Book Review

G. K. Podila and D. D. Douds Jr eds.:

Current advances in mycorrhizae reserach.
St Paul, Minnesota, 2000.
193 pages, 51 ill. APS Press.

The research of mycorrhizae, a symbiotic association common in the most vascular plants, has been accelerated during the last decade. This corresponds to the high ecological and economical importance of mycorrhizal symbiosis. The reviewed book provides a view of the most important problems which are the main interest of several research groups working in the field of mycorrhizae.

The book is divided into 6 thematically distinct sections, each involving 1 to 3 separate contributions. The first one deals with signalling mechanisms which enable communication between the plant and the fungus in mycorrhizal symbiosis. Mycorrhizal symbiosis involves a well-balanced molecular interaction between the two partners in which some normal defense reactions of the plant to fungal invasion are suppressed, whereas other specific plant reactions are induced. However, some defense mechanisms remain active even during the formation of mycorrhiza. Chemical communication occurs even earlier than the partners pass into direct contact, which was observed in experiments. In arbuscular endomycorrhizal symbiosis (the most widespread type of mycorrhizal symbiosis), roots of host plants exude a signal molecule, which affects the growth and branching of germ tubes of the fungus. In ectomycorrhizae, the external concentration of sugars acts as a signal for the regulation of fungal gene expression. This reaction of ectomycorrhizal fungi is similar to that of saprophytic fungi.

The second section is dedicated to the particular reaction of plants to the presence of the fungus, the defense reaction, and its importance in the formation of arbuscular mycorrhizal symbiosis. The various aspects of plant defense mechanisms to mycorrhizal fungi, including the regulation of plant defense-related genes are discussed in details.

The third section involves the molecular genetics of mycorrhizal symbiosis. This kind of research was enabled by the development of modern molecular techniques, which, for example, were used to isolate plant genes induced in mycorrhizal roots. The transcripts of these genes belong to the medium— or low-abundance class of m-RNA and are thus unlikely to be isolated using conventional screening methods. To be detected, arbuscular mycorrhiza-specific RNA was used to prepare DNA library using reverse transcriptase, and non-specific sequences were subtracted using the hybridisation with complementary RNA synthetised in vitro from control DNA library of non-mycorrhizal roots. This results in a significant enrichment of mycorrhiza specific clones. The described method has been shown to be successful in the isolation of plant genes induced in mycorrhizal roots.

Very interesting results presented in the fourth section show the carbon metabolism and energy cost of arbuscular mycorrhizas. High resolution nuclear magnetic resonance has been applied in combination with isotopic labelling techniques to study the fate of saccharides in presymbiotic and symbiotic phases of mycelium of arbuscular mycorrhizal fungi. The major metabolic pathway in germinating spores is gluconeogenesis. Lipid synthesis is almost absent in this presymbiotic phase, and might be an essential factor needed for the fungus to complete its life cycle. Extraradical symbiotic hyphae lack the transporters of exogenous hexose but are able to acquire acetate, whereas intraradical fungal structures are probably specialised to transport hexose, but they do not uptake acetate. These results are very important for understanding the metabolism of arbuscular mycorrhizal fungi since they depict the physiological differentiation of the mycelium.

The fifth section summarises the ultrastructural changes in the root colonised by mycorrhizal fungi, including cytoskeleton modifications. Much of the progress in this field is own to

improvements in molecular and cytological methods. The use of fluorescent probes in conjunction with scanning laser confocal microscopy has been particularly important in these studies.

The sixth section is the shortest but the most exciting one, since it introduces the reader to the problems of genetic engineering of mycorrhizal fungi. While the use of naturally occurring mycorrhizal fungi for improving the health of host plants dates back to several decades ago, efforts to genetically engineer them for extensive use in agriculture, forestry and horticulture is at the beginning. The type of physical co-existence of plants with mycorrhizal fungi makes fungi excellent candidates to be genetically changed for the use in a variety of situations where suboptimal conditions exist for growth and survival of the host plants. For example, ectomycorrhizal fungi expressing genes coding for specific insecticidal proteins might be able to protect seedlings from root damaging insects. However, the application of common transformation techniques almost failed since ectomycorrhizal fungi are recalcitrant to form the necessary viable protoplasts, although successful transformation via protoplast formation had been achieved for *Laccaria laccata* and *Hebeloma cylindrosporum*. On the other hand, cultures of arbuscular mycorrhizal fungi are maintained on live plants which constitutes an experimental system too complex for the procedure of transformation. Among several newer transformation techniques for introducing foreign genes, the particle gun-mediated transformation technique is probably the most versatile and has the potential to be adopted for even complex cultivation systems. It was successfully used to transform the ectomycorrhizal fungi *Paxillus involutus* and *Laccaria bicolor*, introducing antibiotic resistance genes, reporter genes and insecticidal genes. Experiments applying this technique on spores of the arbuscular mycorrhizal fungus *Gigaspora* sp. have been performed as well. However, due to the complex nature of the spores containing multiple nuclei and a high genetic diversity within a single spore, obtaining fungal isogenic lines of arbuscular mycorrhizal fungi represents a serious problem.

Although the reviewed book cannot cover all molecular, physiological and ecological aspects of the studies on mycorrhizal symbiosis, it gives a valuable cross-section of the newly applied methodology which provides a new basis to understanding of the biology of mycorrhizal plants and their functioning in ecosystems. The reader will find a significant amount of relevant references here as well as brief conclusions following each contribution. The book can be recommended to postgraduate and advanced undergraduate students of mycology, plant physiology and phytopathology as well as to the interested scientists.

Milan Gryndler

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