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Using local biodiversity to prevent pollution transfers to environmental components of a Mediterranean semi-arid ecosystem

Alma Heckenroth (1,2), Jacques Rabier (1), and Isabelle Laffont-Schwob (1)

(1) Institut Méditerranéen de Biodiversité et d'Ecologie marine et continentale (IMBE), Aix-Marseille Université, CNRS, IRD, Univ.Avignon, Faculté de Saint Charles, Case 4 - Bât. Sciences Naturelles, 3, place Victor Hugo, F-13331 Marseille cedex 03, France, (2) Ortec Générale de Dépollution (OGD), Groupe ORTEC, Parc de Pichaury, 550 rue Pierre Berthier, CS 80348, 13799 Aix en Provence Cedex 3, France

In arid and semi-arid Mediterranean coastal areas, metals and metalloids (MM) pollution coming from unreclaimed brownfields has increased the negative environmental stresses leading to ecosystems degradations as soil erosion and losses of organic matter and biodiversity. On these sites, maintaining or restoring a local vegetation cover is considered as a key step to stop the degradation cycle. Furthermore, in a context of high pollution occurring in natural areas, phytoremediation is considered as an attractive alternative to conventional soil remediation techniques, the first reducing pollution transfers, improving the soil quality. In protected or natural areas, it is also important to perceive then design phytoremediation as a way to assist ecosystems recovery, using the restoration ecology concepts. However, only few works in the literature deal with the potential use of native Mediterranean plant species for phytoremediation.

On the South-East coast of Marseille (France), the activity of the former smelting factory of l'Escalette, ceased since 1925. However, its brownfield is still a source of pollution by trace metals and metalloids for abiotic and biotic components of the surrounding massif. This massif hosts a rich biodiversity with rare and protected plant species despite the metallic pollution and this area has been included in the recently created first peri-urban French National Park of Calanques. In this context, an integrated research project is being conducted with local actors and stakeholders, from the selection of native plant species, assessment and optimization of phytostabilization capacities of selected species, to the development of ecological engineering techniques well adapted to local constraints and phytostabilization field trials.

The first part of this study has been conducted on two areas, corresponding to different pollution pattern, plant communities and environmental drivers: a halophytic area, characterized by typical coastal plants, mostly halophytic or halo-tolerant calcareous grass and shrubs and medium levels of MM pollution and an area at the bottom of the creeping chimney of the factory, that corresponds to a hot-spot of pollution, with shrublands and stands of Aleppo pines. Phytoecological samplings and soil MM analyses were conducted on 20 sampling plots on each area, organised in transects corresponding to environmental and potential pollution gradients. For each area, few variables related to distances from pollution or disturbances sources, natural and anthropogenic, were added for statistical treatments. Data were analysed using correlation matrix and PCA to identify which variables had major influences on the composition of plant communities.

On the halophytic area, where natural constraints are drastic and despite the soil pollution, sea spray still appeared to be a decisive factor on plant community organization. However, anthropogenic disturbances seemed also to be influent drivers.

On the chimney area, the results of the multivariate analysis indicated that a century of MM pollution pressure produced a noticeable effect on plant population dynamics. These results suggest that some native plant species have successfully developed tolerance or resistance mechanisms to face MM impacts. As a result, a grid of criteria has been chosen based on statistical relationships between occurrence of plant species and variables to select native plant species to be studied for their phytoremediation potential, taking into account the specificity of each study area.