

ESTIMATION OF LEVELS OF 10 METALS IN THE PHANEROGAMS OF THE ANTIKYRA GULF (VIOTIA, GREECE)

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Abstract

Concentrations mainly of Fe, Cu, Cd, Pb, Ca and in some instances of Na and K in *Halophila stipulacea*, *Posidonia oceanica* and *Cymodocea nodosa* collected near an aluminium factory in Antikyra Gulf were generally higher than those measured in the same or different species of the genus or subfamily from other areas. The same trend was also noted in the environment (sediment, water) of the study area.

Key-words: metals, phanerogams, Aegean Sea

Introduction

The submerged and widespread (along Mediterranean coasts) angiosperms *P. oceanica*, *C. nodosa* and the lessepsian migrant *H. stipulacea* (1) are the three most abundant seagrasses along the Antikyra Gulf (Viotia, Greece). Very few studies on metal accumulation in these species have been carried out (see references of Tables 2, 3, 4); moreover less information is available on seasonal variation of metal concentrations in these species.

Antikyra Gulf is interesting because of the bauxitic composition of the substrate and the waste discharges from an aluminium factory. Bauxite substrate is composed, among other elements, of Al, Fe, Cu, Ca, K and Mg, whereas the solid wastes contain, apart from other metals, Al, Fe, Ca and Na. In addition to the above metals Zn, Cd and Pb which are very toxic and relatively available to plants were also selected in our study. The aim of this survey was to discern the bioaccumulation potential of ten metals in three phanerogams from the Antikyra Gulf (Viotia) as well as to compare their concentrations with those in sea plants from other geographic areas and to assess the possibility of using these bioindicators to discern the presence of metal pollution in the Gulf.

Materials and methods

Seasonal sampling (from December 1985 to October 1986) of the phanerogams *P. oceanica*, *C. nodosa*, *H. stipulacea* was carried out at 12 stations in Antikyra Gulf (Greece) where the factory "Aluminium of Greece" is located as well as at Itea which served as a control station (in control station *P. oceanica* samples were not found) (Fig. 1). Aluminium, Fe, Cu, Zn, Cd, Pb, Na, K, Ca and Mg concentrations in seagrasses, *C. nodosa*, *H. stipulacea* (the entire plant) and the leaves of *P. oceanica*, the sediment and the dissolved metals in seawater were measured by Atomic Absorption Spectrophotometry by flame (Perkin Elmer 403) or by graphite furnace (Perkin Elmer HGA 72) (e.g. 1, 2).

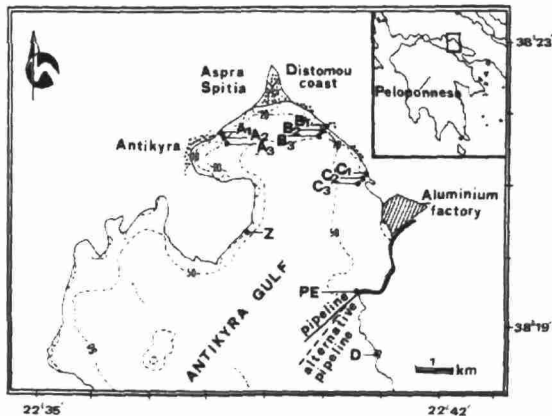


Fig.1. Sampling stations in the Gulf of Antikyra.

The accuracy of method was tested with standard reference material of Orchard leaves (N.B.S. no 1571); the results were within 10% for Fe, K, Na, Ca and Mg and 3% for Zn of NBS values, whereas for Cu, Cd and Pb the results were 6%, 20% and 2%, respectively, lower than the standard.

Results and discussion

Table 1 presents the mean (\pm standard error) and the range of the concentrations of 10 metals in the phanerogams *P. oceanica* leaves,

C. nodosa and *H. stipulacea* from Antikyra Gulf. Comparison of the above concentrations (Table 1) with those observed in other populations of these species or other species of the same genus or subfamily, Posidonioideae (Table 2), Cymodoceoideae (Table 3) and Halophiloideae (Table 4), respectively, has shown the following:

Table 1. Mean value (\bar{x}), range and standard error of the mean value (S.E.) of all concentrations (N) of each metal ($\mu\text{g g}^{-1}$ d.w.) in *Halophila stipulacea*, *Cymodocea nodosa* and *Posidonia oceanica* from different samplings and from all stations of Antikyra Gulf.

| | <i>Halophila stipulacea</i> | | <i>Cymodocea nodosa</i> | | <i>Posidonia oceanica</i> | |
|----|-----------------------------|-------------|---------------------------|-------------|---------------------------|-------------|
| | $\bar{X}(\pm\text{S.E.})$ | Range | $\bar{X}(\pm\text{S.E.})$ | Range | $\bar{X}(\pm\text{S.E.})$ | Range |
| Al | 76(± 46) | 52.0-860 | 148(± 22) | 32.7-487 | 162(± 46) | 22.3-793 |
| Fe | 850(± 106) | 449-2244 | 851(± 102) | 349-2325 | 372(± 32) | 164-815 |
| Cu | 16.4(± 6.4) | 2.0-82.7 | 16.1(± 5.9) | 2.1-98.3 | 18.0(± 7.5) | 2.8-148 |
| Zn | 25.4(± 4.2) | 11.0-76.4 | 31.8(± 2.3) | 17.3-50.5 | 43.4(± 3.0) | 27.1-97.7 |
| Cd | 11.9(± 5.3) | 1.3-93.7 | 18.8(± 4.7) | 0.88-83.0 | 20.8(± 3.0) | 2.7-44.0 |
| Pb | 37.8(± 7.7) | 10.5-123 | 50.9(± 14.8) | 147-297 | 39.5(± 6.6) | 10.5-123 |
| Na | 62596(± 2410) | 48457-87197 | 20557(± 1073) | 11845-28216 | 34275(± 1028) | 25736-44668 |
| K | 18023(± 563) | 13149-21780 | 20421(± 1248) | 12318-36715 | 24320(± 1433) | 14167-36385 |
| Ca | 25365(± 3491) | 6235-51343 | 25533(± 4436) | 3745-65018 | 13285(± 1581) | 4800-32275 |
| Mg | 11788(± 411) | 9727-16184 | 7565(± 318) | 5191-10111 | 6791(± 112) | 5940-7974 |

1. Iron, Cu, Ca and Mg concentrations in *P. oceanica* at the study area (Table 1) are higher than corresponding concentrations in other species of the genus (7-13) (Table 2). Copper, Pb and Cd concentrations in *P. oceanica* from Antikyra Gulf (Table 1) are higher than those of the same species from other areas (3-6) (Table 2) as well as mean concentrations in other phanerogams from "non-polluted" areas (14, 19, 20). Moreover, Pb and Cd concentrations exceed those in *P. australis* from an area characterized as "little or moderately polluted" by the above metals (10).

2. Exactly the same information was selected as concerns *C. nodosa*. Copper, Pb and Cd concentrations as well as the maximum Fe concentrations in *C. nodosa* from Antikyra Gulf (Table 1) are in general high (Table 3). More specifically, they exceed the corresponding values measured in the Gulf of Itea (control) (mean value \pm SD: $2.8 \pm 0.5 \mu\text{g g}^{-1}$ d.w. for Cu, 11.8 ± 1.0 for Pb, 13.7 ± 0.6 for Cd, 1644 ± 86 for Fe) and those observed in phanerogams from tropical, subtropical and intertidal "non-polluted" areas (14, 19, 20). However, Pb and Cd values in *C. nodosa* from the study area do not exceed those from a location highly polluted by these metals (10).

3. Cadmium, Pb, Na, K and Ca concentrations in *H. stipulacea* from Antikyra Gulf (Table 1) are higher than those in different species of the genus from other areas (see references in Table 4). It has also been observed that Cd and Pb concentrations are higher than those in the same species from Itea (control) (mean value \pm SD: $4.3 \pm 0.4 \mu\text{g g}^{-1}$ d.w. for Cd, 31.4 ± 4.0 for Pb) and Cd levels are greater than concentrations reported for the same species from the Red Sea (17).

Concerning Al, no information has been found on its concentrations in marine phanerogams from other geographic areas.

The generally high Fe, Cu, Ca, Pb and Cd concentrations in phanerogams from Antikyra Gulf are explained by their respectively high values in the sediment and seawater from the same area (21). Besides Fe, Cu and Ca constitute the main bauxite components of the area, whereas Fe and Ca also make up the main components of the sewage being discharged from the "Aluminium of Greece" factory. The differences derived from the above comparisons may also be attributed to interspecific and intraspecific variations, to differences in the age of plants and their collection time, as well as to differences in environmental factors (e.g. salinity, pH) that influence metal uptake.