Newsletter of the

FRIENDS OF THE FARLOW

Number 74 Fall 2021

Tracy Barbaro, Editor
Gretchen Wade, Copy Editor

A Tiny Cup-fungus With Connections to the Farlow

Luis Quijada & Donald H. Pfister

Last September Ethan Crenson asked about two fungi he collected in New York. The first one, *Trichoglossum farlowii* (Fig. 1a), was the host of the second one, *Gelatinopsis geoglossi* (Fig. 1b, 2a-c, 3-6). *Trichoglossum farlowii* was described by Mordecae Cubitt Cooke (1825 – 1914) in honor of Willian Gilson Farlow, founder of the Farlow Library. It is found mostly in eastern of North America and Canada growing on soil in association with grass (GBIF 2020, Index Fungorum 2021). The genus *Trichoglossum* has flattened club-shaped fruiting structure and are commonly known as earth tongues. The fruit bodies are large enough, 1-10 cm tall, to be picked up by most collectors. In contrast, *Gelatinopsis geoglossi*, a parasite on *Trichoglossum* species, is almost unnoticeable on the hymenium of the earth tongue. It is only 0.04-0.1 mm diam. and 0.05-0.09 mm high (Fig. 2a-c). It was initially described as *Hypomyces geoglossi* by Job B. Ellis and Benjamin M. Everhart in 1886. The placement in Hypomyces, a pyrenomycete, reflects its fungal parasitic habit but contradicts the morphology of the fungus – it produces apothecia not perithecia. Recognizing the nature of the ascomata, Edgar V. Seeler, working at the Farlow Herbarium, proposed the genus *Micropyxis* for this species (Seeler 1943). Later it was referred to *Gelatinopsis*

Does size matter? This is a common question in biology and one the most interesting traits studied in evolution. In the past, it was common to think that species evolved to reach larger body sizes over evolutionary time. Now we know that this general rule is not always true (Blanckenhorn 2000, Bonner 2006). In any environment on Earth there are an array of organisms of different sizes, from the smallest unicellular organisms to the largest trees or mammals (op. cit.). But what do we know about size changes in fungi?

Mycelial mass and nutrient supplies influence the development of fruit bodies. A good and stable source of nutrient supply will allow the development of larger fruit bodies. Some studies have shown that saprotrophic fungi have on average smaller fruit body than ectomycorrhizal that have less restriction on their carbon sources than saprobes because of their symbiosis with the plants (Bässler et al. 2015). Wang et al. (2009) showed saprobes produce larger fruit bodies compared to leaf endophytes that grow in a limited area with fewer resources. The same happens with dung inhabiting fungi. n quickly perishable substrates like dung, there is competition for nutrients on a limited resource and therefore fruit bodies tend to be smaller (Halbwachs et al. 2018).

Annual Meeting, Saturday November 20, 2021. See page 4 for details.

In general, we can say that fungi with large fruit bodies occur where more resources are available. They live longer and produce a smaller number of fruit bodies, but each one supports more spores. Fungi that grow with limited resources (i.e. small fragments of wood, leaves, etc.) have a restricted supply of nutrients and have smaller fruit bodies. These fungi tend to have short life cycles and compensate for their small size and fewer spores by producing more fruit bodies per surface area (Halbwachs 2018).

We have a good example of these principles with *Trichoglossum farlowii* and *Gelatinopsis geoglossi*. The former is a fungus that grows on soil associated with plants (Fig. 1a) where resources are more available and therefore develop large fruitbodies. The latter is an obligate parasite with tiny fruitbodies (Fig. 1b, 2b) that completes it life cycle quickly on the mature host (*Trichoglossum farlowii*) before its fruitbody senesce. As noted in the literature and as seen in the examination of specimens, the parasite grows in great abundance in the hymenium of the host among the black setae (Fig. 1, 2c). *Gelatinopsis* compensates for its small size by producing hundreds of apothecia and covering completely the hymenium of the *Trichoglossum* (Fig. 1b). This does not allow the *Trichoglossum* to effectively discharge ascospores (Baral & Marson 2000). The parasite changes the appearance of the *Trichoglossum*. Healthy and infected individuals can be distinguished on sight (Fig. 1a).

Recent studies on *Gelatinopsis* are few as are studies of the family Helicogoniaceae to which *Gelatinopsis* is referred. The family has 7 genera and 38 species. They are all parasites in the hymenia of fungi (Ascomycota, Basidiomycota) distributed mostly worldwide mostly in temperate ecosystems (Jaklitsch et al. 2016). There are only a few sequences on GenBank, mostly of two gene regions ITS and LSU for four genera (*Eleutheromyces, Gelatinipulvinella, Gelatinopsis, Geltingia*). In the last revision and large phylogeny of the class Leotiomycetes published by Johnston et al. (2019), only two sequences of two genera (*Gelatinipulvinella astraeicola, Gelatinopsis fungicola*) were used. These species were placed sister to the order Phacidiales, an order with saprobic and parasitic (endophytic) species that grow on leaves, bark, and wood (Jaklitsch et al. 2016). Due to the lack of taxa sampling in the family Helicogoniaceae and the class Leotiomycetes more generally, it is still unclear if these relationships are true. Furthermore, the current information in GenBank for the three species of *Gelatinopsis* with sequences suggest that the genus could be paraphyletic. Further complicating the picture, there is no current sequence for the type genus *Helicogonium*. But we are now able to add sequences of the type species of *Gelatinopsis* (*G. geoglossi*, Fig. 1b, 2a-c, 3-6).

We have started a small project on the family Helicogoniaceae trying to get collections and sequences from species of other genera that are currently lacking. Because of the new fresh collection of *Gelatinopsis geoglossi* from New York, and other collections in the Farlow, we can sequence other DNA regions to help place *Gelatinopsis* and related taxa in the Leotiomycetes. One of these is *Calloriopsis*, a common parasite on the hyphae of *Meliola* "black mildew" that grows on leaves in the tropics. We are presenting this preliminary work to encourage collecting activities of these small fungi. This is not a new project for the lab; we studied these fungi many years ago (Pfister 1976), this was well before the age of sequencing.

Acknowledgements

We acknowledge Ethan Crenson for contacting us, providing the specimens and some macro photography used in this work. Hans-Otto Baral is also thanked for the exchange of information about the specimens and bibliography.

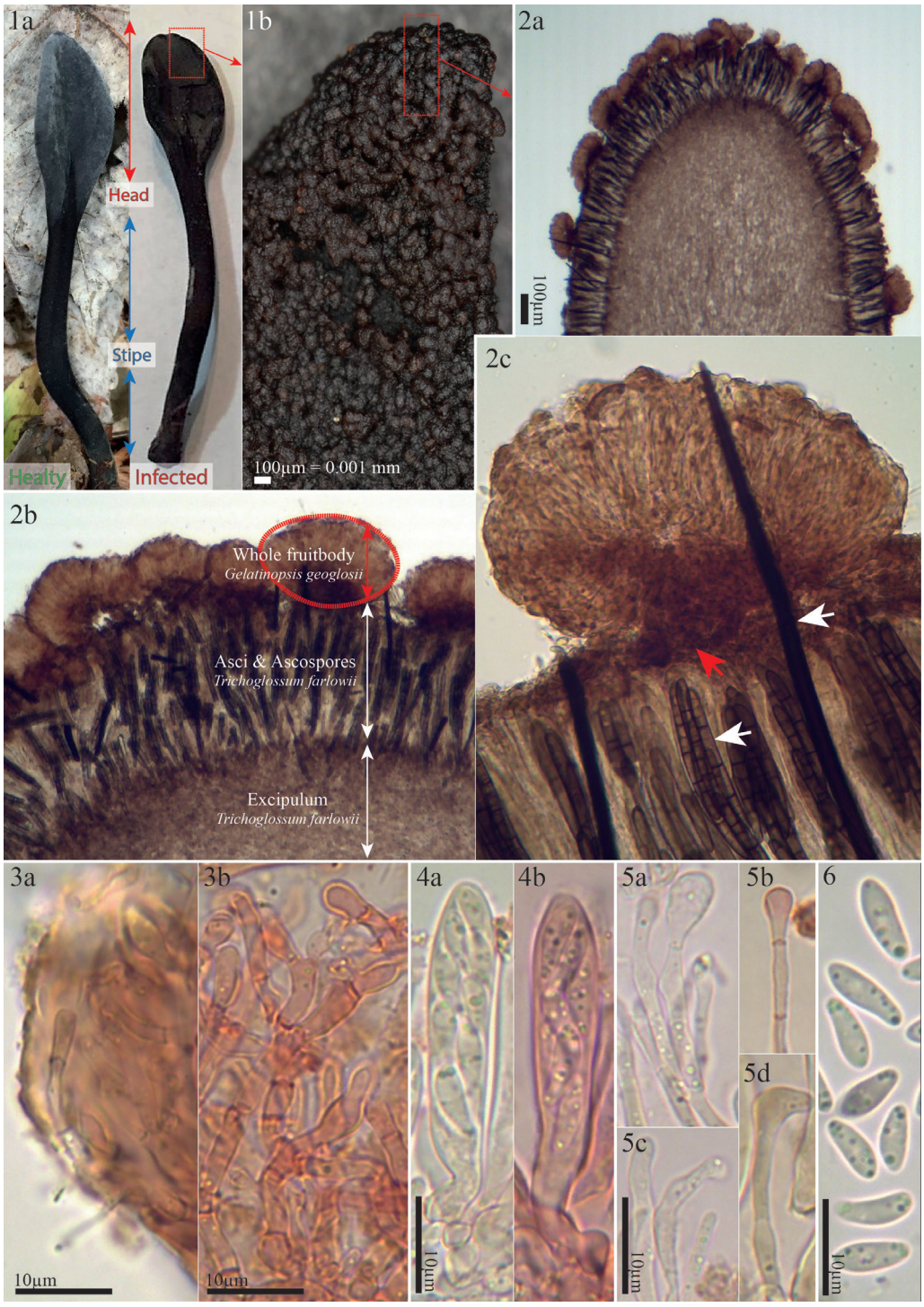


Figure: *Trichoglossum farlowii* parasitized by *Gelatinopsis geoglossi*. 1a. Club-shaped fruitbodies of *T. farlowii*, healthy and infected. 1b. Details of the surface of *T. farlowii* covered by apothecia of the parasite *G. geoglossi.* 2a-b. Transverse section of the head of *T. farlowii* showing the small fruitbodies of the *G. geoglossi* growing over the hymenium. 2c. Red arrow showing the place where the fruitbodies of *G. geoglossi* is attached to the hymenium of *T. farlowii,* white arrow showing details of the hymenium of the *T. farlowii* (asci, ascospores and setae exceeding the hymenium), 3a-b. Excipulum of *G. geoglossi* showing details of the hyphae embedded in gel, 4a-b. Asci of *G. geoglossi*, 5b-d. Paraphyses of *G. geoglossi*, 6. Ascospores of *G. geoglossi.*

References

Baral HO, Maron G (2000) Monographic revision of *Gelatinopsis* and *Calloriopsis* (Calloriopsideae, Leotiales). In G. Consiglio et al. (eds.) Micologia 2000. Associazione Micologica Bresadola, Fondazione Centro Studi Micologici. 23-46

Bässler C, Heilmann-Clausen J, Karasch P, Brandl R, Halbwachs H (2015) Ectomycorrhizal fungi have larger fruit bodies than saprotrophic fungi. Fungal Ecology 17: 205-212.

Blanckernhorn WU (2000) The evolution of body size: what keeps organisms small? The quarterly Review of Biology 75(4): 385-407.

Bonner J (2006) Why size matters: From bacteria to blue whales. Princeton: Princeton University Press.

GBIF 2020: https://www.gbif.org/occurrence/download?taxon_key=7246040

Halbwachs H, Karasch P, Simmel J (2018) Small can be beautiful: Ecological trade-offs related to basidiospore size. Asian Journal of Mycology 1(1): 15-21.

Jaklitsch W, Baral H-O, Lücking R, Lumbsch HT (2016) Syllabus of plant families. In: Frey W (Ed.) Adolf Engler's Syllabus der flanzenfamilien. Part 1/2 Ascomycota (13th edn). Borntraeger Science Publishers, Stuttgart, 322 pp.

Pfister DH. 1976. Calloriopsis and Micropyxis: Two discomycete genera in the Calloriopsideae Trib. Nov. Mycotaxon 4: 340-346.

Seeler EV. 1943 [1944]. Several fungicolous fungi. Farlowia 1: 119-133.

Wang Z, Binder M, Schoch C, Johnston P, Spatafora J, Hibbett D (2006) Evolution of helotialean fungi (Leotiomycetes, Pezizomycotina): A nuclear rDNA phylogeny. Molecular Phylogenetics and Evolution 41(2): 295-312.

Annual Meeting
November 20, 2021

The Friends of the Farlow Virtual Annual Meeting will take place on Saturday November 20, 2021 at 4:00 p.m. ET via Zoom. Giuliana Furci, the founder and president of Fundación Fungi/Fungi Foundation will be our speaker.

Giuliana Furci is the first female mycologist of non-lichenized fungi in Chile, starting her career in 1999 as a self-taught amateur. Under her leadership, Chile became the first country in the world to include the Fungi Kingdom in its environmental legislation, thus allowing Chilean funga to be included in the study and evaluation of environmental impacts throughout the country, through its incorporation into the Law of General Bases of the Environment, also mandating its incorporation into the national inventory of species. Giuliana is the curator of the FFCL Fungarium, which is continuously studied in collaboration with experts from Harvard University, Conicet Argentina, University of Florida, and other institutions. Among her appointments, she is a Harvard University Associate, co-chair of the IUCN Fungal Conservation Committee, and is a member of several mycological societies and associations. Giuliana is also a Board Member of Fundación Acción Fauna, Refugio Animal Cascada de las Ánimas.

Please register in advance:
https://fof.huh.harvard.edu/2021

News and Updates

Work at the Farlow

The Farlow Herbarium has reopened and we are sending out specimen loans again! In addition to in-person curatorial work, Farlow staff continue to digitize specimens, present at (virtual) conferences and attend professional development seminars and courses.

Hannah Merchant, Curatorial Assistant, attended Eagle Hill seminars, Introduction to Lichens and Marine Macroalgae and Ecology, Identification, Distribution, and Importance.

Genevieve Tocci, Senior Curatorial Technician, presented Curating Sporific Basidiomycetes at the 2020 Society for the Preservation of Natural History Collections (SPNHC) Annual Meeting.

Luis Quijada, Farlow Fellow, attended several virtual courses. In 2020: Introduction to Phylogenomics; Morphological phylogenetics: principles, applications, and techniques, map and spatial analyses (SIG) with R; macroevolutionary analyses using phylogenies. In 2021: Statistical analyses with R; Care and management of natural history collections; Obtaining and cleaning species occurrence data with R; Environmental variables: how to obtain and process them with R. Luis was part of the organization committee of the Latin-American congress of Mycology. Quijada et al. (2020) Ecologia y taxonomía de Ascomicetos. X Congreso Latinoamericano de Micología, (Chile, December 2020) and presented a seminar at Facultad de Ciencias, Instituto de Bioquímica y Microbioloía, UAch (Chile, 8 June 2021) entitled - *Leotiomycetes: muchos problemas o infinitas oportunidades.*

Congratulations!

Congratulations to Pfister Lab member James Mitchell on the successful defense of his thesis: "*Investigations into Resinicolous Fungi.”*

Congratulations to Don Pfister on his “retirement” from teaching. Never fear, Don will still be in the Farlow doing research!

Research Fellows at the Farlow

Dr. Michael Bradshaw, HUH Research Fellow, will morphologically and phylogenetically analyze the powdery mildews at the Farlow Herbarium as well as fresh collections from botanical gardens throughout North America, with the goal of writing the first comprehensive monograph of the Erysiphaceae of North America. Dr. Bradshaw recently completed a postdoc with the USDA in Beltsville, Maryland and a Ph.D. at the University of Washington where he worked on the epidemiology and biology of powdery mildews and their host plants with an emphasis on virulent, non-native species. Powdery mildews are ecologically and economically important plant pathogens that belong to a single monophyletic family of unculturable fungi; they have been reported to infect over 10,000 flowering plant species worldwide. Current research has shown that they are a more diverse group than originally thought. Although they are one of the world’s most common plant pathogens, little research has been conducted on the many species found in North America.

Dr. Luis Quijada, Farlow Fellow started in his new role in July 2020. Luis most recently completed a postdoctoral project at the Farlow in “*DNA barcoding for plant-pathogens diagnostic and monitoring. Forest diseases and turbo-taxonomy in Tympanidaceae as a case of study”* sponsored by the Ramón Areces Foundation. As the Farlow Fellow, Luis's project aims to emphasize how historical collections can be the solution to solving taxonomic and systematic problems in Fungi, and more specifically, in the Leotiomycetes. He plans to update our collections with new morphological and molecular details and to link macro- and micro-photographs, sequences and collections details with specimens in the HUH database. This immense undertaking will not only increase the quality of the information for each collection studied, help facilitate the exchange of information requested by researchers around the world, but also help to conserve the specimens by providing more detailed documentation.

Library Updates

Digitization of Original Botanical Illustrations

The Botany Libraries staff has been working on a multi-year project to digitize original botanical illustrations from our collections. The most recent addition to the project is Roland Thaxter's Contribution towards a monograph of the Laboulbeniaceae [original plates]. The volumes of original ink drawings on scratchboard were conserved and digitized this summer and are available online through both the library's catalog record and finding aid. Some of the plates were published in small format and having them digitized and available online allows users to zoom in and get more detail.

Plate from Roland Thaxter's Contribution towards a monograph of the Laboulbeniaceae [original plates]. Volume 4, Plate 10. Oversize T3685cpo. Farlow Reference Library of Cryptogamic Botany, Harvard University.

The corresponding plates were published in five articles titled Contribution towards a monograph of the Laboulbeniaceae in the Memoirs of the American Academy of Arts and Sciences from 1895-1931. The first three published articles are available through the Biodiversity Heritage Library.

Contribution towards a monograph of the Laboulbeniaceae, [Part I]. Memoirs of the American Academy of Arts and Sciences; v. 12, pt. 3.

Contribution towards a monograph of the Laboulbeniaceae, Part II. Memoirs of the American Academy of Arts and Sciences; v. 13, pt. 6.

Contribution towards a monograph of the Laboulbeniaceae, Part III. Memoirs of the American Academy of Arts and Sciences; v. 14, pt. 5.

Digital Object Identifiers

If ou have experienced the frustration of a web link suddenly not resolving, you understand the value of having a link that will always work, regardless of where the page is on the Internet. Diane Rielinger, Digital Projects Librarian, is a member of the Biodiversity Heritage Library's (BHL) Persistent Identifier Working Group (PIWG) that is developing and implementing policies and procedures for assigning persistent identifiers to scanned materials in BHL. Digital Object Identifiers (DOIs), unique alphanumeric strings that identify and link web content, do not change over time, unlike web addresses. Articles from two publications of the Farlow Library - *Occasional Papers of the Farlow Herbarium of Cryptogamic Botany (Numbers 1–19, 1969–1987)* and *Farlowia: A Journal of Cryptogamic Botany (Volumes 1–4, 1943–1955)* - were identified in BHL and assigned DOIs. Additionally, Farlowia lacked another persistent identifier, the International Standard Serial Number (ISSN) used to identify a journal title. The PIWG successfully obtained an ISSN for Farlowia from the Library of Congress. Now when scientists cite articles in these publications, they will use the DOIs to direct readers to the free and reusable copies within the BHL. Here's an example - https://doi.org/10.5962/p.317798.

Specimen Spotlight: *Ophiocordyceps sinensis*

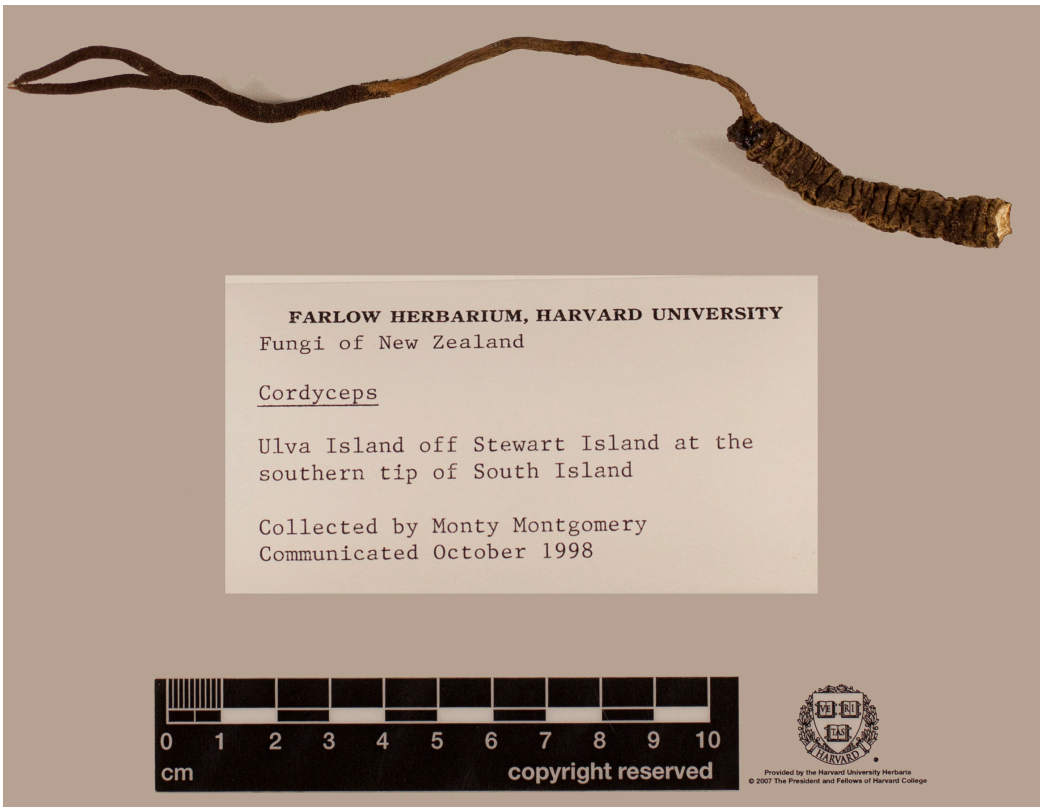
Hannah Merchant

Sensationalist news headlines often describe a "zombie fungus" that lurks among us, taking over the brains of helpless insects and forcing them to do its bidding. In science fiction books, movies, and videogames such as The Girl with All the Gifts and The Last of Us, these parasites can even mutate and infect humans, resulting in terrifying and apocalyptic consequences. While these pathogens may sound fantastical, they represent real, interesting organisms that we can find in our collections at the Farlow Herbarium.

Pictured here is a specimen we often bring out for the "wow" (or "ick") factor on tours: an entomopathogenic fungus called *Ophiocordyceps sinensis* emerging from a mummified caterpillar. The spores of this fungus infect a host, spreading the mycelium through the host's body and digesting its internal organs.

After colonizing and killing the host from the inside out, the fungus produces a lengthy fruiting body that emerges to spread its spores to the next unsuspecting insect. As peculiar as it may look, this specimen is not unique in our herbarium: we have over 100 collections in the genera *Cordyceps* and *Ophiocordyceps* on a variety of hosts such as ants, caterpillars, cicadas, spiders, and even other fungi.

This species of fungus has been used in Traditional Chinese Medicine for centuries and is commoditized globally today. Supplements derived from *Cordyceps* are marketed to treat a wide range of diseases and are sold as capsules and powders. As these treatments become more widespread and desirable to many around the world, the fungus is increasingly threatened by overharvesting. If the *Cordyceps* industry continues to grow unsustainably, this frightening fungus may disappear altogether.



Join us!

Receive the FoF Newsletter, notification of the annual book sale, discounts on Farlow publications and services, invitations to the annual meeting and other events, and a special welcome when visiting the Farlow. Dues notices will be issued in December.

Name: _____

Address: _____

City: _____

State, Zip/Postal Code: _____

Country: _____

Telephone/Fax: _____

E-mail Address: _____

Membership Categories	
Member	($25)
Sponsor	($50-100)
Benefactor	($1000)
Pofcher Fund	$_____
Philip May Fund	$_____
Amount Enclosed	$_____

Please make checks payable to: Friends of the Farlow
Harvard University Herbaria
22 Divinity Avenue
Cambridge, MA 02138 USA

22 Divinity Avenue
Cambridge, MA 02138
United States
http://fof.huh.harvard.edu/

FARLOW REFERENCE LIBRARY OF CRYPTOGAMIC BOTANY * HARVARD UNIVERSITY

FRIENDS OF THE FARLOW

FIRST CLASS