Mycorrhiza (1993) 4:27–28

Mycorrhiza

Observations of canopy bromeliad roots compared with plants rooted in soils of a seasonal tropical forest, Chamela, Jalisco, Mexico

Michael F. Allen[1], **Emmanuel Rincon**[2], **Edith B. Allen**[1], **Pilar Huante**[2], **Jonathan J. Dunn**[1]

[1] Department of Biology, San Diego State University, San Diego, CA 92182-0057, USA
[2] Centro de Ecología, Universidad Nacional Autónoma de México, Apartado Postal 70-275, México 04510 DF, Mexico

Abstract. Roots of canopy bromeliads of a seasonal tropical forest were observed for mycorrhizal activity and compared with plants rooted in the soil during the later part of the growing season. No vesicular-arbuscular mycorrhizae or ectomycorrhizae were observed in the bromeliads. However, some interesting septate fungi were observed within the cortex of all samples where the roots were present in organic matter trapped in the canopy. All 15 soil-rooted plant species we observed were vesicular arbuscular mycorrhizal. While no known mycorrhizal types were apparently present in these canopy epiphytes, we cannot rule out the possible formation of symbioses between canopy epiphytes and other fungi in these habitats.

Key words: *Tillandsia* – *Catopsis* – Mycorrhiza – Canopy epiphytes – Seasonal tropical forest

Introduction

The roles of mycorrhizal associations in differing habitats remains the subject of ongoing research. The presence and functioning of mycorrhizae in terrestrial plants growing in soils is well documented (Allen 1992), but other habitats, such as aquatic systems, have been rarely surveyed, despite reports indicating the presence of mycorrhizal fungi (e.g., Sondergaard and Laegaard 1977). Canopy epiphyte communities represent another such habitat. One literature report indicated the presence of mycorrhizal fungi in roots of canopy bromeliads (Nadkarni 1985), but multiple observations are needed to confirm the extent of mycorrhizal associations in bromeliads.

Determining the presence of a mycorrhizal association in any system is not a trivial task. While the definition of a mycorrhiza, a fungal-plant mutualism, is functional, most assessments are made on the presence or absence of known mycorrhizal fungi or specific structures found through many years of study to cause a mycorrhizal response (e.g., enhanced growth or P uptake). Another alternative is to look for fungi that penetrate the roots but cause no defense reactions in the plant such as lignification, root browning and necrosis, or specialized enzymatic activity (Allen et al. 1989). Since mycorrhizal associations have presumably evolved independently on numerous occasions, looking for such fungi within roots that cause no defense reaction could allow one to hypothesize a "mycorrhizal" association subject to further experimentation. This approach has initiated interest in other "mycorrhizal" associations such as the "dark-septate" mycorrhiza found in alpine regions (Haselwandter and Read 1980; Allen et al. 1987).

To begin studies of the functioning of mycorrhizae in a seasonal dry tropical forest, we initiated a survey of canopy bromeliads in a seasonal tropical forest.

Correspondence to: M. F. Allen

Materials and methods

Site

Samples were taken from a seasonal tropical forest at the Biological Station of Chamela, a protected reserve belonging to the University of Mexico near Chamela, Jalisco in Mexico (longitude 19° 30′ N, latitude 105° 03′ W). The Station is located on the west coast of Mexico with an average precipitation of 748 mm, virtually all of which comes between June and October. The average temperature during the wet season is 26° C and during the dry season is 24° C. Greater detail on the climate can be found in Bullock (1986). The vegetation is extremely diverse with over 900 plant species, including over 130 species of legume trees (Lott et al. 1987). Phenology is tightly coupled to the extreme seasonality (Bullock and Solis-Magallanes 1990).

Sampling

Canopy epiphytes were collected after a large storm on 8 October 1991, near the end of the rainy season when all soil-rooted plants were observed to be have vesicular-arbuscular mycorrhizal (VAM) fungi. The storm blew numerous tree branches contain-

ing the epiphytes to the trail floors. Only freshly deposited epiphytes from the previous night were collected. Three species of bromeliads were found and collected, *Tillandsia bartramii*, *T. balbisiana*, and *Catopsis nutans*. Three specimens were collected of all species and observed. Roots were separated from the canopy branches and organic matter and stained according to Kormanik et al. (1980). The entire root length of all roots was scanned for the presence of VAM fungi or ectomycorrhizal structures of any other fungi under both a dissecting microscope at ×70 and a light microscope at ×100 and ×400.

Results and discussion

We found no VAM fungi or ectomycorrhizal structures on any of the bromeliads observed. However, a coarse, regularly septate fungus that readily stained was observed in the root cortex of all root systems. The fungus remains unknown to date as no fruiting structures were observed. It does not resemble the dark-septate endophyte found in alpine habitats (e.g., Allen et al. 1987). No defense reactions were observed, such as root browning or fluorescence, as has been found between incompatible associations or in tissues colonized by pathogenic fungi (e.g., Allen et al. 1989). All plant species rooted in soil sampled at the same time were observed to form VAM fungi. These include *Physalis maxima*, *Cordia alliodora*, *Caesalpinia eriostachys*, *Capsicum* sp., *Ctenocereus* sp., *Phaseolus lunatus*, *Opuntia excelsa*, *O. puberula*, *Jatropha stanley*, *Nopalea* sp., *Heliocarpus pallidus*, *Cochlospermum vitifolium*, *Eleocarpus* sp., *Celanodendron mexicana*, and *Jacquinia pungens*.

The lack of known mycorrhizae on the epiphytes is interesting. Certainly, the site contains VAM fungi as evidenced by the presence of these associations in the plants rooted in the soil. The rooting material of the bromeliads is highly organic wherein some types of mycorrhizal associations with a fungus could be valuable if the fungus had the ability to mineralize N and P. VAM fungi have at best only a limited capacity and, moreover, are probably not wind dispersed in the dense vegetation present (Allen 1991). Ectomycorrhizal fungi potentially could disperse and degrade the organic material but have not been found in this vegetation type. The unknown fungus observed has the potential to serve as a "mycorrhiza" but further work on this association is needed.

In general, we failed to find known mycorrhizae in these canopy bromeliads. More work on a larger scale is needed to develop patterns of mycorrhizal activity in canopies, an interesting and important component of tropical forests (e.g., Nadkarni 1985). In addition, work on other fungi found in these habitats could reveal alternative types of mycorrhizal associations specific to these conditions.

Acknowledgements. This research was supported by the National Science Foundation of the USA under grants INT 9102120 and BSR 8818266 and by the National Council for Science and Technology of Mexico (CONACYT), no. 0165 N9107.

References

Allen EB, Chambers JC, Conner KF, Allen MF, Brown RW (1987) Natural reestablishment of mycorrhizae in disturbed alpine ecosystems. Arct Alp Res 19:11–20

Allen MF (1991) The ecology of mycorrhizae. Cambridge University Press, New York

Allen MF (1992) Mycorrhizal functioning. Chapman & Hall, New York

Allen MF, Allen EB, Friese CF (1989) Response of the non-mycotrophic plant *Salsola kali* to invasion by vesicular-arbuscular mycorrhizal fungi. New Phytol 111:45–49

Bullock SH (1986) Climate of Chamela, Jalisco, and trends in the south coastal region of Mexico. Arch Meteorol Geophys Bioclimatol Ser B 36:297–316

Bullock SH, Solis-Magallanes JA (1990) Phenology of canopy trees of a tropical deciduous forest in Mexico. Biotropica 22:22–35

Haselwandter K, Read DJ (1980) Fungal associations of roots of dominant and subdominant plants in high alpine vegetation systems with special reference to mycorrhizae. Oecologia 45:57–62

Kormanik PP, Bryan WC, Schultz RC (1980) Procedures and equipment for staining large numbers of roots for endomycorrhizal assay. Can J Microbiol 26:536–538

Lott EJ, Bullock SH, Solis-Magallanes JA (1987) Floristic diversity and structure of upland and arroyo forests of coastal Jalisco. Biotropica 19:228–235

Nadkarni NM (1985) Roots that go out on a limb. Nat Hist 94:42–48

Sondergaard M, Laegaard S (1977) Vesicular-arbuscular mycorrhiza in some aquatic plants. Nature (London) 268:232–233