PROGRESS REPORT - ECTOMYCORRHIZAE PROGRAMME : 1981

Ectomycorrhizae : A natural protective mechanism against *Phytophthora cinnamomi*

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Summary of Progress in the Ecotmycorrhizae Programme to December, 1981

Laboratory studies have indicated the following

1. Ectomycorrhizae of Jarrah may be active against *P. cinnamomi* by

   - providing a physical barrier to infection,
   - reducing the area of roots susceptible to infection,
   - producing antibiotic fungal exudates.

2. Litter is important in the Jarrah forest and apart from a soil mulching action and its role in nutrient cycling, litter

   - promotes ectomycorrhizal development,
   - supports a microflora antagonistic to *P. cinnamomi*.

3. Some common fungi of the Jarrah forest can produce ectomycorrhizae in pure culture.

Field - work has (and will) provided information in the following areas:

1. The effect of applied fertilizer on ectomycorrhizal activity and fungal abundance.

2. Differences in the fungal floras of the Jarrah and Karri forests and provided a selection of ecotypes of particular ectomycorrhizal fungi.

3. The success of inoculation of eucalypt seedlings with ectomycorrhizal fungi in a plant nursery situation - pot and open ground production.

Research Objective

To determine the role of ectomycorrhizae in the jarrah forest, in particular, with respect to the pathogenicity of *Phytophthora cinnamomi*.

Introduction

The programme is based on the established fact that ectomycorrhizae play a major role in plant growth and the prevention of root disease. We consider that ectomycorrhizae may be one of the few protective mechanisms against *P. cinnamomi* (*P.c.*) available to jarrah and, in addition, that the mycorrhizal habit is vital for continued productivity in the nutrient deficient jarrah forest. Hence, the programme seeks to describe the role of jarrah ectomycorrhizae with regard to infection by *P.c.* and to investigate ways of manipulating ectomycorrhizae for forest management purposes. The latter aim may involve manipulation of the environment (i.e. revised burning practices, nutrient application, etc.) to promote the development of ectomycorrhizae.

Experimental Approach:

1. To determine the ectomycorrhizal status of jarrah (and karri) in the forest and study some of the factors influencing ectomycorrhizal development.
2. To investigate factors influencing the survival of zoospores in the soil and on interaction with jarrah ectomycorrhizae.
3. To investigate the potential of selected mycorrhizal fungi in the prevention of disease caused by *P.c.* and in the growth performance of jarrah and other Eucalypt seedlings.

Structure of the Programme

The programme is not a sequential set of steps but rather a series of inter-related projects that are governed by relatively uncontrollable factors such as the time of fungal fruiting season, successful isolation and growth rates of ectomycorrhizal cultures, availability of ectomycorrhizae, etc. The various components of the programme are listed below in the order of initiation and at this time (January 1982) there is a complete overlap in the functioning of the various projects (see Figure 1).

1. Isolation of common forest fungi and verification of their ectomycorrhizal status (duration of the programme - D.O.P.).
2. Establishment of ectomycorrhizal field plots in the forest (D.O.P.).
3. Zoospore survival studies.
4. Field and pot trials of jarrah (and other Eucalypt) seedlings inoculated with selected ectomycorrhizal cultures.

Progress

Component 1: Fungi Collection, Isolation and Verification of Ectomycorrhizal Status

Collection and isolation of epigeous and hypogeous fungi continued throughout the 1981 fruiting season. A list of available cultures and their mycorrhizal status is included as Appendices (Appendix 1 and 2). Many ectomycorrhizal fungi are difficult to maintain in artificial culture and factors influencing their mycorrhizal formation are unknown, therefore, there has not been a large increase in the size or generic diversity of the collection. However, the ecotypic range of a number of species has been increased. Further, with the help of some visiting international fungal taxonomists

Figure 1. Structure of the Programme

VERALL AIM

BIOLOGICAL CONTROL OF PHYTOPHTHORA CINNAMOMI BY ECTOMYCORRHIZAE

OTENTIAL
ETHODS

MANIPULATION OF ENVIRONMENT TO PROMOTE ECTOMYCORRHIZAL DEVELOPMENT
- USE OF NUTRIENTS (P/N)
- ESTABLISH VIABLE LITTER/MULCH LAYER
- PRE INOCULATED SEEDLINGS

RESENT AREAS OF
NVESTIGATION

. MYCORRHIZAL STATUS OF JARRAH AND KARRI	2. ROLE OF MYCORRHIZAE IN THE PATHOGENICITY OF P. CINNAMOMI	3. FIELD AND POT TRIAL OF SELECTED ECTO-MYCORRHIZAE
QUALITATIVE AND QUANTITATIVE STUDIES OF ECTOMYCORRHIZAE IN THE FOREST FUNGI COLLECTION PURE CULTURE SYNTHESIS	- ZOOSPORE SURVIVAL STUDIES - SOIL TYPE - ECTOMYCORRHIZAE AS A BARRIER TO INFECTION - SOIL TYPE/ECTOMYCORRHIZAE INTERACTION ON INFECTION	- NURSERY INOCULATION OF KARRI SEEDLINGS - GLASSHOUSE INOCULATION OF JARRAH AND OTHER EUCALYPT SEEDLINGS
TURE - 1982/83		
VARIATION IN FUNGAL FLORA WRT FORESTRY AND MINING PRACTICES (1982 HONS. PROJECT)	- CONTINUED ZOOSPORE SURVIVAL STUDIES	- OUTPLANT SURVIVAL - NUTRIENT PERFORMANCE
	- Pc CHALLENGE EXPERIMENTS	

WRT – with respect to

(Professor H.Thiers, San Francisco State College, and Professor Egon Horak, Swiss Federal Institute of Technology) some of the problems of description and classification have been solved. A number of joint publications in this area are planned. In addition, the collection of fungi has revealed distinct differences in the variety and fruiting times of the fungal floras of the jarrah and karri forests. Although the significance of these differences is not yet understood, the 1982 fungal season will supply added information in this area.

Preliminary studies on the variation of fungi found in the forest and on mined areas were also undertaken. Results have been summarised in a report submitted to Alcoa which is attached as Appendix 3. Similar work will be continued in 1982 as an Honours project. (Ms. P. IRELAND, UWA.)

Component 2

The effect of applied P and N on the abundance of epigeous and hypogeous fungal sporocarps and eucalypt mycorrhizae in Jarrah forest areas of varying fire history

The philosophy behind this component is that the litter layer is an important factor in the ectomycorrhizal habit and in areas where the litter cover has been removed, the use of fertilizers may stimulate the development of ectomycorrhizae. Therefore, in 1980 plots were set up to observe the effect of applied N and P in forest areas with varying litter cover. The 1981 fungal season has provided preliminary data in the following areas.

2.1 Patterns of Epigeous Sporocarp Occurrence

The spatial distribution of fungal sporocarps from each genera represented on the plots were mapped for each sampling date. This has provided information on fungal succession and periods of ectomycorrhizal activity during the season. The mapping should also help to locate areas of ectomycorrhizae within the plots and indicate which genera of fungi may

be ectomycorrhizal. (There may be some correlation between fruiting abundance and ectomycorrhizal activity - see section 2.3.) Fungi were collected later into the year from litter sites (Cobiac 1, Amphion, Virgin Jarrah) than from the burnt sites. The extended fruiting season can be attributed to the mulching effect of the litter layer which would assist in prolonging ectomycorrhizal activity.

2.2 Biomass of Fungal Sporocarps

All sporocarps observed on the plots were collected to estimate the biomass of fungal material produced relative to fertilizer treatment. Results are presented in table 1. and indicate that there has been a positive response to applied fertilizer. Phosphorus on its own appears to have depressed fungal fruiting (and ectomycorrhizal activity?) and N/P interaction has stimulated the same, (exception N/P - Cobiac 1.). Plots, previously established in a 1977 Karri regeneration site and treated with N and P, were monitored for fungal abundance. The results from these plots follow the same trend as the jarrah sites. In addition, a simple pot trial was set up to test the effect of applied N and P on the initiation and development ectomycorrhizae in unburnt and burnt Jarrah litter. Tentative results are presented in table 2. and represent the area (cm^2) in which ectomycorrhizal roots were observed. Phosphorus was again limiting and N/P interaction the most stimulating in initiation. It was estimated that the fresh weight of ectomyc orrhizae was doubled (or greater) on the unburnt litter, however, the Jarrah seedlings were larger in all treatments on the burnt litter where N in particular stimulated fleshy root production and shoot growth at the expense of ectomycorrhizal development.

2.3 Estimation of Ectomycorrhizal Root Activity

Soil cores were removed from the plots, washed and subjected to a set counting procedure. The root counts are now awaiting computer

Table 1. The effect of fertilizer application and fire history on the total biomass (Kg(FW)/Ha) of fungi found on treated plots in the forest (Year No 1 - 1981)

FERTILIZER TREATMENT 50 kg/Ha	PLOT LOCATION AND FIRE HISTORY					
	COBIAC 1 UNBURNT	COBIAC 2 PB(1)	AMPHION UNBURNT	PLAVINS PB(<7)	VIRGIN JARRAH PB(?)	KARRI REGEN 1977
CONTROL	33.3	18.1	17.5	10.8	50.6	36.7
PLUS N	56.7	14.4	10.5	19.6	63.6	37.2
PLUS P	40.2	10.9	1.7	9.2	26.5	33.5
PLUS N/P	7.4	47.5	78.4	35.6	71.2	181.9

N - Nitrogen as urea

P - Phosphorus as triple super phosphate

PB( ) - Years since area was prescribed burnt

Table 2. The effect of fertilizer application on the initiation and development of ectomycorrhizae (white pyramidal) in two jarrah litter types in root boxes.

FERTILIZER TREATMENT	AREA OF ECTOMYCORRHIZAL INITIATION (cm^2)	
	UNBURNT LITTER	BURNT LITTER/SOIL
CONTROL - O/O	55	44
O/P	20	26
O/N	20	26
P/N	111	70
FRESH WT ESTIMATED	x2	1

TOTAL AREA OF ROOT BOX - 336 cm^2

N - Nitrogen as urea

P - Phosphorus as triple superphosphate
(Both at equivalent rates to field applications)

analysis and should provide information on correlation between sporocarp and ectomycorrhizae numbers, fertilizer effect on ectomycorrhizal root activity and the distribution of ectomycorrhizal types within the soil profile.

Component 3

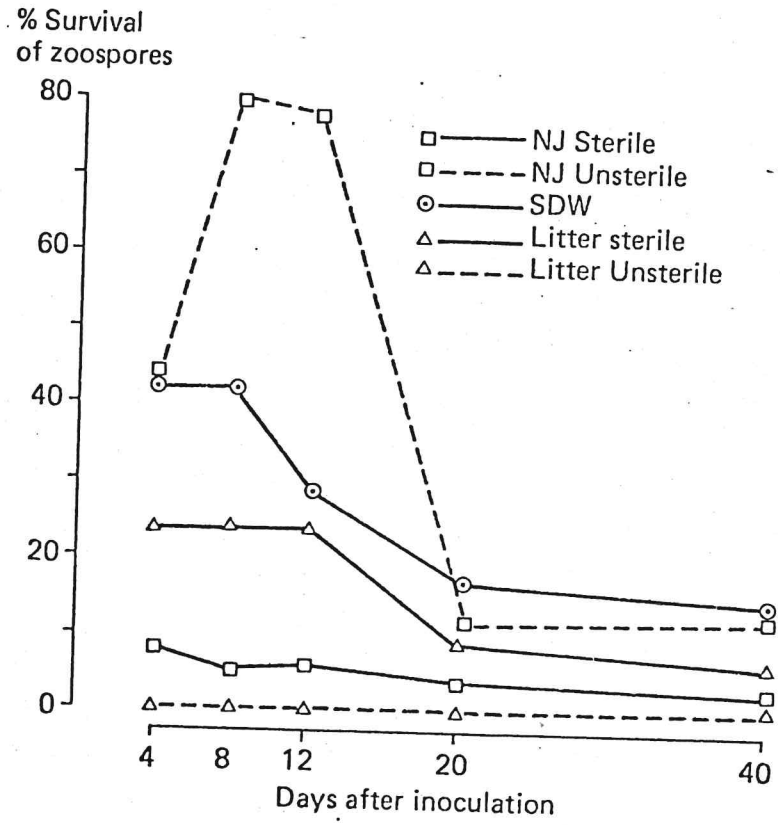
Zoospore Survival and Interaction with Jarrah Ectomycorrhizae

Zoospores have been used as the infective agentsin these studies for a number of reasons. Primarily, because they are the major propagule responsible for the spread of P. cinnamomi in the forest and as such represent the initial contact between the root and the pathogen. In addition, they are particularly suited to quantitative studies, allowing control of inoculum size and easy estimation of population sizes. The encystment of a zoospore, prior to germination, is a necessary component of the infection process and the results of these studies are based on the survival of zoospore cysts.

3.1 Effect of Soil Type on Zoospore Survival

Previous work has indicated that zoospore survival is influenced by soil type; Karri loam significantly reduced survival of cysts when compared to controls and Northern Jarrah (NJ) lateritic soils. (Manuscript in preparation - abstract enclosed as Appendix 4). Further studies have shown that Jarrah litter has the same effect on encysted zoospores as Karri loam. Results are shown in figure 2. The litter extract reduced all cysts non-viable prior to testing germination, while the NJ extract increased zoospore numbers on days 8 and 12. This increase can be attributed to sporangial production (and release of viable zoospores) as a survival response by P. cinnamomi to microbial lysis of mycelium from previously germinated cysts in the NJ extract. A summary of zoospore behaviour in these trials is

Figure: 2 The effect of jarrah litter and northern jarrah laterite(NJ) extracts on the survival of motile zoospores. (SWD—sterile distilled water control).



Summary of the results of soil treatment and zoospore survival.

Treatment	Germination in soil suspension	Viable in mycelium suspension	Viable zoospores on P_{10}UPH
SDW	–	–	YES
NJ	+	YES	YES
Litter	+++	NO	NO
Litter Sterile	+	YES	YES
NJ Sterile	++	YES	YES

presented in the table also in figure 2. Some cyst germination was evident in the litter extract but the hyphae was rapidly lysed by microbial action and no viable zoospores were produced. Figures 6-8 demonstrate bacterial lysis of zoospores and hyphae. The sterile soil extracts demonstrate the above to a result of microbial action. The microbiological suppression of P. cinnamomi by litter may play an important role in the health of the forest and should be considered in future forest management policies.

3.2 Effect of Fungal Exudates on Zoospore Survival:

Ectomycorrhizae suppress P. cinnamomi by any one or all of the following methods. By providing a physical barrier to infection (see section 3.3), by supporting an antagonistic microflora, by reducing root exudates and/or by releasing toxic exudates from the sheathing mantle. To test the last factor, motile zoospores were exposed to pure culture solutio of isolated ectomycorrhizal fungi. Results are presented in figure 3. A number of fungal cultures significantly reduced cyst survival - H59. (Scleroderma sp), H16. (Mesophelia trabalis), and others produced a marked decrease in viable cysts - H60 (Castorium camphoratum), H68 (Scleroderma varicosum). In another trial, zoospores were exposed to sterilized extracts of "white" and "black" Jarrah ecotmycorrhizae. Figure 4 shows that the "white" extract reduced zoospore survival while the black extract had little effect. These studies indicate that ectomycorrhizal fungi can produce substances toxic to zoospores of P. cinnamomi and that they may act in nature. More work is required to define the role of these exudates in the interaction between P. cinnamomi and ectomycorrhizae.

3.3 Interaction of zoospores with Jarrah ecotmycorrhizae and non-mycorrhizal roots

The role of ectomycorrhizae in the protection of Jarrah from P. cinnamomi has been investigated by "point inoculation" of roots with zoospores. A series of scanning electron micrographs, with notes, is presented as results and a

Figure: 3 . Effect of various Fungal Metabolites on the survival of motile zoospores.

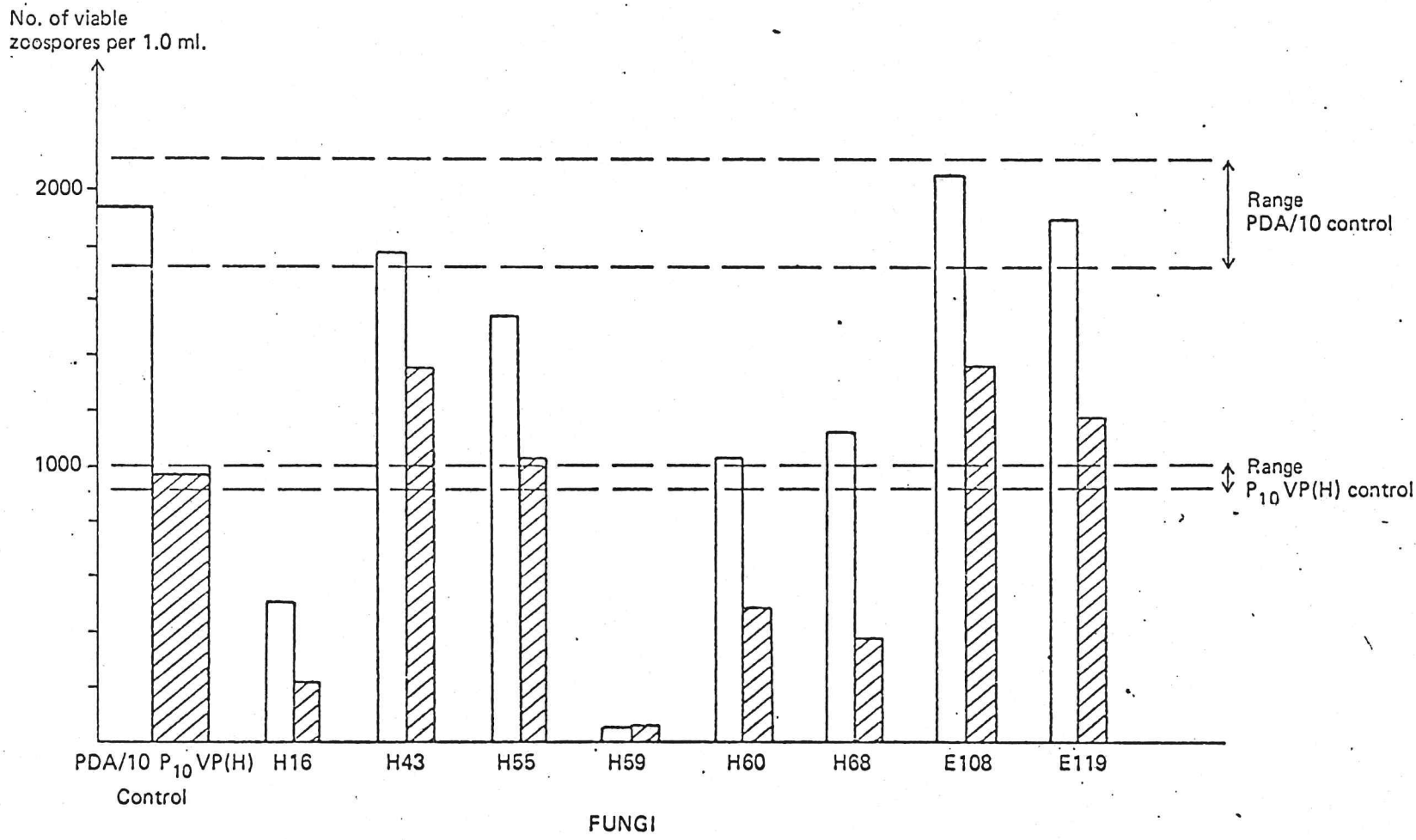
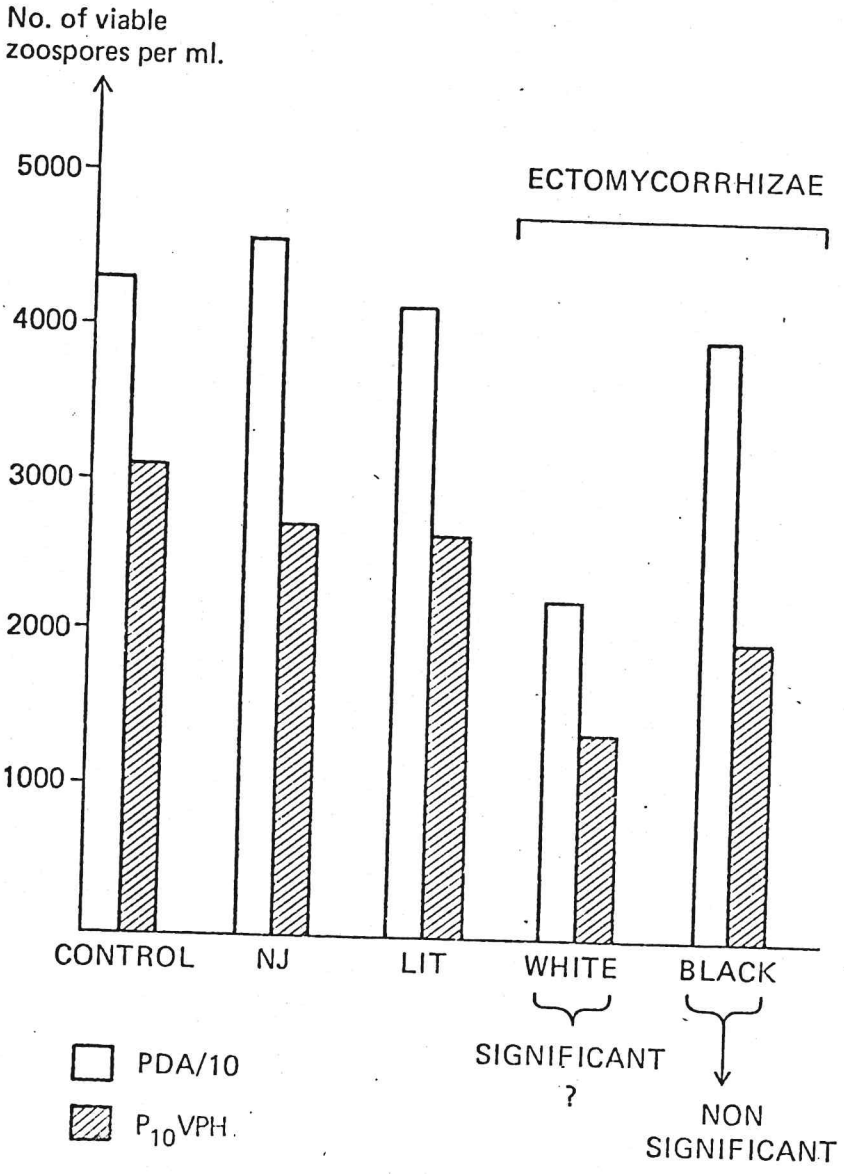


Figure: 4 Effect of sterile root and soil extracts on the survival of motile zoospores.



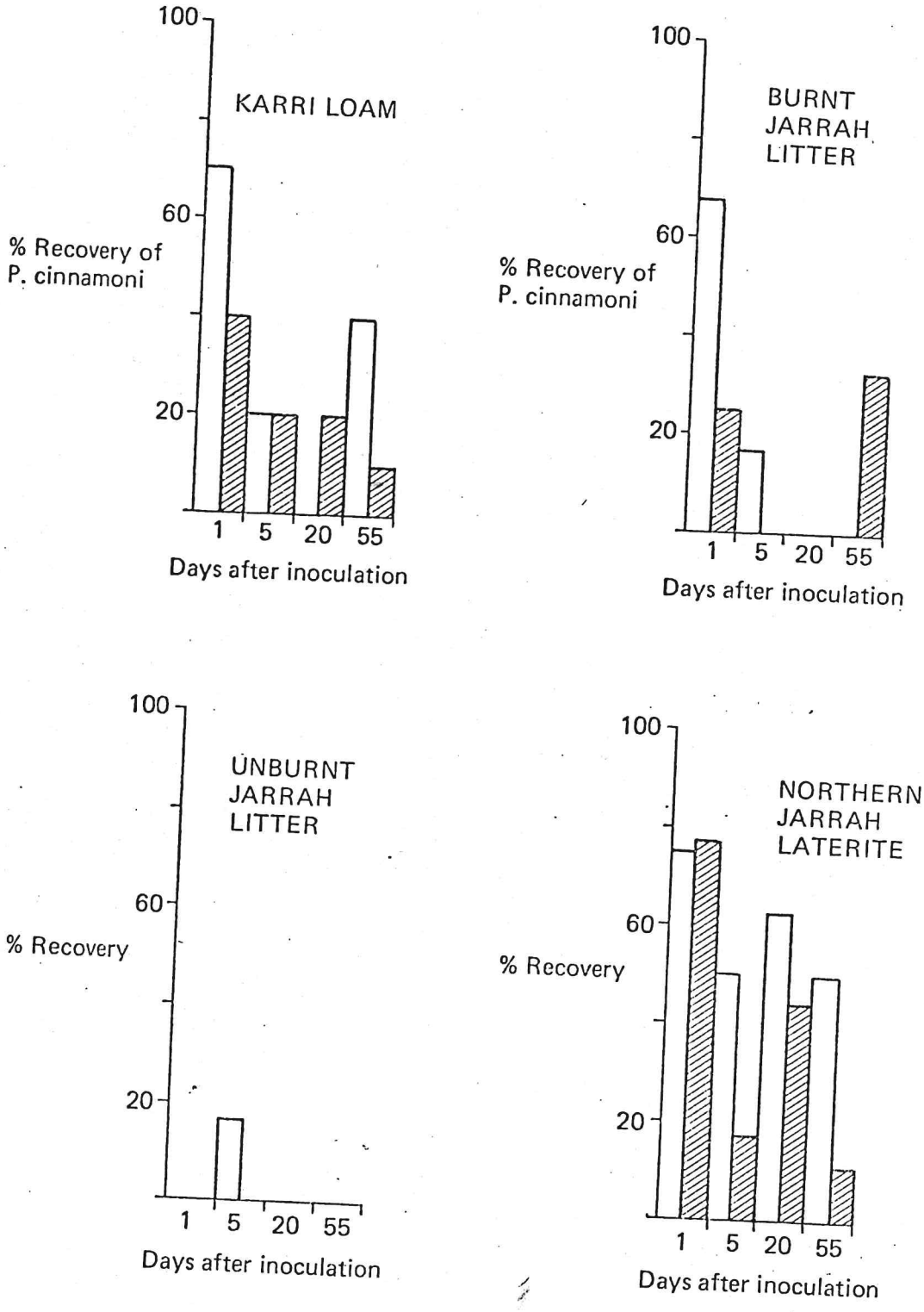
publication is planned in this area. "White" ectomycorrhizae were shown to act as a physical barrier to infection by zoospores. This is particularly evident by comparison zoospore behaviour on ectomycorrhizae (Figures 14-19) and non-mycorrhizal roots (Figs. 9-13). Large numbers of zoospores were attracted to damaged parts of the non mycorrhizal roots, e.g. areas of lateral root emergence (Figure 12) and physical abrasion (Figure 13), and infection occurred. The ectomycorrhizal mantle limits the possibility of physical root damage, reduces secretions of chemotaxic exudates from the root in general and covers the emerging lateral roots with fungal tissue. Potential infection sites are therefore reduced to a minimum.

The protective role of ectomycorrhizae was tested on Jarrah seedlings grown in a number of soil types. Results are shown in figure 5. Infection was greatest in the NJ soil and least in unburnt Jarrah litter. These results reflect the mycorrhizal status of the seedlings, this being greatest in the unburnt litter and least in the NJ laterite. There appears to be little difference in the effectiveness of "black" and "white" mycorrhizae against P. cinnamomi, however more work is required to confirm this observation. Few mycorrhizae were produced in the Karri loam or burnt Jarrah litter where fleshy root development was similar to that in the NJ soil. The reduction in infection rate may, in part, be due to microbial action, however, the major parameter appears to be the degree of ectomycorrhizal development.

Component 4: The Production of Ectomycorrhizal Seedlings, Outplant Survival and P. Cinnamomi Challenge Experiments

Although potentially the most useful aspect of the programme, to date it is the least developed. The mechanisms for production of ectomycorrhizal seedlings in the glasshouse have been established. Figures 20 and 21 demonstrate the stimulating effect of artificially induced mycorrhizae of the fungus Laccaria laccata on the growth of Jarrah and Pine. (See also figures 22 and 23.) These techniques have been applied in pot trials and

Figure: 5 Effect of soil type on the recovery of Pc from non mycorrhizal ☐ and ectomycorrhizal roots ▨ of jarrah.



in the field at the nursery level of production. The trials, using a selection of known ectomycorrhizal cultures, have just begun and results are unavailable. Further pot experiments are planned during 1982 using additional fungi proven to be ectomycorrhizal in pure culture. The mycorrhizal seedlings produced in these trials will be used for outplant survival studies and P. cinnamomi challenge experiments. The latter, apart from providing some general information on the role of ectomycorrhizae in protection against P. cinnamomi, may indicate whether there are degrees of resistance imparted by specific fungi.

Future Work - 1982

The programme will continue along the same lines outlined in the report with modification where necessary. More emphasis will be placed in the following areas:

1. Differentiating the role of "black" and "white" Jarrah mycorrhizae with respect to P. cinnamomi.
2. Development of inoculation procedures to produce mycorrhizal seedlings from selected ectomycorrhizal fungi.
3. Testing the resistance of these ectomycorrhizal seedlings against P. cinnamomi - initially in pot trials.

CULTURE COLLECTION 1981 - EPIGEOUS FUNGI (AGARICOIDE OR AERIAL-FREE SPORED)

Summary: 25^{+} genera represented in the specimen collection.
70^{+} cultures from 18 genera (excluding several unknown genera).

Genus	Species	Ecotype No/Location	Positive - Mycorrhizal			
			Jarrah	Tuart	Karri	*P. radiata*
AGARICUS	sp. (>1)					
AMANITA	*conicobulbosa*		(-)	(-)	1	
	priessii		1	1	(1)	
	umbrinella				1	
	xanthocephala		1		1	
	sp. (>1)		1	1	1	
ARMILLARIA	sp.					
BOLETELUS	*obsuricoccineus*		1		1	
BOLETUS	sp. (>1)		1	1	1	
CLITOCYBE	sp.					
CORTINARIUS	*"phlegmacium"*		1		1	
	sp. (H. Thiers.)	1. Dwellingup	+	+	+	?
	sp. (>1)		1	1	1	
HEBELOMA	*crustuliniforme*	2. Nannup/Gnangara	+	?	+	1
LACCARIA	*laccata*	2. Dwellingup/Jarrahdale	+	+	+	+
LACRYMARIA	sp.					
LACTARIUS	sp.	2. Dwellingup/Jarrahdale	1(+)	(-)	(-)	
LEPIOTA	sp. (>1)					
PAXILLUS	*muelleri*		1			
	sp.		1		1	
PHYLLOPORUS	sp.	2. Ludlow/Perth	(1)	1		
ROZITES	*australiensis*		1		1	
RUSSULA	sp.		1		1	
SUILLUS	*granulatus*		-	-	-	1/2
	luteus		-	-	-	1/2
TRICHOLOMA	sp. (>1)		1	1	1	

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CULTURE COLLECTION 1981 - EPIGEOUS FUNGI (Continued)

Genus	Species	No. of Cultures	Positive - Mycorrhizal			
			Jarrah	Tuart	Karri	*P. radiata*
AMERICAN CULTURES						
AMANITA	*muscaria*	1	(+)	(+)	(+)	
	pantherina	1				
BOLETUS	*edulus*	1				
CORTINARIUS	*elegantor*	1	(+)			
HEBELOMA	*crustuliniforme*	2	(+)	(+)	(+)	
LACCARIA	*laccata*	4				
SUILLUS	*albidipes*	1				
	brevipes	1				
	brunnescens	1				
	grevillei	1				
	lakei	1				
	ponderosus	1	* All are positive on various species of pine.			
	subolivaceous	1				
	tomentosus	1				

KEY:

+ Culture positive in pure culture synthesis (PCS) trials.

Blank – Unknown and/or PCS not tried.

1 Culture deemed positive by association - observed in forest.

2 Same genus proven positive by other workers.

? No result obtained yet in PCS trial.

( ) Possible result

- Definitely not mycorrhizal - fungi specific for set group of plants.

CULTURE COLLECTION 1981

HYPOGEOUS FUNGI (SECOTIOID OR UNDERGROUND "ENCLOSED SPORED")

SUMMARY: - 25 genera represented in the specimen collection.
- 77+ cultures from 13 genera (excluding several unknown genera).

GENUS	SPECIES	ECOTYPE NO/LOCATION	POSITIVE - MYCORRHIZAL			
			Jarrah	Tuart	Karri	P.Radiata
AUSTROGAUTIERIA	sp.					
CASTORIUM	camphoratum				1	
GYMNOMYCES	sp.				1	
HYMENOGASTER	sp. (>1)				1	
HYSTERANGIUM	sp. (>1)		1	(1)	1	
ILYEODICTYON	sp.		PCS negative			
MARTELLIA	sp.				1	
MESOPHELIA	labyrinthomyces trabalis		1		1	
OCTAVIANINA	sp.					
PISOLITHUS	microcarups	2 Ludlow/Quinninup	1	(+)		
PISOLITHUS	tinctorius	H35 - Dwellingup	+	+	+	?
		H37 - Nannup	(+)	+	+	?
		H38 - Nannup	(+)	+	+	?
		H43 - Amphion	+	+	+	?
		H46 - South Australia	+	+	+	?
		H53 - Agroforestry	+	(+)	(+)	?
		H70 - Jandakot				
		H77 - Nannup				
		H80 - CSIRO (Floreat)	+	+		
		H93 - Mundaring				
		H95 - Dwellingup				
		H98 - Dunsborough	+	+	+	?
		H99 - Cobiac				
		H107 - Gnangara				
		H215 - Boddington				
RHIZOPOGON	luteus		-	-	-	1/2
	roseolus		?	-	-	1/2

.../2

CULTURE COLLECTION 1981 - HYPOGEOUS FUNGI (CONTD)

GENUS	SPECIES	ECOTYPE NO/LOCATION	POSITIVE - MYCORRHIZAL			
			Jarrah	Tuart	Karri	P.Radiata
SCLERODERMA	cepa	Dwellingup/Manjimup	+	+	+	
	varicosum	Dwellingup/Ludlow	+	+	+	
UNKNOWN		H75 - Pemberton	+		(+)	
SELLEROMYCES	sp.		1		1	
AMERICAN CULTURES:		NO. OF CULTURES				
CENOCOCCUM	geophilum	1				
	graniforme	2				
CLAVATIA	fumosa	1				
LYCOPERDON	pyriforme	1				
PISOLITHUS	tinctorius	7				1/2
		Code No.H234(0.125)	+	?	+	(+)
		H235(0.138)	?	+	+	?
		H237(0.183)	+	(+)	+	?
RHIZOPOGON	sp. (15 different species - 1 rep.each)		-		-	1/2

KEY: As per EPIGEOUS sheet.

REPORT FOR ALCOA - ENVIRONMENTAL SECTION
NOVEMBER 1981

Fungi on Mined Sites - Del Park and Jarrahdale

A report based on a limited number of observations made over a restricted range of sites towards the end of the 1981 fungal fruiting season. The work was a preliminary examination of the fungal status of these areas with the view to more detailed investigations being undertaken in the future. (Honours student(s), casual staff, CSIRO-ALCOA liaison.)

General

The mined sites do not offer 'ideal' conditions for fungi. Litter development is poor and confined to rip furrows and other collection areas, i.e. logs, stumps, tree bases. Moisture retention in exposed soils is also poor especially as temperatures begin to rise in spring. This would reduce the duration of fungal activity in such areas. Consequently, fungal numbers are low and the variety restricted to a number of common pioneer species.

Fungal Identity and Variety (Table 1)

The fungi observed in replanted areas with little or no development of litter and/or understorey (Del Park 9 and 10, Arboretum) were typically mycorrhizal - *Scleroderma sp., Laccaria laccata, Pisolithus tinctorius.* Under the denser legume regeneration (Del Park 9) where litter existed, a wider range of fungi was found, mostly decomposers but with some *Scleroderma sp.*, though in fewer numbers when compared to the open areas. However, as a result of the high moisture levels under the litter, the *Scleroderma* were contaminated with parasitic fungi and therefore non functional for spore dispersal. This may be a reflection on an 'out of phase' succession, where the pioneer species occur under an artificially induced, unnatural understorey. Unnatural with respect to 'normal' sequential development; understorey type, diversity and density; or even total absence of ground cover. Note: this situation is not analogous to 'hot burn' regeneration which occurs under a mature forest possessing a more diverse fungal flora and a greater inoculum potential.

There were greater numbers of saprophytic fungi (decomposers) noted at the Jarrahdale top soil respread site. This could be due to a combination of factors that make this a unique site, i.e. higher organic matter levels (and soil moisture), age of site, understorey type and diversity, natural fungal inoculum introduced with the top soil. The number and variety of mycorrhizal fungi appeared similar to Del Park. Of all the areas studied, this site most closely resembles the forest in the numbers and diversity of *saprophytic fungi* observed, however, in common with the other areas, *mycorrhizal fungi* were poorly represented. The mixed *E. microcorys* (?) and *marginata* site (Jarrahdale - Shea's root pit site) was similar to Del Park in the almost total absence of decomposer fungi.

Mycorrhizal Development

Known mycorrhizal fungi were collected at both mine sites and some pyramidal mycorrhizae (roots) were observed and collected in litter under

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Possible Projects

1. More detailed studies of fungi associated with mined site.

   - host specificity (ARBORETUM; interstate collections)
   - site differences
   - fertilizer/litter effects.

2. Mycorrhizal root occurrence and distribution related to project 1.

3. Outplant trials of selected mycorrhizal fungi on *Eucalypt* seedlings.

a number of *Eucalypt* species. (Table 2) No effort was made to determine the presence of hypogeous fungi or to assess the development of mycorrhizae in the mineral soil. Note: Jarrah forms 'black mycorrhizae' in the mineral soil of the forest and replanted exotic *Eucalypts* may do the same. Definition of the role of this type of mycorrhizae (in nutrition and disease resistence) is incomplete and they may play an important role in plant health on the mine sites.

Conclusion

TABLE 1. Fungi Observed on Mine Sites - August/September 1981

Area	FUNGAL CATEGORY: A. Saptophytic	B. Not Known - A or C	C. Mycorrhizal
1. DEL PARK - 9 and 10	*Gymnopilus* sp. *Cortinarius* sp. *Galerina* sp.	*Cortinarius* sp.	*Pisolithus tinctorius* * *Scleroderma* sp. *Laccaria laccata*
DEL PARK - ARBORETUM (Sept/Oct '81)	*Gymnopilus* sp.	*Ilyeodictyon* sp. (new species)	*Scleroderma* sp.
2. JARRAHDALE: - Top Soil Respread Site	*Gymnopilus* sp. *Cortinarius* sp. *Mycena* sp. *Galerina* sp. Miscellaneous sp.	*Cortinarius* sp.	*Laccaria laccata* *Scleroderma* sp.
- E. microcorys/marginata site			*Laccaria laccata* *Hysterangium* sp.

NB. The genus *Cortinarius* sp. is a large one and more than one species was represented at each area. It is a difficult taxonomic group and any mycorrhizal status is assumed by association with tree roots.

* SEE TABLE 2.

TABLE 2. Eucalypts Associated with Observed Mycorrhizal Fungi

Laccaria laccata:	*E. globulus, E. microcorys, E. calophylla, E. marginata*
Scleroderma sp:	*E. saligna, E. calophylla, E. diversicolor* (and in Del Park Arboretum under unidentified tree species)
Hysterangium sp:	*E. microcorys*
* *Pisolithus tinctorius*:	Observed in recent regeneration between Del Park Road and the conveyor belt. Eucalypt species unknown

APPENDIX 4.

PRODUCTION AND SURVIVAL OF *PHYTOPHTHORA CINNANOMI* RANDS ZOOSPORES IN SUPPRESSIVE AND CONDUCIVE WESTERN AUSTRALIAN SOILS

By N. MALAJCZUK, C.L. SANFELIEU and S. HOSSEN

CSIRO, Division of Land Resources Management,

Private Bag, P.O., Wembley, W.A. 6014.

Studies were undertaken to investigate the effect of selected Western Australian soils on sporulation, hyphal lysis and zoospore survival of *P. cinnamomi*.

The Soils chosen represented extremes of disease incidence in the forest. They included a loam, suppressive to *P. cinnamomi*; yellow sandy laterite and a red sandy laterite both conducive soils type to disease development initiated by *P. cinnamomi*.

It was found that the loam soil extracts stimulated sporangial production and microbially induced hyphal lysis more than the other soils tested. A positive correlation between sporangial production and hyphal lysis was observed. This relationship could be explained if sporangial production is regarded as a survival response to hyphal lysis.

Seven percent of encysted zoospores survived 43 days in all soil extracts. This survival was not influenced by soil sterility, temperature or type suggesting that cysts are more resistant survival structures than hyphae. Motile zoospore survival is reduced by soil microbial factors, this effect is more pronounced in the loam relative to the two laterite soils. Increased extract temperatures also reduced motile zoospore survival.

These results show that *P. cinnamomi* survival is reduced in the suppressive loam relative to conducive lateritic soils.

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REF: YW5

11th December, 1980

Mr. L.F. Hammond,
Secretary,
Jarrah Dieback Research Foundation,
W.A. Forests Department,
54-56 Barrack Street,
PERTH WA 6000

Dear Sir,

... Please find enclosed the progress report on the Jarrah Ectomycorrhizae programme from its commencement in May, 1980 to December, 1980.

Yours faithfully,

N. MALAJCZUK
Senior Research Scientist
(Project Leader)

C.L. SANFELIEU
Experimental Officer

NM:SD