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Diversity and ecology of epigeous ectomycorrhizal macrofungal assemblages in a native wet eucalypt forest in Tasmania, Australia

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A B S T R A C T

This paper investigates the diversity and ecology of the epigeous ectomycorrhizal (EcM) fungal assemblages of four plots in native *Eucalyptus obliqua* forest in Tasmania at different ages of regeneration since the natural disturbance of wildfire. From fortnightly visits to 1 ha of forest over a period of 14 months, 331 EcM species were documented. The family Cortinariaceae (particularly the genus *Cortinarius*) dominated the EcM communities, with the youngest plot (72 yr since the last wildfire) having the greatest number of EcM species. Each plot was divided up into 25 10×10 m subplots, and both unconstrained and constrained ordination procedures showed a significant association between the woody perennial plant community of the subplots and their EcM assemblages, reflecting the co-variation of plant and fungal communities. The study provides benchmark knowledge of EcM communities in a specific forest type in Tasmania, serving as a good basis for further studies in those forests and in similar forest types elsewhere.

Introduction

It has been known for some time that different macrofungi fruit under different tree species (Maire et al. 1901), on different soil types (Haas 1933) and are associated with different plant communities (Wilkins et al. 1937). Lange (1978) considered that half the species of Agaricales found fruiting on soil in a Danish beech forest were ectomycorrhizal (EcM).

It was recognized in Australia that EcM fungi were essential to plant health and development (see Samuel 1926; Chilvers & Pryor 1965; Chilvers 1968a, 1968b; Ashton 1976; McGee 1986). However, these studies were concerned with discovering which plants in Australia formed mycorrhizal associations and the structure and function of the mycorrhizas. Little was known about the EcM diversity and ecology of these fungi in Australian forests until 1988, when a project was initiated to collect, isolate and identify EcM fungi from forests throughout Australia (Castellano & Bougher 1994). Knowledge of the natural distribution of EcM fungi and an understanding of their biology and ecology can provide insights into their potential responses to anthropogenic disturbances (Klironomos & Kendrick 1993; Castellano & Bougher 1994; Erland & Taylor 2002).

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Folke & Knudsen (1994) suggested that EcM macrofungi, by providing various benefits to the tree and improving soil quality and the stability of the ecosystem as a whole, are good indicators of forest condition. They maintained that if the number of EcM species of selected genera with large, easily seen fruit bodies, e.g. *Boletus*, *Tricholoma*, *Russula* and *Lactarius*, in 10 ha remains relatively constant after a certain time, then the forest can be classified as sustainably managed.

EcM fungal species richness and community structure are threatened by gathering by humans for commercial gain, loss of habitat due to anthropogenic activities, e.g. clearing of forests for agriculture and urban development, and intensive forestry (Rühling & Tyler 1990; Arnolds 1991). Other disturbances contributing to EcM community structure changes are wildfire (Jonsson et al. 1999; Bruns et al. 2002), pollution by acid rain and atmospheric nitrogen deposition (Arnolds 1991), fertilization (Wiklund et al. 1995) and climate change (Watling 2004; Gange et al. 2007; Kauserud et al. 2008).

This paper examines the EcM communities in four plots regenerating at different times since the natural disturbance of wildfire in a native *Eucalyptus obliqua* forest in Tasmania, Australia. We investigate whether there is an association between the EcM communities and the vegetation types identified, and whether there are any species or suite of species that could be considered potential indicator species of a vegetation type to assist in conservation and forest management protocols.

Materials and methods

Study area

Details of the site characteristics, the plot establishment and methods of surveying and documenting the data, are presented in Gates (2009). Briefly, four 0.25 ha plots were chosen reflecting known, but differing, fire history along the 'Bird Track' at the Warra Long-Term Ecological Research (LTER) site in southern Tasmania, west of Geeveston (see Gates et al. 2011b for location maps and positions of the four plots). The forest type was a tall, wet, naturally regenerated native forest dominated by *E. obliqua*. This is the most common forest type at the LTER, but some temperate rainforest is also present (Brown et al. 2001). The mean maximum temperature at the Bureau of Meteorology's Warra weather station is 13.7 °C and the mean minimum temperature is 5.4 °C, with a mean annual rainfall of 1690 mm (http://www.bom.gov.au/climate/data/). The names given to the chosen plots were, respectively, 'Old growth' (unburnt for ≥200 yr), '1898' (thought to have been last burnt 108 yr previously, but later in the study it was found that parts of it were subjected to a second fire in the year 1934, i.e. 72 yr previously), '1934' (last burnt 72 yr previously) and '1898/1934' (last two fires 72 and 108 yr previously). The 50 × 50 m plots were divided into 25 10 × 10 m subplots. The subplots were mapped for their coarse woody debris and also for their standing live vegetation. The diameter at breast height of each living tree was recorded, and the positions of all trees with stems ≥10 cm were determined, and maps prepared. These measurements formed the basis by which each of the total of 100 subplots in the study were subsequently classified into a set of 'vegetation types', which took into account the vascular species present in each subplot in combination with the plot's fire history.

Soil types

The soils of 'Old growth', '1898' and '1898/1934' are best described as intermediate between two soil types – 15.3 and 15.4 (Grant et al. 1995), i.e. yellowish brown mottled clayey soils under wet forest and red-brown clayey soils under wet forests, respectively. These soil types are widespread in Tasmania where annual rainfall is above 1000 mm. The soils are derived from Jurassic dolerite and Quaternary dolerite talus on low, rolling hills to steep mountains. The soil of '1934' is closer to soil type 14.2 (Grant et al. 1995), i.e. sandy over clayey soils under wet forest, derived from Triassic sandstone.

Survey methods

Visits to each plot were made approximately fortnightly over a period of 14 months from May 2006 to Jul 2007, with all macrofungi recorded on all substrata. In this paper, only epigeous basidiomycetous EcM macrofungi associated with soil are considered. While ascomycetes, especially those in Pezizales, have recently been shown to be EcM (Tedersoo et al. 2006), the mycorrhizal status of the four epigeous macroascomycetes that were found are unknown.

Each of the 25 subplots of each of the four plots was traversed five times to simulate a transect 2 m wide to ensure that the whole subplot was completely surveyed. All visible fruit bodies of macrofungi found on any substratum within the subplot were recorded as properly named and described species or as 'tag names' where the species was familiar but still to be described or identified. Those species new to the authors were described from fresh material with written descriptions (color followed Kornerup & Wanscher 1978), photographs, drawings and micrographs of microscopic features. Fruit bodies of all species were then dried for 24 hr in a Sunbeam® food dehydrator and deposited as voucher material in the Tasmanian Herbarium (HO).

Species nomenclature

The taxonomy of Australian fungi is poorly known with only a small percentage of the species actually named and a further small percentage known but not named (Bougher & Syme 1998). Valid names of the species belonging to the Basidiomycota were taken from May & Wood (1997), May et al. (2002) or the interactive catalogue of fungi on the website of the Royal Botanic Gardens Melbourne (http://www.rbg.vic.gov.au, viewed 2006–2009). Family names followed the online interactive version of Index Fungorum (http://www.indexfungorum.org/names/Names.asp, accessed 8 Jan 2011). All but a handful of the 'tag species' were confidently assigned to genus level with very few being unidentified beyond family status. Life modes (i.e. EcM or decomposer) were determined using Trappe (1962), Warcup (1980), Bougher (1995) and Bougher & Syme (1998). The EcM status of host trees was determined using Brundrett (2008) except for *Eucryphia lucida*, the EcM status of which was determined by P. McGee (pers. obs. 25 Aug 2010).