THE EFFECT OF MYCORRHIZAE ON BAMBOO GROWTH

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Abstract: In some systems, plant interactions with mycorrhizal fungi can range from mutualism to parasitism depending on the environment. On Cerro de la Muerte two types of bamboo dominate the understory, *Chusquea longifolia* and *Chusquea subtessalata*, and both species are associated with obligate symbiotic mycorrhizal fungi. We tested whether differences in growth rates among bamboo patches could be a function of mycorrhizae symbiosis. We sampled *Chusquea* spp. at Cuerici Estación Biológica and measured bamboo height, density, biomass and mycorrhizal root coverage. All three measures tended to decrease with increasing mycorrhizae coverage. Mycorrhizal fungi could be parasitic in this system, or may just be present in areas of poor soil that lead to low bamboo growth rates.

Key words: C. longifolia, C. subtessalata, Chusquea, *conditional interaction, mycorrhizal fungi, obligate mutualism*

INTRODUCTION

Mycorrhizal fungi are an important part of many forests, particularly in nutrient-poor soils such as those that prevail in many tropical ecosystems (Begon et al. 1990). Depending on conditions, mycorrhizae can be either beneficial or parasitic to the host plant. Mycorrhizae aid in nutrient uptake, enabling plants to grow in areas with poor soil conditions. However, there is a cost to the plant to maintain the mycorrhizal fungi, so if nutrients are readily available without the mycorrhizae, the fungi can become a parasite. Lovelock et al. (1996, as cited in Leigh 1999) found that plants with associated mycorrhizae on roots often have lower growth rates than plants without mycorrhizae.

Two species of bamboo that dominate the understory on Cerro de la Muerte, *Chusquea longifolia* and *Chusquea subtessalata* (McLearn 1999), have an obligate, mutualistic mycorrhizae (Solano and Seely, pers. comm.). Both *C. longifolia* and *C. subtessalata* occur in patches that differ in the size of plants and density of stems. Because *Chusquea* spp. are monocarpic, semelparous, and reproduce synchronously (Janzen 1983), all stems are the same age and differences among patches in plant size must be a result of different growth rates.

We tested whether differences in plant growth rate among *Chusquea* patches could be a function of differences in mycorrhizal relationships. If areas of high *Chusquea* spp. biomass have more mycorrhizae than areas of low *Chusquea* spp. biomass, the implication would be that mycorrhizal fungi are augmenting bamboo growth in this system. However, if areas of low *Chusquea* spp. biomass have more mycorrhizae, the implication would be that mycorrhizae are inhibiting growth.

METHODS

We sampled *C. longifolia and C. subtesselata* along the loop trail at Cuericí Estación Biológica, Cerro de la Muerte, Costa Rica on 29 - 30 January 2004. For each species, we haphazardly chose five areas that appeared to have low bamboo biomass (i.e., low stem density, small plants) and five areas that appeared to have high bamboo biomass (i.e., high stem density, large plants). To quantify bamboo size and density, we recorded the number of shoots of the target species within a 2 m^2 plot and recorded their average height. We calculated an index of biomass per 2 m^2 as number of stems x height (in m).

To estimate mycorrhizal density, we ran-

domly selected three 10 cm lengths of growing, small diameter root from *Chusquea* taken from different points within each 2 m^2 plot. We rinsed the roots with water to remove loose soil and examined them under a dissecting microscope. We ranked mycorrhizae coverage on a scale of zero to five, with zero being no visible fungus and five being a complete fungal sheath.

RESULTS

We observed three or four different mycorrhizae morphotypes on the root samples we examined. The most prevalent were dark, thin hyphae that covered the roots and the root tips. Another morphotype created a clear gelatinous sheath around the roots. In one sample, the mycorrhizae was white and covered the entire root surface.

All three measures of bamboo growth (height, density, and biomass index) tended to decrease as mycorrhizae coverage increased, although results were not significant (Fig. 1). *C. longifolia* height decreased strongly with increasing mycorrhizae coverage (r = -0.57, P = 0.08), and *C. subtesselata* height also decreased with increasing mycorrhizae coverage (r = -0.21, P = 0.55). For both species, density was unrelated to mycorrhizae coverage (*C. longifolia*: r = -0.13, P = 0.72; *C. subtesselata*: r = -0.09, P = 0.81). Biomass of both species tended to decrease as mycorrhizae coverage increased (*C. longifolia*: r = -0.51, P = 0.13; *C. subtesselata*: r = -0.11, P = 0.76).

DISCUSSION

Our results suggest that lower growth rates are associated with high mycorrhizae root

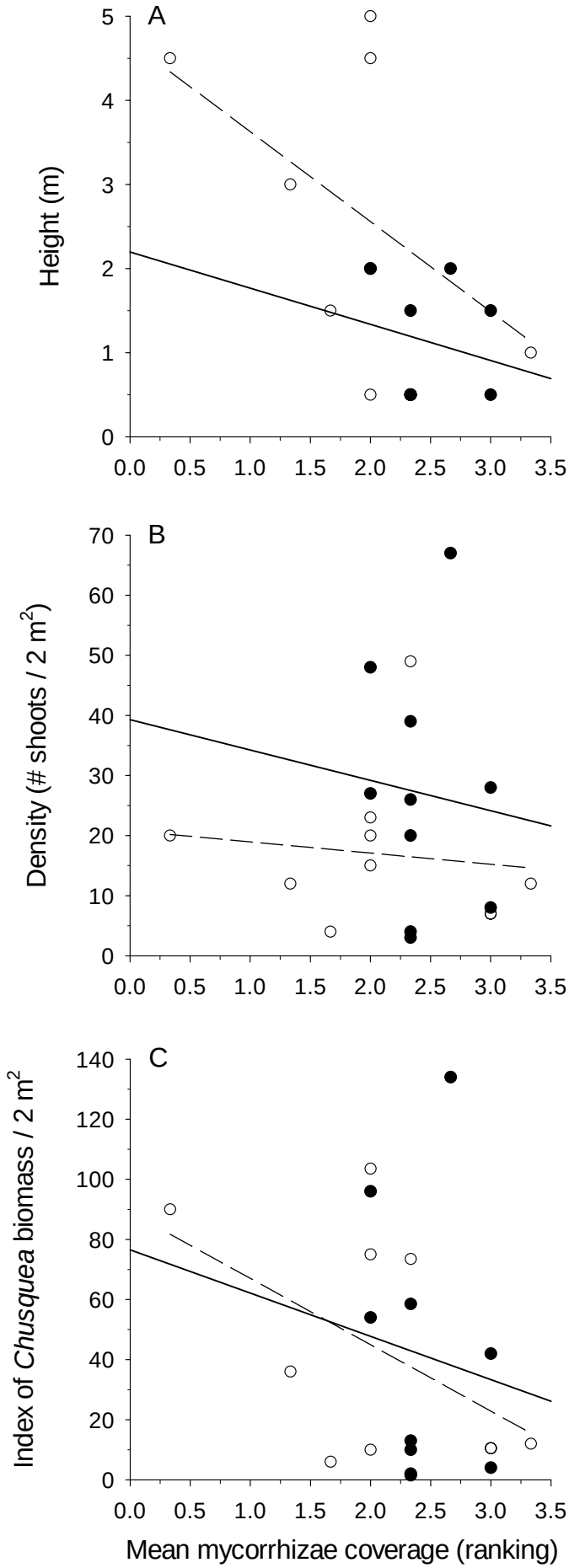

Figure 1. Correlations of height, density, and biomass of *Chusquea* spp. with average mycorrhizae abundance. N = 10 for both species. Open circles, dashed line = *C. longifolia*. Filled circles, solid line = *C. subtesselata*.

coverage. It is possible that in this system, soil nutrients are high therefore mycorrhizal fungi are parasitic on *Chusquea* spp. and decrease bamboo growth rates. Stem density was unrelated to mycorrhizae coverage, suggesting that mycorrhizal fungi do not limit the number of shoots but instead worsen growing conditions for existing plants.

Another explanation for the results could be that bamboo growth rates are low in certain areas because of low soil nutrients. In these areas *Chusquea* may invest heavily in its fungal symbionts, so mycorrhizae are abundant even though they cannot improve growth rates to be equal to rates in nutrient-rich soils. One way to test these two theories would be to manipulate mycorrhizal abundance across different soil types.

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