Could the Invasive Asian Clam Work as a Biofilter of Metal-Rich Effluents?

Two of the major threats to freshwater ecosystems are contamination with industrial effluents, which damage different levels of biological organization, and introduction of non-indigenous species, which may ultimately result in an invasion scenario with severe ecological and economic consequences. Management of both harmful industrial wastes and invasive species are thus major challenges nowadays. Metal-bearing effluents, such as acid mine drainage (AMD), are particularly problematic because metals can easily bioaccumulate in organisms and biomagnify across the trophic chain. The use of living organisms (e.g., bivalves) has been encouraged as more environmentally and economically sustainable solutions to treat AMD and other metal-bearing effluents. In this context, the freshwater invader Corbicula fluminea (Müller, 1774)—commonly known as the Asian clam—stands out as a promising bioremediation agent. It is a bivalve with proven bioaccumulation attributes coupled with a fairly large tolerance to the effects resulting from exposure to different contaminants and high filtration rates.

In a study published in the September–October 2014 issue of the Journal of Environmental Quality, researchers from two Portuguese universities evaluated the bioremediation capabilities of the Asian clam using AMD as an experimental model effluent. The evaluation was performed considering both the chemical and the biological perspectives, and thus involved (i) the quantification of metal concentration changes in AMD solutions following a biofiltration period and (ii) the comparison of the ecotoxicological responses of standard organisms (the bacterium Vibrio fischeri, the green microalgae Pseudokirchneriella subcapitata, and the cladoceran Daphnia magna) to untreated and bio-treated effluents, which is essential for a final, robust conclusion on the water quality after the quantitative evidence provided by chemical analysis. Although there is already scientific evidence of the Asian clam’s ability to accumulate metal elements and to remediate eutrophic waters, this is the first study showing its extended ability to accumulate from complex environmental mixtures such as industrial effluents, thus highlighting its potential use as a bioremediation agent also in this field.

Significant removal of metals from water was indeed recorded, with higher purification levels found for the most diluted effluent treatment (4%). In fact, although absolute metal removal increased as the clams were exposed to a more concentrated effluent (10%), there was a tendency for a reduction in the purification efficiency, that is, the improvement of the overall water quality relative to the initial pollutant contents. The main practical implication of these results is that an eventual bioremediation system based on the Asian clam is likely to be more effective if implemented as a sequential, multistage assembly rather than as a single-step configuration. Still, the ability of the clam to sequester some metals is remarkable. For example, the researchers found that clams can remove 75% of a considerable iron waterborne concentration of 8.9 mg L⁻¹; this translates into 10 clams accumulating approximately 10 mg of iron from the water, mostly into their shells, under the specific conditions used in the assays. Removal of the metals from the water resulted in an improvement of its overall quality, which was demonstrated by a decrease in the ecotoxicity to selected test species of the effluent after biotreatment compared with the equivalent untreated version.

Future studies should fully assess the suitability of such a new role for the aquatic nuisance. In particular, the damage to the clam’s physiology caused by the effluents to be treated should be examined, and the way in which this damage will influence the clam’s bioremediation capabilities must be characterized. Also, the most adequate regeneration periods for each clam batch, as well as the related methods to easily and efficiently discard contaminated clams that die or are no longer effective in bioremediation, should be comprehensively addressed as the actual implementation of the system is considered. Finally, the invasive character of the Asian clam must also be carefully taken into account before its integration in remediation programs.
