Unravelling the diversity of dryland fungi, from soils to rocks

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ABSTRACT:
Drylands cover about 45% of the global land surface and are characterised by water deficiency and polyextreme conditions such as high evaporation rates, extremely high ultraviolet (UV) and solar radiation, extremely low and high temperatures, extreme temperature fluctuations, and low and variable rainfall. In these harsh environmental conditions, fungi drive critical functions, such as soil fertility and pedogenesis, while also uniquely contributing to the biodiversity of these widespread ecosystems. Fungi can colonise both soil and rock substrates, and have evolved unique adaptation strategies allowing them to endure and flourish in the extreme. Recent advancements in sequencing technologies have allowed to unravel the biodiversity of these exceptional dryland specialists, and the environmental factors shaping their diversity and community composition. Dryland soils are dominated by Ascomycota, with *Alternaria, Fusarium, Alternaria, Chaetomium*, and *Cladosporium* as predominant genera. Global surveys indicate that, together with aridity, UV index and temperature seasonality are important environmental predictors of community shifts, resulting in increases in the presence of plant pathogens while decreasing the occurrence of saprotrophs. Conversely, lichenised fungi from the Class Lacanoromycetes (e.g. *Carbonea, Lecidea*, and Lecanorales spp.) dominate rock substrates on a global scale, together with ascomycetous fungi from Arthoniomycetes, Dothideomycetes and Eurotiomycetes. Comparisons of soil and rocks also suggest that rocks support an exceptional diversity of fungi, comparable to that in the surrounding soils, and that the main drivers structuring rock fungal communities are climatic factors regulating moisture and temperature (i.e. mean annual temperature and mean annual precipitation). The overall importance of climatic variables in driving distribution and composition of soil fungi in both rocks and soil indicate that climate change is likely to have a disproportionate consequence for the distribution of fungal groups linked to soil functioning and biodiversity maintenance in drylands, with implications for the balance of biogeochemical cycling in these widespread ecosystems.

KEYWORDS:
Dryland fungi; rock-inhabiting fungi; aridity