

Jan V. Colpaert

**M.G.A. Heijden, I.R. Sanders (eds):
Mycorrhizal ecology. Ecological studies, vol 157
Springer, Berlin Heidelberg New York, 2002. 469 pp, € 139**

Published online: 30 July 2003
© Springer-Verlag 2003

This volume summarises progress during the last decade in understanding the ecological function of the mycorrhizal symbiosis and is a very welcome addition to the mycorrhizal literature for a wide audience. The authors of the various chapters are renowned experts in mycorrhizal ecology, many of them involved in recent discoveries in this field. Undoubtedly, this excellent textbook can be recommended to junior and senior scientists working in mycorrhizal ecology and it will also fascinate ecologists and population biologists working in the broader field of ecology. The different mycorrhizal types described contribute to plant population biology and to ecosystem functioning. They play key roles in rhizosphere processes and there is a growing notion that these below-ground interactions between plants and micro-organisms shape terrestrial ecosystems.

The book is divided into six sections. The first is an introduction to mycorrhizal symbiosis and discusses the progress made in understanding the ecological function of this association. The need for ecosystem-scale testing of hypotheses about the role of the mycorrhizal symbiosis in the dynamics of terrestrial plant communities is proposed by D.J. Read. The more traditional reductionist approaches to mycorrhizal functioning have a rather low ecological relevance and can not be recommended for tackling the inherent complexity of plant and microbial communities. To understand this ecological complexity at the community level, Read makes a plea for more microcosm and field studies and discusses some important advantages and disadvantages of the latter approaches. Although such large-scale studies are indeed greatly needed, they will never reach the precision achieved by well-considered, small-scale experiments. As pointed out by J.P. Grime in his foreword to the volume: “the most significant challenge for ecologists at the present time is to continue to exploit the many current opportunities for penetration into detailed mechanisms but simultaneously to actively promote integration of sub-disciplines within ecological

research”. A major asset of this book is that it provides a platform to researchers active in different subdisciplines and countries, with differing opinions and scientific backgrounds. Most of the authors pinpoint gaps in our knowledge and make suggestions for future research.

In the second section, five chapters are devoted to the eco-physiology of mycorrhizal plants, discussing recently acquired knowledge of carbon and nutrient fluxes within and between plants. In the latter field, the importance of the interplant transfer of C and nutrients at the plant community level remains controversial, although it is evident that such transfers have potentially great implications for ecosystem structure and functioning. The function and diversity of the arbuscular mycorrhizal symbiosis in C and mineral nutrition is discussed further by I. Jakobsen and co-authors. Carefully performed experiments have shown variation in the transfer of resources between mycorrhizal symbionts, transfer that depends on plant and fungal species, on root external and internal fungal structures, and on the longevity of these structures, etc. The authors argue that controlled experiments with dominant plant and fungal species may resolve the frequent discrepancies found between studies in pots and in the field. The subsequent chapter focuses on foraging and resource allocation strategies of mycorrhizal fungi in a patchy environment. The mycelial networks foraging for mineral nutrients in the soil remained underexposed to mycorrhizal research for a long time. P.A. Olsson and colleagues summarise the significant progress of the last years in unravelling nutrient acquisition strategies of arbuscular mycorrhizal and ectomycorrhizal fungi. The ability of the different mycorrhizal types to utilise different soil nutrient sources and the consequences of this for plant competition and plant-soil feedback is the focus of R. Aerts, especially N nutrition and cycling. Testing of the current hypothesis on the role of different mycorrhizal types in nitrogen cycling suffers from a lack of data obtained under realistic conditions at the ecosystem level. Many questions remain open but there is much new research in this field. The last chapter in this section concerns the influences of global change on

the mycorrhizal symbiosis. Rillig and co-authors summarise the work done in the last decade on global change factors. They argue the need for a better mechanistic understanding of the symbiosis and regret that short-term experimental data are often used to infer long-term responses in global change studies.

The third section of the book deals with biodiversity issues, discussing the influences of mycorrhizal fungi on biodiversity and ecosystem functioning, as well as the factors influencing diversity and structure of mycorrhizal communities themselves. S. Erland and A.F.S. Taylor review the diversity of ectomycorrhizal fungal communities in relation to abiotic factors. The possibilities to identify fungal species below ground have increased in the last decade, but we are still far away from making predictions about how ectomycorrhizal fungal communities may change in response to perturbations. The most recent findings in this field are not included, but it is clear that powerful molecular tools such as quantitative PCR and DNA microarray chips can be applied successfully to identify fragile external mycelia and to understand fungal gene expression in an ecological context. The four remaining chapters in this section deal with the AM symbiosis, with some overlap of subject matter. In a chapter on molecular identification of AM fungi, J.P. Clapp and co-authors make reference to phylogeny, taxonomy and AM fungal community structure. M. Hart and J.N. Klironomos highlight the role of AM fungi in ecosystem functioning and how they influence plant community dynamics. This latter is also addressed by M.G.A. Van der Heijden and by J.D. Bever and co-authors. Van der Heijden focuses on mechanisms that may explain how AM fungi determine plant diversity. Bever and co-authors propose possible models based on positive or negative feedback mechanisms that may predict changes in plant and fungal community structure.

The fourth section considers in more detail the interactions of mycorrhizal fungi and organisms of different trophic levels, including plants, herbivores, insects and other soil fungi. Here, a chapter on the interactions of mycorrhizal fungi with bacteria would have been appropriate. The complex mycorrhiza-herbivore interactions are reviewed and analysed by G.A.

Gehring and T.G. Whitham. It is important to understand the implications of herbivore-caused changes in mycorrhizal communities and to quantify how these changes affect plant performance. The authors suggest that, ideally, the mutual impacts on mycorrhiza and herbivore fitness should be examined over a wide range of conditions. In particular, interactions between mycorrhizal fungi and key herbivores may have great effects at the community and ecosystem level. The relatively few studies of interactions with soil invertebrates are discussed in a subsequent chapter. A.C. Gange and V.K. Brown take the opportunity to present a field study in which numbers of either target group (AM fungi or soil insects) were reduced using biocides and impacts on the plant community examined. J.R. Leake and colleagues review the evidence suggesting that intense interactions between ectomycorrhizal and saprotrophic fungi have major effects on the functioning of these organisms and upon nutrient and carbon cycling in forest ecosystems.

The penultimate section looks at host specificity in interactions between plants and mycorrhizal fungi. D.L. Taylor and co-authors focus on myco-heterotrophic plants. Several recent studies have revealed associations with ectomycorrhizal fungi and orchids, monotropes and a liverwort. Phylogenetic overviews of mycorrhizal specificity in Orchidaceae and Monotropoideae are shown and interesting questions about the origin and evolution of specificity, and the physiology and ecology of carbon exchange are discussed. The possible existence of specificity in the AM symbiosis is explored by I. Sanders. Because it remains difficult to describe the AM fungal community in natural systems, there is little evidence for or against AM symbiosis specificity. Although this question remains unanswered, the chapter gives a framework for a more theoretical approach to the problem.

Finally, the editors give their own appreciation of the importance of mycorrhizal fungi in ecosystem functioning, presenting some general conclusions that can be used as prospects for future research. I have no doubt that this book will be a source of inspiration for the many students and researchers who have become mesmerised by the fascinating mycorrhizal fungal web.