Partial mycoheterotrophy in the understory of a tropical forest in Panama: A multi-element stable isotope natural abundance approach

Gebauer Gerhard[1], Zahn Franziska E.[1], Contreras Blexein[2] & Engelbrecht Bettina M.J.[2,3]

[1] BayCEER – Laboratory of Isotope Biogeochemistry, University of Bayreuth, Bayreuth, Germany

[2] Smithsonian Tropical Research Institute, Balboa, Ancon, Panama

[3] Functional and Tropical Plant Ecology, University of Bayreuth, Bayreuth, Germany

Email: gerhard.gebauer@uni-bayreuth.de

ORCID Gerhard Gebauer https://orcid.org/0000-0003-1577-7501

Currently, an intensive and controversial discussion about the existence and relevance of common mycorrhizal networks in forests is going on (Karst *et al.*, 2023; Klein *et al.*, 2023). This discussion mostly focusses on the existence or non-existence of an organic carbon exchange between trees mediated by a network of mycorrhizal fungi and completely ignores the existence of several hundreds of fully mycoheterotrophic plant species mostly thriving in forest understories. Fully mycoheterotrophic plants are mycorrhizal, but simultaneously leafless and achlorophyllous and therefore rather obviously require organic carbon supply through their mycorrhizal fungi from neighbouring autotrophic plants. Mycoheterotrophic plants are the ultimate positive control supporting the existence of mycorrhizal networks. Mycoheterotrophic plants developed evolutionary from photosynthetic anchestors. Thus, also a mycoheterotrophic carbon gain by photosynthetic plant species closely related to mycoheterotrophic plants has to be postulated and was, indeed, found among forest orchids (Gebauer & Meyer, 2003) and Ericaceae (Zimmer *et al.*, 2007). This kind of simultaneous carbon gain from own photosynthesis and from a fungal source is now known as partial mycoheterotrophy. Recently, partial mycoheterotrophy was also identified among photosynthetic temperate forest ground plants forming the *Paris*-morphotype of arbuscular mycorrhiza (Giesemann *et al.* 2020; 2021). This latter finding initiated our most recent search for the occurrence of partial mycoheterotrophy among young tree saplings in the understory of a tropical forest in Panama. Using stable isotope and microscopic techniques, we examined whether common shade-tolerant tropical tree and shrub species are partially mycoheterotrophic as saplings. Own observations of fungal morphology within plant species (n=40) disagreed somewhat with the literature (Dickson *et al.*, 2007), indicating the demand for *in situ* determination. Enrichment in the heavy isotopes ^{13}C, ^{2}H and ^{15}N (cf. mycoheterotrophic *Voyria*) relative to surrounding plants reflected a significant partial mycoheterotrophic nutrition of at least one *Paris*-type target species (*Anacardium excelsum*). Some further tree sapling species provided some evidence towards partially mycoheterotrophic nutrition that has to be confirmed with further investigations.

References

Dickson *et al.* (2007) *Mycorrhiza* **17**: 375–393.
Gebauer & Meyer (2003) *New Phytol.* **160**: 209-223.
Giesemann *et al.* (2020) *New Phytol.* **226**: 960–966.
Giesemann *et al.* (2021) *Ann. Bot.* **127**: 645-653.
Karst *et al.* (2023) *Nat. Ecol. Evol.* Apr;7(4): 501-511.
Klein *et al.* (2023) *Open Research Europe* https://doi.org/10.12688/openreseurope.16594.1
Zimmer *et al.* (2007) *New Phytol.* **175**: 166-175.