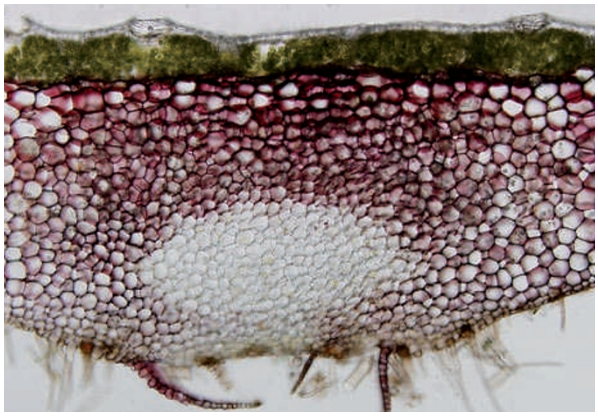
SYMBIOSIS

# Soil fungi helped ancient plants to make land



Cross section of a thallus of *Marchantia paleacea* showing cells with red pigmented walls colonized by glomeromycete fungi. Image is reproduced, with permission, from Humphreys, C. P. *et al.* © (2010) Macmillan Publishers Ltd. All rights reserved.

> “symbiotic associations with soil fungi helped ancient plants to establish themselves on the land”

The suggestion that symbiotic soil fungi assisted in the colonization of the land by early terrestrial plants in the Palaeozoic era is now widely accepted. However, evidence to support this scenario is based mainly on phylogenetic information and the fossil record. Writing in *Nature Communications*, Humphreys *et al.* now demonstrate that a mutualistic relationship between arbuscular mycorrhizal fungi (AMF) and a member of the most ancient clade of land plants promotes carbon uptake, growth and asexual reproduction in the plant.

To directly assess whether symbiosis with AMF might have assisted early plants in gaining the ability to grow on land, the authors focused on the association between members of the *Glomeromycota*, an ancient phylum of fungi, and *Marchantia paleacea*, a member of the complex thalloid liverworts, which are among the most ancient land plants. The authors generated non-mycorrhizal plants by collecting non-infected vegetative propagules and growing them in AMF-free soil, either on their own or adjacent to AMF-colonized plants to allow for the formation of the normal symbiotic associations. Plants were grown at ambient $CO_2$ concentrations (400 ppm) and at concentrations representative of the early Palaeozoic era (1500 ppm). Measurements of net $CO_2$ assimilation revealed that the AMF-associated plants had a substantially enhanced photosynthetic gain at both ambient and elevated $CO_2$ concentrations compared with the non-mycorrhizal plants. The authors also observed an increase in the uptake of phosphorus and nitrogen in the AMF-associated plants. The positive effects of the AMF association translated directly into enhanced growth, with plants exhibiting a substantial increase in biomass. Furthermore, the AMF-associated plants produced more asexual reproductive propagules, suggesting that the fungal association promotes dispersal of the host plant into new habitats. Finally, the authors observed that association with *M. paleacea* supported growth of 100–400 m of fungal mycelium, showing that the relationship between plant and fungus is truly mutualistic.

The findings provide the first functional evidence to support the proposed scenario, in which symbiotic associations with soil fungi helped ancient plants to establish themselves on the land, and also suggest that the high-$CO_2$ atmosphere of the Palaeozoic era created a uniquely strong selection pressure favouring the establishment of mycorrhiza-like partnerships in early land plants.

*Andrew Jermy*

**ORIGINAL RESEARCH PAPER**
Humphreys, C. P. *et al.* Mutualistic mycorrhiza-like symbiosis in the most ancient group of land plants. *Nature Commun.* **1**, 103 (2010)