

**College of Agriculture and Life Sciences
Proposal for Research Funds
Administered by the Office of Academic Programs
and the Cornell University Agricultural Experiment Station**

Cover Sheet

Research Title: Examining arbuscular mycorrhizal fungi function in wetland plants

Name of funding program(s) applying to:

- | | |
|---|---|
| <input type="checkbox"/> Arthur Boller Apple Research Grants | <input checked="" type="checkbox"/> CALS Charitable Trust Research Grants |
| <input type="checkbox"/> Kieckhefer Adirondack Fellowships | <input type="checkbox"/> Andrew W. Mellon Student Research Grants |
| <input type="checkbox"/> Morley Student Research Grants | <input type="checkbox"/> Ram Sagi Dairy Engineering Award |
| <input checked="" type="checkbox"/> Hatch/Multistate Supplement | |

Student's Name: Benjamin E. Wolfe

Degree status:

Graduate student:

Degree currently pursuing: _____

Number of years already completed in current program: 1

Undergraduate student:

Current class: Junior

Major: Natural Resources

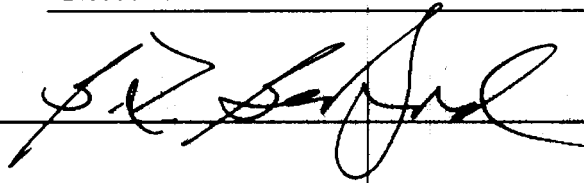
Local Address: 1517 Slaterville Rd., Ithaca, NY 14850

Telephone Number: 607-256-7452

E-mail Address: bew7@cornell.edu

Name and Department of Faculty Research Mentor: Dr. Barbara Bedford, Department of Natural Resources

Signature of Faculty Research Mentor: _____



RESEARCH OBJECTIVES AND SIGNIFICANCE

This research seeks to make an initial assessment of the function of arbuscular mycorrhizal fungi (AMF) in three species of wetland plants, *Solidago patula*, *Senecio aureus*, and *Eupatorium maculatum*. While it is widely known that 80-90% of higher plant species can be colonized by symbiotic mycorrhizal fungi,¹ it has only recently been generally established that mycorrhizas occur in a wide variety of wetland ecosystems throughout the world.^{2,3,4,5,6,7} Very limited information exists as to whether mycorrhizas function similarly in wetland ecosystems as they do in terrestrial systems.^{8,9,10} The objectives of this research are (1) to assess the effect of arbuscular mycorrhizal fungi on plant growth and nutrient uptake and (2) to assess the response of mycorrhizal fungi to different levels of phosphorus availability. The knowledge obtained through this project will help broaden our understanding of the function of these fungi in plant growth in wetland plants. With this knowledge we may be able to better characterize the role of mycorrhizal fungi in maintaining plant species composition in wetlands and other aquatic ecosystems as is currently being done in terrestrial systems.^{11,12,13}

LITERATURE REVIEW

Nutrient enrichment from human activities can alter plant species composition and diversity in plant communities that are adapted to low nutrient availability.¹⁴ At Belle School Fen, a phosphorus(P)-limited, rich graminoid fen located near Ithaca, New York, members of Dr. Barbara Bedford's Wetland Ecology Lab have been conducting a long-term fertilization experiment to examine the fen community response to nutrient enrichment. Rich fens are groundwater fed peatlands that are typically high in calcium and magnesium. The rich fens of Central New York contain high levels of plant species diversity, including many species that are rare or endangered and are a high conservation priority.^{15,16} A survey of the dominant vascular plant species at Belle School Fen, conducted by former undergraduate Will Cornwell, showed that many plants hosted arbuscular mycorrhizal fungi.⁸ These fungal symbionts colonize plant roots and are thought to help plants acquire nutrients when nutrient availability is low, in exchange for photosynthetically derived carbon.¹ Additionally, Cornwell found that mycorrhizal colonization of *Solidago patula*, a rich fen indicator species, declined in response to P addition.

The nutrient dynamics of many fens are changing as a result of anthropogenic factors. We are aware from Cornwell's study and others^{17, 18, 19} that a changing nutrient status has severe implications for AMF associations, but we are less sure of the resulting effects on these diverse plant communities that are influenced by AMF. Some of these relationships have been elucidated in terrestrial systems,^{11,12,13} but a gap in our knowledge exists for wetlands.

Therefore, it is imperative to ascertain the direct effect of AMF on nutrient acquisition of key wetland species.

METHODOLOGY

Non-mycorrhizal plants of each species will be grown in individual pots in a sterile (free of mycorrhizal fungi) peat soil matrix in a greenhouse. In order to simulate the environmental conditions of the natural community in the pot culture, air temperature, water depth, and soil temperature will be controlled. Two mycorrhizal treatments will be used with each plant species; a control (sterilized peat) and an inoculation of the mycorrhizal community from Belle School Fen. Four labile P (equal molar ratios of NaH_2PO_4 + NaHPO_4) treatments, will also be used; a control (distilled water), low enrichment ($< 2 \text{ g m}^{-2}$), moderate enrichment equivalent to

field application rates (2 g m^{-2}), and high enrichment (4 g m^{-2}). Each treatment will be replicated five times.

To assess plant response to the treatments, I will analyze the shoot and root biomass of the plants of all of the treatments. The plant tissue concentration of nitrogen and phosphorus will be determined to assess changes in nutrient uptake. Additional discernable plant characteristics that emerge during the course of the experiment will be assessed. I will also measure available soil P and other soil parameters such as pH and redox potential.

At the end of the study, I will harvest the root systems from the pots to quantify mycorrhizal colonization in each of the plant species. Roots will be stained and mounted on slides, which I will examine using the gridline-intersect method to determine the percentage of root length colonized by AMF.

TIMEFRAME

Jan. 1 – April 1st:	Writing proposals and developing methodologies for use in experiments and analysis. Cold stratification of seeds. Design environmental control system for use in greenhouse. Order supplies.
April 1st – May 1st:	Construction of environmental control system, move setup into greenhouse, prepare soil medium for growing plants. Start seeds.
May 1st – May 15th:	Transplant seedlings into larger growing containers. Collect samples of fen mycorrhizal community in the field and inoculate pots
June 1st :	1 st phosphorus addition for Experiment 1
July 1st:	2 nd phosphorus addition for Experiment 1
Sept. 1st:	Harvest plants and store samples for later analysis. Take and store root samples for mycorrhizal colonization analysis.
Sept. 2nd – 15th:	Disassemble greenhouse setup and cleanup greenhouse area. Make slides of roots for mycorrhizal colonization analysis.
Sept. 15th – 30th:	Collect biomass data, take subsamples for tissue nutrient data.
October 1st – 31st:	Plant tissue nutrient analysis in laboratory
Nov. 1st – 31st:	Mycorrhizal colonization data collection. Data compilation and analysis
Jan. – March (2003)	Write-up of thesis and submission for approval

BUDGET

Microscopy Supplies	\$750.00
Plant Tissue Nutrient Supplies/Fertilizer	\$300.00
Greenhouse Controls System Components and Space	\$1310.00
Sample Storage (bins, bags, bottles, etc.)	\$300.00
Seeds and seed preparation	\$90.00
Total Budget:	\$ 2,480.00

Pending Grant Applications:

Cornell Biogeochemistry Program Small Grants Program (co-application with graduate student Peter Weishampel)	\$2,480.00
Cornell Hughes Scholars Program (<i>stipend support only</i>)	(\$2800.00)
CALS Charitable Trust	\$800.00
Amount Requested:	\$1500.00 1,000.00

Literature Cited:

1. **Smith, S.E. and D.J. Read.** 1997. Mycorrhizal symbiosis, 2nd edn. Academic Press, San Diego
2. **Cooke, J.C. and M.W. Lefor.** 1998. The mycorrhizal status of selected plant species from Connecticut wetlands and transition zones. *Restoration Ecology* 6: 213-222.
3. **Miller, S.P.** 2000. Arbuscular mycorrhizal colonization of semi-aquatic grasses along a wide hydrologic gradient. *New Phytologist* 145: 145-155.
4. **Turner, S.D., J.P. Amon, R.M. Schneble, and C.F. Friese.** 2000. Mycorrhizal fungi associated with plants in ground-water fed wetlands. *Wetlands* 20: 200-204.
5. **Turner, S.D. and C.F. Friese.** 1998. Plant-mycorrhizal community dynamics associated with a moisture gradient within a rehabilitated prairie fen. *Restoration Ecology* 6:44-51.
6. **Thormann, M.N., R.S. Currah, and S.E. Bayley.** 1999. The mycorrhizal status of the dominant vegetation along a peatland gradient in southern boreal Alberta, Canada. *Wetlands* 19: 438-450.
7. **Miller, S.P. and J.D. Bever.** 1999. Distribution of arbuscular mycorrhizal fungi in stands of the wetland grass *Panicum hemitomon* along a wide hydrologic gradient. *Oecologia* 119: 596-592.
8. **Cornwell, W.K., B.L. Bedford, and C.T. Chapin.** 2001. Occurrence of arbuscular mycorrhizal fungi in a phosphorus-poor wetland and mycorrhizal response to phosphorus fertilization. *American Journal of Botany* 88: 1824-1829.
9. **White, J.A. and I. Charvat.** 1999. The mycorrhizal status of an emergent aquatic, *Lythrum salicaria* L., at different levels of phosphorus availability. *Mycorrhiza* 9:191-197.
10. **Wigand, C. and S.J. Court.** 1994. The presence and possible ecological significance of mycorrhizae of the submersed macrophyte, *Vallisneria americana*. *Estuaries* 17 : 206-215.
11. **Van der Heijden, M.G.A., T. Boller, A. Wiemken, and I.R. Sanders.** 1998a. Different arbuscular mycorrhizal fungal species are potential determinants of plant community structure. *Ecology* 79: 2082-2091.
12. **Van der Heijden, M.G.A., J.N. Klironomos, M. Ursic, P. Moutogolis, R. Streitwolf-Engel, T. Boller, A. Wiemken, and I.R. Sanders.** 1998b. Mycorrhizal fungal diversity determines plant biodiversity, ecosystem variability and productivity. *Nature* 396: 69-72.
13. **Streitwolf-Engel, R., T. Boller, A. Wiemken, and I.R. Sanders.** 1997. Clonal growth traits of two *Prunella* species are determined by co-occurring arbuscular mycorrhizal fungi from a calcareous grassland. *Journal of Ecology* 85:181-191.
14. **Mitsch, W.J. and J.G. Gosselink.** 2000. *Wetlands*. Van Nostrand Reinhold, New York.
15. **Reschke, C.** 1990. Ecological communities in New York state. New York State Natural Heritage Program, New York State Department of Environmental Conservation.
16. **Johnson, A.M. and D.J. Leopold.** 1994. Vascular plant species richness and rarity across a minerotrophic gradient in wetlands of St. Lawrence County, New York, USA. *Biodiversity and Conservation* 3:606-627.
17. **Anderson, R.C., and A.E. Liberta.** 1989. Growth of little bluestem (*Schizachyrium scoparium*) (Poaceae) in fumigated and non-fumigated soils under various inorganic nutrient conditions. *American Journal of Botany* 76: 95-104.
18. **Jasper, D.A. and J.A. Davy.** 1993. Root characteristics of native plant species in relation to the benefit of mycorrhizal colonization for phosphorus uptake. *Plant and Soil* 155/156: 281-284.