The role of mycorrhizal associations in the growth and survival of the native hills daisy, *Ixodia achillaeoides*: interactions with root-pathogenic nematodes. Presence of mycorrhizas in *I. achillaeoides* in forests and commercial farms - Final Report

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Background

Although mycorrhizal associations are widespread in Australian ecosystems (McGee 1986; Logan *et al.* 1989; Bellgard 1991; Brundrett 1991) and some studies have shown an improved growth of native plants due to the presence of the symbiosis (Barrow 1977; Jasper & Davy 1993), there is scant information on the ecological significance of the symbiosis in these systems. However, there is consensus that mycorrhizas not only play an important role in the nutrient acquisition of native plants but also may increase the resistance/tolerance of the host plant to root diseases as in some cultivated plants (Fitter & Garbaye 1994).

Project objectives

This project provides important basic information for a larger research program that investigates the role of mycorrhizas in the re-establishment of native communities (E. Facelli, P. Dalby, J. Facelli, S. Smith, F. Smith). It is directly linked to a project funded by the ARC (small) that investigates the possible role of beneficial plant-fungus symbiosis (VA mycorrhiza) in reducing the symptoms of nematode infection by *Meloidogyne hapla* in roots of the native hills daisy, *Ixodia achillaeoides*. The role of mycorrhizas in the growth and survival of native plants is poorly understood and although there is evidence that mycorrhizas increase phosphorus uptake in native plants, nothing is known about interactions between mycorrhizas and root diseases.

Research questions

1. **What is the level of mycorrhizal and nematode infection in populations of *I. achillaeoides* in native forest and commercial farms (monocultures)? (Flora Foundation component).**

2. Does infection by native mycorrhizal fungi, and/or *Glomus intraradices* (used routinely in mycorrhizal research), increase phosphorus uptake in *I. achillaeoides*? (ARC funded, 1997)
3. Does infection by native and/or *G. intraradices* decrease symptoms of nematode (*M. hapla*) infection in *I. achillaeoides*? (ARC funded, 1997).
4. If mycorrhizal infection reduces the symptoms of nematode infection in *I. achillaeoides*, which is the mechanism involved, improved phosphorus uptake (tolerance) or reduced infection by the nematode (suppression)? (ARC funded, 1997).

The initial aim of the project was to determine whether the degree of nematode infection found in *Ixodia* plants under commercial production was similar to that of plants from natural populations found in stringybark forests and to assess if there was a negative correlation between mycorrhizal infection and nematode infection in the forest or commercial environment. However, at the time of the field surveys all commercial plantations had been pulled out in the area of the Adelaide Hills. The only one left was a plantation established at SARDI, Lenswood Research Centre with research purpose. There were few commercial plantations in Nelson, VIC. However, the assessment of these plantations would have increased the cost of the project over the limit of the available funds. Therefore, we decided to survey the experimental plantation and three other natural populations established in eucalyptus forests with different fire history to assess the effect of fire on the potential mycorrhizal and nematode soil infectivity. Fire (together with disturbance) is one of the most important determinants of the establishment of Australian plants (Bell *et al.* 1993; Bonnet 1993). However, there is no information about its effect on the mycorrhizal infectivity of the soils, or on the population of nematodes associated with native plants.
This new project provides seminal information for studies of revegetation and conservation of native plants and their associated micro-organisms.

Methods

-*Surveys*

We sampled plants from three populations of *I. achillaeoides* from native stringybark forests with different fire history and plants of *I. achillaeoides* from an experimental plantation (Lenswood Research Centre). The three native stringybark forests were:
a) Lenswood, SA (few metres a part from the experimental plantation). No fire recorded.
b) Mark Oliphant Conservation Park, SA. Last fire 5 years ago.

c) Devil's Gully (Close to Humbug Scrub, SA. Last fire 8 years ago.

Roots of about 4 year old plants of *I. achillaeoides* were collected, preserved, and the intensity of mycorrhizal infection (McGonigle *et al.* 1990) and presence of nematodes in roots (Baker *et al.* 1996) and soil associated with these roots assessed (Southey 1986).

-*Inoculum production*

Pot cultures with mycorrhizal fungi present on native soils needed to be produced to use as inoculum in some of the main project experiments. Soil from Lenswood (wild site) was collected, disinfested with Nemacur® and used to grow *Danthonia caespitosa*, a native grass that produces abundant roots and is easily infected by mycorrhizal fungi (E. Facelli, unpublished data).

Results

1) The species composition and the number of nematodes per species differed markedly between sites (note high variability between samples, Table 1, SD). *Meloidogyne* spp and *Pratylenchus* spp were present in high numbers in the plantation and scarcely represented in the wild populations. No other species were found in the soil of the plantation (Table 1). Nematodes (females and males) and nematode eggs were observed inside the roots of plants from the plantation only.

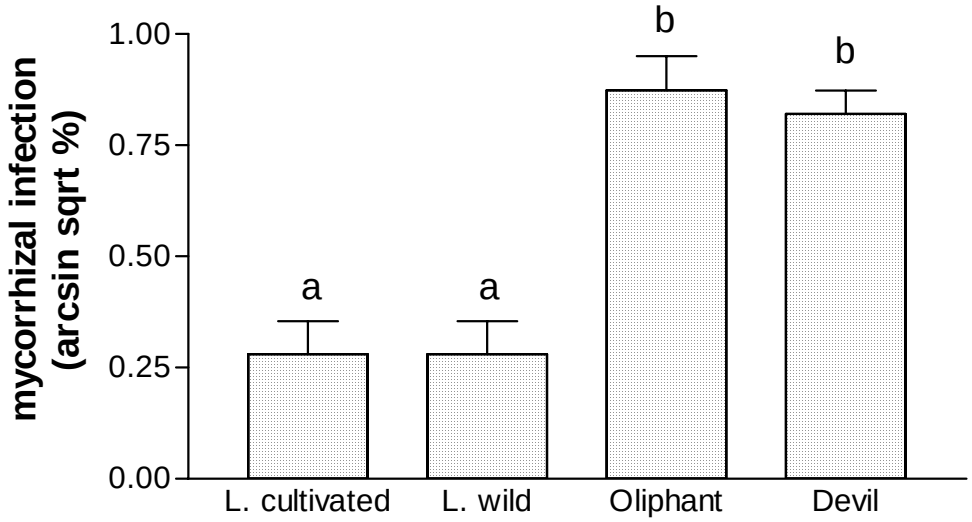
Table 1: Number of plant parasitic nematodes per 250 g of soil

	Lenswood cultivated	Lenswood wild	Devil's Gully	Oliphant Park
Morulaimus spp	0	261 (352)	3300 (3129)	100 (94)
Criconemella spp (ring)	0	0	0	36 (61)
Meloidogyne spp (root knot)	121 (185)	0	0	9 (19)
Pratylenchus spp (lesion)	1093 (911)	0	8 (16)	11 (27)
Helicotylenchus/ *Rotylenchus* spp (spiral)	0	0	22 (68)	148 (323)

Numbers are average of 10 samples. SD in brackets.

2) The percentage of root length infected with mycorrhizal fungi was higher in plants from Devil's Gully and M. Oliphant Conservation Park than in plants from Lenswood (cultivated or wild) (Figure 1). The morphology (very fine hyphae) of the mycorrhizal fungus observed in the wild sites was similar to *Glomus tenue* or "fine endophyte", previously observed in other Australian native soils (Hall *et al.* 1981; Facelli 1998)

Figure 1: Percentage of root length infected with mycorrhizal fungi. Similar letters indicate no significant differences ($p < 0.05$, $n = 10$).



L. cultivated: Lenswood plantation; L. wild: Lenswood wild population; Oliphant: M. Oliphant Conservation Park; Devil: Devil's Gully

3) *Danthonia caespitosa* had more than 75% of root length infected with mycorrhizal fungi and the pot cultures were let dry and stored in plastic bags at room temperature for future use.

Discussion

- Mycorrhizal infection was not affected by cultivation and it may be higher in plants growing on soils exposed to fire. However, more sites should be sampled to test this hypothesis.
- The site without previous fire has only one species of nematodes whereas the two sites with fire history have higher specific diversity (in number of species). It is important to highlight that these are trends and that due to the extreme patchiness of the distribution of the nematodes, more sites should be sampled before confirm any hypotheses.
- Nematode populations were different between the plantation and the wild sites. *Meloidogyne* and *Pratylenchus*, present at the plantation, are likely to be of economic

importance on cultivated plants and are found worldwide as well as *Criconemella, Helicothylenchus* and *Rotylenchus* (Siddiq 2000). In contrast *Morulaimus* spp, is confined to Australia (Siddiq 2000). Different species of this genus were found associated with several native plants (Austin et al. 1985; McLeod *et al*. 1994) but, to our knowledge, this is the first report of its association with *Ixodia* .

- This survey provides with basic information for future work on the effect of fire on the diversity of nematode populations and mycorrhizal infectivity.

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