Piran. Elevated concentrations of toxic metals in representatives of the Dictyotales were most obvious in the Pb content, which ranged from 5 to 11 $ug.g^{-1}$, while that of Cu was between 3 and 8 $ug.g^{-1}$. A high Pb concentration was also found in *Halopteris scoparia*. Of the Scytosiphonales, *Scytosiphon lomentaria* and *Colpomenia sinuosa* were collected in rather polluted sites. It was obvious that the accumulation of Mn and Zn increases towards the end of the vegetative period in *Scytosiphon* and that the Mn content was again higher in the Piran than in the Rovinj material. The oposite was true for the Zn content. Exceptionally high values for Pb and Cu were found in the Scytosiphonales from Rovinj (22 to 69 $ug.g^{-1}$ Pb and 9 to 22 $ug.g^{-1}$ Cu). They are possibly related to an intensified pollution at the immediate sampling sites.

Among the red algae pronounced differences in metal concentrations between the taxonomic groups were obvious. In *Porphyra leucosticta* from a brackish habitat (Lim) low Zn and Mn concentrations were obvious (23 and 15 $ug.g^{-1}$ respectively) and the Cu content was slightly elevated. In the rest of the red algae both Zn and Mn concentrations were higher than in Porphyra. In *Jania rubens* and *Corallina officinalis* the Mn content was high and exceeded the Zn content by two to four times. Also in *Corallina* the Mn content in the Rovinj sample was lower than in that from Piran, whereas the Zn content was on the same level. The Pb content of both species was elevated in summer (8 and 11 $ug.g^{-1}$). Among representatives of the Gelidiales, *Gelidium pusillum* and *Pterocladia capillacea*, even higher concentrations of Mn and Zn were observed (214 and 217 $ug.g^{-1}$ of Mn and 60 and 73 $ug.g^{-1}$ of Zn). In both species the Pb content was elevated to 15$ug.g^{-1}$, whereas the Cu content was high only in the eulittoral *Gelidium pusillum* (15 $ug.g^{-1}$). Both species were collected at different seasons and littoral levels. Similarities in their trace metal content might suggest that taxonomic relationships might be of primary importance for the affinities of seaweeds to dissolved metals. A similarity in metal levels was also observed among representatives of the Ceramiales, *Ceramium ciliatum* and *Laurencia obtusa*. The Mn and Zn concentrations in both species were similar (75 and 85 $ug.g^{-1}$ of Mn and 23 and 17 $ug.g^{-1}$ of Zn), hence lower than in the rest of the red algae investigated. Similarities between the two related species were also obvious in their contents of toxic metals, which were low. All the red algae observed exhibited a low Cd and relatively high Pb content. Like in the brown algae, it became obvious that the Mn content was the main distinguishing characteristic between the taxonomic groups and that among the Gelidiales and the coralline algae, also the elevated Pb content was outstanding.

Only a few samples of green algae were included in our study. Mixed samples of diverse *Enteromorpha* species were collected eulittorally where they form continuous mats. They occur in several subsequent generations during the year, which is reflected in their metal levels. The Mn content was highest in summer and again lower in the Rovinj than in the Piran samples. Slightly elevated Pb values in spring and autumn are noteworthy (8 and 9 $ug.g^{-1}$). Samples of *Cladophora dalmatica* and *Ulva rigida* from Rovinj exhibited similar Zn, Mn and Pb contents, but were collected during different seasons of the year. As a contradiction of the above statment that taxonomic relationships are outstanding in the ability for trace metal accumulation, the two *Codium* species, *Codium vermillara* and *Codium effusum*, were totally different. This relates to the Mn and Zn contents (36 and 82 $ug.g^{-1}$ Mn in the former 349 $ug.g^{-1}$ Mn in the latter).

In spite of several experimental studies on trace metal accumulation in seaweeds (e.g. Munda, 1979,1982 etc.) this contribution yields information on their metal content under unstable field conditions, reflecting metal pollution in the North Adriatic shelf area.

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Résultats de Missions Algologiques en Méditerranée Orientale (Turquie)

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La végétation marine benthique des côtes de la Méditerranée en Turquie est peu c
Les travaux algologiques sur cette région ne sont pas nombreux (CİRİK, 1986, UYSAL
1980, ZEYBEK, 1969). Cette région pourtant contient un grand nombre d'espèces interes
aussi bien du point de vue systematique que phytogéographique.

En 1978 et 1979 nous avons étudié, d'une manière saisonnière, en formant une
scientifique, les divers aspects biologiques (y compris la flore marine) et sedimentolo
de la baie d'Akkuyu près de Mersin (UNSAL et al 1980). Depuis cette période jusqu'
jours, nous avons fait des récoltes soit par dragage soit par plongée, d'une m
sporadique, sur les côtes de la Méditerranée en Turquie. Nos stations de récoltes (st.1-
st. 2-Taşucu, st. 3-Akkuyu st. 4-Alanya, st. 5-Kemer, st. 6-Fethiye, st.7-Knidos) vont
frontière syrienne jusqu'à la mer Egée.

La région d'étude présente toutes les caractéristiques du climat méditerraneen. L
grande partie des côtes sont rocheuses, en calcaire, favorisant les developpements d'
Les phanérogames marines sont développées dans les zones sableuses.

Les espèces marines de cette côte et leur répartition sont influencées par les
chaudes de la Méditerranée Sud. Les espèces tropicales, comme Liagora farinosa, L. vi
Galaxaura oblongata, Digenea simplex, Sargassum vulgare, Acetabularia acetat
Anadyomene stellata, sont assez abondantes. De plus certainement à cause du canal de S
voit de plus en plus dans plusieurs stations, certaines espèces comme Halophila stipula
Caulerpa racemosa, qui sont originaires de l'Ocean Indien, et absentes en Méditer
occidentale.

Dans ce travail, nous avons donné un bref aperçu de la répartition des espèces vé
que l'on peut rencontrer au niveau supralittoral, mediolittoral, et à l'horizon superie
l'infralittoral.

Au cours de nos missions algologiques nous avons récolté et déterminé 186 es
d'algues et 4 phanerogames marines. Parmi ces plantes, 123 espèces de Rhodophycé
espèces de Phaeophycées, 22 espèces de Chlorophycées et 5 espèces de Cyanoph
constituent respectivement 66,13%, 19,35%, 11,83% et 02,69% du nombre total d'es
déterminées.

La répartition verticale des espèces et des peuplements dans nos stations se rap
beaucoup de celle observée sur les côtes égéenne et sur les côtes syriennes (CİRİK,
MAYHOUB, 1976). Comme nous l'avons déjà indiqué plus haut, les espèces à affinité c
sont assez abondantes dans les différents étages.

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