Newsletter of the FRIENDS OF THE FARLOW

Number 49 Spring 2007 K. Griffith, Editor

Studies on the genus *Neolecta*

David A. Hewitt

All journeys begin with a single step, and mine began on Whiteface Mountain in the Adirondacks. During the summer and autumn of 2000, the year before I began my Ph.D. at Harvard, I spent quite a bit of time in the Adirondacks. One day as Michaela Schmull and I were walking through the spruce-fir forest at about 1000 meters elevation, we found a yellow fungus growing on the ground among the mosses.

Neolecta vitellina growing among moss in Concord, MA. Photo by D. Hewitt.

Sand Lake, N.Y., the type locality of *Neolecta irregularis*. Charles Peck , discoverer and author of *Geoglossum irregulare*, (the basionymn of *N. irregularis)*, collected in the site pictured here — a tamarack swamp encircled by spruce-fir forest. Photo by D. Hewitt.

I took it back home to Philadelphia, identified it as *Neolecta irregularis*, and got in touch with Professor Donald Pfister, at the Farlow Herbarium. I knew him and had decided I was interested in working with him for my Ph.D. I was sure that he could help me find out more about this fungus. He told me that the genus occupies an interesting place in the phylogeny (evolutionary history) of the Ascomycota. As it turned out, when I started working on *Neolecta*, there were enough questions surrounding this fungus to make it a focus for my Ph.D. thesis.

Clara Cummings Walk
Sunday, April 29. **See page 6.**

Here I am, collecting *Neolecta irregularis* in the rain at Black Mountain. Photo by Donald Pfister.

There were questions about *Neolecta*'s habitat and distribution. There were related questions about its genetic diversity in a number of different habitats. The unusual microscopic structure of *Neolecta* raised more questions. But the main question was whether or not the *Neolecta* fruitbody was homologous to the fruitbodies found in the ascomycetes. That is, did *Neolecta* evolve complex multicellularity independently of the rest of the ascomycetes?

Ryan Kerney & Alexia Elbrick help me collect at Black Mountain in the White Mountains. They agree with me that "There is grandeur in this view of life." Photo by D. Hewitt.

To give a bit of background, the type species of the genus, *N. flavo-virescens*, was discovered in Brazil and named in 1881 by Bresadola. That species has not, to my knowledge, ever been collected again. There are, however, two additional species in the genus that are easier to find: *N. irregularis* and *N. vitellina*. These are found throughout the northern hemisphere and, it turns out, are quite common in New England in certain habitats.

Particular anatomical peculiarities (i.e. the absence in the genus of croziers or paraphyses) made the phylogenetic placement of *Neolecta* difficult until the early nineties. Around that time Sara Landvik and co-workers discovered, based on phylogenetic analysis of ribosomal DNA,

Neolecta irregularis photographed at Whiteface Mountain in the Adirondacks. Photo by Michaela Schmull.

that *Neolecta*'s relationship to the remainder of the fruitbody-forming ascomycetes was very likely quite distant. That meant that *Neolecta*'s closest relatives were most likely yeasts and simple filaments, and therefore its fruitbodies may have evolved independently of the rest of the fruitbody forming ascomycetes.

Neolecta has resisted domestication and proven impossible to grow in the lab, even after much effort on my part and that of other researchers. This meant that my studies were contingent on finding enough Neolecta to work with, and therefore immediately brought up the question of where *Neolecta* grows in the wild. Because I would be working with different wild strains, I would also need to know how much genetic diversity was present among members of the genus. This posed an additional question: how much genetic variability would I find in *Neolecta*?

Here is where the value of the Farlow came into play. The Farlow has links to a phenomenal network of researchers, and has an unmatched expanse of volumes in its libraries and a seemingly limitless depth to the collections in its herbarium. These were priceless in my research. Truly, my thesis has drawn from a collaborative effort of field biologists, both amateur and professional; librarians and curators; laboratory researchers and curatorial assistants; and it would not have come to pass without them.

I was put into contact with these field biologists, and spent many hours in the library, in the herbarium and in the field. As I worked, my knowledge of *Neolecta*'s habitats grew more precise, from the broadly defined "coniferous forest" which was my starting point, to a more clearly defined range for each of the species. *N. irregularis* grows with spruce-fir forest like that on Whiteface Mountain, where I first saw that species. On the other hand, in New England *N. vitellina* grows with pitch pine, but not all pitch pines. While I've seen *N. vitellina* quite often growing with pitch pine in sandy soils (a pine barrens type of habitat), I've never seen it growing with pitch pines on rocky ridge tops. The reason for this remains unknown to me. Additionally intriguing to me was the fact that though *N. vitellina* grows in western North America and Europe, pitch pine grows in neither of these places, and therefore it is associating with other species.

Neolecta vitellina collections from diverse and widespread locales were quite homogeneous genetically. The localities of these *N. vitellina* collections range from western North America, to New England, to Scandinavia, to Central Europe, and they were associated with multiple conifer species, making their genetic homogeneity quite surprising. This was even more curious because the *N. irregularis,* that I'd collected growing in New England forest spruce-fir, had yielded a great deal of genetic diversity, based on DNA sequences I'd generated. In fact there was much more diversity in the New England *N. irregularis* than the total genetic diversity of all of the *N. vitellina* collections that I surveyed.

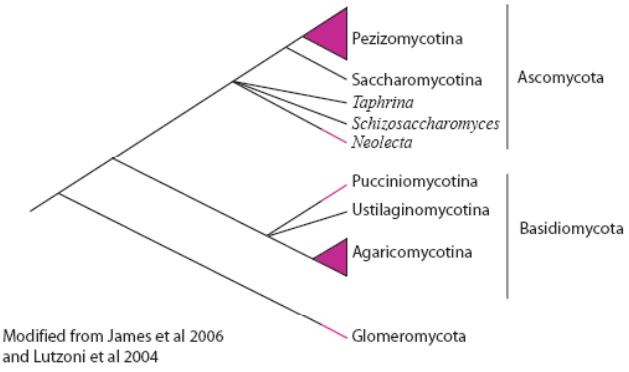
A pitch pine habitat with sandy soil in Concord, MA., a *N. vitellina* collection site. Photo by D. Hewitt.

I'd found answers to questions about where to find *Neolecta* and how much genetic diversity the species contained. But these answers led to another question: why does *N. vitellina*, so widespread, and found in such different habitats, have so much less genetic diversity than *N. irregularis* collected from spruce-fir forest in New England? However, that investigation would have to be left for another day. I needed to answer the bigger question: did *Neolecta* evolve complex multicellularity independently of the rest of the ascomycetes?

Well, I discovered that it most likely did. By looking at its development, and its anatomy, and some of its biochemistry, I was able to find out that *Neolecta* built its fruitbody in a manner quite distinct from those of the other fruitbody-forming ascomycetes, implying that these structures evolved independently of each other.

In the Ascomycota, there are many species that make fruitbodies, multicellular structures that give rise to sexually derived spores. With one exception, all the ascomycetes that make fruitbodies fall into one group, the Pezizomycotina, or euascomycetes, as this group is sometimes called. This one exception is the genus *Neolecta*. Species in this genus make fruitbodies that macroscopically would fit in quite well with the rest of the Pezizomycotina.

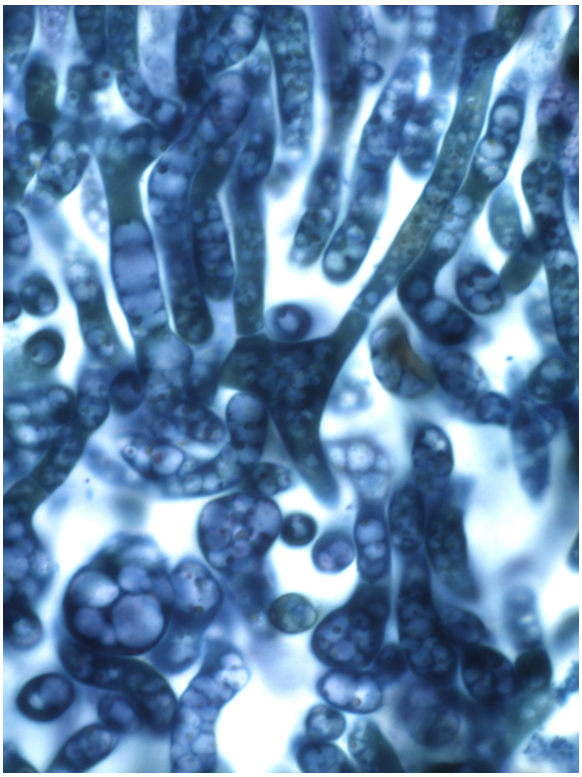
However, although older classification schemes allied *Neolecta* with the earth tongues (Geoglossaceae: Pezizomycotina), there are microscopic anatomical differences that argue against this, and so its evolutionary relationship to the rest of the ascomycetes never had been satisfactorily resolved.



Notice in this partial pylogeny how Neolecta stands outside of the Pezizomycotina.

In fungi, the structural elements of the fruitbody, be it a gilled mushroom or a cup fungus, are hyphae. That is, these fruitbodies are constructed from the interweaving and tight compaction of filaments. A good analogy for a fungal fruitbody is a knitted sweater, with the filaments interwoven to give the form of the structure. This is in contrast to plants or animals, in which cells are the basic unit of construction of the body, and the analogy for them would be more along the lines of bricks being used to construct a house.

And so, though the vast majority of fruitbodies are built of tightly compacted strands, if you were to make a section of one of them, and look at it under a microscope, it would look as though it were composed of individual cells, much like parenchymal tissue in plants. This is because the hyphae are so tightly packed together, that they seem to lose their filamentous character. This type of organization is called pseudoparenchyma, to differentiate it from the true parenchyma found in plants.

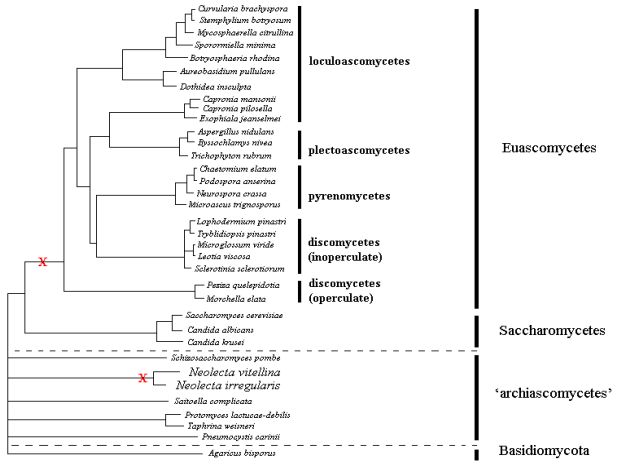


These loosely arranged hyphal wefts differ from the structure of the hyphae in most ascomycetes, which are generally more tightly aggregated. Photo by David Hewitt.

During my first two field seasons, I tried to make thin sections of *Neolecta*, in order to look at fine details of its pseudoparenchyma and see if it differed from that of the euascomycete fruitbody. When I made the sections, either free hand or by using a freezing microtome, they turned to unconsolidated mucilaginous masses, or "blobs," as I called them. The reason for this

became clear when I looked under the microscope at plastic embedded sections of *N. irregularis* from my fall 2003 collections: *Neolecta* doesn't make pseudoparenchyma.

What I found was that the fruitbody is constructed not of tightly packed hyphal strands as found in other ascomycetous fruitbodies, but of very loosely arranged hyphal wefts which barely come into contact with each other. *Neolecta* fruitbodies can grow quite large (I've seen ones growing to over 12 cm tall), and it is quite interesting that they can build such large structures with such a loose arrangement of hyphae. They build their fruitbodies in a completely different way than those of other large ascomycetes. This supports the hypothesis that their fruitbodies evolved independently of the euascomycete fruitbody.



Phylogeny of the Ascomycota (adapted from Gernaldt / Lutzoni). The red x's indicate evolution of *Neolecta* fruitbodies.

This is just one line of evidence that suggests *Neolecta* evolved complex multicellularity independently of the rest of the ascomycetes. Also, I've found that there is far less genetic variability in *Neolecta* than there is in the euascomycetes, and this implies that not only did *Neolecta* evolve multicellularity independently of the rest of the ascomycetes, but also much more recently.

As my thesis research comes to a close, I'm content that I've been able to answer the questions I asked some years ago, and I'm happy that more questions have arisen from my work. The next step in research on this genus would be to investigate its ecology and biogeography. What controls its range? What are its nutrient sources? How is it dispersed? Based on the initial data I've gathered, these questions will be answerable sometime in the future. But for now, *Neolecta* has provided an interesting journey from my first steps in the Adirondacks.

Acknowledgments: I thank Don Pfister and Elinor Hewitt for thorough and thoughtful reviews of earlier manuscripts of this article. I would also like to thank David McLaughlin and his working group at the University of Minnesota (including Maj Padamsee and Gail Celio) for collaboration with the plastic embedding and microscopy of *N. irregularis*.

Editor's note: The photo of *Neolecta vitellina* in the upper left corner of the first page was taken by the author, D. Hewitt.

Illustration from *Icones Farlowianae* p. 115.
Mitrula vitellina Bres. var. irregularis Peck, N.Y. State Mus. Rept. 48*:* 130. *pl. 5, f.* 8-14. 1896.
Geoglossum irregulare Peck, N. Y. State Mus. Rept. **32**: 45. 1879

The Clara Cummings Walk

The Assabet River National Wildlife Refuge Sunday, April 29, 2007 10:00 a.m. - 3:00 p.m.

Meeting Place: The Assabet River NWR parking lot on Hudson Road, Sudbury, MA

The Friends of the Assabet River National Wildlife Refuge will be sponsoring the walk along with the FoF.

Located in the towns of Hudson, Maynard, Stow, and Sudbury, the Assabet River National Wildlife Refuge is a 2,200-acre site that was formerly the Fort Devens Sudbury Training Annex. The site was turned over to the United Sates Fish and Wildlife Service in the fall of 2000. Miles of trails along the Assabet River, along with fields, woodlands, ponds, and wetlands, including a white cedar swamp, support a rich diversity of plants (650 species) and animals (206 species).

The focus of the Clara Cummings Walk will be on the identification of bryophytes, fungi and lichens along the trails and on teaching novices how to appreciate their diversity.

Clara Cummings (1855-1906), for whom the walk is named, was the Hunnewell Professor of Cryptogamic Botany at Wellesley College, where she studied and published articles on fungi, lichens, and mosses and where she was known for her teaching excellence.

You will need: a 10X hand lens, a picnic lunch, and rain gear.

For information/directions, go to the Friends of the Assabet NWR website: http://www.farnwr.org (You will find a good map here to the parking lot on Hudson Road.)

For more information visit the Friends of the Farlow website: http://www.huh.harvard.edu/collections/fof/fof.html

Directions from Exit 26 off Route 128:
Take Route 20 West to Route 27 North to Sudbury Center (the light at the junction of Concord Rd. and Rt. 27). At the intersection follow Rt. 27 for <1/4 mile until it turns sharply right. Continue straight toward Hudson on Hudson Rd. for 3 miles. The Assabet River National Wildlife Refuge sign is on the right at the entrance to the parking area.

Emergency contact number on the day of the walk: 781-801-2734

FoF Book Sale

The 2007 FoF Book Sale list will be sent out in April to all who have paid their dues for the year. All book selection forms should be returned by June 1. When multiple people desire the same volume, a lottery system will be used to determine who will receive the book. Invoices and books will be shipped during the summer.

Myxomycete Workshop a Sell-out
Diatom Workshop planned

FoF President Elisabeth Kneiper listens to myxomycete expert Professor Steven Stephenson in the Herbaria lab. Photo by Karen Garrison.

Last fall's myxomycete workshop filled up quickly. Professor Steven Stephenson, from the University of Arkansas, guided the participants through the mycetozoa with morning lectures and an afternoon lab. By the end of the day enthusiasm was high and plans were being made to go north looking for snowbank myxomycetes in the spring.

Due to the success of this workshop, a diatom workshop is being planned for next fall. This will be coordinated by diatom expert Professor Robert Edgar, along with Karin Ponader, a recent addition to HUH. The diatom workshop will most likely be coordinated with the 2008 Annual Meeting, traditionally the first weekend in November. If you are interested, mark this weekend on your calendars now. Signup information will be included in the Fall Newsletter.

Professor Edgar will deliver the FoF Annual Meeting lecture on the subject of "Jacob Whitman Bailey (1811-1857): Diatoms, West Point and the American Academy."

Eagle Hill Cryptogamic Offerings Summer 2007

Don Pfister will be teaching the course "Advanced Mycology: Integrating Field and Lab Observations" at Eagle Hill in Steuben, ME from August 26-September 1.

Additional courses in mycology are: "Mushrooms for Naturalists," August 12-18, by FoF member Dr. Laurie Leonard along with Rosalind Lowen and Edward Bosman; "Toxic and Look-Alike Mushrooms of Interest to the Health Care Provider: The Maine Poison Mushroom Course" by Dr. Leonard and Dr. Robert Saucier, September 13-15.

Courses in Bryophytes will be offered by Richard Ansrus, Nancy Slack, William Buck and Nat Cleavitt. In lichens, courses by David Richardson, Irwin Brodo and Fred Olday join the roster.

Michaela Schmull joins the Farlow

There is a new face at the Farlow. Michaela Schmull has recently arrived from Germany,

where she has been working at the University of Goettingen as a research associate in the Department of Systematic Botany. As well as being a senior lecturer for higher plant anatomy and plant identification classes, she was a researcher and the computer administrator of her department. She will be working on systematics and the ecology of lichens at the Farlow Herbarium.

Beata Ruris Otia
Fungus Danicis Impensa

"Happy Periods of Rest in the Country in the Company of Mushrooms"

Lisa DeCesare

The Farlow Library is currently exhibiting the work of Theodor Holmskjold (1732-1793). Holmskjold was not a prolific botanical author. However, what he lacked in volume of work he more than made up for in his exquisite and detailed representations of fungi. His work *Beata Ruris Otia Fungis Danicis Impensa* featured seventy-four fungi. Of these, fifty-seven were new names; five new combinations and fifty-two totally new taxa. The images in this article are examples.

Theodor Holm was born in Nyborg, Denmark on 14 June 1732. He studied medicine at Sorø and earned his degree in 1760. He developed an interest in botany through his studies and through travel with the Danish botanist Friis Rottbøll (1727-1797). Holm also studied under Linnaeus at Upsala and, according to one source, "was his favorite pupil."

In 1762 Holm was appointed Professor of Medicine, Natural History, and Botany at the College of Sorø, a position that he kept until 1765. After leaving Sorø he spent much of the next two years in Aarhus, a seaport town in Denmark. There he observed the fungi and wrote thorough descriptions of their habitat, size, shape, color, and growing habits. He also contracted with the artist Johann Adolf Neander to paint these fungi as they would appear, in their natural size.

During this period Holm was also very involved in government. In 1767 he was appointed the General Post Director and in 1772 he was given the position of Cabinet Secretary for Queen Dowager Juliane Marie. Holm was one of the throne's most trusted advisors and was titled in 1781, at which point he assumed the name Holmskjold.

Holmskjold remained a trusted advisor to the Danish crown even after Crown Prince Frederik was confirmed in 1784. He was a key advisor and was given the position of Director of the Royal Danish Porcelain Factory, a position he held until his death in 1793. During his tenure here it is believed by many scholars that he was the force behind the creation of the Flora Danica line of china. This

line is still considered the most exclusive and costly dinner service in the world. It was said that, through the creation of Flora Danica, Holmskjold "brought the scientific spirit of exactitude into the field of decorative art."

During his tenure at the Royal Danish Porcelain Factory he met the artist Johann Christian Bayer (1738-1812). Bayer was an amazing and exacting artist who worked on the multi-volume *Flora Danica Icones plantarum sponte nascentium in regnis Daniæ et Norvegiæ* before being hired as the Danish Porcelain Factory's top painter. Holmskjold was so impressed with his work that he commissioned Bayer to create the remaining plates for his *Beata Ruris Otia Fungis Danicis Impensa.*

Beata Ruris was originally published in Copenhagen in 1790. According to Elias Durand in the *Journal of Mycology*, the volume was not actually issued for sale but distributed through private circulation only. Publication of even this limited edition ceased a scant 3 years later when Holmskjold died, so very few copies were actually made.

The book consists of thirty-three copper plate engravings, the majority hand colored images of *Clavaria* and *Ramaria*. A single species of fungi is highlighted in each plate. It is shown in different stages of development with the name of that fungus charmingly inscribed at the bottom of the image. Many of the plates also include other species of fungi, mosses, or lichens to help create a beautiful tableau. The text accompanying these images was presented in Dutch and Latin and included many important observations of the fungi included.

Those who were lucky enough to see a copy of the completed work were amazed. The Swedish botanist Anders Jahan Retzius (1742-1821) said this was "the most brilliant work which had appeared up to that time." C.H. Persoon (1755-1837), the father of systematic mycology, considered it a work of great value and said that the illustrations were the most beautiful he had seen.

After Holmskjold's death in 1793 his effects, including the completed 1790 publication, all of his notes and drawings, and the original copper plates were purchased by agents of the king. Working from these materials a second volume was prepared and edited by the Danish botanist Erik Viborg (1759-1822).

The 1799 release consists of forty-two colored plates of various fungi. The plates are not labeled and, while the volume contains an index of names, no descriptions are given. The two volumes of *Beata Ruris* were bound together and issued in folio format.

Today, more than 200 years after the publication of the complete *Beata Ruris Otia Fungis Danicis Impensa,* the work is still considered extraordinary and the exquisitely illustrated plates are almost unmatched in their crisp lines, vivid coloration, and charming presentation.

News from the Farlow

We have had several visitors:

Todd Osmundson, a graduate student at Columbia University and the New York Botanical Garden, studied our collections of the bolet genus *Tylopilus*.

Scott LaGreca visited in March to use the herbarium and select material for loan to the Natural History Museum, London.

Ed Setliff, Professor Emeritus, Faculty of Forestry and Forest Environment, Lakehead University, Thunder Bay, Ontario, Canada, spent several days looking at our collections of *Chondrostereum purpurem*, collecting data on the occurrence of this fungus on various tree hosts in North America.

We are pleased to announce that a new postdoctoral fellow, **Matthew Smith**, will be joining us in August. Matt comes to us after earning a Ph.D. at the University of California, Davis where he worked on mycorrhizal fungi in the xeric oak woods. Among these fungi were several members of the genus *Genea*, a truffle in the pezizalean family *Pyronemataceae*. Here at the Farlow he will continue work on *Genea* and related taxa with a particular focus on those that have been described, but rarely collected, from eastern North America. For several of these the only records we have are collections made by Roland Thaxter in the early 1900s**.**

During the next academic year, **Don Pfister** is hoping to offer the course "Lichens and Air Pollution" at the Harvard University Extension School. For more information see (www.extension.harvard.edu).

David Hewitt, graduate student with Don Pfister, is gearing up for his thesis defense in mid-May. His thesis involves *Neolecta* and is featured in part as the lead article in this issue.

On the curatorial front, **Genevieve Lewis-Gentry** has continued to manage the loan operations and many other details of the collections. She was particularly helpful in assembling specimens for some of the recent class tours and exhibits. Thanks to the library staff, a set of our bound exsiccatae in need of attention has been conserved.

From the distant Farlow Herbarium past we are pleased to note that **Dr. Timothy Baroni** of the State University of New York College at Cortland, and a Farlow post doctoral fellow of many years ago, has been named Distinguished Professor in the SUNY System. This is the highest honor in the New York State system. Dr. Baroni will return to the Farlow as our annual lecturer in the fall of 2008. He will talk about his field work in the West Indies and Central America.

The **FoF** has kindly agreed to finance the reframing of W. G. Farlow's portrait, which hangs in the hall opposite the Farlow Reading Room.

William Gilson Farlow (1844 - 1919)

Selected New Books at the Farlow

Compiled by Gretchen Wade

Advances in algal biology : a commemoration of the work of Rex Lowe. edited by R. Jan Stevenson ... [et al.]. Dordrecht : Springer, c2006.

Advances in phycological studies : festschrift in honor of Dobrina Temniskova-Topalova. editors Nadja Ognjanova-Rumenova & Kalina Manoylov. Sofia : Pensoft ; Moscow : St. Kliment University Press, 2006.

Atlante fotografico degli ascomiceti d'Italia. a cura di Gianfranco Medardi. Trento : Associazione Micologica Bresadola, 2006.

Flora dei muschi d'Italia. Carmela Cortini Pedrotti. Roma : Antonio Delfino Editore, c2001-2006

The colonial diatom Bacillaria paradoxa : chaotic gliding motility, Lindenmeyer model of colonial morphogenesis, and bibliography, with translation of O. F. Müller (1783), About a peculiar being in the beach water. Anne P. Ussing ... [et al.]. Ruggell [Liechtenstein] : Gantner, 2005.

Dobson, Frank (Frank S.) *Guide to common urban lichens. 1, on trees and wood.* by Frank Dobson. Shrewsbury, Shropshire : FSC Publications, c2005.

Dobson, Frank (Frank S.) *Guide to common urban lichens. 2, on stone and soil.* Frank Dobson. Shrewsbury, Shropshire : FSC Publications, c2006.

Enderle, Manfred. *Die Pilzflora des Ulmer Raumes.* Manfred Enderle. 1. Aufl. Ulm : Verein für Naturwissenschaft und Mathematik im Ulm, 2004.

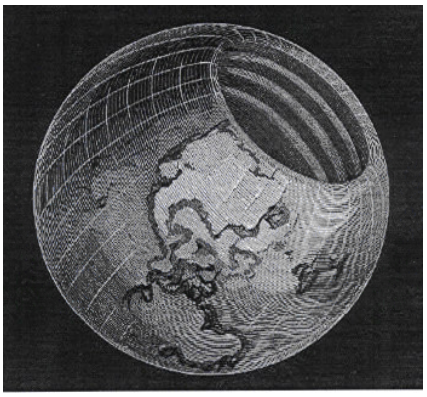
Frontiers in basidiomycote mycology. edited by Reinhard Agerer, Meike Piepenbring, Paul Blanz. Eching : IHW-Verlag, 2004.

Guide to the seaweeds of KwaZulu-Natal. Olivier De Clerck ... [et al.]. Meise : National Botanic Garden of Belgium, c2005.

International Mycological Congress (8th : 2006 : Cairns, Australia) Proceedings of the 8th International Mycological Congress : Cairns, Australia, August 20-25, 2006. editors Wieland Meyer, Ceri Pearce. Bologna : Medimond International Proceedings, 2006.

Exhibit attracts crowds

Voyages and Explorations



Symme's Hole

In March the library staff created an exhibit and presentation that fascinated many people and was used for three very different Harvard courses: Professor Kathleen Donoghue's course "Darwin's Finches," Professor James Hanken's "Museums" course, and Professor Charles Davis's course "Plant Systematics." The presentation included three main topics: Darwin's travels, Galapagos exploration, and the United States Exploring Expedition of 1838-1842, often referred to as the Wilkes Expedition.

Library staff members Judy Warnement and Lisa DeCesare worked with curators from the Harvard University Herbaria, the Peabody Museum of Archaeology and Ethnology, the Museum of Comparative Zoology, and the Scientific Instrument Collection. A marvelous array of materials was brought together, including plant and animal specimens, original photographs, artwork, and journals. Some fantastic stories were told, such as the theory of John Cleves Symmes II (1780 - 1829) that the earth was hollow at the center, open at the poles, and how Symmes had intended to sail to the inside of the earth, as the picture above might possibly suggest.

Join us !

Receive the FOF Newsletter, notification of the annual book sale, discount on Farlow publications and services, invitations to the annual meeting and other events, and a special welcome when visiting the Farlow.

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