

**Endophytes and Mycorrhizal Fungi:
Mutualists with Herbicidal Tendencies**

Annotated Bibliography

Brem, D. and Leuchtman, A. 2001. Epichloe grass endophytes increase herbivore resistance in the woodland grasses *Brachypodium sylvaticum*. *Oecologia* 126: 522-530

The study examined whether endophytic plants of *Brachypodium sylvaticum* were more resistant to herbivory when compared to uninfected plants. It was found that the asexual strains were better able to protect hosts against insect herbivory. In addition, it was suggested herbivore protection may be variable in wild grass communities.

Carroll, G. 1998. Fungal Endophytes in Stems and Leaves: From Latent Pathogen to mutualistic Symbiont. *Ecology* 69(1): 2-9

The study provides a possible explanation of how endophytes evolved from pathogenic fungi to mutualistic symbiont. The author defines two different types of endophytic fungi: Inducible mutualist and Constructive mutualist. Inducible mutualists are air and water dispersed, and infect only vegetative parts of the host, and have little biomass. Constructive mutualism are endophytic grasses propagated in host seed, and have high fungal biomass. The author proposes that endophytes are as widespread as mycorrhizae.

Clay, K. 1988. Fungal Endophytes of Grasses: A Defensive Mutualism Between Plants and Fungi. *Ecology* 69(1): 10-16

The study discusses the symbiotic relationship of grass endophytes. The author considers the association a defensive mutualism, where the fungi defend their hosts against herbivory and, as a result, defend their own resources. This article provides great examples and explanations of the chemical basis for herbivore resistance, the effects of plant fitness, the evolution of mutualism, and the effects on herbivores of grass endophytes.

Clay, K., Marks, S., and Cheplick, G. P. 1993. Effects of Insect Herbivory and Fungal Endophyte Infection on Competitive Interactions Among Grasses. *Ecology*, 74(6): 1767-1777

The study investigated the interaction of insect-herbivory-fungal-endophyte infection, and plant competition of three grasses. The infected grasses were found to have increased biomass, less damage by herbivory, were less nutritious to the herbivore, and were less preferred by the herbivore when compared to the uninfected grasses. This paper emphasized competition, which I wasn't too crazy about.

Gange, A (2000) Arbuscular mycorrhizal fungi, Collembola and plant growth. Trends in Ecology and Evolution 45: 369-372

Review paper on the Collembola literature. Collembola is a microarthropod that is commonly used in belowground herbivory experiments. Recently, it has been suggested that Collembola preferentially feed on nonmycorrhizal fungi, but they will graze on mycorrhizal fungi but not by choice. It has also been suggested that these organisms reduce mycorrhizal functioning due to herbivory.

Gange, A., Bower, E, and Brown, V.K. 2002. Differential effects of insect herbivory on arbuscular mycorrhizal colonization. Oecologia 131: 103-112

The study examined whether natural levels of insect herbivory affect the arbuscular mycorrhizal fungi of mycotrophic plant versus a nonmycotrophic plant. It was found that foliar feeding herbivores reduce arbuscular mycorrhizal fungal colonization. The authors suggest that the mycotrophic (mycorrhizal) plant had little damage by herbivory, whereas the nonmycotrophic plant obtained damage.

Gehring, C., and Whitham, T.G. 1991. Herbivore-driven mycorrhizal mutualism in insect-susceptible pinyon pine. Nature 353: 556-557

The study examined the herbivory-mycorrhizae-host interaction of pinyon pine and natural insects. They found that pinyon pine trees susceptible to insect attack had fewer mycorrhizae than resistant trees. It was suggested that herbivores may negatively affect the mutualism between ectomycorrhizal fungi and trees susceptible to insect herbivory, and that mycorrhizal levels can rebound after herbivore removal.

Gehring, C.A. and Whitman, T.G. 1994. Interactions between aboveground herbivores and mycorrhizal mutualists of plants. Trends in Ecology and Evolution 9: 251-255

A review paper that provides an overview of the aboveground herbivory impacts on arbuscular mycorrhizae, the mycorrhizal impacts on aboveground herbivores, and the effects of aboveground herbivore-mycorrhizae interactions on community structure.

Goverde, M., van der Heijden, M.G.A., Wiemken, A., Sanders, I.R., and Erhardt, A. 2000. Arbuscular mycorrhizal fungi influence life history traits of a lepidopteran herbivore Oecologia 125: 362-369

The study examined the interactions between larvae of common blue butterfly (*Polyommatus icarus*) and AMF. Survival of larvae fed with AMF was greater than those fed with non-mycorrhizal plants.

Jennings, D. H. and Lysek, G. 1996. Fungal biology: understanding the fungal lifestyle Oxford: Bios; Herndon VA: Distributors USA and Canada, Books International Inc.

The book provides a good overview of the biology of endophytic fungi.

Rapp, A., and Vidal, S. 1998. Indirect effects of an unspecialized endophytic fungus on specialized plant-herbivore insect interaction. *Oecologia* 114: 541-547

The study suggests that soil-borne endophytic fungi may influence aboveground herbivory, even when the association with the host plant is weak. Several experiments were performed to determine effects of *Acremonium alternatum* on the development of the moth larvae *Plutella xylostella*, including larvae mortality and food utilization efficiencies (relative consumption rate, approximate digestibility, efficiency of conversion of ingested food, and efficiency of conversion of digested food).

Saikkonen, K., Helander, M., Faeth, S.H., Schulthess, F., and Wilson, D. 1999. Endophyte-grass-herbivore interactions: the case of *Neotyphodium endophytes* in Arizona fescue populations. *Oecologia* 121:411-420

The study examined the plant-endophyte interaction in native grass populations. The authors suggest that such interactions may be much more complex and variable than in the agronomic more genetically homogeneous grasses and more uniform abiotic conditions. They suggest that several alternative hypotheses are necessary to explain the phenomenon of wide distribution and variable frequencies of endophytes in natural plant populations.

Tibbits, T.M. and Faeth, S.H. 1999. *Neotyphodium* endophytes in grasses: Deterrents or promoters of herbivory by leaf-cutting ant? *Oecologia* 118: 297-305

The study of *Neotyphodium* endophytes in wild grasses found that they may not always increase resistance to herbivory, in fact, it is suggested that they may decrease resistance to herbivory by leaf cutting ants. However, endophytic fungi may help to explain distribution, abundance, and foraging patterns of leaf cutting ants.