available at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.elsevier.com/locate/funeco

Taxonomic diversity and community structure of arbuscular mycorrhizal fungi (Phylum Glomeromycota) in three maritime sand dunes in Santa Catarina state, south Brazil

Sidney Luiz STÜRMER, Rosilda STÜRMER, Diego PASQUALINI*

Departamento de Ciências Naturais, Universidade Regional de Blumenau, Cx.P. 1507, 89012-900 Blumenau, SC, Brazil

ARTICLE INFO

Article history:
Received 14 May 2012
Revision received 22 August 2012
Accepted 12 September 2012
Available online 9 November 2012
Corresponding editor:
Kabir G. Peay

Keywords:
Community analysis
Mycorrhizal inoculum potential
Soil fungi
Species richness
Spore abundance

ABSTRACT

Community structure and species richness of arbuscular mycorrhizal fungi (Phylum Glomeromycota) were studied in sand dune sites at Itapiruba (southern), Joaquina (intermediate) and Praia Grande (northern) beaches along the coast of the state of Santa Catarina, Brazil. In each site, a 20 × 20 m plot was established and 20 soil samples collected in a regular grid pattern. Fungal spores were extracted from each sample, counted and identified to species level. A total of 25 species were recovered belonging to seven genera and five families in the Glomeromycota. *Gigaspora albida* and *Acaulospora scrobiculata* occurred in >50 % of samples at all three sites. Other common species whose sample frequency was >50 % in one or two sites were *Scutellospora weresubiae*, *Scutellospora cerradensis* and *Racocetra gregaria*, while the remaining majority of species were detected in <25 % of samples within a given site. Dune sites could be differentiated based on the higher frequency of occurrence of *S. cerradensis* and *Acaulospora morrowiae* in Itapiruba, *S. weresubiae* in Joaquina, and *Scutellospora hawaiiensis* in Praia Grande. No differences across sites were observed for species richness and total spore numbers, the latter averaging from 28.8 to 31.8 spores per 100 ml soil. Shannon diversity was significantly higher in Praia Grande compared to the other two sites. Differences in the relative spore abundance of genera among dunes were detected only for *Scutellospora*, which was significantly more abundant in the Joaquina beach. Community structure, as depicted by species rank/log abundance graphs, was not significantly different between areas according to the Kolmogorov–Smirnov two-sample test. Species accumulation curves demonstrated that 13 samples were enough to detect 90 % of all species. Overall, sand dune systems share similar arbuscular mycorrhizal fungal communities despite being geographically distant (150 km) from each other.

Introduction

The Phylum Glomeromycota contains the arbuscular mycorrhizal fungi (AMF), a group of soil fungi that are well known for establishing the arbuscular mycorrhizal associations with land plants occurring in most of terrestrial ecosystems (Brundrett 1991). Members of this phylum are considered ancient eukaryotes, and structures resembling spores and arbuscules of extant taxa have been found in fossil plants from the Ryhnie chert formation (Remy *et al.* 1994). Despite

* *Corresponding author*. Tel.: +55 47 3321 0924/0363; fax: +55 47 3321 0233.
E-mail address: sturmer@furb.br (S.L. Stürmer).
1754-5048/$ – see front matter
http://dx.doi.org/10.1016/j.funeco.2012.10.001

their long evolutionary history and obligate association with photoautotrophs, there are few species in this group (*ca.* 230 species) which are extremely low compared to the Ascomycota and Basidiomycota. Currently, AMF are distributed in 11–14 families and 18–29 genera depending on the classification scheme followed.

In association with plant roots, AMF spread their hyphae beyond the root surface and colonize the surrounding substratum, increasing considerably the available surface area for nutrient uptake. This has considerable benefits for host plant nutrient uptake, especially phosphorus and nitrogen, which results in improved plant growth and nutrition (Smith & Read 2008). AMF may also contribute to soil structure by entanglement of soil particles by fungal hyphae or through "glomalin"-mediated aggregation (Purin & Rillig 2007), and promote plant tolerance to drought and saline stress (Evelin *et al.* 2009). AMF may be particularly beneficial for plants colonizing a dune ecosystem where they are subjected to low nutrient contents, low organic matter, high salinity levels and sand movement (Willis 1989; Henriques & Hay 1998).

Sand dunes have been extensively surveyed for AMF occurrence in several countries around the world including the USA (Koske 1987), Denmark (Błaszkowski & Czerniawska 2011), Poland (Błaszkowski 1994), Brazil (Stürmer & Bellei 1994), Mexico (Corkidi & Rincón 1997), Italy (Giovannetti & Nicolson 1983), India (Kulkarni *et al.* 1997) and Japan (Abe *et al.* 1994). Stürmer *et al.* (2010) compiled data from the literature and found that 65 AMF species have been reported from sand dune systems worldwide, representing 28 % of the total species, including 32 newly described species (Błaszkowski & Czerniawska 2011). Therefore, sand dunes represent an important habitat for the discovery of new AMF species and understanding the biology of some AMF species. For example, *Scutellospora hawaiiensis* has been reported only from dunes (Koske & Gemma 1995).

AMF species richness and community structure are determined by distinct processes in terrestrial ecosystems such as habitat mosaic (De Carvalho *et al.* 2012), soil characteristics (Santos-González *et al.* 2011; Ji *et al.* 2012), long-term fertilization (Wu *et al.* 2011), invasive plants (Barto *et al.* 2011), tree-based intercropping (Bainard *et al.* 2011) and distinct land use systems (Stürmer & Siqueira 2011). For sand dunes, Koske (1987) observed the effects of a temperature gradient on AMF community structure and frequency of occurrence of some AMF species; species richness increased from 4.2 to 6.3 from the northern toward the southern portion of a longitudinal transect. Cordoba *et al.* (2001) observed that the AMF community was dominated by distinct families along a gradient of dune stabilization: Gigasporaceae dominated embryonic dunes, while Acaulosporaceae and Glomeraceae dominated in foredunes and fixed dunes, respectively.

The state of Santa Catarina in the south region of Brazil is located between the latitudes of 25°57′41″ and 29°23′55″ S. The coastline is situated in the western portion of the state along the Atlantic Ocean with *ca.* 460 km in length consisting of rocky shores, mangroves, lakes, "Restinga", and sand dunes. In recent decades, coastal vegetation, especially where sand dunes developed, has been suppressed by intensive extraction of sand, recreation and human settlements (Cordazzo & Costa 1989). It is now difficult to find sand dunes with no or little human interference making this ecosystem one of the most threatened in the state. Thus, knowledge of AMF species occurring in sand dunes of Santa Catarina is important to improve our knowledge of sand dune biodiversity and to support policies and actions for its preservation. In the present paper, our goal was to assess AMF species richness and evaluate community structure of AMF in three sand dune sites with very little human interference and located in distinct latitudes in the state of Santa Catarina. Considering that edaphic factors and plant communities are similar among sites, we hypothesized that AMF community structure and species richness are not different among sand dune sites despite their location in three distinct latitudes.

Materials and methods

Study area

The diversity of AMF species was measured in sand dune areas in three locations along the Atlantic coastal region of Santa Catarina state, in the southern region of Brazil: (D1) Itapiruba beach, Imbituba, (D2) Joaquina beach, Florianópolis, and (D3) Praia Grande beach, São Francisco do Sul (Table 1). Dunes in Itapiruba beach are a relatively undisturbed system

Table 1 – Location, climate characteristics and vegetation of three sand dune systems in Santa Catarina state, southern Brazil.

	D1	D2	D3
Locality	Imbituba, Itapirubá beach	Florianópolis, Joaquina beach	São Francisco do Sul, Praia Grande beach
Coordinates	28°20′54.4″S 48°42′57.8″W	27°37′45.0″S 48°26′58.1″W	26°14′45.7″S 48°30′35.7″W
Mean annual temperature	19.5 °C	19.5 °C	20 °C
Mean annual precipitation	1 300–1 500 mm	1 500–1 700 mm	1 700–1 900 mm
Vegetation	*Spartina ciliata*, *Sporobolus virginucus*, *Hydrocotyle bonariensis*, *Cyperus* sp., *Andropogon* sp., *Eupatorium* sp.	*Spartina ciliata*, *S. virginicus*, *H. bonariensis*, *Ipomoea pes-caprae*, *Remirea maritima*, *Acicarpha spatulata*, *Polygala cyparissias*, with sparse shrubs of *Dodonaea viscosa* and *Eupatorium* sp.	*S. virginicus*, *R. marítima*, *H. bonariensis*, *Cyperus* sp., *Ipomoea littoralis*, *A. spatulata*, *Tibouchina urvilleana*, *Croton* sp., *Canavalia* sp., *Eupatorium* sp.