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The mosaic of habitats in the high-altitude Brazilian rupestrian fields is a hotspot for arbuscular mycorrhizal fungi

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ABSTRACT

The high diversity in rupestrian field vegetation has been attributed to the mosaic of environments formed by several soil classes, rugged relief and microclimatic variation. Although advances in the knowledge of some biological areas in rupestrian fields have been made, little is known about the relevance of soil microorganisms and their relationships with the vegetation. Symbiosis with arbuscular mycorrhizal fungi (AMF) is one of the most studied interactions between microorganisms and plants, because they are ubiquitous and contribute to the sustainability of ecosystems. This study aimed to investigate the occurrence and diversity of AMF species and to evaluate their relationship with soil physicochemical attributes and plant diversity in different habitats of the rupestrian fields from the Cadeia do Espinhaço, Serra do Cipó, Brazil. These rupestrian fields were delimited into five distinct habitats: rock outcrop, quartz gravel fields, sandy bogs, peat bogs and the Cerrado. Forty-nine AMF species were identified as belonging to nine families and twelve genera. Among them, *Acaulospora colossica* and *Pacispora dominikii* were found for the first time in Brazil. The results of this study suggest that the diversity of AMF is related to the heterogeneity of habitats and that the soil texture (coarse sand, gravel and silt) is better related to the structure of these fungi communities than to the soil chemical attributes. Plant species richness was related to AMF richness only in the quartz gravel field, rocky outcrop, and sandy bog habitats. Considering these habitats constitute one of the most menaced ecosystems on the planet, our survey provides information to improve knowledge about rupestrian field biodiversity, thus supporting policy actions for its conservation and preservation.

1. Introduction

The mechanisms and processes that determine the structure and function of ecosystems, as well as changes in these, are not yet fully understood, especially those found in some tropical mountains. The Cadeia do Espinhaço in Brazil is about eleven hundred kilometers long, with an average width from 50 to 100 km and a wealth of plants and animals. It contains formations of at least three biomes, including the Caatinga, Atlantic Forest and Cerrado (Brazilian savanna) phytophysiognomies. Located in the southern part of Cadeia do Espinhaço, Serra do Cipó is generally credited as belonging to the Cerrado biome. With an altitude above 900 m, this region is dominated by rupestrian fields, which comprise a unique ecosystem and are known for their great diversity of species, mostly plants, and its high endemism index (Joly, 1970; Giulietti et al., 2000; Menezes and Giulietti, 2000; Vitta, 2002; Conceição and Pirani, 2007). The number of plant species in this area is estimated at 4000, with approximately 30% from exclusive taxa (Giulietti et al., 1997). The rupestrian fields are composed of a rich mosaic of habitats, which are distinguished by the substrate configuration, continuity of vegetation, floristic composition, proportion of exposed rock, and presence of rock blocks and sand sediments; they can remain dry or periodically waterlogged in the rainy season

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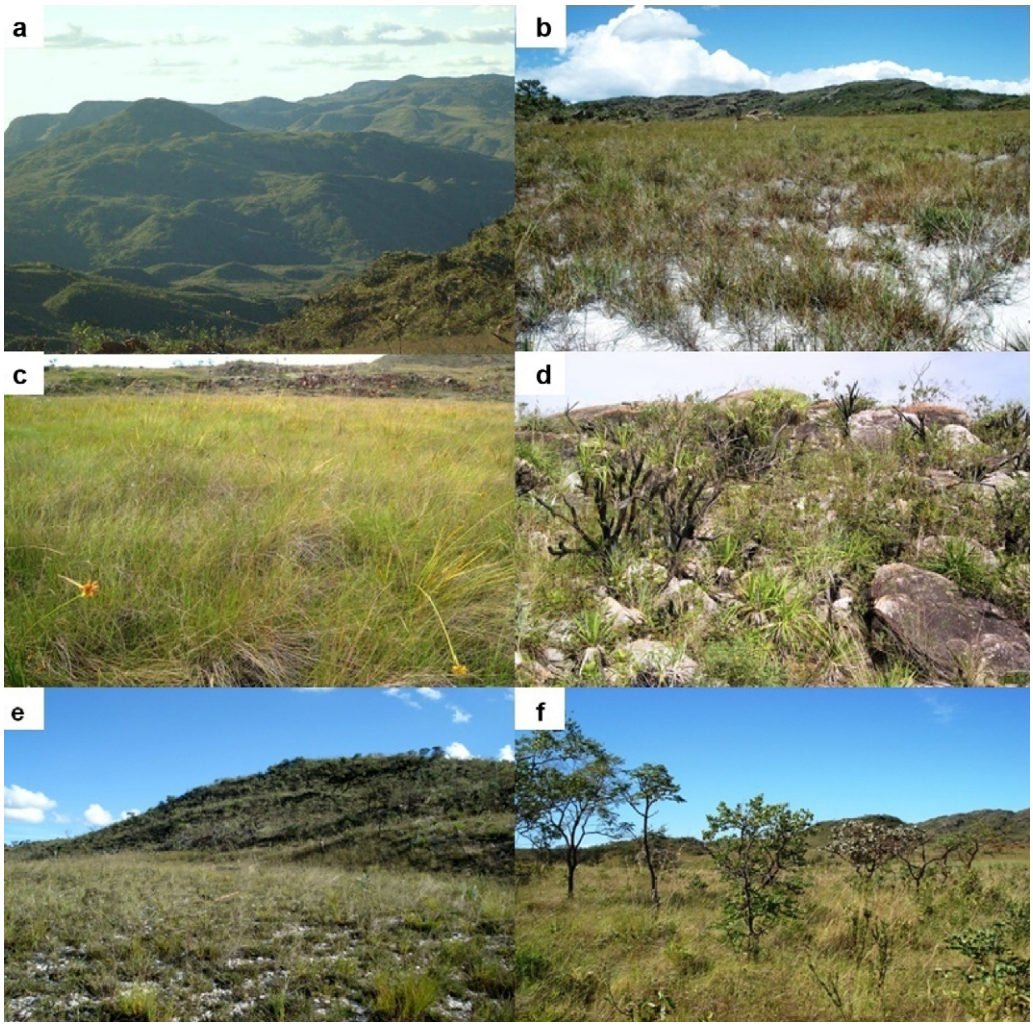

Fig. 1. Habitats found in the Serra do Cipó area studied. (a) Rupestrian field mountains, (b) Sandy Bogs; (c), Peat bogs; (d), Rocky outcrops (d), Quartz gravel fields (e) and the Cerrado (f).

(Conceição, 2000; Conceição and Pirani, 2005, 2007) between the months of November to March. In the rupestrian fields of Serra do Cipo 5 main phytophysiognomies occur: (1) Sandy bogs; (2) Peat bogs; (3) Rocky outcrops; (4) Quartz gravel field; and (5) Cerrado. The soil, poor in nutrients and thin (Benites et al., 2003), is one of the factors modulating the different types of habitats within the rupestrian fields.

The involvement of arbuscular mycorrhizal fungi (AMF) on the ecosystem diversity and function is mainly due to its effect on plant diversity and productivity. Several studies have reported positive relationships between plant diversity and AMF diversity (e.g., Grime et al., 1987; van der Heijden et al., 1998). Therefore, the presence of AMF may be essential for ecosystem sustainability, plant development and maintenance of biological diversity. However, such knowledge is not available for the ecosystems of the rupestrian fields.

The AMF (Glomeromycota) are the most common microsymbionts of plant roots (Smith and Read, 2008). These fungi establish mutualistic relationships with approximately 80% of plant species, acting as an extension of the plant root system, thereby leading to greater absorption and utilization of soil nutrients (Siqueira et al., 2002; Moreira and Siqueira, 2006). They assist in the acquisition and translocation of nutrients (de Souza et al., 2008), enhances water absorption capacity and increases the resistance of the plant root system to pathogen attacks (Jeffries et al., 2003; de Souza et al., 2008).

The Glomeromycetes origin was estimated to have occurred 300 Ma before the appearance of the land plants (Heckman et al., 2001). Nevertheless, the glomeromycotan diversity is surprising low as compared to the terrestrial plant diversity, this result is explained by difficulties to access the underground diversity and to distinguish closely related species (de Souza et al., 2008). Indeed, only approximately 217 species have been described so far worldwide and from these the occurrence of 119 has been recorded for Brazil (de Souza et al., 2010). There is a clear gap of studies in this field. However, previous studies carried out in Brazil have been limited to certain vegetation types or ecosystems (Stürmer and Siqueira, 2008; Carrenho et al., 2010; Oliveira and Oliveira, 2010; Zangaro and Moreira, 2010; Maia et al., 2010; Stürmer et al., 2010).

Considering that the rupestrian fields are composed of different habitats with high diversity and are rich in endemic species, they are also expected to harbor large numbers of AMF. Therefore, we evaluated the specific composition of AMF communities and then to evaluate the relationship of the diversity of these organisms with the soil physical–chemical attributes and the plant diversity in different habitats of the rupestrian fields of Serra do Cipó, Minas Gerais State, Brazil.