Molecular signaling and cellular mechanisms at the basis of root colonization by arbuscular mycorrhizal fungi

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Arbuscular mycorrhizas (AM) are symbiotic associations between 90% of land plants and obligate fungal symbionts belonging to Glomeromycota (Schussler et al., 2001). AM fungi improve plant nutrient uptake and resistance against pathogens by colonizing the root through intra/intercellular hyphal development and the formation of arbuscules, the highly branched structures that mediate nutrient exchange (Parniske, 2008). The presence of a symbiotic interface compartment around the intracellular fungal structures is a landmark of AM establishment and allows fungal development inside the cell lumen whilst maintaining host cell integrity (Bonfante, 2001).

This presentation focuses on the events associated with the perception of the AM fungus and its accommodation inside the lumen of the host plant cell. Our findings, based on an in vivo confocal microscopy approach, demonstrate that root cells perceive AM fungal signals and trigger calcium-mediated signaling in their nucleoplasm, both before and upon direct contact with the fungus (Chabaud et al., 2010). Such calcium signals position within the so-called SYM pathway, the signaling pathway that controls AM establishment. Nuclear calcium spiking is a pre-requisite to the cellular reorganization that initiates the process of interface construction. This starts after the adhesion of the fungal hyphopodium to the root epidermis and leads to the assembly of the so-called prepenetration apparatus (PPA) inside one or a few contacted epidermal cells (Genre et al., 2005). The PPA is a columnar cytoplasmic aggregation containing all the elements of the secretory pathway. The exploitation of a range of fluorescent protein markers indicates that host plasma membrane proliferation takes place within the PPA. This leads to the assembly of the perifungal membrane and symbiotic interface in advance of hyphal tip growth.

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References

Schussler, A. Schwarzott, D. & Walker, C. A new fungal phylum, the Glomeromycota: phylogeny and evolution. Mycol. Res. 105, 1413-1421 (2001)
Parniske, M. Arbuscular mycorrhiza: the mother of plant root endosymbioses. Nat. Rev. Microbiol. 6, 763-775 (2008)
Bonfante, P. At the interface between mycorrhizal fungi and plants: the structural organization of cell wall, plasma membrane and cytoskeleton. In Mycota, IX Fungal Associations, ed. B Hock, pp. 45-91. Berlin: Springer-Verlag (2001)
Genre, A., Chabaud, M., Faccio, A., Barker, D.G. & Bonfante, P. Prepenetration apparatus assembly precedes and predicts the colonization patterns of arbuscular mycorrhizal fungi within the root cortex of both Medicago truncatula and Daucus carota. Plant Cell 20,1407-1420 (2008)
Chabaud, M., Genre, A., Sieberer, B.J., Faccio, A., Fournier, J., Novero, M., Barker, D.G. & Bonfante, P. Arbuscular mycorrhizal hyphopodia and germinated spore exudates trigger Ca^{2+} spiking in the legume and nonlegume root epidermis. New Phytol. doi: 10.1111/j.1469-8137.2010.03464.x (2010)