RECENT ADVANCES IN THE BIOMONITORING OF TRACE ELEMENTS USING POSIDONIA OCEANICA (L.) DELILE

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Abstract

One of the most studied bioindicator in the Mediterranean is the seagrass *Posidonia oceanica*. Trace element (TE) monitoring surveys using that species have however mostly focussed on a few elements (e.g. Pb, Cd), while numerous others, efficiently bioconcentrated by the plant and potentially toxic, have been barely or not studied (e.g. Ag, V, Bi). Furthermore, although *P. oceanica* bioaccumulation behaviour relies on synergistic effects between the sampling environment and its ecophysiology, this aspect has been mostly underestimated until now. This study presents recent advances in the biomonitoring of TEs using *P. oceanica* and insists on the necessity of developing consensual monitoring protocols in order to improve its use as bioindicator.

Keywords: Trace elements, Bio-indicators, Ecotoxicology, North-Western Mediterranean

Coastal ecosystems are submitted to numerous anthropogenic pressures: among them, the chemical pollution by traces elements (TEs). Biomonitoring surveys using the marine magnoliophyte *Posidonia oceanica* (L.) Delile, endemic to the Mediterranean, have mainly focussed on contaminations by Cr, Ni, Cu, Zn, Cd, Pb and Fe. However, other TEs like As, V, Ag, Be, Al, Mn, Co, Se, Mo, Sn, Sb and Bi, categorized as elements of "environmental emerging concern", have been subject to nearly no ecotoxicological survey with that species. As the worldwide evolution of our technologies and of our lifestyle increases the extraction and production of most of the listed TEs, their environmental monitoring remains a topical subject. Furthermore, little is known about TE kinetics within *P. oceanica* meadows. The respective importance of the plant ecophysiology and its sampling environment henceforth needs further investigations in order to properly use this bioindicator in intercomparative monitoring surveys. We firstly monitored TE mean annual levels in *P. oceanica* shoots sampled during 3 years (2008-2010) in front of the oceanographic station STARESO (Calvi Bay, Northwestern Corsica, France). Results showed that *P. oceanica* shoots bioaccumulated TEs of emerging concern to levels ranging from 0.001 (e.g. Bi) to 100 (e.g. Mn) $\mu g.g_{DW}^{-1}$ of shoot (Richir, 2012). A spatial monitoring survey (April 2007) along the French Mediterranean littoral further pointed out that many of these TEs effectively threatened its chemical integrity: the observed spatial variability of *P. oceanica* shoot TE levels (in $\mu g.g_{DW}^{-1}$ of shoot) could be linked to specific anthropic activities like agriculture (Mo: up to 27 ± 14), mining (Sb: up to 0.70 ± 0.13), storage and refinement of oil products (V: up to 23 ± 7), or the presence of major urban centres (Bi: up to 0.049 ± 0.004). Their monitoring, along with the one of TEs classically studied in that species, turned out to be essential (Luy et al., 2012). A complementary small-scale study (May 2010) of TEs contents in *P. oceanica* shoots sampled along a radial located at the back of the Ajaccio Bay (western Corsica) further demonstrated that the spatial variation of their TE contents (e.g. Bi, in $\mu g.\ g_{DW}^{-1}$ of shoot) could vary as much at the scale of 1 km (from 0.009 ± 0.004 to 0.061 ± 0.012) than at the scale of the French Mediterranean littoral (from 0.004 ± 0.000 to 0.049 ± 0.004; Richir, 2012). The election of a representative monitoring site to characterize the global health status of a wider area (e.g. a Bay) is thus a very important step when planning a monitoring survey based on benthic (and rooted) organisms. We also studied the physiological mechanisms of accumulation, storage and excretion of a mix of 15 TEs by *P. oceanica* through the *in situ* contamination of seagrass bed portions (June 2009). Realistic low TE concentrations within the experimental setup (from 0.018 ± 0.004 $\mu g.L^{-1}$ for Ag to 16 ± 8 $\mu g.L^{-1}$ for Zn, as measured with DGTs) were similar to pollution levels recorded in contaminated coastal areas of the Mediterranean. Plant compartments responded differently to TE exposures: adult senescent leaves assimilated TEs less rapidly than young intermediate actively growing ones. Mean contamination factors were 3.0 ± 1.7 for *P. oceanica* intermediate leaves (min. = 1.2 for Fe; max. = 7.4 for Bi) and 2.0 ± 0.9 for adult leaves (min. = 0.95 for Cd; max. = 3.7 for Bi), at the levels of contamination tested. TEs, once accumulated, could be redistributed between plant compartments, notably towards rhizomes buried in sediments. Rhizomes could therefore play the role of storage organs, in particular for essential nutrients such as Cu or Zn, and thereafter supply plant demands during the moment of maximum leaf growth (Richir et al., in press). TE levels and kinetics in *P. oceanica* beds will thus evolve seasonally and spatially according to the synergistic effect of both environmental bioavailable TE levels and the plant ecophysiology. However no general sampling rule and/or protocol prevails nowadays when using that species in biomonitoring surveys, contrary to other species (e.g. *M. galloprovincialis*). In the light of our observations, we strongly recommend developing consensual monitoring protocols in order to improve the use of *P. oceanica* as bioindicator of TE pollution, although we are conscious of the difficulty of such a task.

References

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