MYCOREMEDIATION

THE FUNGAL FUTURE OF ECO-FRIENDLY SOIL CLEANUP

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The scenario depicted in the HBO apocalyptic series The Last of Us could be real – that is, if you are a contaminant in soil. New research shows that fungi can be incredibly efficient at bioremediation, which is a form of in situ ("in the original place") remediation that employs microorganisms or other forms of life to break down or remove contaminants from soil or groundwater. Bioremediation is eco-friendly and sustainable, since it is not energy-intensive, poses a low risk to the environment, does not require much equipment, and can provide remedial longevity that other options cannot.

In the past, bioremediation has been implemented by soil bacteria or plants, but growing research has shown that the "roots" of fungi and mushrooms, called mycelium, can decontaminate media just as, if not more, efficiently.

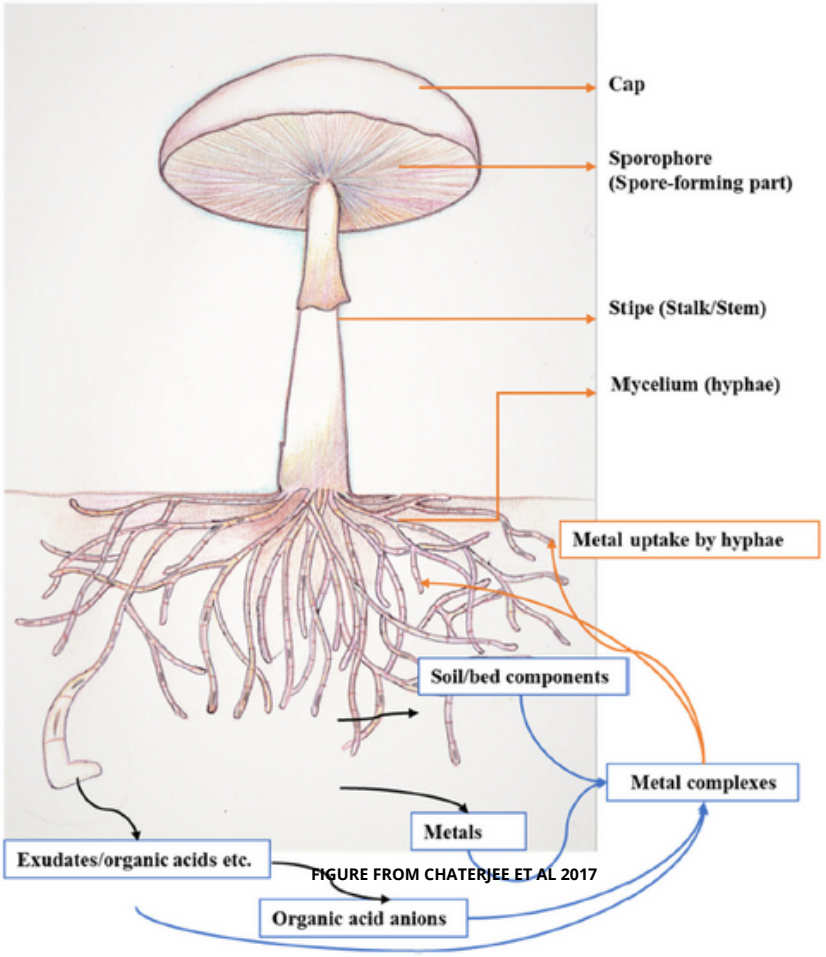

FIGURE FROM CHATERJEE ET AL 2017

This form of bioremediation is called mycoremediation. The stem and cap of a mushroom is just what we see on the surface, but within the soil there is a whole network of mycelium that resemble thread-like structures, capable of transforming pollution.

Studies show that mycoremediation is an effective remedial method for recalcitrant pollutants that are hard to remediate to low levels, such as polycyclic aromatic hydrocarbons, pesticides, herbicides, antibiotics, heavy metals, pharmaceuticals, petroleum products, radionuclides, and can even combat cyanotoxins that contribute to harmful algal blooms (Akhtar, 2020). The mechanisms of how the fungi achieve this are still being studied and vary by species. Some can bioaccumulate heavy metals in the flowering body or mushroom (which should be removed once mature), while others can create powerful enzymes in the subsurface that can break down molecules, facilitate uptake, or encourage bacteria to use the contaminant as a food source. This synergistic action between the fungi and the native or augmented bacteria colonies has shown to be particularly effective (Horel, 2020; Medaura et al., 2021) since they do not compete for resources and, therefore, will not deplete the nutrients in the soil that support fungal and bacterial growth.

Fungi are remarkably tolerant to pollutants. Additionally, fungi have been shown to be heartier against pH and temperature variations than bacteria. One study showed that fungi were able to grow while suspended over an off-gassing petroleum spill, which may have implications for air biofiltration applications (Horel, 2020). Not only are fungi effective at removing contaminants, but several studies show that their presence in the soil can improve plant growth and agricultural crop yield (Akhtar, 2020; Balacco, 2018).

Mycoremediation has been used around the world to clean up carcinogenic pollutants left from forest fires, radiation at Fukushima, petroleum spills in Ecuador, and heavy metal pollution at a brownfield site in California. Researchers have demonstrated the effectiveness of mycelium growth and mycoremediation at urban brownfields sites in New Jersey (Balacco, 2018; Singh et al., 2019; Evans et al., 2015) along with transformation from bacteria and plant growth. Could fungi be the future of remediation? More research needs to be done on the specific mechanisms, species, and compounding or synergistic factors at play but the future of utilizing these types of remediation methods seems inevitable. Stay connected to NJ Brownfield Assistance Center @ NJIT to learn more about issues impacting brownfields in NJ.

Sources:
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