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# Occurrence of macroscopic fungi in different forest types in the Forestry Research Centre (FEPAGRO), Santa Maria, RS, Brazil

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**Abstract.** The macroscopic fungi performance an important role in the maintenance of forest environments, and studies related with the identification of species are fundamental to the research progress. This study aimed to realize a survey the species diversity of wood decomposing fungi in populations of *Pinus elliottii* Engelm, *Eucalyptus globulus Labill*, *Acacia mearnsii* de Wild and natural forest, in State Foundation for Agricultural Research - FEPAGRO, Forestry Research Center, located in Santa Maria, RS. Were collected 53 samples of macroscopic fungi in four areas, being 16 samples in forest of *P. Elliottii*; 12 samples in forest of *E. globulus*, 12 samples in forest of *A. mearnsii* and 13 samples in of native forest. In the laboratory, five genera were identified to the species level: *Fuligo septica* (L.) F.H. Wigg, *Gloeoporus dichrous* (Fr.) Bress., *Lycogala epidendrum* (L.) Fr. and *Trametes villosa* (Sw.) Kreisel.
**Keywords**: biodiversity, mycobiota, taxonomy.

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## Introduction

The fungi may cause disease in crops of economic importance (AGRIOS, 2005), its work is at the decomposition of plant residues in terrestrial ecosystems (TAUK, 1990; PAULA et al., 2006; AUER et al., 2007). However, the expansion of agricultural crops and climate fluctuations are factors acting on the fungi diversity (FISHER et al., 2012; VOŘÍŠKOVÁ; BALDRIAN, 2012).

Observations on the species occurrence of fungi can be based on experience of the mycologist, through field studies, which end up providing information such as the occurrence and distribution of these organisms. Additionally, molecular biology methods may provide the development of databases that assist researchers in the determination of the species (HALME et al., 2012).

The macroscopic fungi are responsible for the dynamics of life in the forests, and may be related to species composition and some trees population density (FUKASAWA, 2012). Among them is the decomposers wood group, which play important roles in processes such as nutrient cycling and formation of soil humus. The decomposition of wood by fungi in a forest can be classified as white rot, brown rot, and soft rot, and this classification is based on the ability which fungal species have to degrade lignin and cellulose (RUEL et al., 1994; VALLIM et al., 1998; HENRIKSSON et al., 2000).

However, some species of wood decomposing fungi have biotechnological importance. The fungi that cause brown rot can also be used in the bioremediation of soil (PURNOMO et al., 2011), in the biodegradation of xenobiotics (MONRROY et al., 2006), in the enzymatic saccharification (LEE et al., 2008), in the biodegradation, and in the enzymes production (VALASKOVA; BALDRIAN, 2006). The ability to degrade xenobiotic compounds through the enzyme system of *T. villosa* is widely studied, since this microorganism has great potential for use in bioremediation due to low cost and the possibility of mineralization of pollutants, although there are difficulties in its implementation on a large scale (YAMANAKA et al., 2008).

The study of these fungi in different ecosystems is important for the knowledge of their diversity, and, even, its evolution (COELHO, 2005; SKREDE et al., 2011). In this sense, the objective of this study was to survey the diversity of fungi decomposing wood in *Pinus elliottii* (Warm.)

Engelm., *Eucalyptus globulus* Labill, *Acacia mearnsii* De Willd. and native forest, at the State Foundation for Agricultural Research (FEPAGRO) Research Center on Forests, located in Santa Maria, RS, Brazil.

**Methods**

The collecting of fungi was performed at the State Foundation for Agricultural Research - Fepagro Forests (29°45' S, 53°43'W) – Experimental Boca of Monte station, located in the municipality of Santa Maria – RS, on October, 2012. The procedure was developed in two rounds, in which four researchers conducted a random tranversal in the area. Initially located material was photographed, and their point of georeferenced location, following the sample was carefully removed, labeled and stored in paper packaging, kraft, for later identification in the laboratory (Lodge *et al*., 2004). Materials were collected at four areas of the forest: *Pinus elliottii*, *Eucalyptus globulus*, *Acacia mearnsii* and native forest.

The study area is located in the physiographic region of the Central Depression of Rio Grande do Sul (RAMBO, 1994), with an average altitude of 130 meters. The climate, according to Köppen, is Cfa, humid subtropical, with average temperature of the coldest month between -3 and 18 ° C, and temperature of the warmest month greater than 22 ° C. The average annual rainfall is 1,770 mm without drought (MORENO, 1961).

The soil of the study area is classified as Paleudalf originating in sandstones and siltstones, with gently rolling relief. This unit is characterized by does not have hydromorphic zones, be well drained and moderately deep, with Bt horizon (textural type B) reddish, with surface texture frank sandy, acidic and poor in organic matter (STRECK et al., 2008).

In each area the collection the points were georeferenced with GPS (Garmin™, Kansas, USA). After collection, the samples were conducted at the Laboratory of Soil Biology for identification and preservation. The material was analyzed in the stereoscopic optical microscope, and compared with the specialized bibliography (WRIGHT; ALBERTÓ, 2006), and distributed into orders, genera, families and species. Five samples of fungi were chosen for detailed description in this work.

**Results and discussion**

Were collected 53 samples in four areas. The highest occurrence was recorded in the forest of *Pinus elliottii* (30%), followed by native forest (24%), forest of *Eucalyptus globulus* (23%) and forest of *Acacia mearnsii* (23%). Of 53 samples, 21 were identified at genus level. These 21 samples, nine belong at *P. elliottii* forest; six belong at *E. globulus* forest; six belong native forest and neither individual at *A. mearsii* forest (Table 1). Among 21 samples, four were identified to the species level, considering their economic and environmental importance, namely: *Trametes villosa* (Sw.) Kreisel, *Gloeoporus dichrous* (Fries) Bresadola, *Fuligo septic* (L.) Wigg. and *Lycogala epidendrum* (L.) Fries.

*Trametes villosa* (Sw.) Kreisel

Basidiomycete lignicola, commonly found in Brazil, belonging to the kingdom Fungi, phylum Basidiomycota and Polyporaceae family (SILVA, 2011). It is an important degrading fungus, causing white rot, and second Moreno et al. (2004) has the capacity to solubilize the lignin and more complex compounds that lignin itself. The poliporáceos fungi are commonly known as "ear-of-stick" because of its shape.

This fungus presents coloring grayscale and its surface is made up of fairly large pores, 1-3 per millimeter. Could present around 70 mm diameter and 3 mm thick, with irregular shape. The spores are between 5-7.5 x 2.5-3.3 microns, hyaline and slightly ellipsoid. The basidiomata growing in chain, in the trunks and stumps, predominantly in summer and autumn, with wide distribution in South America and North (KUO, 2005). The sample identified in the present study showed basidiomata approximately 30 mm, thin and flexible, with a little hairy surface.

The fungus *Trametes villosa* was identified in twigs of *Acacia mearnsii* deposited on the forest floor (Figure 1A). This species has been reported by other authors in different regions of Brazil, such as eucalyptus plantations in the municipality of Entre Rios, Bahia (COSTA et al., 2011); in the Deciduous Forest, in the city of Mondaí, Santa Catarina (SANTANA et al., 2007); and in the urban area of the city of Cascavel, Paraná (VIEIRA et al., 2006).

This basidiomycete has potential for use in bioremediation techniques, since it has tolerance to pentachlorophenol (PCP), and can reduce the concentration this contaminant in the soil (MATHEUS et al., 2000; MACHADO et al., 2005). In work carried out by Silva et al. (2005), *Trametes villosa* stood out for developing in soil containing the chemical oxidation of hydrocarbons products (HCB).

Machado et al. (2006), studying the degradative capacity of the textile dyes by basidiomycetes, suggest *Trametes villosa*, and *Pycnoporus sanguineus* as alternatives in the bioremediation of colored effluents. The study shows the differences between the microorganisms: *T. villosa* decolorized completely 17 dyes while *P. sanguineus* decolorized only 9. However, the best result was obtained when the two were mixed fungal cultures, evidenced by the rapid discoloration of dyes and approximately 80% reduction in seven days of treatment. According to the authors, the consortium of cultures is a promising treatment alternative. Gonzales et al. (2008) also found the *Trametes* gender as potential for synthesis of melanoidin polymer, which is responsible for the dark color of the effluents from the production of molasses.

Okino et al. (2000) conducted a survey of the diversity of the mushroom in different ecosystems of the Tropical Atlantic and contaminated regions of Santos, São Paulo-SP, 116 isolates were selected, causing white and brown rot of these, four were species of *Trametes villosa*. According to the tests performed in the job, this fungus has the ability to oxidize peroxidase and laccase enzymes, which makes it promising for biotechnological degradation studies of organochlorine compounds and decolorization of textile dyes. Yamanaca et al. (2008) used a isolate of *T. villosa*, ccb176, from the previous study to determine culture conditions that enhance the oxidation of laccase and peroxidase. According to the authors, supplementation of the medium with emulsified vegetable oil with surfactant resulted in induction of peroxidase activity and higher values of specific yield of laccase activity were propitiated by copper.

Table 1 – Fungal genera identified in the different forest formations Forestry Research Centre (FEPAGRO) Santa Maria, RS and their respective geographic coordinates (CG).

| Forest formations | | | | | |
|---|---|---|---|---|---|
| *P. elliottii* | CG | *E. globulus* | CG | Native forest | CG |
| *Fibroporia* | 29°39'42,41"S<br>53°54'48,04"O | *Phellinus* | 29°40'09,38"S<br>53°54'45,42"O | *Fuligo* | 29°39'55,28"S<br>53°54'57,21"O |
| *Hyphodontia* | 29°39'41,95"S<br>53°54'48,39"O | *Trametes* | 29°40'09,38"S<br>53°54'45,42"O | *Gloeoporus* | 29°39'55,44"S<br>53°54'57,18"O |
| *Stemonites* | 29°39'42,13"S<br>53°54'48,25"O | *Fomes* | 29°40'09,58"S<br>53°54'46,48"O | *Cymatoderma* | 29°39'54,69"S<br>53°54'58,34"O |
| *Fibroporia* | 29°39'41,13"S<br>53°54'48,25"O | *Auriculana* | 29°40'06,88"S<br>53°54'48,56"O | *Pholhota* | 29°39'54,69"S<br>53°54'58,34"O |
| *Ceratomyxa* | 29°39'41,13"S<br>53°54'48,25"O | *Schizophylum* | 29°40'06,41"S<br>53°54'47,71"O | *Pleurotus* | 29°39'54,85"S<br>53°54'59,18"O |
| *Antrodiella* | 29°39'42,30"S<br>53°54'47,69"O | *Polyporus* | 29°40'06,41"S<br>53°54'47,71"O | *Ganoderma* | 29°39'54,94"S<br>53°54'59,15"O |
| *Hyphodontia* | 29°39'42,30"S<br>53°54'47,69"O | | | | |
| *Postia* | 29°39'42,27"S<br>53°54'47,16"O | | | | |
| *Lycogala* | 29°39'41,79"S<br>53°54'47,15"O | | | | |

*Fuligo septica* (L.) F.H. Wigg.

*Fuligo septica,* knew as "Scrambled-egg slime" because of its yellow color, belonging to the phylum Myxomycota, order Physarales and Physaraceae family. Presents a worldwide distribution and, in Brazil, occurs in regions of Amazonas (JAHN, 1904), Roraima (CAVALCANTI et al., 1999), Bahia, Minas Gerais and São Paulo (TORREND, 1915), Paraná (GOTTSBERGER et al., 1992), Rio Grande do Sul (RODRIGUES; GUERRERO, 1990), Santa Catarina (CAVALCANTI; FORTES, 1994), Alagoas (CAVALCANTI; ARAÚJO, 1985), Ceará (ALVES; CAVALCANTI, 1996), Pernambuco (FARR, 1960) and Maranhão (SILVA; BEZERRA, 2005).

Features as etalium pulvined, yellow, 3.0-5.0 mm in height and 20.0-45.0 mm in length; cortex encrusted calcium, yellow; hipotalum white, well developed, irregular, membranous, limestone; capilicius abundant, hyaline filaments, irregular limestone nodules, yellow; spore blackish-brown; spores globose, with miniature warts, pale brown in transmitted light, from 6.12 to 9.18 μm in diameter. Sporulation occurs in all seasons, with a well peak defined at the end of winter and early spring (August/September), strongly influenced by rainfall (CHIAPPETA et al., 2003).

*The fungus *F. septica* was identified at stumps fallen in native forest (Figure 2A). According to Silva et al. (2008) to *F. septica* species grows in rotting wood and plant debris, but it can also grow on leaves and stems of living plants (SILVA et al., 2008). The occurrence of this fungus was reported in Maranhão on lettuce and cilantro caboclo (*Eryngium foetidum* L.) (SILVA; BEZERRA, 2005) and other hosts such as cabbage plants (*Brassica oleracea* var. *acephala* DC) and watermelon [*Citrullus lanatus* (Thumb.) Matsum & Nakai] (MENDES et al., 1998). Only in lettuce, whose leaves have become unfit for marketing, *F. septica* caused economic damage

Setala and Nuorteva (1989) to study the resistance of *F. septica* to toxic levels of metals, concluded that the species has a high level of zinc metal (Zn) approximately 4-20 ppm. The mechanism of resistance is due to the metallic yellow pigment called fuligoruben which has the function to chelate metals and converts them into inactive forms (ZHULIDOV et al., 2002).

*Gloeoporus dichrous* (Fr.) Bress.

*Gloeoporus dichrous* is a cosmopolitan species, most recurrent in regions of temperate-tropical climate and causes white rot in broadleaf plants and is therefore less common in conifers (WRIGHT; ALBERTÓ, 2006). This genus belongs to the kingdom Fungi, phylum Basidiomycota, Agaricomycetes class, order Polyporales, and family Meruliaceae. Has synonymy with: *Bjerkandera dichroa* (Fr.) P. Karst; *Gloeoporus candidus* Speg. and *Caloporus dichrous* (Fr.) Ryvarden. These individuals can grow on various substrates and have highlighted as decomposers of wood (QUANTEN, 1997).

Basidiomata are white, cream or beige, zoned or not, grown on tree branches falling on the forest floor and on dead wood. In young basidiomata, one can observe the formation of a surface layer containing pores with gelatinous appearance and varying color from yellowish to pinkish to brownish-pink. With the aging of basidiomata, the pores become brown, contrasting with the white color of the edges and the top of the fruiting body (AINSWORTH, 2004). In the microscope can observe his monomitic hyphae system, with only generative hyphae with clamp connections, hyaline, thin to thick wall (2.5 μm), and basidiospores, in a format allantoic. Reports of this kind in the Rio Grande do Sul were recorded by Coelho et al. (2006) e Westphalen et al. (2010).

The basidiomata has a variable ressupinado format, efuso-reflex pileado, imbricated and hardly shows the existence of only one on decaying wood. Their measurements are approximately 13-80 mm in height, 5-35 mm in width and 7-30 mm in diameter. Their measurements are approximately 13-80 mm in height, 5-35 mm in width and 7-30 mm in diameter. The himenóforo consists of short tubes (0.5 mm long), with gelled walls and sometimes you can notice a exudation on the surface of the hymenium. The pores are circular, ranging from 4-7 mm, and the color varies from orange, salmon-coloredasalmonado, brown to purple. Has four basidia (9-14,3 x 3,2-4,3 mm), whose basidiospores are alantoides and with thin walls (3,6-5,7 x 0,5-1,0 mm). As a striking feature, *G. dichrous* has dark abaxial surface (hymenium) and white adaxial surface. Moreover, this specie differs from other species of the gender *Gloeoporus* by the presence of clamp connection and has been widely described in Paraná (BONONI et al., 1981; LOGUERCIO-LEITE; WRIGHT, 1991; RYVARDEN; MEIJER, 2002; GIBERTONI, 2004).

The sample of this work was associated with trunks in native forest (Figure 1C).

*Lycogala epidendrum* (L.) Fr.

The *Lycogala epidendrum* fungus belonging to the phylum Myxomycota, order Liceales, and family Reticulariaceae, is widely distributed in Brazil, with records in the states of Alagoas (CAVALCANTI et al., 1985.), Amazonas (JAHN, 1904), Bahia (TORREND, 1915), Paraíba (CAVALCANTI; ARAÚJO, 1985), Paraná (GOTTSBERGER et al., 1992), Pernambuco (FARR, 1960), Rio de Janeiro (TORREND, 1915), Rio Grande do Norte (BEZERRA et al., 2007a), Rio Grande do Sul (RODRIGUES; GUERRERO, 1990), Roraima (CAVALCANTI et al., 1999), Santa Catarina (JAHN, 1902), São Paulo (SYDOW; SYDOW, 1907), and Sergipe (BEZERRA, et al., 2007b). In this study, the fungus was identified in forest *Pinus elliottii* (Figure 1D).

Occurs in different ecosystems and substrates, as saprophytes and parasites (CAVALCANTI; FORTES, 1994). The aethalia are commonly found in dead trunks of large trees, stumps and fallen branches (DUDKA; ROMANENKO, 2006). Ávila et al. (2005) identified the presence of *L. epidendrum* in turtle droppings. Its occurrence was observed in environments altered by humans and their presence has been reported in sugarcane bagasse stored for industrial environments as well as in culture of edible mushrooms (CAVALCANTI et al., 1985; SANTOS; CAVALCANTI, 1995; CHUNG et al., 1998).

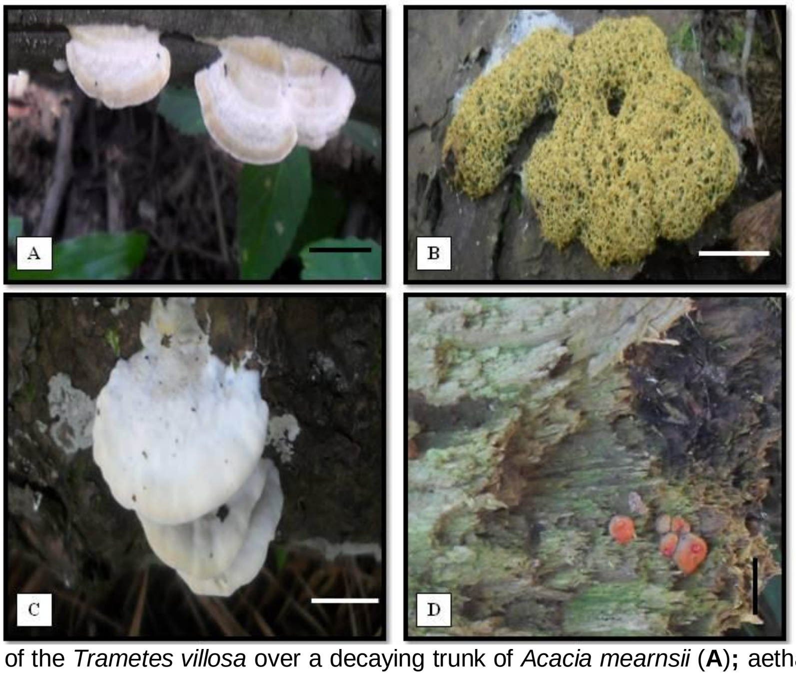


**Figure 1.** Basidiomata of the *Trametes villosa* over a decaying trunk of *Acacia mearnsii* (**A**)**;** aethalia of *Fuligo septica* in stumps in native forest (**B**); basidiomata of the *Gloeoporus dichrous* over a gymnosperm trunk (**C**) and basidiomata of the *Lycogala epidendrum* associated to *Pinus elliottii* wood (**D**). Scale: 1 cm. Source: Authors.

Dudka and Romanenko (2006) indicated the existence of association aethalia of *L. epidendrum* with insects, especially with Leiodidae and Sphindidae (Coleoptera) species, whose oral structures are adapted to fungivorous activity (BETZ et al., 2003; WHEELER; MILLER, 2005). There is evidence that after feeding of the beetles, these assist in dispersing the spores, that are deposited onto the body of the insect remaining viable even after being removed (DUDKA; ROMANENKO, 2006).

The presence of *L. epidendrum* was observed in a study on the Myxobiota of Serra de Itabaiana National Park, Sergipe State, Brazil (BEZERRA et al., 2007b). Features were etalium isolated or clustered, sessile, globose to subglobose, 2-5 mm diameter, dark olive-gray color; hipotalum inconspicuous; persistent cortex covered by irregular vesicular prominences, 30,6-53,55 μm diameter, containing a yellowish fluid.

**Conclusion**

We collected 53 samples of macroscopic fungi in the forest formations of *Pinus elliottii* and *Eucalyptus globulus*, *Acacia mearnsii* and native forest, located in the area of FEPAGRO Forests - Santa Maria, RS. The species identified are: *Trametes villosa*, *Gloeoporus dichrous*, *Fuligo septica* and *Lycogala epidendrum* and have remarkable evidence and importance in ecological niches set in this forest formation.

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