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# SCOPE AND APPLICATION OF ENDOMYCORRHIZAL ASSOCIATION

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# Scope and Application of Endomycorrhizal Association

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***Abstract – Arbuscular mycorrhiza (AM) is the most common symbiotic association of plants with microbes. AM fungi exist in the majority of natural habitats and they provide a number of important ecological services, in particular by enhancing plant nutrition, stress resistance and tolerance, soil structure and fertility. AM fungi also associate with most crop plants like cereals, vegetables, and fruit trees; thus, they receive growing attention for their potential use in sustainable agriculture. Basic research of the past decade has revealed the existence of a dedicated recognition and signaling pathway that is needed for AM. Furthermore, recent evidence offered new insight into the sharing of nutritional benefits between the symbiotic partners. The great potential for application of AM has given rise to a thriving industry for AM-related products for agriculture, horticulture, and landscaping. Here, we address new advances in these areas, and we highlight future potential and limitations against the use of AM fungi for plant production. More than 95 percent short roots of most terrestrial plants are colonized by mycorrhizal fungi as soon as they appear in the upper soil profiles. The establishment of mycorrhizal association requires profound morphological and physiological changes in root and fungus. It is affected by other rhizospheric microorganisms, especially by the bacteria. Bacteria may have evolved mechanisms of selective interaction with surrounding microorganisms, with neutral or positive effects on mycorrhizal interactions, but negative effect on root pathogens in general. Because of the beneficial effect of bacteria on mycorrhizae, the idea of Mycorrhization Helper Bacteria (MHB) was developed. Five key actions of MHB on mycorrhizae were proposed: in the receptivity of root to the mycobiont, in root-fungus recognition, in fungal growth, in the modification of rhizospheric soil and in the germination of fungal propagules.***

***Key Words – Mycorrhization Helper Bacteria, Mhb, Ectomycorrhizal Fungi***

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## INTRODUCATION

It can be counted as a major achievement, if an invention spreads internationally, adapts to a wide range of applications and lasts for years. This certainly refers to mycorrhizal arbuscular (AM). In most earth plants in most taxas and nearly all ecological niches, AM is thought to be of monophyletic origin in the Ordovicians approximately 480 Mio years ago (Redecker et al, 2000;) (Read, 2002; Wang and Qiu, 2006). Most plants are voluntary symbionts, i.e., benefit from AM fungi and can live without them while they are costly for fitness (see below). However, certain plant species became entirely dependent on fungal nutrition, which means that the AM fungus was totally robbed of photosynthesis (mycoheterotrophic) capabilities. On the other side of the scale, some plant taxa, e.g. brassicaceae and chenopodiaceae, were asymbiotics and thus lost the ability to communicate with AM fungi (Brundrett, 2004).

Arbuscular symbiosis of mycorrhizal symbiosis has long been considered a significant promiscuous relationship between >100,000 species of plants and 100 AM fungal morphotypes. However, the typical species definition is problem in AM fungi, because of the relatively few distinctive morphological features of AM fungi (mainly sporoidal), and because of their basically asexual mode of propagation. AM fungi have never proven to be sexual phases or to be mating; however, in the absence of classical meiosis or recombination, they may experience hyphal fusion (anastomoses) and replacement of the genome. This function may therefore be used as an additional criterion to define taxonomies besides spore morphotypes, depending on genetic relationships.

With large-scale approaches to sequence, AM fungal taxonomy and structures increased to a new stage. These modern instruments demonstrate the underestimation of the variety of AM fungi (Husband et al., 2002; Öpik et al., 2006,). Therefore, the true number of genetically and functionally different 'cryptic species' of AM fungal species not distinguishable by morphometric parameters will surpass current estimate by magnitude ranges (Munkvold et al. 2004; Rosendahl, 2008). The fact that recent findings show that even within one AM fungal species at a certain region there is an unparalleled genetic diversity, suggested that systematic and nomenclature in AM fungi are impeding the basic genetics and modes of reproduction of AM fungi.

**Origin and Evolution of AM**

A microcosm in which micro-organisms, plant roots and soil elements function interact is the root-soil interface and which creates what we call rhizosphere. Thus, the rhizosphere is the impact zone on associated soil components and micro-biota of plant roots, with an increasing occurrence and numbers of microorganisms. It is obviously a physical, chemical and biological system different from the bulk of the soil. The structure and diversity of fluorescent pseudomonads associated with roots has actually been demonstrated to vary considerably from those of bulk soil. Based on their ability to use certain organic compounds, mobilize ferric iron and reduce nitrogen oxides, rhizospheric or non- rhizospheric populations may suffer discriminations. In the rhizosphere, the microbial activity is directed by plants that release organic matter, particularly as root exudates. The exudates are used for the endogenous microorganisms. On the other hand, the host plant may respond to stress conditions related to water and mineral nutrition and soil-borne plant pathogens, free or symbiotically live microorganisms plant-related.

Mycorrhiza are the relationship between soil fungi and plant roots. Mycorrhizal development implies profound morphological and physiological root changes, which act in a fungal integrated way, thus promoting the symbionts' adaptability and survival. Wang and Qiu report that 80 per cent of mycorrhizal species and 92 per cent of families were related to mycorrhizae out of the total of 3,617 species from 263 families of terrestrial plants examined. 85% and 94% of all species and families are mycorrhizal among angiosperms. Other rhizosphere microorganisms, particularly bacteria, affect the establishment of mycorrhizal associations. Bowen and Theodorou showed in vitro that certain bacteria can positively or negatively affect growth, depending on the bacterial strain present, of the Rhizopogon Lutéolii ectomycorrhizal fungus, in symbiosis with pinus radiata. Although most interactions are defined as competitive, some may benefit from mycobiont plant infection.

Duponnois and Garbaye proposed for the first time a concept "Mycorrhization Helper Bacteria" for only bacteria that promoted the formation of the roots of fungus symbiosis from the isolation and identification studies of bacterial species present in mycorrhizal funguses and the study of bacterial activity in symbiosis (MHB). Garbaye improved and explained this definition. Since then, significant strides have been made in the study of the bacterial, fungal, and plant relationship. Frey-Klett et al. propose two practical MHB types of bacterial activity know-how: first, Mycorrhization Helper-Bacteria, which strictly refers to those stimulating mycorrhiza formation process (a technique called "controlled mycorrhization" in the sense of mycorrhizal inoculation); and secondly, Mycorrhiza Helper-Bacteria, which I use for bacteria (The two types can be represented by individuals or by overlapping micro-organism groups, but both groups are represented by the word MHB.

**Mechanisms Involved in Intracellular Accommodation of AM Fungi**

A high degree of adaptation and genetic/metabolic cooperation between mycorrhizae partners indicates the long history, with AM symbiosis over 400 million years (Redecker, et al., 2000; Heckman etc., 2001; Schüssler et al., 2001), and the participation of plant and fungal signalization molecules that foster AM. In fact, AM formation requires a dedicated signalling route beginning with strigolactone, which is exuded to stimulate AM fungal activity (Akiyama et al., 2005; Besserer et al., 2006; Kretzschmar et al., 2012). AM fungi will then secrete lipochito-oligosaccharides perceived by the plant and activate an indicator transduction pathway that is shared with root nodule symbiosis and thus recognized in recent years as the Common Symbiosis Signaling Pathway (CSSP) (Harrison, 2012;). In view of the extremely low host specificity in the AM, the implication of a two-sided symbiosis exchange questions our current understanding of interparty communications as it would either involve several different signals for each potential partner or few signals that a broad range of potential partners might recognize.

**New Paradigms in the Exchange of Benefits in AM Symbiosis**

A substantial increase in the touch surface (also known as the symbiotic interface) between the two partners has been measured for several of the entire cell surface. The finely branching fungal arbuscle and the surrounding peri-arbuscular membrane of the host are a major increase (Alexander et al., 1989). The symbiotic interface is also acidified to facilitate nutrient transport through the fungal plasma membrane and periarbuscular membrane, as shown in. Cells with shrubs are also best suited for the exchange of nutrients. The plant host exhibits multiple nutrient carriers with symbiosis that are assumed to mediate mineral nutrient absorption from the AM fungus (Rausch et al., 2001). A symbiotic phosphate transport system (PT), which is expressed only in arbuscled cells (MtPT4 in Medicago truncatula; OsPT11 in rice), is a best-characterized example (Harrison et al., 2002; Yang et al., 2012). Phylogenomic study of MtPT4 and its orthologies on other plants shows that the phosphate-uptake pathway associated with AM is an early developmental advance which was conserved since angiosperms came into existence. Phosphate supply is one of the key advantages for the host in AM (Karandashov and Bukher, 2005), while the collective data indicate that phosphate from a fungus to a plant is transported by arbuscules

**Significance of AM for Plants in Natural Habitats**

The gain of a plant from AM fungal colonization depends to a great extent on the climate. Mycorrhizal plants are thought to have a selective advantage over non-mycorrhizal people of the same species in most natural habitats that are marked by mine rally deficient nutrients and various abiotic stress conditions. Thus, AM may theoretically help competition intraspecific and selectively encourage mycorrhizal plants. This is conceivably the reason why AM symbiosis flourished in most land plant taxa over very long evolutionary periods.

The fact that several different AM fungal partners are possible for plants is a complication and vice versa, each mycelium of the fungus can infect several host plants of a different or the same species. The resulting common mycorrhizal networks (CMNs) add another degree of complexity to mycorrhizal interactions' benefit analysis. A highly interconnected plant population could theoretically achieve stability because the supply of mineral nutrients by the CMN could support weaker individuals at the cost of stronger CMN plants. This means that stronger plants benefit indirectly less competitive plants, which decreases competition between plants. In particular where seedlings grew more when connected with a CMN formed by older plants, a phenomenon known as facilitation, this "underground socialism" was called upon (van der Heijden and Horton, 2009). However, CMN has a highly context-dependent impact on the seedlings and is different for the species involved. The effects of CMN cannot be generalized in some situations; even AMF can improve intra- or interspecific competition. Achlorophyll plants obtain from CMN all of their resources, including carbon, in the most extreme version, thus parasitizing – indirectly – other plants, which supply the network with their carbon (Bidartondo et al., 2002). Although this represents an extreme nutritional strategy that occurs only in a minority of the plants in the world, there are many intermediate examples of plants that derive a portion of their carbon from mycorrhizal fungi (mixotrophy) (Bidartondo, 2005).

**Functional Specificity in AM Interactions**

The difference in the influence of AM fungi on their hosts (see above) suggests that some combinations are favorable for the plant, whereas other combinations are neutral or even negative. In comparison, AM fungal proliferation and sporulation depend heavily on the identity of the plant host (Bever, 2002). These results indicate that the AM interactions have a certain amount of functional specialization. Indeed, a systematic combinatory analysis on the benefits of mycorrhizal diseases, using a wide range of plant and fungal species from various regions showed that the response to mycorrhizal growth (MGR) ranged from -50 to +50 percent, with nearly half of all the combinations that resulted from growth (Klironomos, 2003). The reciprocal capacity in either partner did not correlate with phylogenetic trends, which indicated that adaptive mechanisms were independent of ancestry. Interestingly, combinations of partners from the same place were more effective, suggesting that they were co-adapted. It is known that successful mutualists' combinations receive constructive bilateral responses, which results in the progressive mutual adaptation of the most efficient mutualistic combinations (Kiers and Denison 2008) (see above). Soils with a diverse fungal flora will sustain more diverse plant communities in accordance with functional specialization, than if only one or less AM fungi are present (van der Heijden et al., 1998). This result is consistent with a scenario in which every plant species needs an acceptable AM fungal partner. In the AM fungal culture, therefore, despite its very low host specificity in a laboratory setting, functional specialization influenced biodiversity and plant community productivity.

**MHB - Mycorrhization Helper Bacteria**

Bacterial lines of MHB are classified as belonging to many classes and generations, such as Gram-negative Proteobacteria, Gram-positive firmicutes, (bacillus, brevibacillus, bacteria) and gram-positive actinomyces, such as grams-negative proteobacteria, (agrobacterium, azospirillum, azotobacter, burkholderia, bradyrhizobium, enterobacter, pseudomonas and rhizobium).

In a sample, approximately 106 bacterial units per gramme (fresh weight) of mycorrhizae were detected in Garbaye and Bowen. Of these colonies, the majority was Pseudomonas fluorescent and 80% were positive for the development of mycorrhizas, while only 20% were neutral or inhibitory. Garbaye suggested an MHB description of root and mycorrhizal fungal bacteria that selectively encourage the establishment of mycorrhizal symbiosis based on information available. Background: The authors say the MHB is probably very common, and it can be found everywhere in very different conditions and different combinations of plant-pilzes.

**The effect of MHB on ectomycorrhizal associations**

Garbaye suggested five possible ways for MHB to function on mycorrhiza: in mycobiont root receptiveness and in the identification of root fungi, fungal growth, changes in the rhizospheric soil and the sprouting of fungals. The stimulus of fungal growth seems to be a primary influence for MHB in the ectomycorrhizae studied so far. MHB can stimulate spor germination and mycelial growth by generating growth factors, detoxified antagonisms or inhibiting competition and antagonists. The growth stimulus is a fungal adaptive advantage, which is heavily connected with the host plant and has improved competition against other mycobionts in the planting market. Today there is no fully specified contribution to any of these effects and further research are required to explain these matters.

The stimulation of lateral roots in mycorrhizal plants is also a trait observed at MHB. This fact, combined with the fungal growth stimulus, could lead to a growth in the number of potential interactions between the plant and the fungus and thus to increased plant mycorrhization via mycobiont. In addition, various MHBs can apparently evolve various helping mechanisms, even for the same pair. For instance, the MHB Burkholderia sp, Poole et al. found. EJP67 isolated from both first and second order mycorrhizal roots, Pinus sylvestris-Lactarius ruffus ectomycorrhizae, and Paenibacillus sp. Only the second-order mycorrhizal Roots were assisted by EJP73, insulated from the same ectomycorrhizae.

## TECHNIQUES

Supplies you need to deliver your own AM parasitic inoculum:

The accompanying rules are a selection from Use of Mycorrhizae in Restoration of Hawaiian Habitats by J. N. Gemma and R. E. Koske.

- Containers: One gallon or bigger pots can be utilized to deliver your "pot culture." Allow for seepage so that water doesn't gather in the lower part of the pot.

- Growth Medium: A decent development vehicle for inoculum creation comprises of quartz or basaltic sand (development blue sand) or a sanitized sandy soil with great seepage. The basaltic sand ought to be very much washed to eliminate the better residue particles. Coral sand ought not be utilized.

- AM Fungi: Collect fine roots or soil from the root zone of local vegetation from the living space you are reestablishing or from explicit plants that are probably going to be mycorrhizal [see Appendix I for a rundown of plant animal types that structure AM associations].

- Seeds of a "Host" Plant: [A quickly developing local plant species ought to be utilized as a host plant. Scientists in Hawaii have utilized corn as a host plant. ]

- Low-Phosphorus Fertilizer: For best outcomes, use compost low in phosphorus or moderate delivery manure pellets (for example 17-6-10 with micronutrients). You can make your own low-phosphorus manure by blending the accompanying fixings into 2 gallons of water: 1 teaspoon of Peters 20-0-20 compost, a fifth of a teaspoon (0.9 g) of Epsom salts (MgSO4), and 1_ milliliters of a concentrated PO4 compost arrangement called Quick Start (4-12-4) made by Miracle-Gro. You can gauge milliliters in a youngster's estimating spoon for fluid medication that is accessible at most pharmacies.

**Step-by-step procedure for producing inoculum:**

- Add 10 to 30% of your gathered soil that contains AM parasites or 1 cup of fine roots per gallon of medium and blend completely with your sand development medium. On the off chance that you are utilizing a moderate delivery compost, add 1 tsp of moderate delivery manure pellets (17-6-10 with micronutrients) for each gallon of fertilized soil. Set up a few pots with the goal that you will deliver adequate inoculum for some time in the future.

- Sow "have" plant seeds in your compartment. Grow 4-6 plants.

- After seedlings arise, treat week after week with around 1 cup of the low-P fluid compost arrangement (see above) per gallon of preparing in the event that you are not utilizing the moderate delivery pellets in sync 1. Water in the middle of compost applications.

- Let plants develop for around four months and afterward quit watering, permitting the plants and preparing combination to dry gradually and totally in the nursery over a time of 2-3 weeks.

- Remove the over the ground segment of the "have" plant and dispose of.

- Chop the roots and blend them in with the sand. A perfect pair of cutting shears is valuable. This root and sand combination is your concentrated AM contagious inoculum. The inoculum will stay powerful for in any event one year whenever put away in plastic holders and kept in a cool, dry region. You can utilize this inoculum as your AM contagious source to deliver more "pot societies," to add to preparing blend to bring mycorrhizal plants up in the nursery, just as to immunize non-mycorrhizal plants that are being relocated to the field.

## OBJECTIVE OF THE STUDY

1. The role of bacteria in the creation and activity of associations of ectomycorrhizal

2. Arbuscular mycorrhizal fungal benefits resources from ecology to application

## CONCLUSION

Studies on the action of MHB on ectomycorrhizae will produce an interesting understanding of the interaction between these species and the other environmental components. In particular, the MHB study is vital for fostering understanding of how mixed microbial communities promote mycorrhizal formation. There are few studies in Brazil with MHB, and Pseudomonas in general cover their role in promoting plant growth without evaluating the effect of mycorrhizae. The use of MHB in managed mycorrhization in the management of forests in soil nurseries could be very useful. Mycobiont co-inoculation saves fungal inoculum and may increase the consistency of the seedlings mycorrhizal association. Although the behaviour of most MHBs in laboratories or greenhouses has been seen, and the application of these findings to the natural conditions of cell density and position patterns in situ remains uncertain. The results are not yet clear, but they can be seen anywhere. In-situ studies should be considered as selective pressure of ectomycorriosis on bacterial communities to allow components of mycorrhizosphere to be selected, as seen for pseudomonas.

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