

**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

**STUDENT INFORMATION:**

Student's Name: Benjamin E. Wolfe Cornell I.D.#: 463286  
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**RESEARCH INFORMATION:**

Research Title: Examining arbuscular mycorrhizal fungi function in wetland plants

**NAME OF FUNDING PROGRAM(S) APPLYING TO:**

Undergraduate:

- Hatch/Multistate Supplement  
 Other (includes: Jane E. Brody Undergrad Research; CALS Charitable Trust Research Grants;  
 Dextra Undergraduate Research Endowment Funds; Morley Student Grants)

Graduate:

- Arthur Boller Apple Research Grants       Andrew W. Mellon Student Research Grants  
 Kieckhefer Adirondack Fellowships

Previous CALS Awards (indicate fund name, year and amount received): \_\_\_\_\_

**DEGREE STATUS:**

Undergraduate:


Current Class: Junior  
 Major(s): Natural Resources

Graduate:

Degree currently pursuing: \_\_\_\_\_  
 Number of years already completed in current program: \_\_\_\_\_

**FACULTY RESEARCH MENTOR:**

Name: Dr. Barbara Bedford  
 Department: Natural Resources  
 Email: blb4@cornell.edu

Faculty Research Mentor (Signature): 

Please send completed cover sheet and proposal electronically to:  
 Sharon Loucks, CALS OAP, 173 Roberts Hall, [sh51@cornell.edu](mailto:sh51@cornell.edu).

## 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,<sup>1</sup> it has only recently been generally established that mycorrhizas occur in a wide variety of wetland ecosystems throughout the world.<sup>2,3,4,5,6,7</sup> Very limited information exists as to whether mycorrhizas function similarly in wetland ecosystems as they do in terrestrial systems.<sup>8,9,10</sup> 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.<sup>11,12,13</sup>

## LITERATURE REVIEW

Nutrient enrichment from human activities can alter plant species composition and diversity in plant communities that are adapted to low nutrient availability.<sup>14</sup> 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.<sup>15,16</sup> 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.<sup>8</sup> 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.<sup>1</sup> 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<sup>17, 18, 19</sup> 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,<sup>11,12,13</sup> 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  $\text{NaH}_2\text{PO}_4 + \text{NaHPO}_4$ ) treatments, will also be used; a control (distilled water), low enrichment ( $< 2 \text{ g m}^{-2}$ ), moderate enrichment equivalent to

field application rates ( $2 \text{ g m}^{-2}$ ), and high enrichment ( $4 \text{ g m}^{-2}$ ). 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 1 <sup>st</sup> :	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 1 <sup>st</sup> – May 1 <sup>st</sup> :	Construction of environmental control system, move setup into greenhouse, prepare soil medium for growing plants. Start seeds.
May 1 <sup>st</sup> – May 15 <sup>th</sup> :	Transplant seedlings into larger growing containers. Collect samples of fen mycorrhizal community in the field and inoculate pots
June 1 <sup>st</sup> :	1 <sup>st</sup> phosphorus addition for Experiment 1
July 1 <sup>st</sup> :	2 <sup>nd</sup> phosphorus addition for Experiment 1
Sept. 1 <sup>st</sup> :	Harvest plants and store samples for later analysis. Take and store root samples for mycorrhizal colonization analysis.
Sept. 2 <sup>nd</sup> – 15 <sup>th</sup> :	Disassemble greenhouse setup and cleanup greenhouse area. Make slides of roots for mycorrhizal colonization analysis.
Sept. 15 <sup>th</sup> – 30 <sup>th</sup> :	Collect biomass data, take subsamples for tissue nutrient data.
October 1 <sup>st</sup> – 31 <sup>st</sup> :	Plant tissue nutrient analysis in laboratory
Nov. 1 <sup>st</sup> – 31 <sup>st</sup> :	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
<b>Total Budget:</b>	<b>\$ 2,480.00</b>

### 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
	1,000.00
<b>Amount Requested:</b>	<b><del>\$1500.00</del></b>

**Literature Cited:**

1. **Smith, S.E. and D.J. Read.** 1997. Mycorrhizal symbiosis, 2<sup>nd</sup> 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.
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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.
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