

Preface

The genesis of this book goes back to summer 2010 while formulating Indo-German DFG Workshop on Amity University Campus, Noida, India under the frame of the programme in “Initiation and Intensification of Bilateral Cooperation”. Among the eminent plant biologist, mycologists and microbiologists especially working on the members of Sebaciales like Ralf Oelmüller (Jena), Gerhard Kost (Marburg), Anton Hartmann (München) and François Buscot (Halle) realized that at the moment information on different aspects of members of the Sebaciales is highly scattered and normally not available to scientists in general and young scholars in particular. A decision was taken to concise the published information’s in a form of a book. The active scientists were invited to contribute their valuable chapters. It is gratifying to note that they were so enthusiastic that chapters were contributed much before the deadline. Unfortunately, due to pre-occupation it got delayed. Ajit Varma takes entire responsibility for the inordinate delay.

The first species of this fungal group with inconspicuous corticoid fruit bodies were described by C.H. Persoon in the eighteenth century and the genus name *Sebacina* was created by brothers Tulasne in 1871. In recent decades, the basidiomycetes of the order Sebaciales have emerged as a fascinating order of mutualistic plant–fungal symbionts. While a few members form mycorrhiza-type interactions, others behave more like beneficial endophytes. They promote plant growth and fitness, confer resistance of the host against abiotic and biotic stress and are involved in nutrient exchange between the two partners (Weiß et al. 2011). The authors demonstrated that Sebaciales are not only extremely versatile in their associations with roots but also almost universally present as symptomless endophytes. The multitude of symbiotic interactions in Sebaciales may have arisen from an ancestral endophytic habit by specialization. Weiß et al. (2011) further established a phylogenetic tree for all known Sebaciales and identified two subgroups, A and B. The most basal clades in both subgroups were endophytic, which indicates that this lifestyle maybe ancestral in the Sebaciales and the starting point for further specification towards mycorrhizal symbiosis. “However, the close relationship of endophytes, in particular with orchid mycorrhizal strains, could also be indicative of the capability of Sebaciales strains to switch between

symbioses or to fall back on endophytic habit if no appropriate mycorrhizal partner is present” (Weiss et al. 2011). There is no question that Sebaciniales are not only interesting for basic science but also important contributors to the ecosystems.

Two members of Sebaciniales have been developed as model systems to study plant/microbe interactions at the cellular and molecular basis *Sebacina vermifera* and *Piriformospora indica*. The latter colonizes the root cortex of many different plant species including important crop plants with beneficial effects to its hosts. Given the capability of *P. indica* to colonize a broad range of hosts, it must be anticipated that the fungus has evolved efficient strategies to overcome plant immunity and to establish a proper environment for nutrient acquisition and reproduction (Khatabi et al. 2012). Qiang et al. (2012) have recently demonstrated that *P. indica* colonizes *Arabidopsis* roots by inducing an endoplasmatic reticulum stress-triggered caspase-dependent cell death. Studies in several laboratories have demonstrated that the degree of root colonization is important for the benefits of the plants in this symbiosis (Khatabi et al. 2012; Jacobs et al. 2011; Camehl et al. 2010; Sherameti et al. 2008) and that a balanced activation of the plant defence mechanism is required to maintain a stable symbiosis and to prevent over-colonization (Camehl et al. 2010). Furthermore, an effective phosphate transport process places an important strategy to enhance the symbiotic interaction between the fungus and the host. In addition to this, recently the role of OXI1 (oxidative signal inducible one) has also been implicated in facilitation of fungal colonization process (Camehl et al. 2011). OXI1 becomes activated by H₂O₂ and phospholipid signalling, and it has been proposed that this pathway may balance growth/developmental processes and defence in response to the beneficial fungus *P. indica*. Two groups have established efficient transformation systems for *P. indica*. Using this technology, Yadav et al. (2010) have shown that a phosphate transporter from *P. indica* plays a role in phosphate transport to the host plant. Also Zuccaro et al. (2007) established an efficient transformation system by introducing a reporter gene into the fungal genome. In addition, Zuccaro et al. (2011) have sequenced and annotated the entire genome of *P. indica*. Comparative analysis of the *P. indica* genome with other Basidiomycota and Ascomycota fungi that have diverse lifestyle strategies identified features typically associated with both, biotrophism and saprotrophism. The authors concluded that the tightly controlled expression of the lifestyle-associated gene sets during the onset of the symbiosis argues for a biphasic root colonization strategy, an early biotrophic growth followed by a cell death-associated phase. About 10 % of the fungal genes induced during the biotrophic colonization encoded putative small secreted proteins (Zuccaro et al. 2011; Lahrmann and Zuccaro 2012).

Since it is proved that Sebaciniales are universally present in the ecosystems on the entire world (Weiß et al. 2011), and since their symbiotic interaction with the plants is either symptomless or beneficial for the hosts, they have an enormous potential for agricultural applications. Several groups have already started to study the potential of Sebaciniales for improving crop plants, which will be a fascinating tool for the future, in particular if it can be combined with results from basic science.

The book contains 22 chapters, and they are grouped into five parts namely *Piriformospora indica* as Beneficial Root Symbiont; Interaction with Different Plant Species; Resistance Against Biotic and Abiotic Factors; *Piriformospora indica* and Macronutrients for Plants and Experimental Protocols for *Piriformospora indica* Studies followed by subject index.

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Piriformospora indica

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