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The art and design of harmony in arbuscular mycorrhizal symbioses

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Pavillon Charles-Eugène-Marchand, salle Hydro-Québec (1210)

Abstract:

Symbioses are fundamental to life on the Earth. The arbuscular mycorrhizal (AM) symbiosis is a fascinating beneficial interaction between roots of most land plants and soil fungi. It is so widespread that it majorly influences ecosystem functioning and is considered of fundamental importance for crop productivity and sustainability. Mutualism is achieved through an exchange of soil minerals for organic carbon at specialised fungal structures, the arbuscules. Arbuscules form inside root cortex cells, surrounded by a plant-derived membrane, the peri-arbuscular membrane (PAM), across which efflux of organic carbon and uptake of minerals occurs. However, arbuscules are ephemeral structures, forming and collapsing in a few days, implying a similarly dynamic nature for the reciprocal nutrient exchange.

We used spatial transcriptomics to capture the dynamic nature of root colonisation and arbuscule life span, and employed advanced non-invasive, live imaging to for the first time visualise arbuscule formation and turnover 'from birth to death'. However, symbiosis establishment is tightly regulated by the plant in response to its nutritional demands. We found that the rice Dwarf 14-Like (D14L) signalling pathway integrates the nutritional status of the plant with symbiotic competence, thereby enabling the engineering of continuous fungal colonization, a prerequisite for the development of symbiotic crop nutrition strategies.

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