Newsletter of the FRIENDS OF THE FARLOW

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There's more to Indian pipe than meets the eye

Sylvia Yang

Monotropa uniflora, a plant commonly known as the Indian pipe, flowers with an eerie white glow June through September in forests of New England (Fig. 1). The plant is a member of the subfamily Monotropoideae, which also includes *M. hypopithys* ("pine sap"), and which is also found in New England. *M. uniflora* is a perennial plant characterized by slender, somewhat fleshy, white to reddish inflorescences and a fleshy, brittle, dense root system. The plant's stems support a single flower each. These stems emerge from the soil in a nodding orientation and become erect in fruit.[1]

M. uniflora's ghostly appearance is striking. It has only traces of chlorophyll[2] and does not produce its own carbon energy supply as photosynthetic plants do. Instead, the plant is a mycoheterotroph, meaning that it obtains its carbon from photosynthetic plants via fungal connections. In the case of *M. uniflora*, mycorrhizal fungi link the mycoheterotroph to photosynthetic trees (Fig. 2).

Fig.1 *Monotropa uniflora* (Indian pipe) has only traces of chlorophyll and appears white to pinkish.

Previous studies of *M. uniflora* from various locations in eastern and western North America, Eurasia, and Japan have shown that it is specifically associated with fungi of the family Russulaceae, such as *Russula* and *Lactarius*[3] and related hypogeous taxa[4]. These previous studies began to uncover an intriguing geographic variation in the species diversity of mycorrhizal fungi associated with the

Clara Cummings Walk
Saturday, April 30. See page 7.

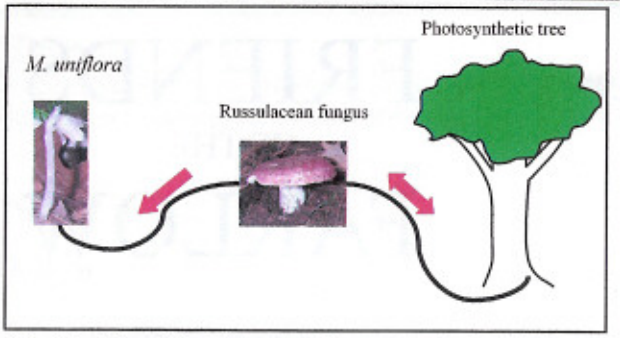

Fig. 2. *M. uniflora* is a mycoheterotroph—it obtains its carbon from photosynthetic trees via connections of a mycorrhizal fungal network.

mycoheterotroph; samplings of *M. uniflora* plants from sites in the western United States had far lower diversity of associated mycorrhizal fungi than those plants of the eastern U.S.

However, relatively few plants from the eastern U.S. had been tested. For my undergraduate thesis research under the direction of Professor Donald Pfister at Harvard College, I investigated the specificity of the mycorrhizal relationship between *M. uniflora* and its fungal partner in the plant's eastern range in the U.S.

First, we collected the roots of *M. uniflora* plants from nearby forests during summer 2003. We selected four sites near Cambridge, MA: the Concord Field Station (Bedford, MA), Estabrook Woods (Concord, MA), Whipple Hill (Lexington, MA), and the woods near Flint's Pond (Lincoln, MA) (Fig. 3). These sites contained a variety of habitats and potential photosynthetic tree hosts, such as oaks, hemlock, hickory, birch, beech, pines, and maples.

M. uniflora mycorrhizae have no morphological features that we could have used to identify the species of the fungal associate. To identify the mycorrhizal fungus, we extracted and sequenced the fungal DNA from the *M. uniflora* root samples. We also sequenced the DNA of nearby mushrooms we collected. If a mushroom sequence matched that of a mycorrhizal fungus, we could determine the the identity of the associates.

Sequencing mycorrhizal fungi from roots of 56 *M. uniflora* plants resulted in 20 different russulaceous fungi, and only three of the fungi matched a mushroom sequence. Through comparing these sequences with those from GenBank, a database of previously documented sequences, we found all of the mycorrhizal fungi to be in the genus *Russula*, except for two samples, which were in the genus *Lactarius*. Both of these genera are within the Russulaceae, confirming previous results.[3,4]

Furthermore, our results revealed a remarkable diversity of mycorrhizal fungi associated with eastern *M. uniflora* plants in comparison to the fungi associated with western plants. To assess the absolute diversity of the mycorrhizal associates we found, we analyzed our sample *Russula* sequences with *Russula* sequences of a previous study on the molecular systematics of the genus.[5] The genetic diversity of our samples was comparable to that of the entire genus.

Studies of western *M. uniflora* mycorrhizal diversity suggest that one fungal species may dominate as the mycorrhizal associate in certain locations covering large areas. For example, *Russula brevipes* was associated with all plants sampled in a 9400 km^2 area in Oregon that contained a mountain range.[3] In central British Columbia, also located in western North America, most plants were associated with a fungus similar in sequence to a species of the genus *Gymnomyces*.[4] In contrast, our study plants from the eastern U.S. were associated with 22 different *Russula* and *Lactarius* species, and if several plants were associated with the same fungus, they were from at least two different sites.

One possible explanation for the higher diversity of fungal associates in

eastern *M. uniflora* plants is a difference in specificity between plants from east and west. Plants in western North America may have developed a narrower specificity to only certain russulacean fungi, whereas eastern plants may be compatible with a wide range of russulacean fungi. Such a case would suggest that after evolving specificity within the Russulaceae, *M. uniflora* populations in different locations may have evolved varied levels of specificity over time. How different geographic populations may have coevolved with the Russulaceae requires further investigation. Experiments exposing western

Figure 3. For our study of *M. uniflora*, we chose four sites located near Cambridge, MA: the Concord Field Station (Bedford, MA), Estabrook Woods (Concord, MA), Whipple Hill (Lexington, MA), and Flint's Pond woods (Lincoln, MA). The following map shows a portion of Massachusetts with focal towns shaded.

M. uniflora to fungi compatible to eastern populations may provide information as to whether lower fungal diversity of western populations is a result of incompatibility or unavailability of possible fungal partners.

In conclusion, we have found that eastern populations of *M. uniflora* near Cambridge, MA are associated with a diversity of fungi in the Russulaceae, a diversity that is unparalleled in any previously studied plant populations from western North America. This result supports the presence of geographical variation in the diversity of mycorrhizal fungi with which *M. uniflora* is associated. It suggests that the specificity level of the mycoheterotroph on its mycorrhizal fungi may have evolved differently over the plant's geographic range. Answering the questions of why or how specificity develops in mycoheterotrophic plants such as *M. uniflora* begins with a description of the phenomenon and must continue with much further exploration.

References:

[1] Wallace, GD. 1975. Studies of the Monotropoideae (Ericaceae): Taxonomy and Distribution. *The Wasmann Journal of Biology* 33(1-2): 1-88.

[2] Cummings, MP and NA Welschmeyer. 1998. Pigment composition of putatively achlorophyllous angiosperms. *Plant Systematics and Evolution*, 210: 105-111.

[3] Bidartondo, MI and TD Bruns. 2001. Extreme specificity in epiparasitic Monotropoideae (Ericaceae): widespread phylogenetic and geographical structure. *Molecular Ecology* 10: 2285-2295.

[4] Young, BW et al. 2002. *Monotropa uniflora*: morphological and molecular assessment of mycorrhizae retrieved from sites in the sub-boreal spruce biogeoclimatic zone in central British Columbia. *Mycorrhiza* 12: 75-82.

[5] Miller, SL and B Buyck. 2002. Molecular phylogeny of the genus *Russula* in Europe with a comparison of modern infrageneric classifications. *Mycological Research* 106(3): 259-276.

New Professor to Join the Farlow

Anne Pringle was born in Kuala Lumpur, Malaysia and spent her childhood in Southeast Asia and West Africa. After attending boarding school in Virginia she worked with the aid organization CARE on women's development projects in Mali, West Africa. Anne went on to receive an undergraduate liberal arts degree from the University of Chicago and then spent several years teaching science in Brooklyn, NY. After teaching, Anne moved to Durham, NC to complete a Ph.D. in botany and genetics at Duke University. The title of her dissertation was "Ecology and genetics of arbuscular mycorrhizal fungi". Anne subsequently moved to the University of California, Berkeley to pursue post-doctoral research as a Miller Fellow.

Anne uses molecular methods to explore the ecological genetics of various fungi. Her current research focuses on the ecology of the invasive and deadly mycorrhizal fungus *Amanita phalloides*.

In June 2005 Anne and her family will move to Cambridge, MA where Anne will take up a position as Assistant Professor in the Department of Organismic and Evolutionary Biology at Harvard University. She is married and has two mushroom-loving daughters.

Ann will be this year's speaker at the Annual FoF Meeting in November. The title of her talk: "Is the Death Cap mushroom *Amanita phalloides* a European immigrant to North America?" **Welcome, Ann!**

Spring & Summer Courses

Eagle Hill, Steuben, Maine

Taxonomy and Biology of Discomycetes
June 12—18
Instructor: Professor Donald Pfister
Emphases—Morphology, systematics, and ecology of Cup Fungi (Ascomycota); mycorrhizal relationships, habitats, life histories, ecology; field collections and lab identification using microscopic characters.

See http://www.eaglehill.us for their many other course offerings with detailed descriptions.

Garden in the Woods, Framingham, MA

Introduction to New England Bryophytes
Thursdays, March 31, April 7, 14, 7–9 p.m., and Saturday, April 9, 10 a.m.–2 p.m.
Instructor: Mary Lincoln, avid amateur bryologist

Cemetery Lichens: Two Views
Saturday, May 14, 10 a.m.–4 p.m.
Instructors: Elizabeth Kneiper, lichenologist, and Lyn Hayden, artist and NEWFS Certificate Program Graduate

Cannon Mountain Lichens and Mosses
Franconia, NH
Saturday, September 10, 10 a.m.–4:30 p.m.
Leaders: Elizabeth Kneiper, lichenologist, and Mary Lincoln, avid amateur bryologist

Amanita phalloides drawn by Beatrix Potter

Farlow / Lister Correspondence

by Lisa DeCesare, Farlow archivist

The *Myxomycetes,* or slime molds, are a fascinating group of organisms that have had a complex and confusing history. In 1833, Swedish botanist Elias Magnus Fries (1794-1878) called the organisms *Mycogastres.* In 1836 Karl Friedrich Wilhelm (1792-1857) renamed them *Myxomycetes* (slime-fungi). Then in 1858, German botanist Anton DeBary (1831-1888), focusing more on the physiology and the life cycle, decided to name them *Mycetozoa* (animal-fungus).

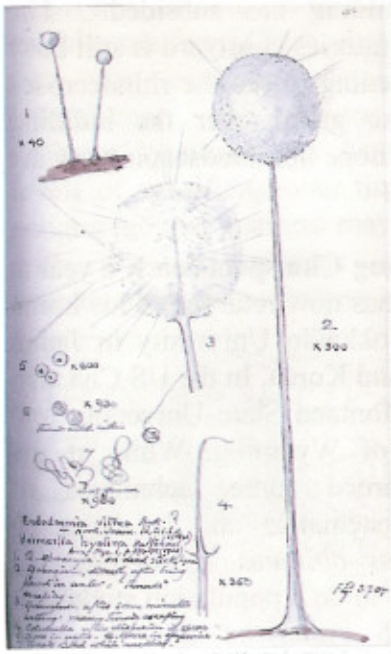

illustration from Lister letter

Unfortunately, the proliferation of names within the group was also confusing. Ohio mycologist, C.G. Lloyd, in his *Mycological Notes* observed that by the 1890s there were on average five synonyms for every species of *Mycetozoa*! It was during this period that an amateur British botanist, Arthur Lister (1830-1908), began to work with his daughter, Gulielma (1860-1949), to sort out the nomenclature.

Arthur Lister was a wealthy businessman, who became interested in natural history as a young man. He instilled the same passion in his daughter, **Gulielma**, who became his close companion, collaborator, and illustrator during the later part of his life. Lister was 57 years old when he and Gulielma began their study of slime molds. The Listers studied the slime mold collections at the British Museum, the Royal Botanic Gardens at Kew, the Paris Natural History Museum, and Anton DeBary's collection at the University of Strasbourg. Arthur Lister began a correspondence with **William Gilson Farlow** in 1892 to help with his research. Farlow responded by identifying specimens, providing the Listers with American specimens, and discussing the nomenclature. Lister's gratitude was apparent when he wrote to Farlow on 23 June 1892, "asking you kindly to remember that there is no one but yourself that I am able to receive any assistance from on this side of the Atlantic." What started as a scientific collaboration soon developed into a lasting friendship between both Listers and Farlow.

illustration from Lister letter

Lister's work, *A Monograph of the Mycetozoa*, was published in 1904. The author identified 175 species, reducing to synonomy more than 800 names! The monograph was a great success in clarifying species. The illustrations, by both Listers, were amazing and are still considered to be among the best even today. Martin and Alexopoulos, in their book *The Myxomycetes* [1969] stated, "The illustrations in this work, many of them in natural colors in later editions, have never been surpassed in comprehensiveness and

in general accuracy, and it is not surprising that European treatments in other languages have largely been modeled upon this excellent work."

In 1908 Arthur Lister's heath began to decline. He developed a severe case of shingles that spread to his face and his eyes. He was unable to use his microscope and could no longer closely examine his specimens. Eventually the shingles began to clear, but by then Lister began to have heart problems. He never recovered and died in July 1908.

from *A Monograph of the Myxomycetes*

Gulielma wrote to Farlow in early fall and asked him to help her with the nomenclature and he readily agreed. On 11 November 1908, she sent Farlow a touching note thanking him for his help. She wrote: "I can't tell you how grateful I am for your very kind and full letter on nomenclature. I go to the job of looking up the early names with quite a different spirit: for, with your approval, I almost feel to have fresh sanction from my father, instead of being haunted by the fear that I might be going beyond what he wished in these many changes." Gulielma was responsible for two revisions of the book produced by her collaboration with her father. The third edition is rare and eagerly sought after by myxomycologists.

from *A Monograph of the Myxomycetes*

The Farlow / Lister correspondence is housed in the Archives of the Farlow Herbarium and spans the years 1892 to 1917. It is filled with identifications, illustrations, and personal reflections. It also chronicles an important time in the history of Myxomycology and the publication of a seminal work.

Donald Pfister updates us with ....

News from the Farlow

The excavation and disruption outside the Farlow Building has subsided. The Biological Laboratories courtyard is still busy but it was heartening to see the rhinoceroses reappear to take guard over the building activities. We hope for landscaping as the spring advances.

Joo Young Cha spent nearly a year at the Farlow and has now returned to his home institution of Hokkaido University in Japan via Vancouver and Korea. In the US Cha also spent time at Montana State University and the University of Wyoming. While at the Farlow he learned some techniques of phylogenetic systematics and he began a study of *Ionotus obliquus*, a polypore on birch. He hopes to do a population study that compares North American and Japanese collections.

Other visitors have centered on seminars and lectures. **Dr. Amy Rossman**, Director of the National Fungus Collection, gave our annual lecture in November. In February **Richard Kessin**, Professor at the Columbia School of Medicine, gave an Organismic and Evolutionary Biology seminar on his work on *Dictyostelium*, a cellular slime mold. Most recently **Raymond Stotler** and **Barbara Crandall-Stotler**, specialists on hepatics, the liverworts, spent several days working in the herbarium. Barbara **Crandall-Stotler** gave a seminar in the HUH series on her work on morphology and phylogeny of the hepatics. We blush with pride that they called the Farlow hepatic herbarium, "the best in North America." On April 26th **Elizabeth Arnold** from the University of Arizona will visit to give an HUH seminar on her work on fungus endophytes in vascular plants.

Michaela Schmull, from Göttingen, Germany, spent two weeks in March studying apothecial development in species of *Lecidea* sensu lato. Also on the lichenological front, **Scott LaGreca** plans be back in the Farlow the first week of April to finish some projects that he left when he moved to the British Museum.

Clara Cummings Walk

This year the annual Clara Cummings walk will be held at **Pack Monadnock**, in **Miller State Park**, Peterborough, NH, on Saturday, April 30, from 11:00 AM to 4:00 PM. Bring your lunch and bring your friends. Coffee and donuts/bagels will be served before the walk.

Directions: Take Route 3 North to Exit 8 (Nashua, NH), then Route 101A West towards Milford, NH. Get on Route 101 West and follow signs to Miller State Park. Look for the entrance on the right side of the road. From Boston the driving time is estimated to be 1 hour and 30 minutes. For more information about the park, and alternate directions see http://www.nhparks.state.nh.us

Parking permits for visitors

Harvard has a limited number of one-day parking permits available. Visitors to the Farlow can go on-line themselves and generate one of these $8.00 permits with a credit card. Cash or check purchases must be made at the HU Parking Office. Please call either Judy Warnement at 617-496-1025 or Rose Balan at 617-495-2365 for further instructions.

Membership Dues

Please check your mailing label. If it is highlighted in color, we have not received any membership dues from you this year.

Selected New Books - Farlow Library

January – February 2005

compiled by Judy Warnement

The genus Stauroneis in the Arctic and (Sub)-Antarctic Regions. Bart Van de Vijver, Louis Beyens, Horst Lange-Bertalot.
Berlin ; Stuttgart: J. Cramer, 2004.

The Lichen Hunters
O. L. Gilbert. Lewes: Book Guild, 2004.

The Lichens and Allied Fungi of the Polish Carpathians : an annotated checklist.
Urszula Bielczyk, editor.
Kraków: Polish Academy of Sciences, W. Szafer Institute of Botany, 2003.

Neotropical polypores; Pt. 1 Introduction, Ganodermataceae & Hymenochaetaceae.
Leif Ryvarden
Oslo: FungiFlora, 2004.

Liverworts of the Mediterranean : ecology, diversity and distribution.
Bischler, Helene. Berlin: J. Cramer, 2004.

Fungi in forest ecosystems : systematics, diversity, and ecology: dedicated to Dr. Orson K. Miller, Jr.
Cathy L. Cripps, editor. Bronx: New York Botanical Garden Press, 2004.

A Field Key to Common Churchyard Lichens (and to commoner species found elsewhere on stone, fences and gates).
Frank S. Dobson. New Malden, England, 2003.