ECTOMYCORRHIZAS IN THE ECOSYSTEM
Structural, Functional and Community Aspects

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1. INTRODUCTION

This text has been excerpted from various contributions in a previously published proceedings volume in order to provide examples of the different elements you may be using in your chapter. The text itself may, therefore, be illogical and disjointed.

1.1 Initial Comments

One hundred years have elapsed since Frank (1894) used a combination of careful field observations and laboratory growth studies to develop the first detailed hypothesis concerning the significance of the ectomycorrhizal symbiosis. He envisaged that mycorrhizal fungi absorbed organic nitrogen (N) from the superficial layers of forest soil, passing this element to the trees, at the same time obtaining carbon to sustain themselves. It is in many ways regrettable that in the ensuing century, research on the symbiosis has not been based on the same integrated approach, but followed two distinct and often divergent paths one leading to analysis of function under simplified laboratory conditions, the other to evaluation, in the field, of the relationships between the fungi involved and plant roots. In order to achieve any understanding of the ecological significance of the ectomycorrhizal symbiosis, a synthesis of progress made in the two separate lines of advance is essential. This paper, while attempting to provide such a synthesis, also contains a plea that in the next century of research the two hitherto largely independent paths will converge so that the diverse biological attributes of the symbiosis can be viewed in a more realistic context.

2. STRUCTURAL FEATURES OF ECTOMYCORRHIZAL ROOTS

There is now little dispute over the nature of the complex fungal structure, the Hartig-net, which provides the intimate contact between the mycorrhizal partners. Indeed, it appears to be constructed in a remarkably uniform manner across a whole range of plant-fungus partnerships. The hyphae of the fungal partner, in penetrating between the radial walls of the outer cells of the root cortex, produce a largely unseptate but much branched and compact fan-like development (Fig 1) in which the individual walls of the hyphal branches provide a very large surface area and hence a structure which was recognised by Dudderidge & Read (1984a) as being analogous to that of ‘transfer cells’ of plants. These hyphae are multinucleate, coenocytic, and contain numerous mitochondria as well as extensive rough endoplasmic reticulum (Dudderidge and Read 1984 a, b, Massicotte *et al* 1986, Blasius *et al* 1986, Kottke and Oberwinkler 1986a, b 1987). These are all features suggestive of intensive physiological activity.

Figure 1. Pattern of branching of hyphal elements of the Hartig net interpreted from a tangential section through mycorrhiza formed by *Amanita muscaria* on *Picea abies.*

2.1 Ecological Considerations - A Synthesis of Laboratory and Field Observations[1]

Analyses of the structural and functional attributes of selected fungi such as *Suillus bovinus*, growing on natural substrates, while useful in clarifying likely nutritional roles, still provide greatly oversimplified views of the situations prevailing in nature where mixed communities of plant and fungal

[1] This is an example of a footnote.

species co-exist and interact. In order to understand their interrelationships there is no alternative but to depend upon careful field observations of the kind traditionally made by those adopting the more holistic alternative path in mycorrhizal research. Access to the powerful tools of molecular biology now, however, promises to provide a much greater rigour in studies which attempt to unravel the complicated web of these microbial interactions. So far these tools have allowed us only top plot the distribution of distinctive genomes. In future they may have to be developed to permit a more dynamic understanding.

3. PLANT DEFENCE REACTIONS

Catalase could be involved in the regulation of the production of activated oxygen species elicited by cell wall elicitors of ectomycorrhizal fungi (Schwacke & Hager 1992). Transcript concentration of catalase is down-regulated by 50% in 4-day-old eucalypt ectomycorrhizas and this decreased expression might favor the accumulation of the defence molecule H_2O_2.

Table 1. Expressed sequenced tags cloned from 4-day-old ectomycorrhizas of *Eucalyptus globulus bicostata* - *Pisolithus tinctorius* corresponding to known proteins

cDNA clone	Putative protein	Organism	Homology (%)
EST 94	Cylicin	*Bos taurus*	20
EST 32	Hydrophobin	*Schizophyllum commune*	68
EST 141	Hydrophobin	*S. commune*	39

This table has only been reproduced in part.

4. CONCLUSION

Ectomycorrhiza development influences both plant and fungusgene expression in a pleiotropic manner. A range of fungal tissues can be distinguished by a combination of anatomical and cytological features (e.g. mantle, Hartig net). On the other hand, root tips proliferate and root cells experience major alteration in their orientation and morphology.

NOTES

There are inclusions in this text from a number of different articles, which is why it makes little or no sense.

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