# Arbuscular mycorrhiza: Mineral-specific fungal interactions

J. QUIRK*, J.R. LEAKE AND D.J. BEERLING

Animal & Plant Sciences, University of Sheffield, UK (*correspondence: j.quirk@sheffield.ac.uk)

Arbuscular mycorrhizas (AM) are the ancestral type of root-fungal associations that co-evolved with vascular land plants >400 Myr ago and today occur in ~80% of land plant species. The fungi are extremely effective at scavenging phosphorus from soil solution and passing some of this into their host plants, at a much lower carbon cost to the plant than a root system [1]. However, the capacity of AM to liberate nutrients from minerals by weathering remains uncertain and few studies have investigated the nature and effect of AM mycelial interactions with rocks and minerals.

Using plants with AM and without AM, grown in pots of sand in which we buried nylon mesh bags containing washed grains of perlite or tertiary basalt, we show for the first time strong preference of AM hyphae for basalt over perlite.

## Mineral-specific AM fungal interactions

AM fungal lengths were up to 40 times greater per unit volume of basalt grains than per volume of perlite. Plant species that are habitually non-mycorrhizal supported minimal fungal colonisation of the basalt, confirming the importance of AM fungi as the main fungi present in pots containing AM plants. This was further supported by the total lengths of hyphae in a mesh bag per unit dry mass of mineral grains which were >2 times greater in bags with basalt than with perlite, and >12 times higher than hyphal lengths observed in pots with non-mycorrhizal plants. Aqueous leachate samples of the minerals recovered from the mesh bags were found to be acidified by the plants from pH 5.2 to pH 3.7 with basalt, and from pH 4.7 to 3.5 with perlite. Acidification increased in proportion to the log of hyphal lengths (m $g^{-1}$) mineral grains.

The results demonstrate preferential colonisation and growth of AM hyphae around grains of basalt compared to perlite, and the acidification associated with this more intensive colonisation will enhance acid dissolution. Our findings suggest that AM fungi may play a direct and significant role in enhancing mineral dissolution and that the fungi allocate their biomass preferentially around mineral grains such as basalt that can supply essential nutrient elements (e.g. P, K, Ca, Mg, Fe) required both by the fungi and the partner plants from which they obtain organic carbon.

[1] Leake *et al.* (2004) *Can. J. Bot.* **82**, 1016–1045.

# Proteogenomic insights into anaerobic biodegradation of hydrocarbons

RALF RABUS[1,3], HEINZ WILKES[2] AND FRIEDRICH WIDDEL[3]

[1]Institute for Chemistry and Biology of the Marine Environment (ICBM), University Oldenburg, Oldenburg, Germany
[2]GFZ Helmholtz-Zentrum Potsdam, Potsdam, Germany
[3]Max Planck Institute for Marine Microbiology, Bremen, Germany

Aromatic compounds and hydrocarbons are major constituents of crude oil and widespread in nature. However, they represent unusual growth substrates for bacteria, since their extraordinary chemical stability necessitates special degradation reactions and their toxic properties may challenge bacterial viability. Aerobic bacteria use the long known oxygenases, which employ highly reactive oxygen species ($O_2$-derived) as co-substrates for initial hydrocarbon activation and cleavage of the aromatic ring. In contrast, $O_2$-independent reactions are required under anoxic conditions, which prevail in many natural environments, such as marine sediments or oil reservoirs. To our current knowledge, the fumarate-dependent activation of *n*-alkanes and alkylbenzenes to their respective alkyl- and arylsuccinates appears to be the most common reaction type for hydrocarbon activation among different types of anaerobic bacteria. Interestingly, all currently known alkyl- and arylsuccinate synthases can be grouped into three distinct phylogenetic clusters that reflect the hydrocarbon substrate range of the individual enzymes. Recent proteogenomic studies with the denitrifying betaproteobacterium "*Aromatoleum aromaticum*" strain EbN1 have allowed new insights into (i) substrate-specific regulation of respective catabolic operons, (ii) metabolic strategies to deal with the toxicity of the aromatic growth substrate, e.g. formation of PHB and specific efflux systems, and have inspired (iii) the discovery of novel aromatic growth substrates and respective degradation pathways, e.g. anaerobic degradation of *p*-ethylphenol.