Remediation Of Contaminated Soils By Soil Washing Procedure

Marine environments ant its sediments act as a sink, accumulating many persistent pollutants that will be slowly released and made available for the trophic chain (Di Leonardo et al., 2014). This scenario suggests a need to apply methods for the identification, evaluation and intervention to reduce the risks for the environment and inhabitants. Among several technologies, that of soil washing, based on the chemical-physical process, can be efficiently applied to reduce contaminant concentration in soil and sediments. Usually, the effectiveness of the recovery processes is assessed by comparing contaminant level “before” and “after” the treatment. Contrarily, we investigated the effectiveness of the “soil washing” treatment determining the effects of a washed-sediment on a biological system using the mussel Mytilus galloprovincialis. Having focused the interest on the recovery of marine sediments, the approach used for the experimental set up, took into account the contribution of some aspects that happen in the marine environment, such as water turbulence or cable and pipeline laying activities, responsible of sediment resuspension. This disturbance influences the inorganic compound availability, contributing to the rise of the contact with biological organisms and their abiotic stress.

Another aspect that has to be considered is the age of the polluted sediments. Commonly, sediments have a high ability for binding heavy metals from contaminated water, and even though a significant proportion of the metal remains strongly bound to the sediment, they become a potential source of water contamination especially in specific environmental conditions that may influence marine chemical-physical parameters (Zang et al., 2017; Komárek and Zeman, 2004).

In this work, we have focused the attention on Hg, Cd and Pb because they are important elements from a toxicological point of view. In fact, they are not essential elements, do not have any biological role and are not part of living organisms, (Vodyanitskii, 2016; Tchounwou et al., 2012) and, unlike elements such as Cu, Zn, Fe, etc., which, having a biological role, can become toxic only beyond certain concentrations, Hg, Cd and Pb they can exert toxic effects even at low doses. As a general consideration, we can assert that mussels maintained in the mesocosm G, constituted by washed sediment, appeared as the group subjected to even greater stress. Although the Pb and Hg content are reduced in the sediment processed by soil washing (the content of Hg has decreased by 10 fold), the levels of these metal accumulated in the mussels derived from mesocosm G are significantly higher compared to those maintained in mesocosm B; this observation well correlates with DNA damages and mRNA expression of MT10, HSP70 and HSP90. Very likely, the soil washing procedure has mobilized metals, initially adsorbed to the sediment, making them more available to the samples causing a certain toxicity.

Another possibility could lie in the washing procedure consisting in EDTA, EDDS e KI/I2. In particular, EDDS (ethylenediaminodisuccinic acid) is a chelating agent particularly effective in the extraction of heavy metals, however characterized by high biodegradability therefore, if not quickly removed from the system, it could generate by-products with their own effect on the biological environment. Also be noted that the metal bioaccumulation is influenced by several

factor such as chemical form, oxidation state, environmental concentration, and physico-chemical conditions (Hund-Rinke and Kördel, 2003; Phillips and Rainbow, 1994; Rainbow, 1993) that in turn affect metal bioavailability, the fraction of the metal that is available to exert action in the receptor organism. Furthermore, it has been reported that elements, like Hg and Cd, can easily react with compounds and block metabolic pathways or disrupt the structural components at a cellular level (Tunca et al., 2018). Ultrastructure studies support this observation. In particular, in gills, beside a general tissue disorganization and cell vacuolation, common to mussels kept in B and G mesocosm, an important hemocyte infiltration, particularly evident in animals maintained in the mesocosm G has been shown. Our finding has also highlighted the presence of cells rich in peroxisomes and lysosomes, and in accordance with an upregulation of CAT mRNA, in both gills and digestive gland, suggested a marked degradation-detoxification activity. In marine mussels, the digestive gland is a pivotal organ for digestion and homeostasis maintenance. Changes in cell type composition and morphology, together with histopathological alterations, as we have found in our specimens, constitute a non-adaptive response to the pollutant. However, when a certain recovery occurs, the signal will fade with the cessation of the stimulus. Notwhitstanding, if the measured response is suitable to affect fitness, its persistence should be considered a signal of distress (Garmendia et al., 2011).

Altogether, our observations supported an activation of the whole immune system in animals exposed to pollutants (Duchemin et al., 2008; Auffret et al 2006) that in turn, lays for a reversibile or irreversible iflammatory responses.

Conclusions

This research was part of a national project funded by the Italian Ministry on Systems Biology, aimed at evaluating the effect of soil washing procedure on biological system as the Mytilus galloprovincialis. As they persist, in soil, compounds become progressively less available for uptake by organisms, for exerting toxic effects but also for degradation and remediation. On the other hand, resuspension of the sediments, as it can happen in case of storms or turbulence induced by the wave motion or by boats, as well as soil washing treatment, can increase the availability of pollutants to aquatic organisms causing toxicity. Overall, the results from this study confirmed the need of intervene, as quickly as possible, in the rehabilitation of marine sediments using an effective procedure that is capable of promptly remove the reagents used.