

Mycohétérotrophie et mixotrophie : ces plantes qui mangent des champignons
Mycoheterotrophy and mixotrophy : plants eating mycorrhizal fungi.

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The evolution of land plants provided repeated emergences of mycoheterotrophy, where achlorophyllous plants exploit carbon from their mycorrhizal fungi. This condition, suggested to be an adaptation to forest environments where little light is available, recently made strong achievements due to two tools: fungal molecular barcoding allowed identification of the (often uncultivable) mycorrhizal fungi; natural isotopic abundances supported which fungal guild was giving carbon to the mycoheterotrophic plants. Temperate and Mediterranean species, mainly orchids and Monotropoideae (Ericaceae), have specific basidiomycetous fungal partners that usually form mycorrhizae with surrounding trees (ectomycorrhizal fungi). By contrast, subtropical and tropical species often connect to arbuscular-mycorrhizal (AM) fungi or even to saprotrophic, wood- or litter-decaying basidiomycetes. Their specificity is often lower.

More recently, intermediate evolutionarily steps were found to exist, where the plant is still green and photosynthetic, but partly uses carbon from its fungal associates. This strategy, called mixotrophy, is now well described for green temperate orchids and Monotropoideae species associated to ectomycorrhizal basidiomycetes or sometimes ascomycetes. Phylogenetic frameworks suggest that mixotrophy pre-dispose to evolution of mycoheterotrophy. In some mixotrophic *Cephalanthera* and *Epipactis* spp. (orchids), the rare survival of achlorophyllous plants (albinos) further supports their use of fungal carbon. More recently, our investigations of albinos' nutrition and fitness revealed why emergence of mycoheterotrophy is rare in evolution of mixotrophs: photosynthesis is not used for survival, which is supported by fungal carbon, but mainly for seed production. Thus, photosynthesis loss drastically reduces fitness and, as a result, mixotrophy is evolutionarily metastable.

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