ARMILLARIA STRATEGY

AUSTRALIAN NATIONAL BOTANIC GARDENS

2003-2013

CONTENTS

Introduction

Armillaria is found worldwide and comprises of approximately 40 species. Five Armillaria species have been found in temperate and tropical Australasia. Four of these are:

- Armillaria luteobubalina
- Armillaria hinnulea
- Armillaria novae-zelandiae
- Armillaria fumosa

The vegetative morphology (appearance) is slightly different and can assist with identification. Four species form basidiomes in pure culture, which can aid with identification either through observation of basidiome morphology or by obtaining haploid mycelia.

The Armillaria life cycle involves many developmental events, which leads to the expression of several morphological forms. Specific structures include fruiting bodies or basidiomes, basidiospores, mycelia, pseudo sclerotial tissue and rhizomorphs. These structures enable Armillaria to accommodate various habitats and allow, indirectly or directly, various species to survive in the wild and to colonise and infect a diverse host range.

As a root disease fungus, Armillaria is one of the most prominent killers and decayers of deciduous and coniferous trees and shrubs in plantations, natural forests, orchards, amenity plantings and botanic gardens throughout Australia and the world.

It is believed that Armillaria luteobubalina has been located on the ANBG for many years prior to the gardens development. It was occurring naturally and would have probably maintained a stable population in the Black Mountain vegetation without having the ability to increase in size and therefore kill off surrounding vegetation. Since the development of the ANBG in the 1960's, the Armillaria has been given an ability to increase in size due to an increased food source (due to plants being planted more densely than the previous natural vegetation) and improved growing conditions.

Armillaria in general can be described as a 'botanic garden' disease as the increased density of plantings and the improved irrigation and nutrition have improved the living conditions of this pathogen.

Strategies to Date

Since 1984, some trenching work has been undertaken in order to contain the disease and prevent it from spreading into larger sections of the gardens. There are now several dominant areas that have Armillaria present and these are:

- Sections 66a Tasmanian Gully
- Sections 120,121,122,123,1,2,3 Acacias
- Sections 84,88
- Sections 191s Sydney Basin Flora
- Sections 161,162

- Sections 36,37 (Proteacea)
- Sections 39,40 (Casuarinas)

The extent of Armillaria in these sections is such that many large trees and shrubs have died due to the disease. Some of these sections are now bare of most vegetation and have become somewhat unsightly for visitors and interpretation has been required.

Sections 161,162 have been clear felled and most organic material (roots, stems, etc) have been removed from these sections. The intent is to starve the Armillaria for 3-5 years and hope that the pathogen completely dies. This method of control is not guaranteed and is in itself a trial. It has a great impact on the aesthetics of the gardens and for this reason has been restricted to sections away from visitors and will not be used in the more popular display sections.

Each autumn the fruiting bodies (basidiomes) are present. These are removed and destroyed on a regular basis (daily) during the fruiting period.

Stumps of trees can be a place for the Armillaria to rest and build up populations that can harm neighbouring plants. It is an important strategy for all stumps to be removed from the gardens as soon as resources will allow. All future tree removals will include stump grinding or removal.

1. New Strategies

1.1 Open fell clearing:

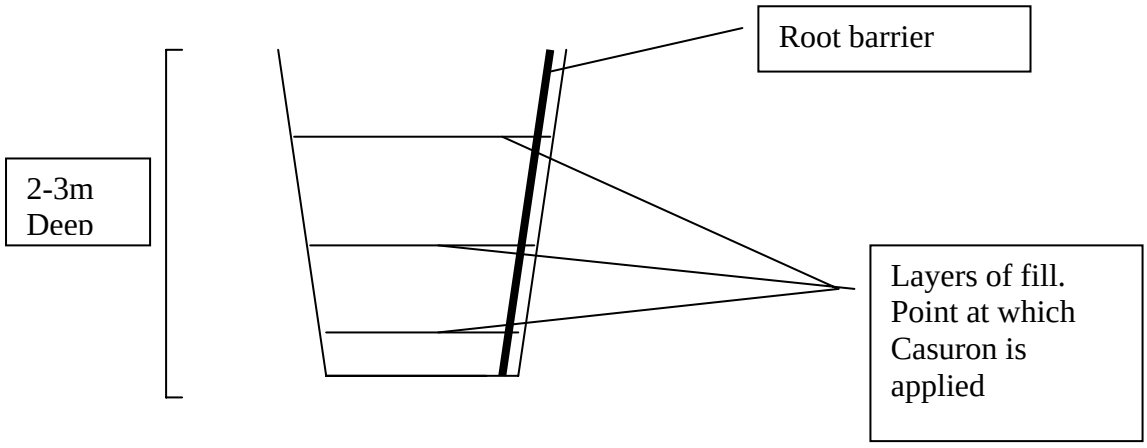
This has been mentioned in the introduction of this strategy. It was discussed in some detail at an Australian National Botanic Gardens Armillaria strategy meeting held on the 1st September 2003. The general consensus from this meeting was that the method of complete clearing sections of all vegetation in order to starve the pathogen is yet unproven, is costly and has a negative visual impact for visitors of these sections. It has therefore been decided that we will monitor sections 161, 162 where this method has been adopted, to see whether it has had much effect. This information will not be known until 2007 (four years after the clearing).

Sections 84 and 88 have severe Armillaria damage and this area will be the only section to be clear felled. This is because it is out of the way of visitors, there are many dead dangerous trees in these sections that must be removed anyway and it is more beneficial for trial purposes to have two areas of study rather than just the one.

1.2 Trenching

Trenching to contain areas of Armillaria was first conducted in 1984. It is used to create a barrier between infected areas and non-infected areas. The trench is dug down to approximately 3-4 metres deep. A stiff plastic sheet of root barrier is inserted down one side of the trench. A treatment of Casuron herbicide is applied to the bottom of the trench @ 100gm/m. The trench is then backfilled with a 300mm thick layer of fill.

Some more Casuron is applied @ 100gm/m. Another layer of fill is placed on top of the Casuron and so on. This continues until the trench is full. It is believed that if the roots of infected trees are prevented from moving into other areas (caused by the root barrier and herbicide), then the Armillaria cannot spread. The mapping and long-term maintenance of these trenches is important for historical reasons. Areas already trenched are in the appendix of this strategy. Future trenching is also marked on this map.



1.3 Sanitation:

The sanitation method utilised at the ANBG is the daily collection of fruiting bodies during autumn for destruction as well as the separating and burning of infected timber from removed trees and shrubs. Timber is burnt annually during winter.

Soils and other materials from known Armillaria infected sites will not be moved to other cultivated garden areas at the ANBG. This is to reduce the chances of the pathogen spreading into other areas.

These methods of sanitation appear to be working and will be continued into the future.

1.4 Monitoring:

Since 1980 some degree of monitoring has occurred, although this has been stopped over recent years. There are several reasons for monitoring the Armillaria and mapping of the pathogen location is also included under ‘monitoring’.

Monitoring is important for the following reasons:

a. To determine the distribution of Armillaria across the ANBG site.
b. To determine if the Armillaria is from the same clone or different species.
c. To determine the rate of spread across the gardens over many years.
d. To determine if the containment trenches have been effective in reducing spread.
e. To determine if any inoculants used for control have had effect on suppressing the pathogen.

Methods of monitoring.

- During autumn, a record of the location of the pathogen must be mapped and dated. This should be done each year so a history of the pathogens presence and possible spread can be established.
- Samples from each known Armillaria infected section should be collected and DNA tested to determine if the Armillaria on site is all from the same clone. This would only be required once for each ‘patch’. New areas of infection should be tested as they arise.

1.5 Testing Mycelium

Testing of suspected mycelium on a regular basis will provide the following information:

1. A definite identification of the sample to determine if it is Armillaria;
2. A pattern of distribution, which would become evident over several years of sampling.

Sampling will occur as a part of this strategy on an as required basis.

1.6 Inoculums

a. Brown rot fungus:

It is known that Armillaria is not a competitive fungal pathogen. On stumps contaminated with brown rot fungus, armillaria has remained as a low population. It is believed that some fungi can 'out compete' armillaria, which means that armillaria, will remain on the stump with a size that does not harm surrounding vegetation. It is when the armillaria is the sole fungi in an area that it has the potential to increase in size and cause devastation to trees and shrubs.

It is intended that ANBG staff will inoculate certain stumps with brown rot fungus as a study to determine if this theory is in fact correct. Brown rot fungus appears unavailable commercially so on going investigations will occur.

b. Trichoderma:

Trichoderma are fungi that are present in almost all soils. They feed of other fungi and can be utilised to control such fungal pathogens as Schlorotinia, Rhizoctonia and Pythium. They have been used in some informal trials at the Royal Botanic Gardens Hobart but there has been no follow up work to determine how effective it was. At the ANBG, we will conduct our own trials to determine if Trichoderma has an effect on slowing down the growth and spread of armillaria.

Trichoderma containing the Fungi species T. harzianum and T. viride will be applied monthly to selected sites at label rates. The first applications will occur after the fruiting bodies are have diminished in size, which is around May. These sites will be monitored each autumn to see if the presence of armillaria mycelium and/or basidiomes have diminished or increased in size.

Possible Research:

Research into armillaria at the ANBG would be a great benefit to understanding this pathogen. It would be hoped that any research would lead to better management of armillaria. A research proposal will be drafted in the second half of 2004. There may be a possible Graduate available to conduct this work in early 2005.

References

1. Shaw C. G. 3rd, Kyle G. A. (1991) *Armillaria Root Disease* USA Dept Agriculture.

2. Summerell B. (2000) *Armillaria Root Rot, Australian National Botanic Gardens Canberra,* RBG Sydney.

3. Roland T.V.Fox. *Armillaria* Root Rot: Biology and control of Honey Fungus. University of Reading, UK.

10 year plan – Armillaria at the ANBG:

2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Trench between rockery and RFG. Sections 16,79	Clear fell sections 84,88	Trench to contain sections 84,88							
Trench in Rainforest road. Extension from previous trench to research cottage	Remove stumps in sections 1,2,3,121,122 ,123	Stump removal in contaminated sections- ongoing	Stump removal in contaminated sections- ongoing	Stump removal in contaminated sections- ongoing	Stump removal in contaminated sections- ongoing	Stump removal in contaminated sections- ongoing	Stump removal in contaminated sections- ongoing	Stump removal in contaminated sections- ongoing	Stump removal in contaminated sections- ongoing
Trench along SBD culvert. contractors									
May – inoculate stumps and sections with Trichoderma. Continue monthly applications	May – inoculate stumps and sections with Trichoderma. Continue monthly applications	May – inoculate stumps and sections with Trichoderma. Continue monthly applications	May – inoculate stumps and sections with Trichoderma. Continue monthly applications	May – inoculate stumps and sections with Trichoderma. Continue monthly applications	May – inoculate stumps and sections with Trichoderma. Continue monthly applications	May – inoculate stumps and sections with Trichoderma. Continue monthly applications	May – inoculate stumps and sections with Trichoderma. Continue monthly applications	May – inoculate stumps and sections with Trichoderma. Continue monthly applications	May – inoculate stumps and sections with Trichoderma. Continue monthly applications