Newsletter of the FRIENDS OF THE FARLOW

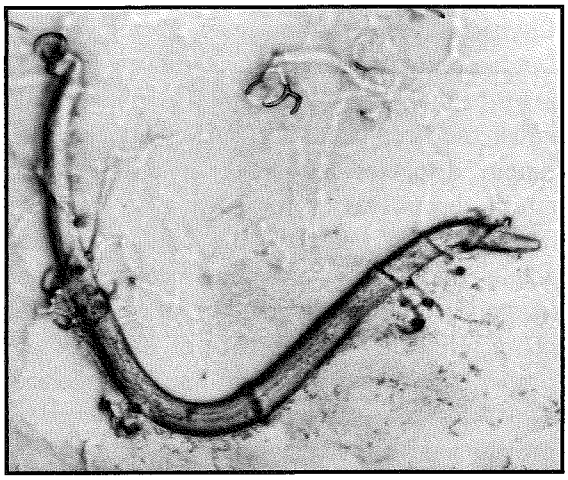
Number 25 | Fall 1994 | R. K. Edgar, editor

NEMATODE-DESTROYING FUNGI AT THE FARLOW

Michael Liftik

Research at the Farlow by Professor Donald Pfister and Michael Liftik has focused recently on one of the more exciting relationships between the fungal and animal kingdoms. The adaptations of fungi to trap and prey upon nematodes, unsegmented worms measuring 100 µm-1000 µm in length, were discovered more than one hundred years ago when Zopf found motile nematodes caught in the hyphal networks of *Arthrobotrys* sp. The connection between these organisms remained largely veiled until Drechsler's extensive studies on the subject throughout the 1930's. His publications, famous for their superb illustrations (and reprints of which are at the Farlow), outline the interactions between fungi and nematodes in a most colorfully detailed fashion. His research, along with significant contributions from Duddington and others, has revealed over one-hundred and fifty species of fungi that prey upon nematodes. The role of this predation on the microecology of soil ecosystems remains mostly unclear and unstudied.

The fungi in which nematodes play a part in their natural history fall into two broad categories: the predatory fungi and the endoparasitic fungi. The predatory nematode-destroying fungi radiate an extensive hyphal network through substrates, such as damp wood, and produce various organs of capture. The nematodes are caught either through constricting rings or, more commonly, adhesive organs, structured as branches, nets or simply a material that covers the surface of all the hyphae. The last method is common only to the Zygomycetes while the other devices occur in the Deuteromycetes. The nematodes do not die immediately upon attachment but often struggle until the point of apparent exhaustion. Once attached in some manner to the hyphae, the nematode is invaded by assimilative hyphae that quickly decompose its body. The invasion occurs along the entire length of the nematode and is often accompanied by an initial hyphal bulb that penetrates the cuticle of the nematode. Thus, the attacking fungus is able to make



Nematode in culture medium ensnared in traps (x200)

immediate use of its prey and clearly depends on them for nutrients.

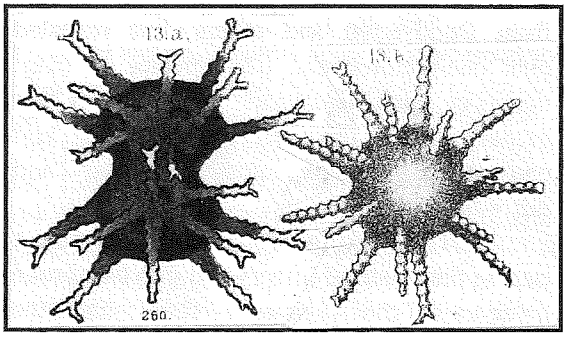
This method of capture is starkly contrasted with that of the endoparasitic fungi which destroy nematodes through their ingestion of dormant spores or the encystment of the spores on the body. The spores of these species are usually elongate, thin, small (< 5 μm) and sometimes sickle-shaped with very little food reserves. They have the ability to persist on a substrate until contact with the host organism is made. Spores of the endoparasites from the classes Chytridiomycetes, Oomycetes, Zygomycetes, Deuteromycetes, and Basidiomycetes are ingested by the host where they germinate and infect the host internally. Alternatively, the fungus disperses zoospores or conidia that attach themselves to the body of a passing nematode and penetrate the cuticle with a single germ tube and thus colonize the nematode. Often these types of spores are characterized by the presence of flagella that propel the spores through aqueous media. Thus, for the endoparasites the nematodes provide a critical vehicle for reproduction.

In our study of the discomycete genus *Orbilia* Fries at the Farlow, several species of *Arthrobotrys* grew in pure culture as the hyphomycetous anamorphs, or asexual stages of *Orbilia*. Though Drechsler had indicated a discomycetous teleomorph for *Arthrobotrys*, we now have been able to confirm that several *Arthrobotrys* species complete the life cycle of *Orbilia* species. The presence of *Arthrobotrys* states in cultures gave us the opportunity to observe closely the interaction with the nematodes. Easily recognized by the tall, erect conidiophores with whorls of septate conidia, *Arthrobotrys* produce three-dimensional networks of adhesive rings. The rings, which form in response to contact with nematodes, are constructed from anastomosing hyphae that grow out of prostrate hyphae. When nematodes were added to cultures, networks of rings formed within 12-24 hours and capture occurred after a short period.

Direct observation of the nematodes swimming through the networks revealed that casual contact does not result in capture but rather the nematodes seem to sense the presence of the rings and withdraw their heads before swimming through a ring. It is only when the nematode pauses in the field of nets that extended contact facilitates attachment. While the rings do form in a range of diameters, the larger nematodes are caught more easily, and the smaller, perhaps younger, individuals can elude capture for many hours or days. Our observations seemed to indicate that not all species are as effective in their trapping abilities. While we could not find any living nematodes within 24 hours after their introduction to plates of *Arthrobotrys oligospora* var. *oligospora,* strains of *Arthrobotrys cladoides* var. *macroides* never trapped all the nematodes presented to them. Visual inspection might predict these results as the ring network of the latter never built up as densely as that of the former.

That the life history of a group of discomycetes includes a nematode-destroying phase raises issues of adaptive strategies and the ecological importance of these organisms. Other research indicates that other anamorphs of *Orbilia* may prey upon other small animals.

Michael Liftik, class of 1996, is faculty aide for Professor Donald Pfister. He is a Social Studies concentrator interested in environmental policy and conservation biology.



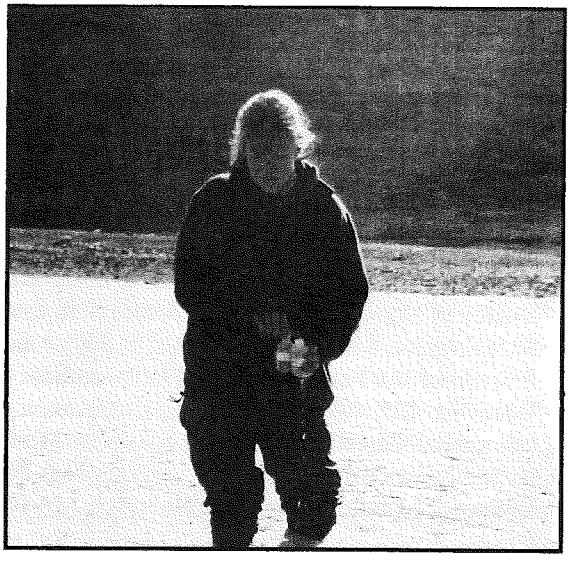
Desmids in H. C. Wood's (1873)
A Contribution to the History of the Fresh-water Algae of North America

FARLOW FRIENDS OLD & NEW

Buried in the basement cabinets of the Farlow is a set of nearly 200 small vials of freshwater algae collected about 50 years ago from a variety of habitats in eastern Canada. Large herbaria and museums are full of esoteric stuff like this - seemingly destined to collect dust until the buildings are razed. These samples were collected by **Nicolas Polunin** (1909-) as part of the Canadian Eastern Arctic Expedition of 1936. The algal flora in the samples was described by Roy Whelden of Harvard and published in the *Bulletin of the National Museum of Canada.* A list of the diatoms in some of the samples was prepared by Robert Ross, a British diatomist (and later to be director of the British Museum of Natural History), and was published in the same issue of the *Bulletin.* The samples were deposited by Dr. Polunin at the Farlow upon the completion of floristic work on them. These samples have been guarded for nearly five decades, their locus identified in the Farlow's files, but fully living up to the common caricature of museum specimens.

Last year one of my more engaging diatomist colleagues visited me at the Farlow, specifically to use its library resources. She's not your run-of-the-mill diatomist - she sports certificates in bear deterrence and gun safety as part of the preparation for her research in the field. Engaging indeed! **Marianne Douglas** is currently a research associate in the Department of Geology and Geography at the University of Massachusetts Amherst. Born in England, now a citizen of Canada and France, Marianne took her doctorate in 1993 from Queen's University in Kingston, Ontario, where she studied in its Paleoecological Environmental Assessment and Research Laboratory under John Smol and John Kingston. Her dissertation research focussed on the ecology of diatoms and the paleolimnology (the study of lake history) of High Arctic ponds, primarily on Ellesmere Island in Canada's North West Territories. Hence, her interest in bears and guns - and early on in our conversation also in Polunin's vials.

Although diatoms are more commonly in Marianne's sights than bears, her mind's eye has a penetratingly clear target. She and her colleagues in Amherst and Kingston are studying global climatic change. The freshwater ecosystems of the High Arctic have come to be recognized as showing amplified responses to several global climatic stresses, such as those involving acid haze and snow and greenhouse warming. These High Arctic ecosystems have become important areas for long-term biomonitoring programs for global environmental change and for reconstructions (retrospectively a few centuries) of climate using freshwater microorganisms, such as the diatoms and their lacustrine sedimentary (fossil) record. When Marianne started her doctoral work, knowledge of high arctic diatoms, especially in Canada, and their biogeography was sparse; her work - reflecting the taxonomic astuteness and statistical saavy of a new generation of diatomists - is bringing that knowledge to new levels.



Marianne Douglas collecting in the Canadian Arctic.

Marianne recounted to me recently that "*During my years of fieldwork in the Canadian Arctic I have become very interested in the distribution of diatoms throughout the Arctic, but also on a global scale. The pond flora of shallow arctic ponds closely resembles that of aerial and semi-terrestrial habitats. Many of the diatoms from these ponds can be found in semi-arid regions of the southwestern United States, for example. Moisture is undoubtedly an important controlling factor, but there must be other environmental controls on the populations living in these extreme environments. The Polunin vials are a goldmine for comparison with my own studies and for increasing the general knowledge of Arctic diatom distributions.*"

In working on the Ellesmere Island samples, she explained to me that she kept a category of diatoms called "weird and wonderful", assuming most were just teratological forms. She said other workers occasionally had described some things similar, as had Ross from the Polunin samples, but, and we both agreed, that when these "forms" carry specific epithets like *dubiosa, confusum* and *obscura*, they don't exactly engender confidence that the investigators were comfortable in their interpretations of what they saw.

We reflected on the immense value in being able to go back and look at the actual specimens to see if, in fact, investigators are talking about the same things. Application by diverse workers of the "same names" to samples diverse in space and time is often not enough to resolve the problems you encounter when you are trying to establish biogeographic ranges and environmental tolerances for species - simply dealing with "names" often doesn't promote confidence when you are trying to synthesize continental and global landscapes from lots of very local snapshots.

I was really lapsing into a profoundly pensive mood, but I felt we had really touched the essence of the Farlow. I recalled those cautions about "solitary birdwatchers." One moral of that story is that, as much as possible, scientific information needs to be public information. Well, diatomists, and cryptogamists generally, have no excuses not to be very public about what they see. Specimens are so easily archivable in herbaria that anyone can check the data - the specimens themselves. After all, you don't see a *Diatoma elongatum*, you see a pattern of light waves in a microscope and interpret that pattern as deserving that name. An identification is a claim, not an observation. The real value of Polunin's vials is that he was courageous enough to commit to posterity not just his conclusions but the ability to reassess his observations, so that one's confidence in assessing his work is so much greater than if he had only left a literature.

Marianne came to use the library; however, she wound up in the herbarium. The same thing has happened to many of us. That's the Farlow.

Marianne's most recent work (with John Smol of Queen's and Weston Blake, Jr. of Geological Survey of Canada) is published in *Science* (v. 266, p. 416-419; 1994). It concludes - disappointingly - that any current rush to catalog natural (prior to human disturbance) diatom assemblages in the apparently pristine ponds of the Canadian Arctic is probably about two centuries too late. Marianne became a member of Friends of the Farlow this past year.

R.K.E.

FARLOW NEWS

- The FoF Annual Meeting was held on Saturday afternoon, November 5th, at the Farlow. **Gregory M. Muller** of the Field Museum of Natural History in Chicago was the guest speaker for the Friends. He spoke on the conservation of large fleshy fungi (Macromycetes).
- Lichenologists in the New England area were treated to a special slide show at the

Farlow by **Irwin Brodo** and **Sylvia** and **Stephen Sharnoff** in early October. They have recently teamed up to create a much-needed book on Norh American lichens.

This spring, the Arnold Arboretum, Jamaica Plain, will mount a photgraphic exhibit "Lichens: Fine details of the nautral landscape". This is an Oakland Museum Traveling Exhibition by the Sharnoffs. The show is planned to run from February 15th to the middle of May. Watch for mailed announcements of special events related to this exhbit.

- **Benito Tan** spent much of July and August collecting in New Zealand's southern alpine region, doing herbarium work in the Royal Botanical Gardens, Sidney, Australia and collecting bryophytes in the Mount Wilhelm areas of Papua New Guinea.
- **Don Pfister, Sam Hammer, Elizabeth Kneiper, Elizabeth Lay** and **Phil May** attended the Fifth International Mycological Congress in Vancouver in August.
- **Don Pfister** attended a Symposium at Cornell University in late October honoring **Richard P. Korf**, retired Professor of Plant Pathology and a mycologist (and Don's dissertation advisor).
- **Robert Edgar** spent 5 weeks this summer collecting 2-3 million year old fossil diatoms in north-central Kenya as part of the Baringo Paleontological Research Project's work in elucidating early hominid evolution and its climatic context. He also attended in early September the International Diatom Symposium in Aquafredda di Maratea in Italy.
- **Elizabeth Kneiper** again this November produced an FoF-sponsored display in Harvard's Cabot Science Library. The display focussed on the exsiccati in the Farlow.

FoF Financial Report
July 1, 1993 - June 30, 1994

Acct. # 4348

Beginning Balance	**$ 1,207.31**
Income	
Membership & Donations	3,474.22
Book Sale	75.97
Total	3,550.19
Expenses	
Printing Newsletter	925.25
Stationery & Supplies	19.86
Postage	226.07
Annual Meeting	304.36
Book Repair (Binding)	806.10
Farlow Fellowship	380.60
Total	2,662.24
Closing Balance	**$ 2,095.26**
Surplus	**$ 887.95**

Acct. #1033

Beginning Balance	**$ 26,193.94**
Increment	1,337.39
Closing Balance	**$ 27,531.33**

FARLOW VISITORS
April -October 1994
Excluding members
of the Harvard University community

R. Abor (Middleboro), V. van Beynum (Leiden, Holland), L. Berard (Cambridge), P. Busher (Boston), I. Castro (Manila, Philippines), D. Daly (New York), W. Ecklaugh (Oxford, OH), J. Hinds (Orono), W. Hoyt (Boxboro), S. Kortepeter (Cambridge), H. Gomez (Havana, Cuba), A. Hubbard (Lincoln, MA), C. Thaxter Hubbard (Cambridge), S. Thaxter Hubbard (Lincoln, MA), S. J. Hubbard (Lexington), H. Iglesias (Havana, Cuba), E. P. Janis (Santa Fe), M. Maxfield (Holliston), A. Najarain (Watertown),), M. Philippi (Leiden, Holland), D. Reyes (Havana, Cuba), E. Rott (Innsbruck, Austria), I. Spreche (Cambridge), W. Tanaka (Cambridge), E. J. Thier (West Boothbay Harbor), A. B. Wagner (Portsmouth, RI).

FIRST CLASS

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FRIENDS of the FARLOW

FARLOW REFERENCE LIBRARY OF CRYPTOGAMIC BOTANY • HARVARD UNIVERSITY

Friends of the Farlow is an international group of amateur and professional botanists concerned with supporting the programs and resources of the Farlow Reference Library and Herbarium of Cryptogamic Botany of Harvard University. Membership categories are: Associate member, $5-25; Full member, $25; Sponsor, $50-100; Benefactor, $1000 or more. To join please make your check payable to the **Friends of the Farlow** and send to the address below. The membership year runs from January 1st to December 31st. Members receive a discount on Farlow publications and services, participate in book sales, annual meetings and other events, and receive a special welcome at the Farlow. This newsletter is published twice a year, in April and October. For more information, contact the Farlow Reference Library, 20 Divinity Avenue, Cambridge, MA 02138 USA (Tel. 617-495-2369; FAX 617-495-9484).