Mycorrhiza (2004) 14:375–381
DOI 10.1007/s00572-004-0297-2

ORIGINAL PAPER

Admir J. Giachini · Luiz A. B. Souza ·
Vetúria L. Oliveira

Species richness and seasonal abundance of ectomycorrhizal fungi in plantations of *Eucalyptus dunnii* and *Pinus taeda* in southern Brazil

Received: 7 April 2003 / Accepted: 3 February 2004 / Published online: 6 March 2004
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Abstract The abundance and diversity of ectomycorrhizal fungi (EMF) was assessed based on the collection of basidiocarps during 12 months comprising the spring of 1995, and the summer, autumn, and winter of 1996, in three stands of young, middle-aged, and rotation age plantations of *Pinus taeda* and *Eucalyptus dunnii*, in the state of Santa Catarina, southern Brazil. A total of 3,085 collections yielded 34 presumed EMF taxa in ten genera, including mushroom-like and sequestrate species. Fruiting patterns of EMF differed with host and season, and host specificity was apparent in some. The overall relative importance (RI) and the Shannon diversity index (*H*) suggested that stands of *E. dunnii* had a more diverse aboveground EMF community than those of *P. taeda*. Overall, species of *Scleroderma* and *Laccaria* were not only the most abundant but also had the highest biomass values. The results show that a small number of species of abundant biomass and a larger number of species of less-abundant biomass characterize each forest class.

Keywords Fungal diversity · Species richness · Ectomycorrhiza · *Eucalyptus* · *Pinus*

Introduction

Despite the importance of ectomycorrhizal fungi (EMF) in forest ecosystems, little is known about their community structure and dynamics in natural and man-made vegetation in the tropics (Hawksworth 1991). Information on distribution patterns, host specificity, and factors that control or limit EMF abundance in such environments remains incomplete. For these reasons, Cairney (2000) considers that the number of EMF species is normally underestimated, and that it will increase significantly as diversity of EMF is further explored.

Recent interest in maintaining biological diversity has intensified the need to inventory all organisms in forested areas around the world. Accurate mycological data in man-made and native, and disturbed and undisturbed, forests are needed to understand fungal community dynamics and to recognize the magnitude of their di-versity.

Few studies on EMF diversity and ecology in native and/or introduced forests have been accomplished in Brazil (Singer and Araújo 1979; Singer et al. 1983; Yokomizo 1986; Giachini et al. 2000). Most of these studies are limited to mushroom-forming fungi, thus neglecting an important portion of the ectomycorrhizal community, represented by sequestrate species (fungal sporocarps that have evolved from having exposed hymenia and forcibly discharged spores to a closed or even hypogeous habit in which spores are retained in the sporocarp until it decays or is eaten by an animal vector). Although Giachini et al. (2000) showed the diversity of EMF species in plantations of *Eucalyptus* and *Pinus* in Brazil to be much higher than previously reported, and that sequestrate species are an important component of these plantations, no information on the pattern of distribution of associated EMF is available, suggesting that more long-term studies are needed to fully inventory the ectomycorrhizal communities of these habitats.

During a 12-month study, Giachini et al. (2000) identified 49 species of EMF representing 9 orders and 12 families including mushroom-like and sequestrate species. Among them several species have never been reported for Brazil and/or South America, and of those, three are new species. Furthermore, different communities of EMF were detected under the conditions studied, corroborating the specificity phenomenon observed in many host-fungi associations (Trappe 1987; Trappe and Luoma 1992; Smith and Read 1997), raising additional

A. J. Giachini (✉) · L. A. B. Souza · V. L. Oliveira
Departamento de Microbiologia e Parasitologia,
Centro de Ciências Biológicas,
Universidade Federal de Santa Catarina,
Caixa Postal 476, SC 88040–900 Florianópolis, Brazil
e-mail: giachina@onid.orst.edu
Fax: +1-541-7371393

Present address:
A. J. Giachini, Department of Forest Science,
Oregon State University,
Corvallis, OR 97331–5752, USA

questions regarding which factors may be involved in fungal establishment and diversity in these ecosystems.

Eucalyptus and *Pinus* were introduced to South America in the early 1900s with the main objective of boosting the paper and cellulose industries. High temperatures and abundant water, in conjunction with the often rich soils, allowed these plants to prosper, yielding short rotation cycles, averaging 18 years for *Pinus* and 9 years for *Eucalyptus*. Currently, Brazil alone has more than 4.6 Mha planted with species of these genera, of which more than 10% are located in the state of Santa Catarina. The occurrence of ectomycorrhizas with these plants is well documented in many different parts of the world (Dighton et al. 1986; Dahlberg 1991; Castellano and Bougher 1994; Dunstan et al. 1998; Lu et al. 1999; Bougher and Lebel 2001). For Brazil, however, little is known about the fungal community associated with these hosts.

With these concerns in mind, the broad scope of this study was to determine EMF community structure based on the occurrence of EMF sporocarps in relation to host species and season of the year in *Pinus taeda* and *Eucalyptus dunnii* plantations in Santa Catarina State, southern Brazil. This study will provide information about fungal species richness, sporocarp production, aboveground fungal community structure, and dynamics of fungal sporocarp phenology.

Materials and methods

Biogeographic aspects of the sampling sites

Over 12 months—the spring of 1995 (November, December), and summer (February, March), autumn (April, May, June), and winter (August, September) of 1996—four field trips per season were made to three stands of *P. taeda* (1, 9, and 18 years old) and three stands of *E. dunnii* (1, 7, and 9 years old) located in Correia Pinto and Bom Retiro, in the state of Santa Catarina, southern Brazil (for location details see Giachini et al. 2000). Stands were located from 3 to 130 km apart, at about 800 m above sea level, on slopes of 5–7%, on latitudes between 27°35′ and 27°45′ S and longitudes between 49°30′ and 50°22′ W. Stands were set on a brown, moderately-to-well drained cambisol, with an average pH of 4.8 and organic matter content of 6.4%. The climate in these areas is defined as mesothermic humid, with mild summers and a mean temperature of 16°C. Annual precipitation ranges from 1,400 to 2,000 mm/year with a pronounced dry spell from April through July (Anonymous 1986). Each stand was inventoried in three blocks of a hundred 4 m^2 plots each, for a total of 300 plots per stand per season (four seasons). Plots were re-sampled at each season.

No additional ectomycorrhizal hosts were detected under the main canopy for plant species inventoried. *P. taeda* stands were free of any understorey plant species, except for the youngest, which had several grass species, whereas *E. dunnii* stands had several small understorey species belonging to the genera *Baccharis*, *Bidens*, *Panicum*, *Setaria*, *Sida*, and *Vernonia*.

All sporocarps of putative ectomycorrhizal species were collected, packed and labeled from each 4 m^2 plot. In addition to collecting mushroom-forming species, the topsoil was raked to look for sequestrate sporocarps. Topsoil plus litter fall were replaced after each visit to reduce the effects of disturbance. For each field visit, fresh specimens were photographed and notes taken on macro and micro morphology as described by Giachini et al. (2000). Further morphological and anatomical details were obtained from hand-cut and microtomed sections. Sporocarps were oven-dried (38°C±1) for 10 days and subsequently weighed for fungal biomass assessments.

Data analysis

EMF diversity was obtained via the Shannon diversity index (H'; Clifford and Stephenson 1975) using the combination of number of species recorded and total number of individuals over the total number of species as shown below:

$$H' = -\sum pi \ln pi \quad (1)$$

pi being the proportional abundance of the ith species =(n/N).

The Shannon index was chosen because it weighs towards species richness (number of species per unit area) and therefore is more useful for detecting differences between sites, hosts, and seasons than other indices, which normally emphasize the dominance/evenness component of diversity (Magurran 1988).

The relative importance (RI) of each species was also calculated according to Nantel and Neumann (1992). The relative dry mass (RDm) for each species was calculated by dividing the dry mass value of sporocarps of each species (Dmi), by the total dry mass of all species (Dmt) of the same block, and multiplying the result by 100:

$$\mathrm{RDm} = (\mathrm{Dmi}/\mathrm{Dmt}) \times 100 \quad (2)$$

The number of 4 m^2 plots in which each species was found (spatial frequency) was determined, and the value of relative spatial frequency (RSf) was obtained by dividing its frequency (Fi) by the total frequency of all species (Ft) of the same block, and again multiplying the result by 100:

$$\mathrm{RSf} = (\mathrm{Fi}/\mathrm{Ft}) \times 100 \quad (3)$$

To obtain the RI of each species, we simply summed the values of RDm (Eq. 2) and RSf (Eq. 3):

$$\mathrm{RI} = \mathrm{RDm} + \mathrm{RSf} \quad (4)$$

Results

Abiotic factors

Rainfall for September 1995 through August 1996 was 1,860 mm, and the mean temperature 21.75°C. Both rainfall and temperature were slightly above the mean annual values for the region, which are 1,700 mm and 16°C, respectively. Total precipitation and mean temperature for the spring were 427 mm and 21°C, summer 646 mm and 28.7°C, autumn 324 mm and 22°C, and winter 461 mm and 15.3°C.

Abundance of sporocarps

A total of 3,085 collections of EMF were obtained in the six sampled stands, comprising 28 identified taxa in 10 genera with an additional 6 unknown *Scleroderma* species. Two species, *Scleroderma areolatum* and *S. citrinum*, had the highest RI values in the *E. dunnii* stands from spring through autumn. For *P. taeda* the highest RI values were obtained for *S. citrinum*.

Scleroderma alone accounted for 78%, 81% and 63% of the total RI for *E. dunnii* and 79%, 87% and 82% of the total RI for *P. taeda* during autumn, spring, and summer, respectively. Overall, this genus accounted for approximately 62% of the total RI observed (Table 1).

The second most abundant genus observed was *Laccaria*. *Laccaria* species, particularly *L. laccata* var. *laccata*, were the most abundant taxa fruiting from spring to autumn under both host species. *Laccaria* accounted for 77% and 58% of the total RI for the winter for *E. dunnii* and *P. taeda*, respectively. During winter, *L. bicolor* in *E. dunnii*, and *L. laccata* var. *laccata* in *P. taeda*, were the species with the highest RI values of all fungi encountered.

Host specificity

Chondrogaster, *Descomyces*, *Labyrinthomyces*, *Setchelliogaster*, some *Laccaria* (*L. laccata* var. *pallidifolia* and *L. proxima*) and some *Scleroderma* species (*S. albidum*, *S. areolatum*, *S. bougheri*, *S. cepa*, and five unidentified species) were observed only under *E. dunnii*. Conversely, *Amanita*, *Lactarius*, *Rhizopogon*, *Suillus*, and some *Scleroderma* species (*S. fuscum* and *Scleroderma* sp. P5) were verified only under *P. taeda* (Table 1).

Because stand age classes were not replicated, it is not possible to analyze the results in detail. However, general trends showed *Laccaria* (*L. laccata* var. *laccata* and *L. pumila*), *Scleroderma citrinum*, and *Suillus granulatus* occurring in all stands of *P. taeda* regardless of plantation age. *Amanita muscaria*, *Lactarius fragilis* var. *fragilis*, and *L. rufus* var. *parvus* were restricted to the 18-year-old *P. taeda* stand. For *E. dunnii*, *Laccaria amethystina*, *L. bicolor*, *L. laccata* var. *laccata*, *L. pumila*, *L. tortilis*, and *Scleroderma areolatum* were observed under stands of all ages (Table 1). On the other hand, *L. proxima*, *S. cepa*, and 3 unidentified species of *Scleroderma* (16, 43, and 88), were restricted to the 1-year-old stand, while *Descomyces albellus* and *S. bougheri* were restricted to the 9-year-old stand.

Fungal diversity

The Shannon index (H') showed higher diversity of fungi under *E. dunnii* compared to *P. taeda* ($p<0.001$, $\alpha=0.05$) (Table 2). In each season studied, H' had a statistically unique value that was host-independent ($p<0.001$). Autumn, followed by winter, had the highest diversity of EMF species independently of the host analyzed (Fig. 1, Table 2). For *E. dunnii*, H' values in spring and winter were not significantly different (Table 2). For this host species, autumn, followed by summer, was the season with the highest diversity of EMF (Table 2). For *P. taeda*, however, the index was statistical different at every season ($p<0.001$). Winter was the season with the highest diversity of species recorded, followed by autumn.

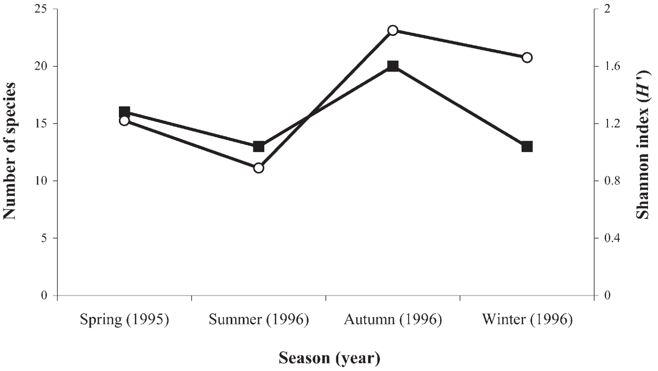

Fig. 1 Seasonal abundance (number of species) and diversity/species richness (Shannon index, H') of ectomycorrhizal fungi in plantations of *Eucalyptus dunnii* and *Pinus taeda* in Santa Catarina, southern Brazil, from spring 1995, and summer, autumn, and winter of 1996. ■ Total number of species, ○ H'

Fungal biomass productivity

Scleroderma citrinum (92%) and *S. areolatum* (3.5%) accounted for over 95% of the total fungal biomass. In terms of total fungal biomass, *P. taeda* stands produced a much higher total dry biomass compared to *E. dunnii* (Tables 1, 3). The conifer stands accounted for 87.5% (ca. 35.8 kg/ha) of the total dry biomass of EMF sporocarps (Tables 1, 3). Within each host, summer and autumn were the two seasons with the highest biomass values, accounting for 71% of the total biomass in *Eucalyptus* and 97% of the total biomass in *Pinus* (Table 3). Regardless of host, summer was the season with the highest total dry biomass (~50%), followed by autumn (~44%), and spring (~5%) (Tables 1, 3).

Discussion

EMF fruiting abundance in 1995–1996 seemed to be average for the conditions where the study was conducted (Giachini et al. 2000). In this study, occurrence and diversity of EMF species were related to season as well as host species. Matsuda (1994) and Matsuda and Hijii (1998) obtained similar results from an *Abies firma*-dominated forest in central Japan, where sporocarp phenologies differed according to season of the year, suggesting that abiotic factors such as precipitation and temperature in single-host dominated forests are directly correlated to the patterns of occurrence and abundance of EMF sporocarps.

Dunstan et al. (1998) obtained analogous results in a similar study under plantations of *Pinus* spp. in western Australia, although with a much lower species diversity value (9 EMF species) than observed under *P. taeda* (17 species) in the present study. Because the former study covered a much higher number of *Pinus* species and was of much longer duration, we would have expected it to have a much higher species diversity than that found in this study. There is no mention, however, whether *P.*

Table 1 Relative Importance (*RI*) and sporocarp dry weight (*DW*) (grams) of ectomycorrhizal fungi in *Eucalyptus dunnii* and *Pinus taeda* plantations in Santa Catarina, southern Brazil

Species	*E. dunnii*								*P. taeda*							
	Spring		Summer		Autumn		Winter		Spring		Summer		Autumn		Winter	
	RI	DW	RI	DW	RI	DW	RI	DW	RI	DW	RI	DW	RI	DW	RI	DW
Amanita muscaria	0	0	0	0	0	0	0	0	0	0	0	0	3.55	60.70	0	0
Amanita panth. var. *multisquamosa*	0	0	0	0	0	0	0	0	0	0	0	0	0.90	24.70	0	0
Chondrogaster angustisporus	1.70	3.40	0	0	2.50	5.90	0	0	0	0	0	0	0	0	0	0
Descomyces albellus	5.25	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Descomyces albus	27.20	8.50	0.55	0.10	16.35	18.90	61.85	26.35	0	0	0	0	0	0	0	0
Descomyces giachinii	0	0	1.15	2.35	0	0	0	0	0	0	0	0	0	0	0	0
Labyrinthomyces varius	0	0	0	0	3.30	0.70	0	0	0	0	0	0	0	0	0	0
Laccaria amethystina	5.50	0.05	46.25	11.30	22.00	74.05	19.25	3.30	0	0	0.25	0.05	0.55	0.15	34.30	0.40
Laccaria bicolor	0	0	21.20	3.15	24.05	69.75	262.30	158.45	0	0	3.80	2.65	1.10	1.45	64.65	10.30
Laccaria laccata var. *laccata*	91.25	16.90	38.55	13.50	75.75	113.20	92.55	23.05	3.70	0.10	9.90	0.85	4.75	5.40	200.00	0.45
L. laccata var. *pallidifolia*	0	0	0	0	0	0	32.25	10.45	0	0	0	0	0	0	0	0
Laccaria proxima	0	0	0	0	5.05	12.40	0	0	0	0	0	0	0	0	0	0
Laccaria pumila	0	0	3.65	0.90	66.20	40.45	40.15	10.60	0	0	8.35	2.65	18.65	59.05	33.15	10.20
Laccaria tortilis	0	0	0.55	0.10	4.20	21.20	17.75	7.40	0	0	3.05	20.10	0	0.00	17.14	0.20
Lactarius argi. var. *argillaceifolius*	0	0	0	0	0	0	0	0	0	0	0	0	0.90	5.70	0	0
Lactarius deliciosus var. *deliciosus*	0	0	0	0	0	0	0	0	0	0	2.05	74.80	3.20	167.20	0	0
Lactarius fragilis var. *fragilis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	81.40	110.65
Lactarius rufus var. *parvus*	0	0	0	0	0	0	0	0	0	0	0	0	37.55	9.85	42.70	53.45
Lactarius rufus var. *rufus*	0	0	0	0	0	0	0	0	79.65	106.10	0	0	2.25	252.15	51.45	44.65
Rhizopogon fuscorubens	0	0	0	0	0	0	0	0	0	0	36.40	6.50	16.55	2.35	0	0
Scleroderma albidum	36.20	8.55	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleroderma areolatum	261.20	313.50	302.45	540.00	272.80	550.05	59.10	36.55	0	0	0	0	0	0	0	0
Scleroderma bougheri	0	0	0	0	0.60	0.60	0	0	0	0	0	0	0	0	0	0
Scleroderma cepa	0	0	22.50	44.05	0	0	0	0	0	0	0	0	0	0	0	0
Scleroderma citrinum	150.70	776.05	163.10	922.35	107.25	1,173.0	11.40	17.30	309.30	707.50	519.35	18,790.00	490.95	15,192.00	75.22	3.30
Scleroderma fuscum	0	0	0	0	0	0	0	0	5.65	6.45	0	0	0	0	0	0
Scleroderma sp.16	5.30	22.70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleroderma sp.43	3.30	6.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleroderma sp.88	8.60	29.90	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleroderma sp.E5	1.95	4.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleroderma sp.E5.1	1.80	3.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleroderma sp.P5	0	0	0	0	0	0	0	0	1.70	6.30	0	0	0	0	0	0
Setchelliogaster tenuipes	0	0	0	0	0	1.50	3.40	0	0	0	0	0	0	0	0	0
Suillus granulatus	0	0	0	0	0	0	0	0	0	0	16.75	10.35	19.15	54.80	0	0
Sub-total		1,193.50		1,538.00		2,081.50		293.45		826.45		18,908.00		15,835.50		233.60

Table 2 Shannon diversity index (H') for ectomycorrhizal fungi in *E. dunnii* and *P. taeda* plantations in Santa Catarina, southern Brazil

Host	*E. dunnii*				*P. taeda*			
Season	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
	1.22 c*	1.61 b	2.04 a	1.2 c	0.53 c	0.24 d	0.83 b	1.46 a
Total	2.00 a				0.84 b			
Season	Spring		Summer		Autumn		Winter	
	1.22 d		0.89 c		1.85 a		1.66 b	

* Values in the same line, between seasons for the same host, or between hosts and between seasons (bottom line), followed by the same letter, are not significantly different according to the *t* test at $p<0.001$

Table 3 Relative percentage of biomass for sporocarps of ectomycorrhizal fungi from plantations of *E. dunnii* and *P. taeda* in southern Brazil

Host	*E. dunnii*				*P. taeda*			
Stand age (years)	1	7	9		1	9	18	
Relative %	67.00	23.50	9.50		0.70	36.30	63.00	
Season	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
Relative %	23.35	30.10	40.75	5.75	2.30	52.80	44.25	0.65
Total % per host	12.50				87.50			
Season	Spring		Summer		Autumn		Winter	
Total % per season	4.95		49.95		43.80		1.30	

taeda was one of the *Pinus* spp. in Dunstan's work. Moreover, the fungal species composition observed by Dunstan et al. (1998) was quite distinct from that observed here. Only two species, *Lactarius deliciosus* var. *deliciosus* and *Suillus granulatus* were concomitantly found in both studies, suggesting that either (1) these species are competitive and able to survive adversities after initial colonization and maintain viable communities under different habitats; (2) only these two species were concurrently introduced in both geographic regions, since they are not native to either Brazil or Australia, or finally (3) they are the only two species associated with more than one *Pinus* species and therefore able to thrive under the above-mentioned conditions. It is well known that *Pinus*-related species of EMF found in both studies do associate with many species of *Pinus* (Smith and Zeller 1966; Hesler and Smith 1979; Singer 1986; Mueller 1992; Giachini et al. 2000), thus ruling out the latter hypothesis. It is possible that *L. deliciosus* var. *deliciosus* and *S. granulatus* are more competitive than other species of either *Suillus* or *Lactarius* occurring under *Pinus* spp. An indication that this may be the case is the abundant fruiting detected in some areas in southern Brazil, especially for *L. deliciosus* var. *deliciosus* (Giachini et al. 2000). Also, soils and environmental conditions for these species may be more suitable in Brazil than in Australia. However, the more likely explanation for the differences in fungal composition is the initial inoculum brought with the seeds and/or seedlings at the time of introduction of each host species.

A similar scenario is observed for *Rhizopogon* species. Only one species, *R. fuscorubens*, was detected in our study, while three different species, *R. luteolus*, *R. roseolus*, and *R. vulgaris* were found under *Pinus* spp. in western Australia. It is noteworthy that Giachini et al. (2000) found five species of *Rhizopogon*, including *R. vulgaris*, under *P. elliottii* and *P. taeda* in southern Brazil. This indicates that differences related to climatic conditions between the two surveys, carried out in two different years, may be responsible for these results. Furthermore, the study may not have been of long enough duration to capture all the fungal diversity of these plantations, since fungal species are often seasonal (Dighton et al. 1986; Dahlberg 1991; Matsuda 1994). Additionally, Dunstan et al. (1998) identified species in the genera *Hebeloma*, *Paxillus*, and *Thelephora*, which, with the exception of the latter, to the best of our knowledge are not found in southern Brazil. Genera unique to this study and not found by Dunstan et al. (1998) include *Amanita* (two species), *Laccaria* (five species), and *Scleroderma* (three species).

One striking difference in the occurrence of mycorrhizal genera observed between the present study and that of Dunstan et al. (1998) is the presence and total dominance of *Scleroderma* species. Since *Scleroderma* species associate with several species of *Pinus*, and ectomycorrhizas seem to be absent among southern Atlantic forest native plants (Andrade et al. 2000), the occurrence of *Scleroderma* species in our study again might result from the initial inoculum introduced into our region. The dominance of these species may be related to more adequate environmental conditions for fruiting compared to the regions studied by Dunstan and coworkers.

Other results involving *Scleroderma* species noted by Giachini et al. (2000) were also observed in this study. Among them the restricted occurrence of *Scleroderma areolatum*, fruiting abundantly although confined to *E. dunnii*. These findings contradict the observations of Guzmán (1970), who stated that this fungus is infrequent or rare for South America, although he did not specify the conditions (habitat) from which they were drawn. Guzmán (1970) also reported *S. areolatum* to be quite frequent under conifers in temperate conditions. Further molecular characterization is desirable to test the identity of this organism, which would clarify the patterns of host-association observed for the species. The high abundance of *Scleroderma* and *Laccaria* species in both plantations and the total absence of sporocarps of *Pisolithus* spp. are also particularly interesting. This is even more intriguing considering that *Pisolithus* spp. have received great attention in the majority of ectomycorrhizal-related studies developed in Brazil (Junghans et al. 1998; Rodrigues et al. 1999).

Species of EMF found under *E. dunnii* in this study were also observed in Australasia (Grgurinovic 1997; May and Wood 1997), suggesting that transportation of inoculum occurred when *Eucalyptus* species were introduced to South America from Australasia.

Because stand age classes were pseudoreplicated, it was not possible to analyze the results in detail. However, general trends showed age class specificity for some of the EMF species obtained. In general, only *Laccaria laccata* and *L. pumila* did not have host- or age-class-specificity. For host-specific species, only *R. fuscorubens* (*P. taeda*), *S. areolatum* (*E. dunnii*), and *S. granulatus* (*P. taeda*) did not present age class specificity.

Sporocarp biomass is often considered an important parameter in diversity studies because it is a direct measure of the productivity of a particular forest component. Higher biomass values were obtained during the summer and autumn, when large numbers of sporocarps of *Scleroderma*, especially *S. citrinum*, were present. Sporocarps of *Scleroderma* were large and weighed considerably more than other EMF found in this study, thus being, in part, responsible for the higher biomass values obtained for the aforementioned seasons. Additionally, *Scleroderma* is a very competitive and successful genus in these ecosystems (A.J. Giachini and V.L. Oliveira, unpublished), perhaps readily responding to even slight changes in climatic conditions.

In general, a small number of biomass-abundant and a larger number of less biomass-abundant species characterized the two forest types studied (Table 1). Host specificity for some of the EMF species obtained was indicated, showing that simply the number of species of EMF is not a good indicator of species diversity/richness for *P. taeda* and *E. dunnii* under the conditions in which this study was developed.

The results of this study corroborate previous observations on the importance of sequestrate fungi in plantations of *Pinus* spp. and *Eucalyptus* spp. in southern Brazil (Giachini et al. 2000). In the present study, at least 25% (seven species) of the fungal community recovered was represented by sequestrate fungi, a large proportion that normally has been omitted in the few studies of fungal diversity carried out in Brazil.

In conclusion, additional data and further research are needed to clarify the correspondence of fungal sporocarp with ectomycorrhizas by molecular and morphological characterization techniques. These approaches will, in turn, contribute to a better understanding of the structure of EMF communities in these plantations.

Acknowledgements The authors gratefully acknowledge the ‘Universidade Federal de Santa Catarina’ (UFSC) for funding this research; Celulose Catarinense S.A. (Klabin) at Correia Pinto, SC, Brazil, for facilities; Paulo Munhoz (Kablin), Lindomar V. Pritsch and João R. Alves (UFSC), and several workers from Klabin for invaluable help during data collection; and Dr. Jean Garbaye, Dr. Michael A. Castellano, Dr. James M. Trappe, Kristen L. Whitbeck, and three anonymous reviewers for reviewing earlier versions of this manuscript.

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