THE MANGANESE BIOREMEDIATION ECOSYSTEM

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Dissolved Mn concentrations in mine discharge waters are regulated until 2 mg/L in the U.S. because of potential toxicity or aesthetics problems. We analyzed microbial growth downstream from high-Mn mine discharges where Mn concentrations were being lowered due to natural bioaccumulation processes. Monthly experiments on epilithic attachment of organisms onto glass or limestone thin-section slides were conducted for a year downstream from active copper mines in Arizona and a closed coal mine in Pennsylvania. The Pinal Creek microbial ecosystem in semi-arid, hot Arizona (Globe-Miami area) grows on the perennial creek bed: rainfall, 50 cm; flow, 2,850 gal/min; pH, 7.1; and Mn, 50 mg/L. The Shade Mine ecosystem in humid, cool Pennsylvania grows on a limestone remediation bed: rainfall, 104 cm; flow, 10 gal/min; pH, 7.3; and Mn, 30 mg/L. These monthly studies show a similar microbial ecosystem flourishes at both sites and lowers Mn concentrations 2 mg/L on limestone at the coal mine. Bacteria, cyanobacteria, fungi, and algae exhibit at least 13 strategies that lower Mn concentrations. Cyanobacteria mats collect clumps of amorphous Mn oxides typically associated with photosynthetic elevation of pH up to 10. A filamentous green alga (Ulothrix sp.) and an iron bacterium (Leptothrix discophora) produce Mn-oxide-encrusted annular holdfasts. Individual sheaths and rods of bacteria, rosettes of Metallogenium, filaments of algae, hyphae of fungi, and biofilms of extracellular polysaccharides are thickly coated with Mn oxides. This diverse community is extremely efficient in its ability to remove Mn, which suggests that stability or biodiversity are issues for successful remediation designs.