Exploring the diversity and arsenic bioremediation potential of microbial communities living in an acid mine drainage-affected mountain stream

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Introduction

Arsenic is a metalloid naturally abundant in the Earth crust. Arsenic contamination affects groundwater and soil in several countries around the world, exposing millions of people to a broad range of illnesses including cancer (WHO, 2010).

In many areas in Northern Italy arsenic exceeds the Italian law limit (20 mg kg^{-1}, D.Lgs 152/2006), due to the mineralogy of bedrock and to mining activities (Rotiroti et al. 2015). A unique example is the Rio Rosso stream, located in the Anzasca Valley (Piedmont) and heavily affected by an acid mine drainage derived from an abandoned gold mine. Arsenic, together with other heavy metals, is transferred by the stream to the surrounding area, leading to severe impacts to the local community.

According to preliminary physicochemical characterizations, arsenic content in water, sediments and surrounding bank soil accounted for 0.14 mg L^{-1}, 930 and 1014 mg (kg of dry soil)$^{-1}$, respectively. Moreover, arsenic measured in the epilithic biofilm living in the stream accounted for 6200 mg kg^{-1}.

Arsenic cycling in the environment is strictly dependent on microbial transformations, that include redox reactions and conversion of inorganic to organic arsenic species (Slyemi and Bonnefoy, 2012). Several studies have characterized the identity and involvement of the microbial communities in arsenic biogeochemical cycle of different ecosystems (Paul et al. 2015, Desoeuvre et al. 2016, Zecchin et al 2017, Oremland et al. 2017). However, many aspects of arsenic microbial cycling remain unknown.

The Rio Rosso river and the surrounding banks, with their extremely high arsenic contents, represent a peculiar ecosystem where microorganisms cope metalloid toxicity likely using diverse strategies. This microbial diversity might be employed in the establishment of phytobarriers, proposed to limit the impact of arsenic contamination in this area. For this reason, a collection of 300 bacterial strains was obtained from the rhizosphere soil and the roots of three autochthonous plants (*Hepatica* sp., *Dryopteris* sp., and *Salix alba*) known to have arsenic accumulation or stabilization properties (Díaz et al. 2013, Fayiga and Saha 2016, Lebrun et al. 2017).

Proposed research activity

The microbial communities living in the Rio Rosso ecosystem, specifically the epilithic biofilm in the stream and the rhizosphere microbiota of the three studied plants, will be characterized phylogenetically by 16S rRNA sequencing. Furthermore, shotgun metagenome sequencing will be performed on the epilithic biofilm in order to elucidate the functional properties and metabolic pathways allowing these microorganisms to live in such extreme conditions.

Concomitantly, the isolated rhizospheric strains will be characterized for their potential plant growth-promoting properties, in view of their possible employment for phytoremediation purposes.

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