About this Issue

The abstracts of papers for the MSA Annual Meeting are included in this issue of *Inoculum* so there are only a few pages of news. The deadline for the next issue is August 1 and I need copy. Think ahead to the upcoming school term, the fall collecting season, important meetings and workshops and send me the news! See the masthead on page 7 for details.

Ellen Farr

Contributions of Mycological Research to Plant Pathology

_by Margaret Tuttle McGrath, Nina Shishkoff, Thomas Harrington, Bryce Kendrick, Suha Hare, and Charles Mims_

This statement was prepared because of our concern that the value of research in the field of Mycology can easily be taken for granted by plant pathologists. It is important that we address this now while departments are feeling the need to downsize. Many important mycological contributions were described during a recent symposium, Advances in Mycology and Their Impact on Plant Pathology, at the annual meeting of the Northeastern Division of the American Phytopathological Society. These are summarized below. Without an understanding of fungi, how can the diseases they cause be managed?

1. Correct identification of fungi. For example, results from years of research on *Armillaria* and on the biocontrol agent *Trichoderma viride* are ambiguous because proper identifications were not made. The name of a fungus is the key to its entire literature: everything we know about it. Therefore, correct identification is of paramount importance.

2. Identification of the causal agents of new or newly introduced diseases.

3. Taxonomy allows prediction of the ecology of fungi, such as host range and life cycle.

4. Knowledge of taxonomy narrows the search for medicinal drugs and fungitoxic compounds.

5. Taxonomists are needed to convert raw data from molecular biologists to a form more useful for plant pathologists (e.g., from bands on gels to comprehensive genetic trees indicating relationships among fungal groups).

6. Understanding of life cycles, in particular anamorph-teleomorph connections. Knowledge of life cycles enables control measures to be directed at the most
vulnerable phase of the cycle. Establishing a connection between anamorph and teleomorph may clarify the role of each in the etiology of a disease-vulnerable phase of the cycle. Establishing a connection between anamorph and teleomorph may clarify the role of each in the etiology of a disease.

7. Understanding of host-pathogen interactions (physical and molecular), including the nature of resistance, has resulted from mycological research.

8. Understanding of pathogenesis.

9. Knowledge of the roles of fungi in the biosphere has resulted in the realization that fungi can be used as biocontrol agents.

10. Mycologists within a Department of Plant Pathology are a valuable resource for both research and diagnosis.

Comments and additions are welcome. Send them to Margaret Tuttle McGrath, Long Island Horticultural Research Laboratory, Cornell University, 3059 Sound Avenue, Riverhead, NY, 11901-1098.

MSA Official Business

Addition to Abstracts

The following abstract was received too late to be included in the Abstracts Supplement.

LEPTOGRAPHIUM PYRINUM IS A MYCANGIAL FUNGUS OF DENDROCTONUS ADJUNCTUS

Diana L. Six and T. D. Paine
Department of Entomology, University of California, Riverside, CA 92521 USA

Several species of Dendroctonus (Coleoptera: Scolytidae) have structures developed in the integument called mycangia that are specialized for carrying specific symbiotic fungi. The mycangium of Dendroctonus adjunctus is located under a callus that surrounds the thorax. The mycangial fungus carried by D. adjunctus has not been identified prior to this time. In this study, fungi from mycangia of D. adjunctus were isolated and compared morphologically and genetically with Leptographium pyrinum and Ophiostoma adjuncti, two species of fungi known to be present in D. adjunctus colonized trees. Fungi isolated from D. adjunctus mycangia were morphologically and genetically identical to L. pyrinum.

Myco Online

Finding Mycological Information

Remember to check the Smithsonian Natural History Gopher Server (nmnhgoph.si.edu) for copies of Inoculum, an up-to-date directory of MSA members and a link to the MSA Bulletin Board. Look on the Botany menu for the “Mycological and Lichenological Information” submenu.

Send news for immediate distribution to the MSA Bulletin Board. Submit news as an e-mail message to <msa-news@huh.harvard.edu>.

Mycologists Online

Mycologists Online is a world-wide directory of mycologists and lichenologists, fungal/lichenological herbaria and/or culture collections, editors of periodicals, officials of national and international organizations, and contact persons of amateur societies accessible by e-mail. An updated edition is posted every 3–4 months. The last edition listed over 650 entries and included addresses of mycologists and lichenologists from 34 countries.

Links to the directory are found on the Biodiversity and Biological Collections Gopher <muse.bio.cornell.edu> and the World Wide Web Mycology Virtual Library <http://muse.bio.cornell.edu/bio/fungi.html>.

Check the directory and correct or update your address, and/or send new entries to the editor Pavel Lizon at <PL1@cornell.edu> or to the co-editor Erast Parmasto at <erast@iozb.tartu.ee>.

URLs Briefly Noted

<http://www.igc.apc.org/mushroom/index.html>
<http://www.inf.unitn.it/~mflorian/mycopage.html>

Two mycological pages. One from the Colorado Rocky Mountains. One from Italy.

<http://lycos.cs.cmu.edu>
“The Catalog of the Internet.” A site to search for Internet Resources.
**News of Herbaria**

University of Missouri Fungi transferred to Field Museum.

The mycological herbarium of the Department of Plant Pathology, University of Missouri has been transferred to the Field Museum of Natural History to provide this collection with better curation and increased access by the mycological community. This nearly 28,000-specimen herbarium contains a number of important sets of exsiccatae including Sydow’s Mycotheca Germanica, Ellis & Everhart’s Fungi Columbani, Bartholomew’s Fungi Columbani, Seymour & Earle’s Economic fungi, Rehm’s Ascomyceten, Roumegueur’s Fungi selecti Gallici exsiccati, Rabenhorst’ Fungi europaei et extraeuropaei, Petrák’s Mycotheca generalis, Bartholomew’s North American Uredinales, and Krieger’s Fungi Saxonicum & Schadliche Pilze. The collection also contains a large number of Missouri smuts, rusts, Agaricales, and other fungi. Collections are available for loan by writing either Greg Mueller or Qiuxin Wu.

**News of Mycologists**

Francois Lutzoni has been appointed Assistant Curator in the Department of Botany at The Field Museum, Chicago, IL. Following the completion of his Ph.D. from Duke University this summer, Francois will take up a one year postdoctoral position at Indiana University with Miriam Zolan. He will Start at The Field Museum in the Fall of 1996. Francois joins the expanding mycology program at the Museum which includes Greg Mueller (Associate Curator), Qiuxin Wu (Collections Manager), Sabine Huhndorf (Resident Research Associate) and Jack Murphy (Postdoc). Opportunities exist for graduate and postdoctoral studies in lichenology/mycology with Francois and Greg through local universities, including the University of Chicago.

Adauto Ivo Milanez has been appointed General Director of the Instituto de Botânica de São Paulo. Among its 84 botanists, 10 are full time mycologists staffed in the Mycology and Lichenology Section, with the following research lines: taxonomy and ecology of the Mastigomycotina, Zygomycotina (including VAM), Basidiomycotina and lichenized fungi in different Brazilian ecosystems, including polluted areas; fungal succession; degradation of chenobiotic compounds by fungi; and edible fungi. The Herbarium (over 300,000 exsiccate) has over 30,000 exsiccate of fungi. The culture collection has 730 specimens, 270 of zoosporic fungi.

John Murphy has accepted a postdoctoral research position at the Field Museum of Natural History in Chicago. He will be working with Greg Mueller on the biodiversity and conservation of macrofungi of the Midwest, emphasizing Illinois and northern Indiana. Starting in late June, his new address will be Dept. of Botany, The Field Museum, Chicago, IL 60605-2496. Phone: 312-922-9410 ext. 319, Fax: 312-427-7269.

H. P. Upadhyay retired from the Departamento de Micologia, Universidade Federal de Pernambuco, Pe., Brasil, but will continue teaching mycology and research on fungi in the Departamento de Engenharia Florestal, Universidade Federal de Mato Grosso, Cuiaba, Mt., Brasil as visiting professor. His permanent address is: 11232 Morning Creek Drive S., San Diego, CA 92128. Ph.: 619-486-9657.<sgupta@charon.stm.com>. His e-mail address at Universidade Federal de Mato Grosso is: <Hpu@Cpd.Ufmt.Br>. Dr. Upadhyay reminds us that Mato Grosso and neighboring states probably possess the greatest diversity of fungi, but are understudied.

**Deaths**


Nils Thorsten Elias Fries was born 17 July 1912 in Uppsala, Sweden. He received his Ph.D. from the University of Uppsala in 1939 and was a Docent at that university from 1939-1956. He served as Professor of Physiological Botany at the University of Uppsala from 1956-1978 and then Professor Emeritus until his death on 11 November 1994. Some of his many honors include serving on the Swedish Natural Science Research Council from 1959-1964, being elected into the Royal Swedish Academy of Sciences in 1964, being named an Honorary Member of the British Mycological Society in 1980, and being named an Honorary Member of the MSA. Nils published over 150 books and articles on plant physiology and mycology. He probably is best known for his work on mycorrhizae and for his pioneering work on developing protocols and elucidating mechanisms for germinating basidiospores of basidiomycetes, especially those that form ectomycorrhizae. Nils is survived by his wife Lisbeth, three children, and grandchildren. [Gregory M. Mueller]

Josef Poelt
17 October 1924-3 June 1995

Josef Poelt, Emeritus Professor of the Institut für Botanik, Universität Graz, Austria, and a leading authority on the systematics of cryptogams especially...
lichens, died on 3 June 1995 at his home in Graz. Professor Poelt was born on October 17, 1924, in the small village of Pocking in upper Bavaria. He studied botany in Munich, completing his Ph.D. in 1950 and his habilitation in 1959. In October 1965, after several years as Curator and Lecturer at Munich, Poelt took a professorship at the Institut für Systematische Botanik und Pflanzengeographie of the Freie Universität Berlin. In February 1972 he left this position to become Professor of the Institut für Botanik, Graz. In October 1991, after almost 20 years as head of the Institut, he stepped down to become an Emeritus Professor. Even in retirement Professor Poelt remained active, lecturing until June 1994 and conducting field work and systematics research until his death.

Professor Poelt leaves an impressive body of systematic research reported in over 320 publications. The publications reflect his diverse interests in floristics, morphology, evolution, and classification. Especially his flora Bestimmungsschlüssel Europäischer Flechten is a standard reference for the lichenology. His floristic interests were not limited to Europe; Professor Poelt traveled extensively, especially conducting field research and floristic studies on the lichens of Himalaya. Although most of his publications are in this speciality—the systematics of lichen-forming fungi—many are on non-lichenized fungi and bryophytes, and a few on vascular plants. The significance of his scientific research has been recognized with numerous awards, including membership in the Bavarian Academy of Science, honorary membership in the Regensburg Botanical Society, foreign membership in the Linnean Society in London, corresponding memberships in the Austrian Academy of Sciences and the Botanical Society of America, and Acharius Medals from the International Association of Lichenologists. Also, Professor Poelt was President of the 4th International Mycological Congress in Regensburg, Germany, 1990.

Professor Poelt was a capable and enthusiastic teacher. Over his long university career he trained many talented students, first in Munich, and later Berlin and Graz. To these students and numerous colleagues and collaborators, he provided freely a fountain of ideas and research suggestions. Both his institution and his home were international meeting places where science and friendships flourished. Over time his scientific family grew to include many generations of students, all directly or indirectly influenced by Professor Poelt’s ideas. This large group of lichenologists and mycologists should be recognized as the “Poelt School.”

In addition to his scientific achievements, Professor Poelt was a devoted husband and loving father. After the early death of his wife, Christa, he cared for their young daughters. He is survived by these two daughters, Julia Poelt and Mag. Doris Poelt. [Paula DePriest]

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**Calendar of Events**

Items will remain on the calendar until the information is out of date. After the initial detailed announcement, the item will be shortened and given a reference to the issue of *Inoculum* where the full announcement last appeared. See the MSA Bulletin Board for more details about items marked with an asterisk.


**August 6–10, 1995. Mycological Society of America meets with AIBS. Town & Country Hotel, San Diego, California.**


**August 24–27, 1995. The Annual NAMA Foray, the Mary S. Whetstone Foray, Bemidji State University, Bemidji, MN. Contact: Anna Gerenday. Phone: 612-624-3241. Fax: 612-625-5299. <geren002@maroon.tc.umn.edu> (Inoculum 46(1)).**

**August 24-27, 1995. The 15th annual Telluride Mushroom Conference, Telluride, Colorado. Contact Fungophile, P.O. Box 480503, Denver Colorado, 80248-0503. Phone/Fax: 303-296-9359.**

**August 27–September 1, 1995. 7th International Symposium on Mycological Society in Association**


**August 29–September 2, 1995. British Mycological Society in Association**
with the British Society for Plant Pathology. The Downy Mildew Fungi (first European Meeting) Gwatt Conference Center, CH-3645 Gwatt, Thun, Switzerland. (Inoculum 46(1)).


September 7–9, 1995. Antigenic Peptides, Glycobiology and Vaccines (Immunology in Medical Mycology Workshop), Big Sky, Montana. Contact: Sheri Gardner, Extended Studies Office, 204 Culberston Hall, Montana Status University, Bozeman, MT 59717. Phone: 406-994-5240. Fax: 406-994-6546. <uxssg@msu.oscs.montana.edu>.

(Inoculum 45(4): 15).*


September 18–22 1995. The Environmental Monitoring and Assessment Program's (EMAP) First North American Workshop on Monitoring for Ecological Assessment of Terrestrial and Aquatic Ecosystems, Mexico City. Contact: Dr. Sidney Draggan, Environmental Monitoring and Assessment Program [8205], U.S. EPA, 401 M Street, SW, Washington, DC 20460. <draggan.sidney@epamail.epa.gov>

September 29–October 1, 1995. Symposium on Integrated Microscopy, Madison, Wisconsin, organized by the Integrated Microscopy Resource, University of Wisconsin-Madison. Presentations in this symposium will focus on biological problems for which a combination of microscopies (i.e. integrated microscopy) has been used. The techniques which will be discussed include: DIC, confocal, 2-photon excitation imaging, SEM, TEM, cryo-specimen preparation, and AFM. A two-day workshop will follow the symposium. Contact: IMR, University of Wisconsin-Madison, 1675 Observatory Drive, Madison, WI 53706. <imradmn@calshp.cals.wisc.edu>.

Consult the Web site for additional information: <http://www.bocklabs.wisc.edu/imr/imr.html>.

October 22–25, 1995. Biologists having expertise in the physiology and morphology of spore forming organisms are invited to participate in an International Workshop on Interdisciplinary Harmonization of Terminology Used in Describing Spore-forming Microorganisms at the School for Scientific Communication in Santa Maria Imbaro, Italy. The organizers are asking for expressions of interest in attending. Participants will be asked to deliver information on spore terminology in their particular subspecialty at least six weeks prior to the meeting. If you are interested but unable to attend, consider participating in the substance of the workshop by e-mail or fax. Contact: Micah I. Krichesky, Chair, Bionomics International, 12221 Parklawn Drive, Rockville, MD 20852. Phone: 301-881-2804. Fax: 301-881-1625. <micahk@helix.nih.gov>.

Letters and Commentary

Update to "The Tokyo Code …"

Following the article by Pavel Lizon on the Tokyo Code, I would just like to add to the paragraph on types and typification, which has overlooked one significant difference from the Berlin Code (1987). Article 8 (Tokyo Code), previously Article 9 (Berlin Code), now provides for a culture being designated as a type as long as, "it is permanently preserved in a metabolically inactive state by lyophilization." This is given in Example 1 under Art. 8.2, citing the particular case of Candida populii Hagler & al. (1989). It is also important to note that, according to Recommendation 8B.2, any living isolate from such metabolically inactive cultures should be designated as 'ex-type', 'ex-holotype' or 'ex-isotype', as they themselves are not the nomenclatural type.

John David Hawksworth
International Mycological Institute
U.K.
Mycological Classifieds

Read the Mycological Classifieds for announcements of courses, employment opportunities, positions wanted, and mycological goods and services offered or needed.

Courses

The 10th annual Introduction to the Edible and Poisonous Fungi of Michigan's Upper Peninsula short course will be conducted 8-10 September 1995 at Michigan Technological University's Ford Forestry Center. Consisting of approximately 8 hours of lecture interspersed with 7 hours in the field and 4 hours in the lab, the objectives of the short course are to help participants 1) understand and recognize the roles played by fungi in forest ecosystems, as well as 2) learn how to safely and reliably find, collect, identify and prepare choice edible wild fungi. The course is scheduled during the Upper Peninsula's peak late summer mushroom-hunting season. Instructors include Dr. Johann Bruhn, Ralph Duffek, Mary Ellen Kozak and Joe Krawczyk, Dr. Dana Richter, Dr. John Rippon, and Dr. Thomas Volk. For registration materials, please call 906-524-6181. Johann Bruhn

Publications Wanted


Services Available

Illustration services available. I do pen and ink, pencil and watercolor illustrations for scientific publication or fine art purposes, of mycological and related subjects. I also design T-shirts with a fungal theme. Christine Roberts <croberts@efn.org>.

Positions Available

Assistant/Associate Professor(s) of Plant Pathology, University of Kentucky. Applications are invited for two tenure-track faculty positions focusing on fundamental research concerning plant-pathogen interactions. Although the successful candidates will be allowed broad latitude in determining particular research directions, they will be expected to develop/direct nationally recognized programs. Strong preference will be given in one position for an individual using molecular approaches to the study of prokaryotes and plant diseases in which they are causally involved. The appointees will be expected to contribute to the instructional program in the department as well as to provide expertise to other departmental efforts. A Ph.D. in plant pathology or a related discipline is required. Postdoctoral experience is desirable. Applicants should send curriculum vitae, transcripts, sample publications, any other evidence of professional accomplishments and at least three professional references to Dr. David A. Smith, Department of Plant Pathology, S-305 Agricultural Science Building-North, University of Kentucky, Lexington, KY 40546-0091 Phone: 606-257-3901. Fax: 606-323-1961. <dsmith@ukcc.uky.edu>.

Applications will be accepted until August 31, 1995, or until suitably qualified candidates are found. The University of Kentucky is an equal opportunity employer. Women and minorities are encouraged to apply.

The DuPont Company is seeking highly motivated research scientists to join a multidisciplinary team working to exploit modern biological methods in the discovery and development of novel products for the control of weeds and plant diseases. Send resumes and a list of references to the following addresses by July 3, 1995.

Agricultural Products: Molecular Biologist, (DuPont Human Resources, P.O. Box 30-MB, Newark, DE 19714).

Central Research and Development: Yeast Molecular Genetist, (DuPont Human Resources, PSS-0106, Wilmington, DE 19898).

Change of Address

Allen Press now handles such MSA membership services as maintaining the MSA mailing list, preparing mailing labels, and processing membership applications and renewals. Send all corrections of directory information (including e-mail addresses) directly to Allen Press. MSA's contact at Allen Press, Karen Hickey, can be reached by any of the following:

Mycological Society of America
Attn: Karen Hickey
P.O. Box 1897
Lawrence, KS 66044-8897

phone: 800-627-0629 (U.S. and Canada)
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Abstracts of papers and posters presented at the MSA annual meeting
held 6-10 August, 1995, at the Town and Country Hotel, San Diego, CA
abstracts appear in order by first author's surname

TAXONOMIC REVISION OF TAXA ORIGINALLY DESCRIBED IN LEPTOSPHAERIA FROM SPECIES IN THE RANUNCULACEAE, PAPAVERACEAE AND MAGNOLIACEAE. Young-Mee Ahn and C. A. Shearer, Department of Plant Biology, University of Illinois, 505 S. Goodwin St., Urbana, Illinois, 61801, USA

The taxa originally described in the genus Leptosphaeria comprise a heterogeneous group. As part of an ongoing revision of this genus, twenty six taxa described from species in three plant host families, Ranunculaceae, Papaveraceae and Magnoliaceae, were reexamined, redescribed and illustrated from type and authentic materials. In addition, the taxonomy of L. vagabunda and its five infraspecies was reconsidered. Previous disposition of six species, L. clematicola, L. doliolium, L. haemattites, L. umbrosa, L. papaveris and L. vitalbae, was confirmed. One new genus, Barrella, was established for L. thalictri. The remaining species were transferred to various genera of Loculoascomycetes and Hymenochaetaceae. There was no morphological basis to support the present classification of L. vagabunda and its five infraspecies. Leptosphaeria vagabunda was therefore transferred to the genus Melanomma and its five infraspecific taxa were assigned at species level to separate genera in Pleosporales and Melanommatales.

ECOLOGY OF ARBUSCULAR MYCORRHIZAE: REGULATION OF ECOSYSTEM PROCESSES IN CHANGING CONDITIONS. M. F. Allen, J. Kilronomos, F. Edwards, S. Harney, and M. Rillig, Dept. of Biology and SERG, San Diego State University, San Diego, CA 92182, and E. B. Allen, Dept. of Botany and Plant Sciences, University of California, Riverside, CA 92521.

Understanding perturbations to natural communities has provided the means to evaluate how arbuscular mycorrhizae (AM) function in ecosystems. Most studies have evaluated how plants function with versus without AM using either inoculation of severely disturbed sites or fumigation of less disturbed sites. However, this approach assumes that all AM fungi act similarly in regulating ecosystems. We have assessed comparative AM functioning in response to subtle perturbations or comparative species inoculations. We have found that species of Glomus are less sensitive to soil physical or nutritional perturbations than either Scutellospora or Acaulospora. The fungi also differently affect seedlings versus mature plants in that the Acaulospora and Scutellospora are detrimental to seedlings but promote the growth of mature plants compared with Glomus or nonmycorrhizal plants. Enhanced CO2 levels enhance AM activity but when coupled with nutrient deposition there were shifts towards a high sporation of Glomus. These data indicate that several different perturbations select for species of Glomus versus Acaulospora and Scutellospora which changes the structure of the host plants.

SOME OBSERVATIONS ON CORTINARIUS TRAGANUS AND C. CITRINIFOLIUS. J. F. Ammirati, M. Seidl, T. O'Dell and M. Decher, Department of Botany, University of Washington, Seattle, WA 98195 and M. Moser, Institut fur Mikrobiologie, University of Innsbruck, A-6020 Innsbruck, Austria.

Cortinarius traganus Fr., a lilac-violet species with ochre to cinnamon lamellae in the Subgenus Sericeocybe, infrequently produces an ochraceous form in Europe and North America. The latter form will be closely compared with the more typical form of the species and its known distribution given for each continent. Cortinarius citrinifolius Smith, initially collected in the Olympic Mountains in 1935, was recently collected near Boulder Creek, the type locality for the species. This taxon, originally placed in the subgenus Myxacium, appears to be closely related to Cortinarius percomis Fr. of the subgenus Phlegmacium. A comparative study of these two species will be presented.

FIELD TESTS OF TRANSGENIC STRAINS OF THE CHESTNUT BLIGHT FUNGUS FOR BIOLOGICAL CONTROL. Sandra L. Anagnostakis, The Connecticut Agricultural Experiment Station, New Haven, CT 06504, USA.

Cryphonectria parasitica kills the stems of American chestnut trees and American chinquapins. A virus that makes it hypovirulent works well in orchards as a biological control. Its usefulness in the forest is limited by the diversity of the C. parasitica population, and by the ability of the fungus to produce spores that do not contain the virus. Transgenic hypovirulent strains with cDNA made from the dsRNA of Hypovirus CHV1-713 are extremely efficient at transmitting the viral genome to both sexual and asexual spores of C. parasitica. Two strains have been deployed by two methods in a forest in Connecticut (biotechnology permit #94-010-01). Treated and control American chestnut trees are being monitored for evidence that these transgenic strains can initiate a biological control of chestnut blight disease: that is, become established in the fungal population and spread from the site of introduction, and reduce tree mortality.

Acknowledgement
This year's MSA program came together while I was on sabbatical 12,000 miles from home. The final program and collection of abstracts are the result of team effort by members of the Duke University Mycology Lab and the wonders of the Internet. I'd like to apologize for any mistakes or omissions (strictly my own fault). The following people deserve more than a few beers for their contributions: Erin Caister, Jaqui Johnson, Scott LaGrega, Lisa Law, François Lutzoni, Shian-ren Liou, Kris Shanks, Peggy Schultz, and Miguel Volovsek. -R. Vilgalys, Program Person for 1995

1995 MSA abstracts, page 1
GENETIC EXCHANGE AND RECOMBINATION IN NUCLEAR AND MITOCHONDRIAL GENOMES OF ARILLARIA GALLICA. J. B. Anderson and B. J. Saville. Department of Botany, Erindale College, University of Toronto, Mississauga, Ontario L5L 1C6 CANADA.

Genetic individuals of Armillaria and other root-infecting basidiomycetes are usually found in discrete patches that often include the root systems of several adjacent trees. Each individual has a unique multilocus genotype that, with rare exception, is recovered in only one location. Because of this pattern of spatial distribution, we can infer that each genetic individual arises from a unique mating event and then grows vegetatively to reach its present size. In a sample including 282 collections representing 121 genetic individuals of A. gallica (= A. bulbosa) from two locations in each of four regions of eastern North America, genotype frequencies at seven nuclear loci were close to those expected with random mating. Allele frequencies at the seven loci were not significantly different between regions. Additional genotypic data from restriction polymorphisms associated with four mating alleles were utilized to examine the properties and development of the granules. The holotype collected by Lindblad in Sweden in 1845 and other specimens from around the world were studied. Dictyidine granules are spherical or lobed and vary between 0.7 and 1.8 μm in diameter; they are hollow and often possess a small hole at one end. Fractured granules exhibit walls which measure ca. 0.2 to 0.3 μm in thickness; the wall is composed of a matrix in which small "grains" (>0.1 μm in diameter) are embedded. This structure is also like that of the peridium as seen in fractured views.

Evidence, such as fractured granules still joined to the peridium, indicates that dictyidine granules may be extruded from the peridium during development.

SUCCESSION OF MYCOFLORA ASSOCIATED WITH THE YUCCA INFLORESCENCE. E. A. Armstrong and F. W. Spiegel, Dept of Biological Sciences, University of Arkansas, Fayetteville, AR, 72701 USA.

The Yucca filamentosa L. inflorescence is an analogous habitat to the phylloplane. The annually differentiated aerial surface of the flower stalk provides a model to examine the primary succession of mycoflora that have immigrated from other sources. Two sites in Fayetteville where Yucca have been introduced were selected for a comparative study. Paradermal tissue samples (including cuticle, epidermis, and cortex) were plated out on a Yucca infusion agar plates. The sampling time ran from May through July when the flower stalk senesced. Samples were collected every ten days. The plates were observed and fungi were recorded every three days for 15 days. Four genera of fungi were constant throughout the sampling time, however, other genera revealed a successional pattern. The use of simple sampling methods are amenable to applications of studying the association of genera of fungi with Yucca that are distributed across the continental United States.

THE STRUCTURE AND DEVELOPMENT OF DICTYDINE GRANULES IN LINDBLADIA. H. J. Arnott, L. E. Lopez, T. Hatano and H. Keller, Dept. of Biology and Center for Electron Microscopy, Univ. of Texas at Arlington, Arlington TX 76019 USA and Dept. of Microbiology and Immunology, Univ. of North Texas Health Science Center, Ft. Worth, TX 76107 USA.

The dictyidine granules of Lindbladia tubulina (Mxymycetes, Liceales, Cribrariaceae) are one of the defining characteristics of this monotypic genus. Light and scanning electron microscopy were utilized to examine the properties and development of the granules. The holotype collected by Lindblad in Sweden in 1845 and other specimens from around the world were studied. Dictyidine granules are spherical or lobed and vary between 0.7 and 1.8 μm in diameter; they are hollow and often possess a small hole at one end. Fractured granules exhibit walls which measure ca. 0.2 to 0.3 μm in thickness; the wall is composed of a matrix in which small "grains" (>0.1 μm in diameter) are embedded. This structure is also like that of the peridium as seen in fractured views. Evidence, such as fractured granules still joined to the peridium, indicates that dictyidine granules may be extruded from the peridium during development.

COLONIZATION AND DISTRIBUTION OF FUSARIUM MONILIFORME WITHIN RESISTANT CORN HOSTS. C. W. Bacon, and D. M. Hinton, USDA, ARS, Russell Research Center, Athens GA, 30613 USA.

Fusarium moniliforme Sheldon is a pathogen of corn and on corn this fungus produces several phytotoxins and mycotoxins. Several studies are providing evidence that this fungus exists as specialized forms. We present here a microscopic study of corn and rice isolates of F. moniliforme penetrating and colonizing resistant and susceptible corn cultivars and isolines. On susceptible cultivars this fungus produced extensive hypertrophy of the xylem parenchyma cells, and complete collapse of the cortical cells in the roots of the corn seedling. In resistant cultivars there is no evidence of pathogenesis, but hyphae were observed within the cortical and parenchyma cells. The distribution of hyphae in resistant corn is restricted but in older resistant plants, it is no longer restricted. This work is one of the first to show this fungus within the tissue of resistant corn plants as a systemic infection, providing visual evidence that F. moniliforme is indeed an endophyte of corn.
This is the first account of members of the family Entolomataceae (Agaricales) from Puerto Rico. Stevenson (1975), in a summary of fungi reported from Puerto Rico and the Virgin Islands, listed 75 species in 33 genera of Agaricales, but not a single taxon of the mushroom family Entolomataceae was included in that publication. In this report, twelve species of Entolomataceae, including six new species, are briefly characterized. For comparison with other areas in and around the Caribbean, Dennis (1970) listed 44 taxa of Entolomataceae for Venezuela and Trinidad, having described 28 new taxa for the family over a seventeen year period. Pegler (1983) described 13 new species and a total of 48 members of Entolomataceae from the islands of the Lesser Antilles. In a revision of the Agaricales of Cuba, Pegler (1988) provided descriptions and keys to seven species of Entolomataceae. No new taxa were described by Pegler. Our investigations are still preliminary, however we fully expect that many more taxa of Entolomataceae will be enumerated from Puerto Rico. Certainly the numbers will double or even triple, and we expect that more new species will be discovered. Several North American members of Entolomataceae, which are now known to occur in Puerto Rico, are not listed in the accounts of either Dennis (1970) or Pegler (1983 and 1988). Biogeography of the Entolomataceae in the Caribbean will be considered by examining the distributions of some selected species. A key to the species of *Alboleptonia* in the Caribbean will also be distributed.
Disruption of tip growth in hyphae of Rhizoctonia solani: An experimental test of the hypoid model. S. Bartnicki-Garcia1, G. Gierz2, D. Bartnicki3, R. López-Franco4, and C. E. Bracker5, Departments of Plant Pathology1, Mathematics2, and Computer Science3, Univ. California, Riverside, CA 92521; Centro de Biotecnología4, ITESM, 64849 Monterey, NL, Mexico: Dept. Botany and Plant Pathology5, Purdue Univ., West Lafayette, IN 47907.

A mild disturbance caused the Spitzenkörper to move away from its normal position next to the apical pole and wander briefly inside the apical dome in a growing hypha of Rhizoctonia solani. Hyphal elongation rate declined abruptly, the hyphal apex became rounded, and the cell increased in diameter. As the Spitzenkörper core migrated back to the pole and vesicles accumulated around it, rapid cell elongation resumed, and the contour of the hyphal tip returned to the typical hyphal shape. The brief dislocation of the Spitzenkörper left a permanent bulge in the hyphal profile. This morphogenetic sequence was mimicked by computer simulation based on the hyphoid equation, which relates hyphal shape generation to the linear displacement of a vesicle supply center (VSC). The VSC was programmed to retrace the Spitzenkörper's path during the experimental sequence. The resulting similarity between real and computer-simulated cells validates the prediction that the Spitzenkörper acts as a VSC and generates typical hyphal tubes. Thus, the hyphoid model and its VSC concept provide a plausible hypothesis to explain hyphal tip growth.

Endophytes in epiphytes: Xylaria species in Puerto Rican orchids. P. Bayman1, L. L. Lebrón2, A. Carrero, Jr.1, and D.J. Lodge3, 1Dept. of Biology-UPR, Box 23360, San Juan PR 00931; 2Terrestrial Ecology Division-UPR, Box 363682, San Juan PR 00936; 3Center for Forest Mycology Research, U.S. Forest Service, Box B, Palmer PR 00721.

Mycorrhizal fungi of temperate, terrestrial orchids are well known, but much less is known about mycorrhizae of tropical, epiphytic orchids. Fungi were isolated from roots of epiphytic orchids in Puerto Rico. Xylaria was the most common genus isolated. At least four Xylaria species were found, with no apparent host specificity. They were also isolated from orchid fruits and leaves, though at lower frequency. Some of these species are also saprotrophs in the rain forest. Pelotons were observed in stained roots. Although all orchid mycorrhizal fungi described to date are basidiomycetes, endophytic Xylaria species clearly show some of the characteristics of mycorrhizae.

Bitunicate ascus origins and loculoascomycete phylogeny. M. L. Berbee, Department of Botany, Univ. of British Columbia, Vancouver B.C. V6T 1Z4 Canada.

Bitunicate asci with two wall layers separating at maturity have traditionally been used to characterize the Loculoascomycetes. Would rDNA sequence data support clustering bitunicate fungi into this monophyletic class? To answer this question, I have sequenced the 18S rDNA genes of 18 species from the orders Pleosporales, Dothideales, and Chaetothyriales. I predicted that if the two-layered ascus evolved once, then the bitunicate fungi would form a monophyletic group in a DNA sequence-based tree. If the two-layered walls of the loculoascomycetes originated multiple times, the ascus wall layering would not always predict relationship and at least some loculoascomycete species with and without bitunicate asci would cluster together in sequence trees. Within the Loculoascomycetes, the Pleosporales appear as a monophyletic group with strong support from the data. The Dothideales may constitute a monophyletic group, but without strong support. My results suggest that the Loculoascomycetes is not monophyletic as currently defined because the family Herpotrichiellaceae (Chaetothyriales) is more closely related to the plecctomyces than to the other loculoascomycetes. The two-layered ascus wall probably evolved at least twice.

Host-specificity and diversity of glomalean fungi: Experimental and theoretical approaches. J. D. Bever1, J. B. Morton2, J. Antonovics1, and P. A. Schultz1, 1Department of Botany, Duke University, Durham, NC 27708-0338, USA and 2Department of Plant and Soil Sciences, West Virginia University, Morgantown, WV, USA

Intensive sampling of an old field grassland community revealed a high diversity of glomalean fungi. In laboratory microcosm experiments with co-occurring host plant species, glomalean fungi exhibited strongly differential rates of sporation. These differences were not affected by the time of harvest, suggesting that they resulted from underlying differences in the relative growth rates of the fungal populations. Furthermore, the distribution of fungi in the field was found to be significantly correlated with the host specific growth rates observed in the laboratory, suggesting that host-specific differences are operating in the field. Host-specificity of relative population growth rates may play an important role in the maintenance of high fungal diversity within a community. Furthermore, the host-specific differentiation of the fungal community allows for an active dynamic between the composition of the plant and fungal communities. The expected consequences of such dynamics are discussed and a program for evaluation of these dynamics presented.
INFECTION OF WATER OAK BY THE PLANT PATHOGENIC FUNGUS *TAPHRINA CAERULESCENS*. D. Birdwell and J. Taylor, Dept. of Biology, Stephen F. Austin State Univ., Nacogdoches, TX 75962 USA.

*Taprina caerulescens*, causal organism of oak leaf blister disease, was isolated from infected leaves of water oak (*Quercus nigra*). Pure cultures maintained on potato dextrose agar were examined microscopically to characterize the saprophytic phase of the fungal life cycle. Leaves of healthy water oak seedlings were inoculated with a suspension of conidia, development of mycelial hyphae, and indirect penetration of host leaves through stomata, initiating the parasitic phase of *T. caerulescens*. Transmission electron microscopy was used to study ascus morphology, ascospore development, and ultrastructural changes occurring in host cells associated with the infection site.

DO EFFECTS OF HUMAN ACTIVITIES ON FUNGI CONTROL THE BALANCE OF TREE SPECIES IN EASTERN DECIDUOUS FORESTS? R. E. J. Boerner, Department of Plant Biology, Ohio State University, Columbus OH. 43210 USA.

This presentation summarizes two lines of research concerning the regulation of the balance of VA mycorrhiza-dependent species (e.g. maples) and ectomycorrhiza-dependent species (e.g. oaks) in eastern forests. (1) Whereas the spatial pattern of VA infectivity in soils along a successional chronosequence was homogeneous and high throughout, there is a high degree of spatial heterogeneity in ECM infectivity which may regulate entry of ECM-dependant oaks into this succession. (2) Our ongoing studies of the effects of atmospheric deposition (especially N) and forest management on the relative success of ECM and VAM dependent tree species, the relative abundance of fungi vs bacteria, organic N turnover, and nutrient status suggest that silvicultural improvement of oak stands and fire suppression both have the potential to shift the competitive advantage towards VAM-dependent species and away from oaks.


The endomembrane system of most fungi is poorly characterized biochemically. In addition, significant and widely unappreciated differences in the morphology of endomembrane compartments exist between fungi and other taxa. With these differences in mind we examined the ultrastructure of the ascomycetous yeast *Pichia pastoris* prepared by freeze substitution. *Pichia* Golgi were well defined and remarkably different compared with fenestrated smooth cisternae, "Golgi equivalents," observed in higher filamentous fungi. Golgi consisted of 3-4 stacked, fenestrated, cisternae associated on their concave (presumably trans-Golgi) face with a prominent zone of exclusion. Golgi were oriented so that this zone of exclusion was adjacent to either the plasma membrane or the nuclear envelope. Golgi cisternae but not the zone of exclusion labeled uniformly with ConA in a post-embedding procedure. Potentially endocytotic, finger-like invaginations of the plasma membrane were observed commonly. Filasomes were also observed.

HOST SPECIFICITY AND NUCLEAR CONDITION IN *TILLETIA FUSCA*. M. L. Boyd and L. M. Carris, Dept. of Plant Pathology, Washington State Univ., Pullman WA, 99164-6430 USA.

*Tilletia fusca* is a species complex infecting wild grass hosts. *Tilletia fusca* var. *fusca* infects *Vulpia* spp. (annual fescues) while vars. *bromi-tectorum* and *guyotiana* infect *Bromus* spp. Host range and number of nuclei in primary sporidia are criteria used to distinguish species in this group of smut fungi. We observed host specificity between populations of *T. fusca* var. *fusca* infecting *V. microstachys* and *V. octoflora* in central Washington. This specificity was supported by polymorphisms between different *Vulpia* isolates with 7 of 11 RAPD-PCR primers tested. RAPD markers also distinguished isolates of *T. fusca* var. *fusca* from vars. *bromi-tectorum* and *guyotiana*. Up to 5% of the primary sporidia in *T. fusca* var. *fusca* were binucleate whereas only uninucleate sporidia were found in vars. *guyotiana* and *bromi-tectorum*. Twelve percent of *T. fusca* var. *fusca* single-sporidial lines produced teliospores in vitro. In the sporogenous colonies, 55% to 75% of the secondary sporidia were binucleate, indicative of dikaryon. Based on host specificity, nuclear condition and RAPD data, *T. fusca* var. *fusca* is distinct from the brome-infecting varieties. The occurrence of binucleate sporidia appears to be widespread in some members of *Tilletia* and may play a role in speciation.
VIDEO-ENHANCED LIGHT MICROSCOPY: AN ELEGANT TOOL FOR STUDYING CELL DYNAMICS. C. E. Bracker. Department of Botany and Plant Pathology, Purdue University, W. Lafayette, IN 47907-1057.

Modern technology for video-enhanced light microscopy (VELM) is the operational successor of the video-enhanced contrast concept championed by Robert Allen in the 1970s and 80s. The system consists of a high-resolution video camera interfaced with analog and digital real-time image processors which manipulate contrast, density, and the gamma curve of the image to optimize contrast and visibility of delicate, low-contrast structures. The technique functions at or close to the resolution limit of light optics and therefore is useful for high-resolution imaging and analysis when specimens have been suitably prepared and mounted. VELM technique allows images to be produced at unusually high magnifications for light microscopy (20,000x on a 19" video monitor) while maintaining resolution. The images of living cells recorded in videotaped sequences, make qualitative and quantitative investigation of subcellular dynamics possible with ease and clarity not previously possible. The extraordinary detection (not resolution) capabilities of this technology, combined with measurement of digital RGB images using a microscanner (or through firmware resident in the VELM computer) allow structures and their motion (growth) to be measured at a remarkably small scale (down to the limit of pixel size, about 30 nm). Examples of the applications of VELM to fungal cell dynamics and measurements will be shown.

THE ROLE OF SATLLITE SPITZENKÖRPER IN THE DETERMINATION OF CELL SHAPE IN GROWING HYPHAL TIPS. C. E. Bracker and D. J. Murphy. Dept. Botany and Plant Pathology, Purdue University, W. Lafayette, IN 47907.

Dynamic changes in the shapes of the cell profiles of growing hyphal tips of Trichoderma viride were correlated with the frequency and migration rates of satellite Spitzenkörper. The satellites appeared to disturb the normal gradient of cell expansion that gives rise to a hyphal apex with the characteristic "hyphoid" shape. If a satellite paused or slowed down instead of migrating at its "normal" accelerating rate, the cell profile bulged outward adjacent to the location of the dwelling satellite, indicating that the satellite was responsible for localized cell expansion. Changes in satellite behavior were correlated with changes of shape in the hyphal apex, including hyphoid, hemispherical, flattened, and conical-tapered profiles. In several instances, satellites became the determinants of hyphal branch initiation. They interrupted their migration long enough to generate a discrete local bulge of the cell wall and then developed into a full fledged Spitzenkörper supporting a hyphal branch.


Over the past four years we have developed a suite of PCR-based techniques to identify the fungal components of ectomycorrhizae. We are currently using these tools in combination with various sampling schemes and manipulative studies to dissect the structure and function of ectomycorrhizal communities in Pinus muricata forests at Pt. Reyes National Seashore. Although species diversity is moderately high, and the particular species present vary from site to site two broad patterns have emerged: 1) The most frequent and abundant mycorrhizal fungi are usually generalists that appear to expend relatively little resource on fruiting; in this category, Russula spp. and a Tomentella sp. are among the most important at all sites studied to date. 2) Most other fungi appear to be relatively infrequent or low in abundance or both, but several in this group are the most abundant fruiters in these forests.

CHARACTERIZATION OF GAEUMANNOMYCES GRAMINIS MELANIN MUTANTS. T. Caesar-ToiThat, B. Frederick, T. Goins and J. M. Henson. Dept. of Microbiology, Montana State University, Bozeman, MT 59717 USA.

Gaeumannomyces graminis, a filamentous, soil Ascomycete, exhibited enhanced cell wall melanin accumulation when exposed to 0.01 mM CuSO4. Because its synthesis was inhibited by tricyclazole, melanin produced in response to copper was dihydroxynaphthalene (DHN). This study characterized mutants that are affected in melanization. Unmelanized mutants of G. g. var. graminis were more sensitive to CuSO4 and were as pathogenic as wild type strains on rice. Mutants of G. g. var. graminis and G. g. var. tritici with increased melanization were less pathogenic than wild type strains. An additional third hyphal wall layer, composed of DHN melanin, was present in mutants with increased melanin. A similar layer was observed in the wild type strain exposed to copper. In contrast, unmelanized mutants did not exhibit this third wall layer, even in the presence of copper. Atomic emission spectrometry (ICP-AES) was used to demonstrate copper binding by mutants. Mutants with increased melanization bound more copper than unmelanized mutants. These results suggested that melanin binds copper and protects the fungus from metal toxicity.
MOLECULAR TAXONOMY OF SPRUCE ENDOPHYTIC FUNGI. F. J. Camacho, D. S. Gernandt, A. Liston, J. K. Stone, and A. S. Klein*, Dept. of Botany and Plant Pathology, Oregon State University, Corvallis OR, 97331 USA.*Dept. of Biochemistry and Molecular Biology, University of New Hampshire, Durham NH, 03824 USA.

With the help of PCR and taxon specific primers, it is becoming easier to study symbiotic relationships. We have discovered fungal internal transcribed spacer one (ITS1) sequences that were accidentally PCR-amplified in a phylogenetic study of spruce. These fungal sequences were amplified from DNA of healthy spruce needles. The suspected origin of the ITS1 sequences is foliar endophytes. It is our goal to match the ITS1 sequences with their respective fungi. Over 100 fungal isolates have been cultured from surface sterilized spruce needles. The entire ITS of most of these species has been PCR-amplified. The four most closely related spruce fungal sequences were used to design an oligonucleotide probe specific to a region in the 5' end of spruce fungal sequences. This oligonucleotide is being hybridized to dot blots of original ITS sequences. We have PCR-amplified the ITS2 of these individuals. The ITS of these isolates will be sequenced in order to determine their relationship to the four most closely related spruce fungal sequences. At present three isolates have been identified by the probe. The ITS of these individuals will be sequenced in order to determine their relationship to the original ITS sequences.

PRELIMINARY PHYLOGENETIC STUDIES ON THE FAMILY HYALOSCYPHACEAE (LEOTIALES, DISCOMYCETIDAE, ASCOMYCOTINA). S. A. Cantrell and R. T. Hanlin, Department of Plant Pathology, University of Georgia, Athens, GA, 30602.

The family Hyaloscyphaceae includes saprobic organisms that are characterized by having hairs on the apothecia and ectal excipulum of textura prismatica. It is divided into five subfamilies. The purpose of the present study is to evaluate the possible relationships of the species within this family using morphological and molecular data. Analysis of 31 morphological characters using parsimony shows no clear distinction among the subfamilies. Sequence analysis from both internal transcribed spacer regions (ITS1 and ITS2) revealed that Lachnellula calyciformis (Lachnoideae) and Perrottia flamma (Perrotioideae) are closely related. In addition, Hyaloscypha aureiella (Hyaloscyphoidae) and Lachnum bicolor (Lachnoideae) contains an insertion (~400 bp) upstream of the 3'-end of the small subunit ribosomal DNA.


Endophytes within leaves of evergreen plants often occupy very limited infection domains. In these circumstances estimates of infection frequency based on sampling units large enough to be multiply infected could seriously overestimate overall infection frequencies and probably would be biased towards rapidly-growing combative fungi. To test these predictions all leaves on ten 15cm long stem segments of Linnaea borealis were removed, surface-sterilized, cut into 2mm² pieces, and placed in order on a medium containing cyclosporin - an antibiotic which greatly retards growth of many rampant endophytes. About 20 endophyte taxa were recovered from the total leaf sample. The commonest fungus proved to be an unidentified member of the Helotiales with an anomalous Aureobasidium-like anamorph. Also found were Phyllosticta, Phomopsis, Nodulisporium, Cryptosporiopsis, and a number of slow-growing isolates which may be degenerate strains of Xylariaeaceous fungi and Phomopsis. Within leaves species of endophytes showed aggregated distributions. Simulated subsampling of these leaves provided information on errors and biases associated with inappropriately large sampling units.

PHYLOGENY OF NUCLEAR SMALL SUBUNIT RIBOSOMAL RNA GENE INTRONS FROM PLASMODIOPHORA BRASSICAE. L. A. Castlebury* and L. L. Domier, Dept. of Plant Pathology, University of Illinois, Urbana, IL 61801 and USDA-ARS, Urbana, IL 61801.

*Current address: National Center for Toxicological Research, Jefferson, AR 72079

The nuclear small subunit ribosomal RNA (nsrRNA) genes of Plasmodiophora brassicae were determined to contain what appear to be three group I introns. Insertion sequences were found at positions 567 (388 bp), 1195 (383 bp), and 1786 (442 bp) of the nsrRNA genes and were not present in the reverse transcriptase PCR amplification product of the nsrRNA. Phylogenetic analysis of the insertions at positions 1195 (Pbs SS-12) and 1786 (Pbs SS-13) found that both grouped with introns located in the middle of the nsrRNA genes from several species of algae and fungi. This analysis suggests that Pbs SS-12 and Pbs SS-13 are more closely related to each other and to midposition nsrRNA introns than Pbs SS-13 is to 3' nsrRNA introns. This is in contrast to previous studies which have suggested that relationships among introns are correlated with position rather than species. Pbs SS-11 at position 567 does not appear to be closely related to Pbs SS-12 or Pbs SS-13.
Mexico, the U.S. and Canada are undergoing rapid changes, central to which is a pressing need for devising and implementing concepts of sustainability into economic practices. The fungi are key to sustainability in agricultural, forest and wild-land management. However, those persons essential to integrating modern mycology into sustainable development have yet to be brought together in a coherent forum. The goals of this workshop are to facilitate an exchange of ideas and experiences, analyze current practices, and chart future projects of mutual interest, concentrating on the role of mycology in sustainable development. Panelists will present each country’s perspective as well as regional concerns related to the following topics: Reclamation of Marginal and Derelict Land: mycorrhizae, bioreactors; Enlightened Natural Resource Management: nutrient cycling, non-timber forest products, monitoring and inventory of biological diversity; Environmentally Friendly New Technologies: biocontrol, recombinant symbiosis, endophytes; Diversification of Markets and Short-circuiting of Production/Consumer/Disposal Routes: edible mushrooms, bioprospecting.


Since the genus Ganoderma was established in 1881 with Polyporus lucidus (G. lucidum) as the type species, only two types of asexual spores have been described; chlamydospores, and basidiospores produced by monokaryotic fruiting. In subculturing a G. lucidum strain, a number of small colonies developed, in addition to the one from the inoculum. This observation led to the speculation that a form of asexual propagation may be involved. Microscopic inspection with bright field and SEM demonstrated microconidial formation by several strains from Asia and North America. These viable, whitish, subglobose microconidia, 0.2-2.0 microns or smaller, are formed in a row in association with staghorn hyphae of variable size. Formation of microconidia was also observed on the inner walls of the tubes in basidiocarps. The impact of microconidia on dissemination, culture preservation and breeding will be discussed.

SOME CHYTRIDS OF TAIWAN. S. F. Chen, and C. Y. Chien, Institute of Biological Sciences, National Taiwan Normal University, Taipei, Taiwan, R.O.C.

Ten species of monocentric chytrids were identified and illustrated. Nine species of them are reported as new to Taiwan. They are Rhizophydium chaetiferum, R. laterale, R. haynaldii, Rhizophlyctis variabilis, R. mastigotrichis, Phlyctochytrium planicorne, Chytriomyces hylainus, Catenochytrium carolinianum, Allocytridium expandens, and Entophlyctis confervae-gleromatae.

NATURAL OCCURRENCE OF SPORODINIELLA UMBELLATA (MUCORALES) IN TAIWAN. C. Y. Chien and B. C. Hwang, Institute of Biological Sciences, National Taiwan Normal University, Taipei, Taiwan, R.O.C.

During the course of an investigation of some mucoraceous fungi indigenous to soil of an old-growth forest in Taiwan, an entomogenic fungus was found twice and identified as Sporodinella umbellata. It has a conspicuous umbellate habit, each branch having a sterile spine and a single sporangium. It was growing on the dead insects Acraea issotia-formosana and Danaus plexippus. A description of the Taiwan collections and living cultures derived from a newly collected specimen are provided, along with illustrations of taxonomically important structures. Artificial infestation of S. umbellata on larvae of mealworm (Tenebrio molitor) on corn meal agar at 24 C after 74hr was successful. The fungus produced a radial growth of young sporangiophores which emerged from tested worms.

NUCLEOTIDE SEQUENCE OF 5.8S rDNA AND ELECTROPHORETIC KARYOTYPE OF THE MUSHROOM VOLVARIELLA VOLVACEA. S. W. Chiu, M. J. Chen, W. M. W. Cheung, S. T. Chang and D. Moore, Dept. of Biology, The Chinese Univ. of Hong Kong, Shatin, N. T., Hong Kong and Dept. Biological Sciences, Univ. of Manchester, Manchester M13 9PT, U. K.

Volvariella volvacea is the most popular fresh mushroom in Hong Kong. This is the first report not only on the sequence of its 5.8S rDNA but also on its partial electrophoretic karyotype. The Volvariella 5.8S rDNA shares the highest homology with that of mushroom Lentinula edodes. Pulsed field gel electrophoresis reveals 9 chromosomal DNA bands of size ranging from 1.3 to 5.4 Mb. Densitometry scans of the karyograms reveal that 4 bands contained two co-migrating DNA molecules. The genome of the mushroom strain examined is estimated to be 35 Mb.

1995 MSA abstracts, page 8

Both calcium and manganese compounds are used during mushroom cultivation. The germination stage in both mushrooms were the most sensitive to the presence of either metal. Insoluble calcium carbonate stimulated vegetative growth whereas soluble calcium chloride at/above a certain dose inhibited. For renewed fruiting in vitro, addition of either metal even at low concentrations delayed fruiting. High doses of manganese killed the excised fruitbody tissues. For fruiting in vivo, the more the metal added, the longer the time taken for primordia to appear. Also, the crop yield was decreased, and the amino acid contents decreased with higher metal contents in the crop.


Epichloë species (Clavicipitales) are grass biotrophs and teleomorphic ancestors of seedborne mutualists (endophytes), many of which are interspecific hybrids. However, a potential barrier to interspecific hybridization between Epichloë species and anamorphs is vegetative incompatibility. This possibility was tested by complementation of nitrate non-utilizing (nit) mutants to assess the formation of intraspecific and interspecific heterokaryons. The nit mutants, obtained as sectors on medium with 4 % potassium chloride, were derived from ten isolates representing four Epichloë species. Each was putatively identified as nit1, nit3, or nitM by its growth phenotype on nitrate, nitrite, ammonium, hypoxanthine, or uric acid. All nit mutants grew sparsely and appressed on minimal medium containing nitrate as the sole nitrogen source. When appropriate nit mutants were paired, heterokaryon formation and complementation were indicated by vigorous, aerial mycelial growth on minimal medium with nitrate. Most isolates complemented each other even when from different species. There were no indications of incompatibility groups. Thus, vegetative compatibility between Epichloë strains and species appears common, and incompatibility appears rare or nonexistent in this genus. Heterokaryon formation and growth is probably important both in the Epichloë sexual cycle and in the evolution of interspecific hybrids.


A peptidic secondary metabolites, trichorizianines, obtained from Trichoderma harzianum were tested on mycelial growth of Sclerotium cepivorum. Bioassays were carried out to evidence the inhibitory activity of trichorizianines obtained by Sephadex LH20. The inhibitory activity of the peptide mixture was high and 100% of growth inhibition was observed at 500 µg/ml. This mixture which was, in turn, fractionated by silica gel chromatography resulted in two groups of trichorizianines (A and B/C). Trichorizianines types A and B/C at 100 µg/ml inhibited 75% and 40% respectively the mycelial growth of S. cepivorum. It was assumed that the inhibitory activity of peptide mixture which act on the membrane permeability could become fungicidal. Bioassays also shown that trichorizianines A inhibited the own mycelia of T. harzianum, which could be considered as an absence of immunity.


Virulence instability of the rice blast fungus [Pyricularia grisea (= Magnaporthe grisea)] has been the focus of a considerable amount of research worldwide. Virulence and MGR-DNA fingerprinting are being used to characterize population diversity of the rice blast pathogen in Arkansas. Extensive collections of field isolates from Arkansas indicate that four genetically distinct DNA fingerprint groups predominate in the contemporary population. Virulence diversity has been observed within DNA fingerprint group "B". Three isolates collected in 1975, 1992, and 1994 that belong to DNA fingerprint group "B" each have a distinct virulence phenotype. The 1994 isolate was virulent on the cultivar Katy, which was previously resistant to all known virulence phenotypes in Arkansas prior to 1992. Our working hypothesis is isolates in MGR-DNA fingerprint group "B" may be more genetically unstable with regard to virulence than isolates in some of the other DNA fingerprint groups identified.
A discrete aspen clone was sampled for ectomycorrhizal sporocarps over four years, in an area impacted by copper mining in Butte, Mt. Locations of sporocarps were noted and species identified. Ectomycorrhizal rootlets were sampled to determine if the above ground species reflected the abundance and distribution of species below ground. Over 94% of the mycorrhizae were identified by morphology and RFLP analysis, and 91% (excluding *Cenococcum*) were species which fruit. One fourth of the mycorrhizae were Paxillus vernalis which produced one sporocarp in 4 years. Fruitings exhibited a clustered "edge effect" at the canopy perimeter, in contrast to their mycorrhizae which were found throughout the stand. Explanations for the unusual vertical distribution of mycorrhizae to 48 cm, with few above 16 cm are discussed, along with disturbed site taxa such as *Inocybe lacera*, and *Laccaria laccata*.

**THE MYCOSPHAERELLA NUBILOSA COMPLEX OCCURRING ON EUCALYPTUS SPP. IN SOUTH AFRICA.** P. W. Crous, A. den Bree en, and M. J. Wingfield*, Dept. of Plant Pathology, Univ. of Stellenbosch, P. Bag X1, Stellenbosch 7602, South Africa; *Dept. of Microbiology and Biochemistry, Univ. of the Orange Free State, P.O. Box 339, Bloemfontein 9300, South Africa.

*Mycosphaerella* leaf blotch is an important foliar disease of *Eucalyptus* spp. in South Africa. Two *Mycosphaerella* spp., *M. molleriana* and *M. nubilosa*, have been reported from eucalypts in this country. Although *M. nubilosa* has been considered synonymous with *M. molleriana* in the past, recent studies have shown these species to be distinct. *Mycosphaerella nubilosa*, originally described from Australia, is associated with light brown circular lesions on juvenile leaves, and predominantly hypophyllous pseudothecia. Ascospores are not constricted at the median septum, are widest near the apex of the apical cell, and germinate with germ tubes parallel to the long axis of the spore. Several South African collections matching this description have been obtained from *E. bicostata* and *E. nitens*. However, based on their cultural characters and the fact that they have distinct anamorphs, these two collections differ markedly from each other and also from *M. nubilosa*. These findings suggest that at least two different species of *Mycosphaerella*, resembling but distinct from *M. nubilosa*, occur in South Africa.

**GENETIC VARIATION WITHIN THE CYLINDROCLADIUM FLORIDANUM PHENOTYPE.** P. W. Crous1, D. Victor2, M. J. Wingfield3, and B. J. H. Janse4, Dept. of 1Plant Pathology and 2Microbiology, Univ. of Stellenbosch, P. Bag X1, Stellenbosch 7602, South Africa; 3Dept. of Microbiology and Biochemistry, Univ. of the Orange Free State, P.O. Box 339, Bloemfontein 9300, South Africa.

*Cylindrocladium floridanum* is characterized by short, 1-septate, straight, cylindrical conidia and spheared-opedunculate vesicles. Isolates of *Calonectria kyotensis* (anam. *C. floridanum*), *Calonectria candelabra* (anam. *C. scoparium*), *Calonectria morganii* (anam. *candelabra*), *C. ovata* and *C. navicularum* were compared based on morphology, sexual compatibility, RAPD markers and RFLPs of genomic DNA. RAPD profiles of type cultures of the two acknowledged synonyms of *Calonectria kyotensis* (*C. floridanum*, *C. uniseptata*) shared 78-97% similarity, supporting their conspecificity. Matings type strains of the heterothallic species studied, also had high similarities (77% for *C. candelabra*, 92% for *C. morganii* and 99% for *C. ovata*). Canadian isolates of *C. kyotensis* shared only 12-45% similarity with the type strains, suggesting that they represent a distinct taxon. Similar results were also obtained when RFLPs for these fungi were compared. Isolates similar to *C. kyotensis* but with curved conidia had distinct RAPD and RFLP profiles, and shared less than 35% similarity with any of the species studied. These findings suggest that strains with curved conidia and spheroopedunculate vesicles represent an undescribed taxon.

**COMPARISONS BETWEEN SWEDISH CANTHARELLUS CIBARIUS AND CANTHARELLUS SPP IN THE PACIFIC NORTHWEST, BASED ON DIFFERENCES IN RFLP PATTERNS OF THE ITS REGION.** E. Danell, Dept. of Forest Science, Oregon State University, Corvallis OR, 97331-7501 USA.

The edible ectomycorrhizal mushroom *Cantharellus cibarius* is appreciated worldwide as a condiment. The decline in central Europe has been followed by increased research and import of fruit bodies from other parts of the world, e.g. Oregon and Washington. Differences between Swedish and Pacific Northwest (PNW) *C. cibarius* considering size, colour, texture, hosts and ability to grow on artificial media made additional molecular studies necessary to determine if they are in fact conspecific. Using PCR of the ITS region of rDNA, it was found that the ITS of Swedish *C. cibarius* was 1400 base pairs (bp), while PNW *C. cibarius* ITS was about 1600 bp. Restriction enzymes Mbo I, Hinf I and Hae III revealed distinct differences. Variation in RFLP patterns within PNW *C. cibarius* was not found, with the exception of a coastal fruit body under *Picea sitchensis* which had an RFLP pattern similar to Swedish *C. cibarius*. RFLP patterns of *C. subalbidus* was also different from PNW *C. cibarius*. No variation in RFLP patterns within *C. subalbidus*, including a yellow variety from Mt Hood, was found. The results in combination with earlier mentioned differences indicate that PNW *C. cibarius* might be a species different from Swedish *C. cibarius*. The study also supports the separation of *C. subalbidus* from PNW *C. cibarius*.
The shape of growing hyphal tips previously has been mathematically analyzed from published light and electron micrographs. However, determination of actual shape for analysis of patterns of tip growth should be done with hyphal tips that are demonstrably growing at a steady rate at the time the measurements are made. Furthermore, the measurements must be made at magnifications and with accuracy that is unattainable with images at conventional magnifications for light microscopy, with fixed cells, or with images of sections through the supposed median plane of preserved and embedded hyphae. We have used video-enhanced DIC optics, combined with digital processing of images at 6,000 to 20,000 and a digital microscaler, to measure cell diameters in the apical 50-100 μm of growing and chemically fixed hyphal tips of several taxonomically diverse fungi as a basis for calculating shape of the hyphal tip cell. The data were plotted against the idealized hyphoid shape described by the hyphoid equation. The results show a close correlation with the hyphoid equation for some hyphae, and considerable departure for others. These findings have helped us determine the limits of applicability of the hyphoid equation and to begin assessing factors which cause hyphae to depart from an ideal hyphoid shape.

This is an update on the status of our biotic survey of the Agaricales of the Hawaiian Islands. Over the past several years we have sampled in numerous habitats on six of the eight main islands (Ni’ihau and Kaho’olawe excluded), focusing on native forests, lowland alien forests and grasslands. Prior to our research, only 93 species of agarics had been reported from the Islands. To date, we have collected 251 species, belonging primarily to the Tricholomataceae (94), Coprinaceae (29), Agaricaceae (28), Entolomataceae (18), Cortinariaceae (17), Hygrophoraceae (12), and Crepidotaceae (12), with the remainder spread among 7 additional families. Of these species, only 16 (6%) are putatively mycorrhizal with introduced conifers, myrtaceous or fabaceous trees; none are mycorrhizal with native plants. Noticeably absent are Russulaceae and Gomphidiaceae. The remaining 235 species (94%) are saprotrophic or parasitic. Only 30 species (12%) are restricted to growth in native forests and are considered by us to represent native species; 24 of these are potentially endemic. The majority of species, 221 (88%), were most likely introduced following human occupation, along with the more than 4600 species of alien plants. We will speculate on why there are so few native Hawaiian mushrooms and present hypotheses on mushroom dispersal to and establishment on isolated oceanic islands.

The life cycle of Zygorhizidium planctonicum is characterized by a haploid, asexual infection stage and the formation of a sexual resting spore by means of gametangial conjugation. Nuclear fusion occurs within the recipient thallus and the resulting spore remains dormant in the diploid state. Dormancy is determined by both endogenous and exogenous factors; however, prolonged exposure to <10 C followed by activation at >10 C serves as the primary mechanism for activation. Resting spore germination is characterized by the emergence of a thin-walled meiosporangium through a single pore in the resting spore wall. Meiosis occurs shortly after germination and is in turn followed by sporogenesis and the release of haploid zoospores. Our findings provide the first account of zygotic meiosis in the Chytridiales. Mechanisms of spore dormancy further illustrate that resting spore germination is synchronized with annual host blooms.

1995 MSA abstracts, page 11
PHOTO-ACCUMULATION OF ALLOMYCES ZOOSPORES. Richard Ellis and Melissa Eash, Department of Biology, Bucknell University, Lewisburg, PA 17837.

In contrast to the wealth of information describing photo-induced cell movements in algae, very little is known about these behaviors in motile fungal cells. Robertson (1972) reported that the zoospores of Alomyces reticulatus are phototactic to both blue and green light. Sensitivity to green light is highly unusual and invites further study. A. reticulatus was grown in PYG broth and the zoospores were separated from thalli by passage through 8 layers of cheesecloth. Photo-accumulation was monitored at the population level and the technique validated using Euglena. Zoospore suspensions were challenged for 15 min with monochromatic light at 450, 480, 510, 540, and 570 nm at a variety of fluence rates. Resultant fluence rate-response curves are typically bell-shaped. Crude action spectra based on the quantities of light necessary for two response levels will be presented. Both indicate an absence of activity for 570 nm light and confirm the earlier finding that green light is effective. Weak accumulation peaks at 450 nm, strong accumulation is most responsive to 540 nm. These results will be compared with action spectra for taxis in other species. Finally, zoospores from dark-grown cultures are more sensitive than are zoospores from light-grown cultures to low fluence rate 450 nm light; the reverse is true in high fluence rates.

STRUCTURAL ANALYSIS OF A MEIOTICALLY UNSTABLE CHROMOSOME IN NECTRIA HAEMATOCOCCA. J. Enkerli1 and S. F. Covert2, 1Dept. of Botany, 2Warnell School of Forest Resources, University of Georgia, Athens GA, 30602 USA

Certain isolates of Nectria haematococca contain a meiotically unstable chromosome 1.6 Mb in length (B-chromosome). Previous karyotype analysis of genetic crosses suggested that specific regions of this chromosome are particularly susceptible to chromosome breakage during meiosis (Miao et al., 1991 Science 254: 1773 - 1776). Our goal is to test this hypothesis. Using a chromosome specific cosmid library and a hybridization protocol known as sampling without replacement, we are creating a contiguous cosmid map of this B-chromosome. When the map is complete, the chromosome specific cosmid library will be probed with a variety of deleted forms of the B-chromosome to identify breakpoints and missing fragments. In addition, to investigate its importance for the pathogenicity of N. haematococca on chickpea, we are attempting to disrupt the Mak1 gene. Mak1 is located on the 1.6 Mb chromosome and detoxifies the chickpea phytoalexin maackiain .
ULTRASTRUCTURAL AND IMMUNOCYTOCHEMICAL STUDIES OF COMPATIBLE AND INCOMPATIBLE INTERACTIONS OF SOYBEAN ROOTS WITH PHYTOPHTHORA SOJAE. K. Enkerli, C. W. Mims and M. G. Hahn. Depts. of Plant Pathology and Botany, Complex Carbohydrate Research Center, Univ. of Georgia, Athens GA, 30602.

Host-parasite interfaces in roots of susceptible and resistant plants inoculated with *P. sojae* were studied using TEM. Early events were similar in both compatible and incompatible interactions. Zoospore encystment, germination and host penetration occurred within 30 min. Aggregations of plant cytoplasm were found at infection sites and cell wall appositions were laid down adjacent to or opposite penetrating hyphae. By using antibodies against α-1,3 glucan and xylolucan, it was shown that the appositions consisted of callose and hemicellulose. Differences between susceptible and resistant plants were evident 4 to 11 h post inoculation. Cortical cells were necrotic in resistant plants but appeared healthy in susceptible plants. Extensive inter- and intracellular hyphal growth which never progressed into vascular tissue was observed in the incompatible interaction. In contrast, in the compatible interaction only intercellular growth was seen and the stele was heavily colonized. Haustoria formation only occurred in susceptible plants.

MODELING GENERATION TIME OF WHEAT LEAF RUST AS A FUNCTION OF LATENT PERIOD. M. G. Eversmeyer, and C. L. Kramer, USDA-ARS, 4007 Throckmorton Hall, Kansas State University, Manhattan, KS, 66506 USA.

The number of generations that wheat leaf rust has to increase from primary inoculum to final severity has decreased over the last several decades due to changes in cultivar maturity and other cultural practices. Functions have been developed to relate the effect of temperature, wheat growth stage, and level of cultivar resistance or susceptibility to latent period. Length of latent period was determined at seedling, heading, and early dough growth stages for cultivars with susceptible, intermediate, or resistant responses to different isolates of *Puccinia recondita f.sp tritici* at temperatures between 10 and 35 C. A function of hourly temperature was developed to predict number of generations that could be expected given the daily temperatures and expected cultivar response to the prevailing parasite population.

A MOLECULAR APPROACH TO THE PHYLOGENY OF THE CANTHARELLACEAE. T. P. Feibelman, R. L. Doudrick, W. G. Cibula, and J. W. Bennett. Tulane University, New Orleans, LA 70118; Southern Institute of Forest Genetics, USDA Forest Service, Saucier, MS 39575; and Stennis Space Center, MS 35929-6000.

The Cantharellaceae are a cosmopolitan and ecologically important family of ectomycorrhizal fungi. Although the members of the family have been well known for centuries as excellent edibles, the delimitations of the genera and species remains uncertain. Most species have been transferred repeatedly between the two main genera, *Cantharellus* and *Craterellus*. Representative species which are found on the Gulf Coast were used in this study. DNA was extracted from dried specimens, the 5' end of the nuclear 28S ribosomal gene was sequenced, and the sequences were compared. Sequence analyses showed that *Cantharellus* and *Craterellus* are distinct genera. The phylogeny generated suggests that *Cantharellus tubaeformis* and *Pseudocraterellus sinuosus* may be considered species of *Craterellus*. A reassessment of the morphological characters used to separate the genera, including the presence of clamp connections and secondary septa, is indicated.

BIOGEOGRAPHY OF TRUFFLES AND FALSE-TRUFFLES IN THE GREAT BASIN, USA. Robert Fogel. University of Michigan Herbarium, Ann Arbor MI 48109 USA.

The Great Basin (714,854 square km comprising most of the states of Utah and Nevada, plus portions of California, Idaho and Oregon) is an ideal "natural laboratory" for studies of truffle biogeography because of the historical factors affecting plant and animal distributions in the region. Several general patterns are starting to emerge from the on-going study. The larger forest islands are refugia for hypogeous fungi associated with upper montane and subalpine ectomycorrhizal trees, i.e., *Picea engelmannii*, *Pinus longaeva*, *P. flexilis*. A few hypogeous fungi have re-invaded the Great Basin with their ectomycorrhizal hosts in the post-pluvial period, i.e., *Pinus monophylla*, *P. ponderosa*, *Pseudotsuga menziesii*, *Abies concolor*, *Cercocarpus ledifolius*. Several false-truffles with "obligate" host requirements common just outside the Great Basin have apparently become locally extinct and have not been able to re-invade with their hosts. The low elevation oak forests of the Pine Valley Mountains, UT are refugia for a number of taxa. Host switching, a prelude to speciation, has been documented. Several undescribed taxa have been collected. Subalpine hosts, especially *Pinus longaeva*, have not been thoroughly collected.
New wood preservatives are tested by exposing treated and untreated wood to the elements and regularly checking for visible signs of decay. Wood exposed above ground generally decays more rapidly in the tropics than in temperate climates. To better understand the course of biodeterioration in these regions, wood decay fungi were collected from a test site near Hilo, HI as sporocarps or cultured from wood in various stages of decay. The site receives 3250-4000 mm of rain per year and has an average daily temperature of 25°C. Untreated wood exposed above ground decays within 12 to 18 months. The fungi collected include tropical taxa as well as taxa with wider distributions. Antrodia sinuosa, found throughout the Northern hemisphere, was among the most common species fruiting on and isolated from the test pieces. A list of species found and their wood decay capacities is presented.

The N. crassa arg-2 gene is negatively regulated by arginine (Arg) through mechanisms affecting the level of both mRNA and translation. A 24-codon upstream open reading frame (uORF) has been implicated in translational regulation. We isolated UV-induced mutations that affect this negative regulation by Arg. A single copy of an arg-2-hph fusion gene was transformed into N. crassa; expression of the reporter gene conferred arg-regulated hygromycin resistance. Following UV mutagenesis, 47 mutant strains were isolated that grew on media containing Arg and Hyg. One class of mutations appeared to affect only the expression of the arg-2-hph reporter gene. In one strain, hygromycin phosphotransferase activity was not Arg-regulated, and the mutation was tightly linked to the arg-2-hph locus in genetic crosses. Recovery and sequencing of the S' region of the arg-2-hph gene revealed that the uORF contained a missense mutation (D12N). Retransformation of this arg-2(D12N)-hph gene into N. crassa yielded strains showing unregulated Hph activity. The level of both arg2(D12N)-hph mRNA and Hph activity were increased. Examination of the distribution of arg-2(D12N)-hph mRNA on polyribosomes indicated that the D12N mutation affects the translatability of the fusion gene. The mutational analyses described here reveal the importance of the uORF peptide sequence for the regulation of arg-2 in response to Arg.

Eocronartium muscicola is a widely distributed heterobasidiomycetous moss parasite. Historically, Eocronartium and its tropical relative, Jola, have been theorized to be the progenitors of the Uredinales. Early attempts to culture Eocronartium failed, and details of its life cycle necessary for a comparison to rusts remain incomplete. Basidiospores of E. muscicola germinated on agar and formed mycelial colonies of white, densely spreading monokaryotic hyphae. Dikaryotic hyphae emerged from surface-sterilized moss branches onto agar and developed into a sparse, white mycelium. Ultrastructural characteristics of both the monokaryotic and dikaryotic cultures were identical to those of the fruitbody. On both cultures, an unreported Sporothrix-like anamorph developed. Conidia germinated by a germ tube or by repetitive conidial production. A similar anamorph is known in Jola javensis, further suggesting a close relationship between these taxa. Morphological, ultrastructural, and molecular data suggest a close affinity of E. muscicola and other phytoparasitic taxa to the Uredinales. The role of the conidial stage in Eocronartium's life cycle is unknown, as is the significance of the conidia in the evolution of rusts.

Homokaryons are alive and well in natural populations of the basidiomycete Heterobasidion annosum. M. Garbelotto, G. Slaughter, T. Popenuck, F. W. Cobb, and T. D. Bruns. Dept. of Environmental Science, Policy and Management, Univ. of California, Berkeley CA, 94720 USA.

Intensive sampling of the pathogenic fungus Heterobasidion annosum in 14 white fir mortality centers yielded up to 30% homokaryotic isolates. To assess the stability and virulence of homokaryotic isolates, as well as to gain information on the vegetative spread of this fungus, 4 homokaryons and 4 heterokaryons were individually and randomly inoculated on 200 roots from 50 mature trees. Roots were sampled after 4 and 12 months. Over 90% of the isolates retrieved were somatically compatible to the isolates originally inoculated. Homokaryons were not heterokaryotized. No significant growth difference was observed between homokaryons and heterokaryons. Other results regarding the rate, direction, and seasonal variation of fungal spread, as well as the correlation between the rate of spread and root diameter were obtained. These results can be used to better understand the epidemiology of this pathogen.
MULTIPLE ORIGINS OF LICHEN SYMBIOSES IN FUNGI SUGGESTED BY SSU rDNA PHYLOGENY.
Andrea Gargas1,2, Paula T. DePriest1,2, Martin Grube2, and Anders Tehler3, 1Department of Botany, NHB-166, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560, U.S.A., 2Institut fuer Botanik, Holteigasse 6, 8010 Graz, Austria, 3Botaniska Institutionen, Stockholms Universitet, S-106 91, Stockholm, Sweden.

Phylogenetic hypotheses provide a context for examining the evolution of heterotrophic lifestyles. The lichen lifestyle, the symbiotic association of fungi with algae, is found in various representatives of the Dicaryomycota -- Ascomycetes and Basidiomycetes. A highly resolved parsimony analysis of small subunit rDNA (SSU rDNA) sequences, suggests at least five independent origins of the lichen habit in disparate groups of Ascomycetes and Basidiomycetes. Lichen associations arose from parasitic, mycorrhizal or free-living saprobic fungi, implying that neither mutualisms nor parasitisms represent endpoints in symbiont evolution.

THE EFFECT OF AIR DUCT SANITATION ON FUNGAL POPULATIONS IN RESIDENTIAL ENVIRONMENTS:
PHASE I, WINTER; PHASE II, SUMMER. R. A. Garrison, B. S.; L. D. Robertson, M. S., B. S., S. R. Wynn, M. D., R. D. Koehn, Ph. D. Route 1, Box 182, Jewett, Texas, USA 758461.

Eight residential heating, ventilation-air-conditioning (HVAC) systems in six homes, and seven HVAC systems in 5 homes, for Phase I and Phase II, respectively, were sampled to determine fungal colony forming units (CFUs) prior to and after HVAC sanitation procedure. Posttreatment sampling was performed 48 hr and then weekly after sanitation. Eight weeks after sanitation, the study houses demonstrated an overall CFU reduction of 91.6% for Phase I and 84.4% for Phase II. No significant change in CFU values were observed for the houses selected as controls. These data indicated that HVAC sanitation, as defined by the combination of duct cleaning, application of a disinfectant, duct sealing, and the installation of an electrostatic filter, is effective in reducing airborne fungal populations in residential environments.

LOSS OF MEIOSIS IN ASPERGILLUS. David M. Geiser, William E. Timberlake, and Michael L. Arnold, Department of Genetics, University of Georgia, Athens, GA 30602 USA.

Most Aspergillus species are not known to produce meiotic spores and propagate in a strictly mitotic fashion. Meiotic and strictly mitotic Aspergilli are often morphologically similar, suggesting multiple independent losses of meiosis in the genus. Many strictly mitotic species retain characters that may be vestiges of a meiotic state, including the production of sclerotia, sclerotium-like structures, Hülle cells, and heterothallism. We tested the hypothesis that meiosis has been lost several times independently in Aspergillus by inferring phylogenetic relationships among meiotic and strictly mitotic taxa, using DNA sequences from the mitochondrial small ribosomal subunit, the nuclear internal transcribed spacers, and the nuclear 5.8S ribosomal gene. Over 950 bp of sequence was analyzed in each taxon. Both data sets show at least four independent losses of meiosis in the genus. These results suggest that strictly mitotic lineages arise frequently from older meiotic lineages in Aspergillus. There are many well-characterized Aspergillus genes with pleiotropic effects on ascospore production, suggesting that there are potentially many means by which meiosis is lost.

VEGETATIVE COMPATIBILITY OF FUSARIUM OXYSPORUM ISOLATES FROM ROOTS OF DISEASED DOUGLAS-FIR AND PONDEROSA PINE SEEDLINGS. D. S. Gernandt, K. M. Dennis, and J. K. Stone, Dept. of Botany and Plant Pathology, Oregon State University, Corvallis OR, 97331 USA.

Fusarium oxysporum was isolated from surface sterilized root tissue of diseased conifer seedlings from two nurseries in Bend and Medford, Oregon. Complementary nit-mutants representing 21 isolates were generated and paired to determine patterns of vegetative compatibility. Three multiple-member groups were found as well as 11 single-member groups. One three-member group was comprised of isolates from both host genera, and a second was comprised of four isolates from Douglas-fir. A single isolate from ponderosa pine exhibited weak complementation with the Medford Douglas-fir group. The results suggest that vegetative compatibility groups need not be specific to a single host. DNA-based molecular markers are being used to better characterize clonal relationships.
EVOLUTIONARY ANALYSIS OF THE B1 GENE WITHIN THE A MATING-TYPE OF COPRinus CINEREUS. Paul T. Gieser and Georgiana May, University of Minnesota, Twin Cities Campus, St. Paul MN, 55108 USA.

Self-incompatibility mechanisms prevent inbreeding in many organisms, including fungi. While of great importance to the organism’s evolution, little is known about the forces acting upon the genes controlling self-incompatibility. I am studying self-incompatibility in the basidiomycete Coprinus cinereus to better understand how self-incompatibility genes evolve. In this fungus, self-nonself discrimination occurs sub-cellularly to determine mating compatibility for sexual reproduction. This sub-cellular mechanism is governed by mating-type genes. To better understand how this mechanism operates in C. cinereus, I am studying the evolution of the b1 mating-type gene. As inbreeding (self-mating) does not occur, a region of the b1 gene product must provide a means to discriminate between self and non-self. Also since natural selection favors outcrossing (nonself-mating), a large number of different b1 alleles exist in natural populations. My work examines how b1 has evolved at the molecular level by comparing the sequences of several native b1 alleles, along with functional studies of artificial b1 alleles (chimeras) constructed in vitro. The results suggest how certain changes may allow for discrimination of self versus nonself for mating compatibility and provide for a better understanding of how selection can produce extreme variation in b1, yet still maintain identical function for self-incompatibility.


The sectional classifications within Acremonium distinguish the grass endophytes (sect. Albo-lanosa) from nonendophytic species such as A. alternatum, the type of the genus. To examine the validity of sect. Albo-lanosa, rDNA sequence comparisons were performed using ITS regions and a portion of the 18S gene region. The ITS sequences supported the monophyletic nature of the endophytes, but the endophytes proved difficult to compare to the nonendophytes as a result of the highly divergent ITS regions. However, the conserved 18S gene subsequently showed that endophytes are indeed distant from nonendophytic Acremonium species and are distinctly situated near Balansaia (=Ephelis) within the Clavicipitales. Some of the nonendophytic Acremonium species constitute a sister group to the Clavicipitales, suggesting an evolutionary affiliation to the Hypocreales. The connection to Ephelis anamorphs and the distant relationship to nonendophytic Acremonium species strongly suggest that a more phylogenetically appropriate genus is needed for the asexual grass endophytes.

Biodiversity of arbucular mycorrhizal (AM) fungi associated with mesquite at alkaline, saline sites in southwestern U.S.A. S. Goodnight, J. C. Stutz, C. A. Martin, Dept. of Botany, Arizona State University, Tempe AZ, 85287 USA.

Although plants in alkaline, saline environments are often colonized with AM fungi, surveys of these environments have found low AM spore numbers and diversity. In this study, the successive trap culture technique was used to induce sporulation of non-sporulating AM fungi from this type of soil. Rhizosphere soil from Prosopis pubescens and P. glandulosus var. Torreyana was collected from four sites in the Sonoran and Chihuahuan deserts in Arizona, California and Texas. Root colonization varied from 6.7%-20.6%. AM fungal communities were trapped from each site using sudangrass as a host for two propagative cycles. Species richness at all sites was greater than had previously been reported. Species in the family Glomaceae predominated. AM species isolated include Glomus etunicatum, G. intraradices, G. macrocarpum, G. microaggregatum, G. mosseae, Acaulospora trapezi, and a previously unreported Glomus species. Many of these species were found to be present in all four sites.

AN EVALUATION OF THE ENDOMYCORRHIZAL STATUS OF CROPS ON AN ORGANIC FARM AND COMPARISONS WITH CONVENTIONALLY GROWN PLANTS. C. M. Gruhn and K. M. McMurray, Dept. of Biology, Nazareth College of Rochester, Rochester NY 14618.

Endomycorrhizal colonization, rhizosphere pH, phosphorus (P) level, and spore numbers were determined throughout the growing season in a variety of vegetable crops collected on an organic farm in western New York. The farm has used only organic methods of fertilization and pest control for the past fifteen years. Similar samples were made from nearby vegetable farms using more conventional farming methods. Results from the first growing season show extremely low soil P and extensive endomycorrhizal colonization in crops grown using organic methods. Significantly greater colonization was observed in organically grown vegetables, possibly due to the higher soil P of the conventionally grown crops. Colonization decreased as the growing season progressed in all the annual crops sampled but not in carrot, a biennial. The presence of weeds appears to increase mycorrhizal colonization in some crops. Data from this on-going study will be used to determine crop rotations and other cultural practices to enhance endomycorrhizal colonization in organic agriculture.
REGULATION OF NITRATE REDUCTASE ACTIVITY IN SPOROSORIUM RELIANUM. M. Gunasekaran, R. Yang, S. Gunasekaran, and M. Imbayagwo. Department of Biology, Fisk University, Nashville TN, 37208 USA.

Nitrogen is one of the major elements required for all living organisms for their growth and survival. The enzyme, nitrate reductase (NR; EC.1.6.6.2.) catalyzes the reduction of nitrate to nitrite, the initial step in the assimilatory reduction of nitrate to ammonia. We have studied the regulation of nitrate reductase from a plant pathogenic fungus Sporosorium relianum that causes head smut in sorghum. The fungus was grown in Czapek-Dox broth containing sodium nitrate (35 mM) as the sole nitrogen source, at room temperature for various growth periods. At the end of incubation, cells were harvested, washed and growth was measured. NR activity was measured from the cell free homogenate. Among the different forms of nitrogen tested, only NO3 induced the NR whereas others such as ammonia, glutamate and urea repressed the NR activity. NO2, hydroxylamine and hydrazine were toxic to cells. Complex media such as potato dextrose broth and Sabouraud dextrose broth supported profuse growth but very little enzyme production. Our results also indicate that NO3 is essential for NR induction and transfer of NO3 grown cells to ammonia, results in rapid reduction in NR activity. On the other hand, repression caused by ammonia can be derepressed by NO3. (Supported by grants from HHMI-71194-527802 and W.K. Kellogg Foundation - P0010125).

THE ENVIRONMENTAL SCANNING ELECTRON MICROSCOPE AS A TOOL FOR THE BIOLOGIST. T. A. Hardt, ElectroScan Corp., Wilmington, MA, 01887 USA.

While environmental scanning electron microscopy is a relatively new technology, the use of the Environmental Scanning Electron Microscope (ESEM) is rapidly growing worldwide. The key to the ESEM's success is the ability to use virtually any gas around the sample, especially water vapor. This allows for the imaging of not only unprepared samples, but even live samples directly. Plant tissues, plant seedlings, molds, fungi, insects and bacterial cultures have been imaged and kept alive after exposure to the electron beam.

PHYLOGENETIC RELATIONSHIPS WITHIN SARCOSCYPHA (FRIES) BOUDIER (PEZIZALES, ASCOMYCOTINA) BASED UPON NUCLEOTIDE SEQUENCES FROM THE NUCLEAR RIBOSOMAL DNA ITS REGION. F. A. Harrington and Daniel Potter*. L.H. Bailey Hortorium, Cornell Univ., Ithaca, NY 14853; *Bigelow Lab for Ocean Sciences, McKown Point, West Boothbay Harbor, ME 04575.

Gene sequences from the internal transcribed spacer (ITS) region of the nuclear ribosomal DNA (including the 5.8S ribosomal RNA gene and the flanking ITS1 and ITS2 regions) were used as evidence of phylogenetic relationship among the species of the scarlet-cup fungus genus Sarcoscypha (Fries) Boudier. Of the 646 nucleic acid sequence characters obtained, 144 were phylogenetically informative. Thirty-one isolates representing all (8) species and the outgroup taxa Pithya and Phillipsia were sequenced. The consensus cladogram is consistent with the exclusion of species S. striatispora and S. vassiljevae. Morphological characters also support excluding these taxa from Sarcoscypha. Both species require further study. The species of Sarcoscypha were grouped into two major clades, however, these clades do not correspond to two geographical areas. Both clades include taxa from North America, Europe and Asia. There is support for the delimitation of 4 new species.

1995 MSA abstracts, page 17
MATING TYPE SWITCHING AND SELF-FERTILITY IN *CERATOCYSTIS*. T. C. Harrington and D. M. McNew, Department of Plant Pathology, Iowa State University, Ames, IA, 50011 USA.

Many species of *Ceratocystis* have a form of homothallism in which both self-fertile and self-sterile progeny are recovered from a selfing in a 1:1 or greater ratio. In *C. fimbriata*, *C. virescens*, *C. laricicola*, *C. polonica* and *C. coerulescens*, homothallism appears to be due to uni-directional mating type switching in which MAT-2 strains give rise to both MAT-1 and MAT-2 progeny. Hermaphroditic MAT-2 strains are capable of selfing, whereas MAT-1 strains are always self-sterile. Some mutants with the MAT-2 mating type produce no or few protoperithecia, and these mutants must be paired with MAT-1 strains to produce ascospores. Generally, MAT-2 (self-fertile) progeny from a selfing grow faster than the MAT-1 (self-sterile) progeny, suggesting that the mating type switching involves loss of a chromosomal segment containing genes other than MAT-2. A low level of interfertility is seen in interspecific crosses among the homothallic species, an undescribed heterothallic species from *Eucalyptus*, and the putative asexual fungus *Chalara australis*. The MAT-1 and MAT-2 alleles of these taxa complement in interspecific crosses. All progeny from selfings of *C. moniliformis* and *C. adiposa* are self-fertile, suggesting another mechanism of homothallism.

DO COMPETITIVE INTERACTIONS AND ABIOTIC CONDITIONS SHAPE A FUNGAL COMMUNITY? L. K. Hawkins, Dept. of Biology, Pennsylvania State Univ., Mont Alto, PA 17237 USA.

Granivorous heteromyid rodents have interacted with graminicolous fungi for 10 million years. It is not yet clear if this symbiosis has positive or negative effects on the rodents or the fungi. The microfungal communities of the desert soils and associated with the rodents differ consistently in species composition and abundance, even though both microhabitats are accessible to dispersing fungi. I experimentally evaluated competitive interactions among the fungi under thermal conditions mimicking the soil or rodent burrow environments. These experiments indicate some of the fungi associated with the rodents benefit by living under the thermal conditions in the rodent burrows. Much additional information is required before this symbiosis can be classed as a mutualism, commensalism, or parasitism.

SEASONALITY OF AGARICS IN NATIVE RAINFORESTS OF HAWAII. D. E. Hemmes and D. E. Desjardin, Dept. of Biology, University of Hawaii at Hilo, Hilo HI, 96720 and Dept. of Biology, San Francisco State University, San Francisco CA, 94132.

Species of *Collybia*, *Hygrocybe*, *Pholiota*, *Galerina* and *Marasmiellus* were chosen as representative members of the Agaricales inhabiting the native rainforests of Hawaii. Measured trails in three forest sites, Puu Makaala, a montane wet ohia/napu'u forest, Kahaualea, a montane wet ohia forest, and kipukas along the Saddle road on the Big Island of Hawaii, a montane mesic ohia forest, were visited every third week for a period of three years and the relative number of fruiting bodies of each of these groups was quantified. Species within these genera appear at low levels throughout the year but show dramatic increases from July through December. The fruitings could be correlated with heavy rainfalls after prolonged dry periods.

SPATIAL AND TEMPORAL PATTERNS OF FUNGI INHABITING RODENT DENS. Jose Herrera, C. L. Kramer and O. J. Richman; Division of Biology; Kansas State University; Manhattan, Kansas 66506.

Populations of microfungi that inhabit food caches of three rodent species in two different environments: white-throated woodrats and banner-tailed kangaroo rats in a New Mexican desert, and eastern woodrats in the Flint hills of Kansas were studied to show spatial and temporal variations. Six adjacent core dens and individual dens at geometrically increasing distances up to 3.2 km along a transect from the core dens were sampled. Samples from the caches were washed to remove externally contaminating spores. Organic fragments were removed and incubated on nutrient agar. In addition, wire mesh wrapped milo seeds were placed in all dens. Fungi emerging from the fragments and seeds were isolated, identified, enumerated and ecological indices calculated. Results suggest that: 1) diversity is governed primarily by type and number of substrates; and, 2) diversity appears to increase quickly, then decrease slowly over time in both arid and mesic habitats.
We performed phylogenetic analyses of internal transcribed spacer sequences (ITS) of nuclear ribosomal DNA from 24 isolates of shiitake (*Lentinula edodes* sensu lato) from across Asia and Australasia. Results suggest that shiitake includes at least four distinct lineages. This conflicts with previous distance analyses of mitochondrial gene trees with mitochondrial sequence data. Geographically separated, genetically distinct lineages of shiitake should be targeted for conservation. Significant threats to indigenous shiitake populations include habitat loss through deforestation as well as contamination by exogenous genotypes originating from mushroom farms.

**TOLYPOCLADIUM NIVEUM, ANAMORPH OF CORDYCEPS FACIS.** Kathie T. Hodge and Stuart B. Krasnoff, Dept. of Plant Pathology, Cornell University, Ithaca, NY 14853 and USDA-ARS, PPRU, Tower Rd. Ithaca NY 14853.

The anamorph species *Tolypocladium niveum* (O. Rostrup) Bissett (= *T. inflatum* W. Gams) is an important fungus of cold soils and is capable of killing a range of arthropods in laboratory assays. *Tolypocladium niveum* also produces two important secondary metabolites: cyclosporins are valuable immunosuppressant agents and efrapeptins are powerful mitochondrial ATPase inhibitors. We report the first telemorph connection for *Tolypocladium*: isolated part ascospores of the clavicipitalean fungus *Cordyceps facis* Y. Kobayashi & D. Shimizu yielded an anamorph attributable to *T. niveum*. The morphology of the telemorph and its anamorph will be discussed, and the results of analyses of secondary metabolites will be compared to other isolates of *T. niveum* and other *Tolypocladium* species.

**ASSOCIATION OF MORPHOLOGY AND MYCOTOXIN FORMATION WITH VEGETATIVE COMPATIBILITY GROUPS IN ASPERGILLUS FLAVUS, A. PARASITICUS, AND A. TAMARII.** B. W. Horn. National Peanut Research Laboratory, USDA/ARS, Dawson GA, 31742 USA.

Isolates of *A. flavus*, *A. parasiticus*, and *A. tamarii* were obtained from soil and peanut seeds from a peanut field. Vegetative compatibility groups were determined by pairing complementary nitrate-nonutilizing mutants on a nitrate medium. Diversity of vegetative compatibility groups, expressed as the number of groups divided by the total number of isolates, was greatest for *A. flavus* (0.56) followed by *A. tamarii* type B (0.31), *A. parasiticus* (0.22), and *A. tamarii* type A (0.15). Vegetative compatibility groups in all species were associated with morphological differences in conidial pigmentation and production of sclerotia. Concentrations of the mycotoxins aflatoxin, cyclopiazonic acid, and kojic acid were also associated with specific vegetative compatibility groups.

**ECTOMYCORRHIZAL FUNGI SIMULTANEOUSLY ASSOCIATE WITH TWO PLANT SPECIES IN MIXED STANDS.** T. R. Horton, and T. D. Bruns. Dept. of Environmental Science, Policy and Management, University of California, Berkeley CA, 94720 USA.

Pure culture synthesis and fruiting patterns indicate fungal symbionts may associate simultaneously with two plant species in mixed stands. However, direct demonstration of shared symbionts in natural settings has been impeded because of difficulties in identifying fungal species directly from mycorrhizal root tips. We are using ITS-RFLPs to identify symbionts of field collected mycorrhizae from two sites in Marin county, California. Sampling at both sites involves collecting intermingling roots of the two species. At site one, we have identified several mycorrhizal fungi associating with both mature *Arctostaphylos glandulosa* and *Pseudotsuga menziesii* seedlings. These fungal species form both arbutoid and classical ectomycorrhizal morphologies. At site two, several fungi associate with *P. menziesii* and *Pinus muricata* in mixed stands. At both sites, common and abundant fungi associate with both plant hosts and include species in the Russulaceae and Thelephoraceae. These data demonstrate a high probability that fungal individuals simultaneously associate with plants of different species when their roots intermingle. More generally, these results contribute to our understanding of fungal and plant communities.
DIFFERENTIATING INTERSPECIES HYBRIDS OF ASPERGILLI BY RAPD ANALYSIS AND ELECTROPHORETIC KARYOTYPING. J. Hothersall and J. F. Peberdy. Department of Life Science, University of Nottingham, Nottingham NG7 2RD, United Kingdom.

Interspecies hybrids of auxotrophic mutants of the filamentous fungi Aspergillus nidulans and A. rugulosus were produced by polyethylene glycol induced protoplast fusion. Haploidization of prototrophic fusion products by exposure to benomyl containing medium resulted in the formation of haploid segregants. The aim of this investigation was to assess the suitability of randomly amplified polymorphic DNA (RAPD) and electrophoretic karyotyping in distinguishing interspecific hybrid haploid progeny from their parents. Several 10-mer oligonucleotide primers which gave unique RAPD profiles for the parental species were used to analyse ten segregants. RAPD profiles different to those of either parent were generated demonstrating that recombinant hybrids had been isolated through an induced parasexual cycle. Electrophoretic karyotypes were established by pulsed field gel electrophoresis using the CHEF DRII system. Unique karyotypes were obtained for the parental species: A. nidulans was separated into six chromosomal mobility groups and A. rugulosus into five, in both cases some groups probably contain more than one chromosome of similar size. Six segregants karyotyped to date indicate chromosomal reassortment has occurred. These results demonstrate both techniques to be valuable in the differentiation of interspecies hybrids.

BASIDIOMYCETES ASSOCIATED WITH BARK AND AMBROSIA BEETLES (COLEOPTERA: SCOLYTIDAE). Portia T. W. Hsiau and T. C. Harrington, Dept. of Plant Pathology, Iowa State Univ., Ames, IA, 50011 USA.

A few Scolytidae have been closely associated with basidiomycetes, which may provide a nutritional benefit to the developing brood in conifer stems or branches. One of four such fungi was placed in the monotypic genus Entomocorticium; E. dendroctoni was described from the pupal chambers of the mountain pine beetle (Dendroctonus ponderosae). Holtermanniia corniformis was identified from the mycangium of the ambrosia beetle Pityoborus comatus. Unidentified basidiomycetes have been associated with the mycangia of the southern pine beetle (D. frontalis) and the western pine beetle (D. brevicomis). Sequences were determined for rDNA from the nuclear small subunit, the large and small mitochondrial subunits, and the internal transcribed spacer. Comparisons using other databases suggest that the four fungi form a single clade within the genus Peniophora (Corticiaceae). Extra-cellular phenoloxidase activity in the beetle associates indicates that they are white-rot fungi, as are Peniophora species. The beetle-associated fungi appear to be very closely related members of the Corticiaceae. The identification of the P. comatus isolate as the tremellaceous H. corniformis appears to be in error.

SPECIES OF SACCARDOELLA (PLEUROTREMATACEAE) KNOWN FROM THE TROPICS. S. M. Huhndorf, Department of Botany, Field Museum, Chicago, IL, 60605-2496 USA.

Eight species of Saccardoella occur in tropical regions and five are known from temperate areas. Most of the species have large, stoutly papillate, often clypeate ascomata and are immersed, often at an oblique angle, becoming erumpent from old wood or periderm. But two species are found immersed in the petioles of Heliconia leaves with the asci oriented parallel to the leaf surface. All the species in the genus have distinctive long cylindrical, unistomate asci and uniseriate, hyaline, fusiiform ascospores with three-to-numerous septa and lens-shaped, cellular lumen. All of the species have some type of fluorescent structures in the ascus apex. The tropical species are described and illustrated and a key to all species is provided.


A microbiological survey was conducted in one office building after water intrusion during a summer weekend of 1994, to detect the microbiological proliferation in these offices and to provide recommendations for managers. Frequent flooding had occurred in these offices due to the overflow of the air handling unit (AHU) located on the floor above. Musty and moldy odor was detected in several offices. Condensate drip pans were hung in corridors and offices to collect water from the ceiling. Visible fungal growth was detected on baseboard. Paint on wall was peeling off, ceiling material had fallen, carpet was soaked, and electric short circuit occurred. In this survey, the offices and the AHU were inspected for water damage and visible fungal growth. Bioaerosol (Andersen N-6 sampler, 28.3 L/min.), surfaces, wipe, and bulk samples were taken from various locations for fungal and bacterial analyses. Relative humidity readings in those offices with water intrusion were higher than those without water damage. Penicillium and Aspergillus spp. were the dominant fungal species recovered from various surfaces. Recommendations were provided to clean and disinfect these offices and to permanently fix the AHU in order to prevent future water intrusion.


Hymenoscyphus crocatus (Mont.) K. S. Third & H. Singh and H. sclerogenus (Berk. & M. A. Curtis) Dennis are the only two species of the genus collected in the Guayan region (the Venezuelan states Bolivar and Amazonas, Guyana, Surinam, and French Guiana). Their taxonomy and the taxonomy and the distribution of related members of Hymenoscyphus reported in the Neotropics are discussed.

1995 MSA abstracts, page 20
Current classification schemes for *Lepiota* (sensu lato) range from a single enormous genus, possibly containing 1000 or more species, to as many as three tribes divided into 17 segregate genera. I am addressing the generic level classification within *Lepiota* s. 1. using phylogenetic approaches based on molecular sequence data to determine monophyletic groups. Representative taxa have been sampled from not only Europe and North America, but from Central and South America, since much of the species diversity occurs in the Neotropics. Preliminary results using nuclear ribosomal DNA (large subunit) sequence data suggest that *Lepiota* s. 1. is paraphyletic, and that several segregate genera are also phylogenetically problematic.

Plants and arbuscular mycorrhizal (AM) fungi are inextricably linked evolutionarily, physiologically, and ecologically. Experiments indicate that there are feedbacks between populations of plants and AM fungi. These feedbacks may play a role in structuring both plant and AM fungal communities. Exchange of limiting resources are likely to be important to the mechanism of this reciprocal control. For plants, the limiting resources exchanged include a variety of mineral nutrients, or even water. However, for the fungi, the critical limiting resource is always reduced carbon. Taxa of AM fungi appear to differ in their utilization of, and influence on, plant carbon allocation. A better understanding of the carbon relations of AM fungi may provide insights into the mutualistic differences among taxa. This information is a prerequisite for effective inoculation programs.

The asexual genus *Symbiotaphrina* contains two species of yeast-like fungi that exist in nature strictly as gut endosymbionts of anobiid beetles (Coleoptera:Anobiidae). The yeast cells mediate a range of detoxification reactions that facilitate the ability of their beetle hosts to feed on xenobiotic substrates. The phylogenetic affinities of *Symbiotaphrina* have been debated for nearly a century. The genus has been placed within *Taphrina* on the basis of gross morphological and physiological similarities to the anamorph states of *Taphrina*. However, several workers have proposed placement within the genus *Candida*, a view supported by the fact that other yeast-like beetle endosymbionts resolve phylogenetically within Saccharomycetales. We have inferred the phylogenetic position of *Symbiotaphrina buchneri* and *S. kochii* by cladistic analysis of ssrDNA sequences. These analyses do not support either of the previously proposed relationships for the genus, but rather place *Symbiotaphrina* as a monophyletic group within the early radiation of filamentous ascomycetes. The closest mycelial relatives of *Symbiotaphrina* remain obscure, but exclusion of the genus from Saccharomycetales implies that anobiid beetles have evolved similar endosymbiotic relationships with yeasts from distinct ascomycete lineages.

Dimorphism, the ability to grow as either a unicellular or a multicellular organism, is one of the hallmarks of the fungi. The ascomycete yeasts *Saccharomyces cerevisiae*, *Schizosaccharomyces pombe*, and *Saccharomycodes ludwigii* when cultured on complete medium (YPD) develop into round colonies with smooth margins that have a topological dimension of one. These same species when cultured on nitrogen-limited medium (SLAD) develop into colonies with an irregular margin that have a fractal dimension of ~1.2. The irregular colony outline in nitrogen- limited medium is caused by a transition from unicellular yeast growth to multicellular pseudohyphal growth. Initially, yeast colonies on nitrogen- limited medium resemble those on complete medium. But, as the local nitrogen supply is depleted, pseudo- hyphae form and a dimension greater than one but less than two is produced. The fractal dimension of yeast colonies on nitrogen- limited medium is typical of other biological structures adapted for absorption.
Secondary metabolites have been used as one criterion to place *Aspergillus* spp. into taxonomic groups called Sections. Aflatoxin (AF) and sterigmatocystin (ST) are two toxic secondary metabolites produced by a number of *Aspergillus* spp. found in Sections Fumigati (ST), Nidulantes (ST), Versicolores (ST) and Flavi (AF). We have determined that *A. nidulans*, Section Nidulantes, possesses a ~60 Kb gene cluster containing at least 20 genes proposed to encode both enzymatic activities and regulatory proteins necessary for ST biosynthesis. It appears that all but the two final enzymatic activities needed for making AF are present in the ST cluster. The ST cluster activities include a transcription factor (aflR), a polyketide synthase, an a fatty acid synthase (FAS), a b FAS, 6 mono-oxygenases, 1 esterase, 2 dehydrogenases, 1 methyltransferase and a ketoreductase. We have shown the ketoreductase and aflR to be regulated and to function in the same manner in *A. nidulans*, *A. flavus* and *A. parasiticus*; the latter two species members of Section Flavi. This data suggests that a ST/AF gene cluster is conserved throughout several diverse *Aspergillus* sections.

**SYSTEMATICS OF A BASIDIOMYCETOUS YEAST, TRIMORPHOMYCES PAPILIONACEUS, BASED ON THE SEQUENCE ANALYSIS OF THE CYTOCHROME B GENE OF MITOCHONDRIA.** Y. H. Kim, Y. W. Kang, and H. S. Jung, Department of Microbiology, College of Natural Sciences, Research Center for Molecular Microbiology, Seoul National University, Seoul 151-742, Korea.

The DNA sequence of the cytochrome b (cob) gene region of the mitochondrial DNA from a basidiomycetous yeast, *Trimorphomyces papilionaceus*, has been determined. The cob gene is interrupted by a group IB intron of 1267 bp, which has an open reading frame of 893 bp. The predicted amino acid sequence shows 52 - 60 % homology with those of previously reported fungi. The phylogenetic relationships of *T. papilionaceus* with *Neurospora crassa*, *Podospora anserina*, *Aspergillus nidulans*, *Saccharomyces cerevisiae*, *Schizosaccharomyces pombe*, and *Homo sapiens* were inferred through sequence alignment and homology comparison of amino acids deduced from cob genes. When *Homo sapiens* was set as an outgroup, two ascomycetous yeasts *S. cerevisiae* and *S. pombe* made one group and three ascomycetous fungi *N. crassa*, *P. anserina*, *A. nidulans*, and the basidiomycetous fungus *T. papilionaceus* the other group, the branch distances of the phylogenetic tree suggesting that the former group evolved first and then the latter group separated into ascomycetous and basidiomycetous fungi right after that.

**ULTRASTRUCTURAL EVIDENCE FOR PLACING BARSSIA IN THE HELVELLACEAE (PEZIZALES).** J. W. Kimbrough and Li-Tzu Li, Department of Plant Pathology, Box 110680, University of Florida, Gainesville, FL 32611 USA.

The truffle genus *Barssia* has been considered in three different families of Tuberales and one of the Pezizales. Light and electron microscopic examinations were made in efforts to resolve the proper systematic position of *Barssia* and its relationship to other epigeous and hypogeous Pezizales. Smooth, tetranucleate ascospores with a large lipid body and structures in the septal pores of asci, ascogenous hyphae, and vegetative cells of the ascomata confirmed that *Barssia oreogonensis* belongs in the Helvellaceae. Its relationship to species of *Helvella* and evolutionary tendencies in the Helvellaceae are discussed.

**5S rRNA SPACERS AS SPECIES-SPECIFIC PROBES FOR PYTHIUM.** Glen R. Klassen, Dept. of Microbiology, Univ. of Manitoba, Winnipeg MB, R3T 2N2 Canada, and Arthur W.A.M. de Cock, Centraalbureau voor Schimmelcultures, Yeast Division, Julianalaan 67, 2628 BC Delft, Netherlands.

Most *Pythium* species with globose zoosporangia have their 5S rRNA genes arranged into arrays of tandem repeats with intergenic spacers about 600 bp in length. Many of the species with hyphal swellings instead of sporangia also have this arrangement. The spacer was amplified in about 40 species and used as a probe against amplified and genomic DNA from type cultures (or representative cultures) of more than 90 *Pythium* species. In many cases, absolute species-specificity was obtained and homology classes were in good agreement with current taxonomy, with some significant exceptions. The 5S spacer appears to diverge rapidly after speciation and may be a good indicator of genetic isolation.

**SOIL FUNGI OF SOME LOW DESERT COTTON FIELDS AND THEIR ABILITY TO INHIBIT ASPERGILLUS FLAVUS.** M. A. Klich, and C. C. Chu, U.S. Department of Agriculture, Agricultural Research Service, Southern Regional Research Center, New Orleans LA 70124 and USDA ARS Western Cotton Research Laboratory, Brawley CA.

*Aspergillus flavus* chronically infects cotton bolls and seeds in the desert southwest and forms aflatoxin, the most potent naturally-formed carcinogen, in the seeds. It is presumed that the soil is a major source of inoculum. In this study, dilution plates of soils from cotton fields in southwestern Arizona and southeastern California assayed for filamentous fungi, resulted in isolation of approximately 40 taxa. Methylene chloride/acetone (1:1) extracts from strains of each taxon were screened for activity against *A. flavus* by overlaying developed thin layer chromatographic plates with agar and an *A. flavus* spore suspension and by paper disk bioassay on seeded petri plates. Several strains of *Fusarium solani*, *Penicillium vinaceum* and *A. auricomus* were found to inhibit *A. flavus* germination and growth.
VARIATION IN MITOCHONDRIAL DNA OF SCLEROTINIA SCLEROTIORUM. Y. Kohli and L. M. Kohn, Dept. of Biology, Erindale College, University of Toronto, Mississauga, Ontario, Canada L5L 1C6.

Variation in mitochondrial DNA was screened in 235 strains of Sclerotinia sclerotiorum isolated from disease lesions from one field of Brassica napus cv. Alto in 1992 (Kohli et al., 1995, Molecular Ecology 4: 69-77). This sample represented 67 clones or genotypes identified by DNA fingerprinting with a repeated, dispersed element of nuclear DNA from S. sclerotiorum. By Southern hybridization of restriction-digested, whole genomic DNA to several probes, including mtDNA from S. sclerotiorum and from Neurospora crassa, 15 mtDNA haplotypes were observed. Some clones were comprised of isolates with one mtDNA haplotype, other clones had more than one haplotype, and groups of clones shared common mtDNA haplotypes. The occurrence of more than one haplotype within a clone might be the result of lateral transfer of mitochondria from isolates in other clones. Alternatively, groups of clones with the same mtDNA haplotype might share a common ancestor. We will use mtDNA haplotypes to group clones into putative lineages that will be tested with other markers.

OCCURRENCE OF SYZYGITES MEGALOCARPUS (ZYGOMYCETES, MUCORALES, MUCORACEAE) IN THE UNITED STATES. R. L. Kovacs and W. J. Sundberg, Department of Plant Biology, Mail Code 6509, Southern Illinois University at Carbondale, Carbondale, Illinois 62901-6509.

The geographic and host ranges of Syzygites megalocarpus Ehrenberg: Fries (Zygomycetes, Mucorales, Mucoraceae), a fungus that occurs on fleshy Basidiomycetes, are not well documented in the literature. Data obtained from a literature search, study of personal collections, and examination of over 100 specimens from herbaria in the United States indicate that S. megalocarpus occurs on 33 different host genera of fleshy fungi in 18 different host families of Basidiomycetes. Four of the families and 15 of the genera were not previously recorded in the literature and thus represent new host records. Possible hosts for S. megalocarpus occur throughout the United States. However, collections of S. megalocarpus examined by us were made only from the east coast (Maine to Florida), many midwestern states, and Texas. Herbarium curators contacted in the states of California, Oregon, and Washington reported that there are no collections of S. megalocarpus in their holdings. Specimens examined were collected in bogs, swamps, lawns, pastures, and a variety of woodland habitats between the months of June and December. Clearly, more attention by collectors to making and preserving voucher specimens of S. megalocarpus would broaden both the host and geographic ranges even further.

VERTICAL TRANSMISSION OF THE FUNGUS ATKINSONELLA HYPOXYLON TO CHASMOGAMOUS SEEDS OF DANTHONIA MAKES THE HOST CASTRATION STRATEGY COSTLY. P. X. Kover and K. Clay. Dept. of Biology, Indiana University, Bloomington, IN, 47405.

Atkinsonella hypoxylon infects Danthonia grasses that produce two kinds of seeds: potentially outcrossed chasmogamous (CH) seeds and self-fertilized cleistogamous (CL) seeds. CH flowers are castrated in infected plants and fungal stromata develop instead, but vertically infected CL seeds are still produced. Vertical transmission appears to be the major mechanism of A. hypoxylon transmission, since horizontal transmission is seldom observed. Danthonia compressa inoculated with a strain from D. sericea showed a high frequency of inflorescences with both stromata and CH flowers, unlike naturally infected plants. Seeds from partially castrated, castrated and healthy plants were tested for the presence of the fungus in seeds and seedlings. The fungus was absent from seeds of healthy plants but was present at high frequency in CL seeds from castrated plants (90%). Both CH (80%) and CL (66%) seeds from partially castrated plants contains the fungus. After 10 weeks of growth 75% of CL seedlings from infected plants, and 57% of the CH and CL seedlings from partially castrated plants remained infected. These results indicate that spores and CH seeds can be produced simultaneously. More importantly, they show that CH seeds can be infected vertically, entailing a significant loss in fungal transmission since 60% or more of the seeds produced by Danthonia grasses are from CH flowers.

PROMOTER ANALYSIS OF A HEAT SHOCK GENE (hsp 70) OF ASPERGILLUS NIDULANS. Cas Kramer1, Jane A. Newbury1, Theo Goosen2, and John F. Peberdy1.

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A previously isolated and cloned hsp 70 gene of Aspergillus nidulans was subjected to further characterisation. A PCR amplification product of the S' flanking sequences of this heat shock gene has been fused in frame to the Escherichia coli lacZ gene, in order to study the promoter activity. Plasmid pCK70 carrying this promoter-lacZ fusion has been introduced into an ArgB-strain of A. nidulans. Site directed integration of a single copy of the vector into the Aspergillus genome has been accomplished. Enzyme assays to determine the β-galactosidase activity were found under uninduced conditions and no significant increase in enzyme activity was apparent after heat stress. Although several heat shock elements (HSEs) can be found in the promoter sequences, this A. nidulans hsp70 gene seems to be constitutively expressed. Results of a detailed promoter study to elucidate this phenomenon using promoter deletions are shown. Furthermore, growth phase related changes in enzyme activity and the effects of other inducers (like heavy metals, ethanol and cold shock) have been studied.
PHYLOGENY OF *SUILLUS* AS INFERRED FROM ITS-SEQUENCE DATA. A. Kretzer, Y. Li, T. Szaro and T. D. Bruns, Department of ESPM, 1083 Hilgard Hall, UC Berkeley, Berkeley CA 94720, USA.

Nucleotide sequences of the Internal Transcribed Spacer within the ribosomal repeat have been used to gain insight into the phylogeny of the genus *Suillus* sensu lato (Boletales) which includes species often classified as *Boletinus* sp. or *Fusoboletinus* sp. ITS-sequences were obtained from 51 different isolates belonging to 34 different species, and phylogenetic analysis of the aligned sequences was done using PAUP. As analysed so far, the data support the idea that *Suillus* sensu lato is monophyletic. *Fusoboletinus*, however, does not form a monophyletic clade within this group of organisms. *Suillus* species are mycorrhizal with pinaceous conifers, mainly *Pinus*, *Larix*, and *Pseudotsuga*. Our data suggest that larch-association is primitive while associations with pine and Douglas-fir are derived. Isolates of *S. granulatus* originating from America, Europe, and Asia appear to be polyphyletic; the European and Asian isolates fall into one clade together with *S. collinitus*, *S. luteus*, *S. pungens*, and others, whereas the American isolates fall into a different clade next to *S. placidus*.

MORPHOLOGICAL DATA AND rDNA ITS NUCLEOTIDE SEQUENCES FOR *GELASINOSPORA* SPP. (SORDARIACEAE). J. C. Krug, and R. S. Jeng, Dept. of Botany, University of Toronto, Toronto M5S 3B2, and Dept. of Forestry, University of Toronto, Toronto M5S 3B3, Ontario, Canada.

Isolations of species of *Gelasinospora* are frequently obtained from studies of terricolous fungi. Using light microscopy and SEM, observations are presented for the type strain of *Gelasinospora santi-florii* and several potentially unknown taxa. The nucleotide sequences of the ITS region in rDNA are presented for these strains. An attempt is made to compare the information obtained from observations of the phenotype with that from nucleotide sequences.

DECOMPOSITION OF STANDING DEAD LITTER OF THE EMERGENT MACROPHYTE *JUNCUS EFFUSUS*. K. A. Kuehn and K. Suberkropp. Department of Biological Sciences, University of Alabama, Tuscaloosa AL, 35487 USA.

Standing dead plant litter of emergent macrophytes is a common feature within wetland habitats, and may often form a considerable portion of the above ground biomass. However, little is known concerning the decomposition of such plant litter. We conducted field studies to examine the decomposition of standing dead litter of the emergent macrophyte *Juncus effusus*, from a small freshwater wetland ecosystem. Senescent culms of *J. effusus* were placed 1 mm mesh litterbags and suspended above the sediment-water interface. Litterbags were retrieved periodically over 487 days. Decay of standing plant litter was slow (k= 0.0012 d-1), with only 46% weight loss in 487 days. Fungal biomass, as measured by ergosterol content, averaged between 6.5-8.0 % of the total detrital weight and was not significantly different among sampling dates (p<0.05, ANOVA). Carbon to nitrogen ratios of plant litter decreased from 80 to 27 during the study. Fungal taxa associated with plant litter were dominated by Hyphomycetes, Coelomycetes and the basidiomycete, *Pannellus copelandii*.

AGARICUS BISPORUS FRUITING ON INERT CASINGS MATERIALS. R. H. Kurtzman, Jr. Western Regional Research Center, U.S.D.A., 800 Buchanan Street, Albany, CA 94710 USA.

Casing, a soil-like covering, on the beds of *Agaricus bisporus*, is required to obtain normal fruiting. In commercial practice, it usually consists of peat moss and ground limestone. Many theories of physiologic activity of and in casing have been proposed. Some theories depend on characteristics of peat moss. Experiments were carried out using calcined clay chips (brick chips), gravel (ca. 3 mm dia.), or Fargo silty clay in place of peat moss. The Fargo soil has many of the characteristics of peat moss, but lacks others. While peat moss casing gave the highest yield, 21 Kg m-2, the brick chips and the gravel gave slightly less, 20.5 Kg m-2. However, Fargo silty clay yielded only 17.7 Kg m-2 and the same soil after autoclaving yielded 13 Kg m-2. Brick chips were washed and used for a second crop, yields were essentially the same as those with fresh chips. The results are interpreted to mean that gas-air porosity is the most important characteristic associated with the casing. Large amounts of peat moss are used in commercial production; it is not reused. Gravel is generally cheaper and since it can be washed, as the brick chips were washed, it could be reused. The use of gravel allows a simpler milieu for experiments and commercial use could conserve peat moss, a valuable natural resource.
Microbotryum violaceum is an anther smut which uses the anthers of its host plant to distribute its spores. It parasitizes 37 genera worldwide in the Caryophyllaceae. The fungal spores are distributed via the host's insect vectors which normally transfer pollen. To date there have been no molecular studies of the phylogeny of the fungus though the evolutionary relationships of some of the hosts have been studied. The coevolution of the host and parasite has not been compared from a phylogenetic perspective as yet. Ultimately a phylogeny for both the isolates of M. violaceum and its hosts will be constructed to determine how informative a knowledge of the evolutionary history of the pathogen is for making inferences about the evolutionary history of the host and vice versa. To investigate the relationships between fungal isolates from different hosts, the internal transcribed spacer (ITS) region of the nuclear ribosomal DNA of isolates from different hosts have been sequenced. Preliminary cladistic analyses indicate that this region of the genome may provide a strong signal for delineating relationships within the M. violaceum species group, and for investigating relationships among other species of Microbotryum.

THE GREAT LAKES SPECIES OF LACTARIUS, SECTION DAPETES INCLUDING L. SALMONICOLOR. P. R. Leacock, and D. J. McLaughlin, Dept. of Plant Biology, University of Minnesota, St. Paul, MN 55108 USA.

Lactarius salmonicolor is newly recognized for the United States. Seven species of Lactarius (Russulaceae), section Dapetes Fr. ex Burl. (subgenus Lactarius sensu Hesler and Smith) are found in the Great Lakes area. Based largely on Minnesota collections, the following morphologically distinct taxa are described: L. chelidonium, L. deterrimus, L. indigo, L. paradoxus, L. salmonicolor, L. subpurpureus, and L. thyinos. Several of these taxa, L. deterrimus in particular, have passed under the name L. deliciousus, which is itself absent from this area. Lactarius subpurpureus is the only Great Lakes species in Dapetes not presently documented for Minnesota. The variability in color of L. chelidonium and its relationship to the European L. hemicyanus is discussed. Specimens of L. salmonicolor from Minnesota and Michigan are comparable to Heim and Leclair's type material from France. These taxa are distinguished primarily by coloration of latex and fruitbody, color changes, basidiospore size and ornamentation, stipe pellis, and tree associates (Abies, Picea, Pinus, Quercus, Thuja, and Tsuga).

THE GENERIC LIMITS OF SEQUESTRATE RUSSULAS BASED ON MORPHOLOGICAL CHARACTERS. T. Lebel, J. Trappe, and M. Castellano, Botany and Plant Pathology Dept., Oregon State University, Corvallis OR, 97331 USA.

Past workers have recognized five sequestrate Russula genera, Macowanites, Cystarium, Elasmomyces, Gymnomyces and Martellia. The limits between these genera are indistinct as they form a morphological gradient from sequestrate to mushroom-like. The description of several new collections from Australia enabled a further examination of these boundaries. Various morphological characters, such as pileipellis structure and spore ornamentation will be discussed and their usefulness in defining the sequestrate russuloid genera will be proposed.

SEPTAL ULTRASTRUCTURE IN THREE SPECIES OF TUBER (HYPOGEOUS PEZIZALES). Li-Tzu Li and J. W. Kimbrough, Department of Plant Pathology, Box 110680, University of Florida, Gainesville, FL. 32611 USA.

Ultrastructural studies of septa in ascogenous hyphae, ascii, and vegetative cells were conducted on three species of Tuber and compared with results obtained from several epigeous Pezizales. Septal pore organelles in the asci and ascogenous hyphae of T. californicum and T. texense were similar to those found in taxa of Otideaeeae, while those of T. luomai were like those of Helvellaceae, Morchellaceae, and Sarcosomataceae. The types of Woronin bodies associated with septa of vegetative cells were also similar to those of some Helvellaceae and Morchellaceae. These data suggest that Tuber may be a biological rather than a phylogenetic taxon.
EFFECT OF VA MYCORRHIZAL FUNGI AND PLANT GROWTH-PROMOTING RHIZOBACTERIAS ON THE STOCKS OF WENTAN POMELO. Suh-Jen Lin1, Shan-Ney Huang1, and Chi-Guang Wu2. 1Department of Soil and Fertilizer, Hualien District Agricultural Improvement Station, Chi-an, Hualien, Taiwan. 2Soil Microbiology Lab, Department of Agricultural Chemistry, Taiwan Agricultural Research Institute, Wu-feng, Taichung, Taiwan.

Wen-tan pomelo (Citrus grandis Osbeck forma buntan Hayata) is one of the important cultivated crops in Hualien area, Eastern Taiwan. In order to improve the quality of fruits, farmers grafted young shoots of pomelo to Citrus maxima. In this study, VA mycorrhizal fungi (i.e., Glomus etunicatum and G. intraradices) and plant growth-promoting rhizobacteria (PGPRs) (i.e., phosphate-solubilizing and free-living nitrogen-fixing bacteria) are chosen to compare their plant growth-promotion effect, especially on the stock of living nitrogen-fixing bacterias. Obviously, these microorganisms showed the synergistic effect on the growth of pomelo stocks and shed the lights on the potential use of biofertilizers in the sustainable agriculture. The functions of VA mycorrhizal fungi and PGPRs in the growth promotion effect will be discussed individually.

INTERNAL TRANSCRIBED SPACER SEQUENCES OF CONIFERS: "THERE IS A FUNGUS AMONG US". A. Liston and E. Alvarez-Buylla, Dept. of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331 USA and Centro de Ecologia, UNAM, Mexico, D.F. 04510 Mexico.

Published nuclear ribosomal 18S-5.8S internal transcribed spacer (ITS1) sequences from spruce (Picea) and pine (Pinus) are not representative of these plants, but rather originated from filamentous ascomycetes. The fungal sequences were inadvertently PCR-amplified due to the fact that the "target" ITS1 of spruce and pine is ca. 2600 bp in length, significantly longer than the ITS1 of angiosperms and most fungi. Foliar endophytes are considered a likely source of these "contaminant" sequences. In order to assess their phylogenetic position, the ITS1 regions of 12 sequences amplified from spruce and pine DNA preparations were aligned with 32 ascomycete sequences. Despite high levels of ITS1 divergence, conserved sequence motifs were identified which characterized well-supported groups in distance-based and parsimony analyses. The 12 sequences from spruce and pine form two discrete groups: ten are associated with inoperculate Discomycetes; two align with Pyrenomycetes. Considering the known taxonomic diversity of foliar endophytes, the relatively restricted phylogenetic distribution of these sequences is surprising.

MOLECULAR EVOLUTION OF THE MYCORRHIZAL FUNGUS CENOCOCCUM GEOPHILUM. K. F. LoBuglio1, M. L. Berbee2 and J. W. Taylor1. 1Department of Plant Biology, University of California at Berkeley, Berkeley, CA, 94720 USA and 2Department of Botany, University of British Columbia, Vancouver B.C., V6T 1Z4 Canada.

Cenococcum geophilum is one of the most widespread and commonly encountered ectomycorrhizal fungi in nature. This fungus, for which only one species is recognized, has no known sexual reproduction and exists as a sterile mycelium. The absence of sexual or asexual spores, which are important taxonomic characters among fungi, make the phylogenetic position of this fungus uncertain. We are using nucleotide sequence data from the nuclear small (18S) rRNA gene to examine the phylogenetic relationship of C. geophilum among the ascomycetes. In addition to questions of C. geophilum's phylogenetic position, we are also interested in the population biology of this mycorrhizal fungus. The genetic structure of natural C. geophilum populations is being assessed through linkage analysis of multilocus polymorphic loci obtained by PCR-SSCP (Single Strand Conformation Polymorphism). Results of this research will be discussed in this presentation.

1995 MSA abstracts, page 26
ABUNDANCE AND DISTRIBUTION OF ENDOHYTIC FUNGI IN LEAVES OF A TROPICAL TREE, MANILKARA BIDENTATA. D. I. Lodge, P. J. Fisher, and B. Sutton, Center for Forest Mycology Research, USDA-FS FPL, PO Box B, Palmer, PR 00721; Hatherly Laboratory, Univ. of Exeter, Exeter EX44PS, UK; International Mycological Inst., Bakeham Lane, Egham, Surrey TW20 9TY, UK.

Endophytic fungi were isolated from healthy leaves of *M. bidentata* (Sapotaceae) collected in Puerto Rico. One young, fully expanded leaf was collected from each of three trees in the El Verde Research Area of the Luquillo Mountains. Four 1x1 cm squares were cut from each leaf, surface disinfested, cut into 50 1x2 mm pieces, and plated on Malt agar. Petioles were cut into fifteen 1 mm segments. Fungi were isolated from 90-95% of the leaf pieces and 32-50% of the petiole segments. *Xylaria* spp. were found in 73-74% of the leaf pieces in two of the three leaves, but only 21% in third leaf. Two physiologically different forms in the *Xylaria* multiplex complex, a *Xylaria* sp. and 25 other fungal species were isolated. Of the 28 spp., 21 were found on two or more leaves.

SLIDE CULTURE CHAMBERS FOR HIGH RESOLUTION MICROSCOPIC STUDY OF FUNGAL CELL DEVELOPMENT AND DYNAMICS. R. López-Francó¹, D. J. Murphy², S. N. Grove³, and C. E. Bracker². Dept. Botany and Plant Path., Purdue Univ., West Lafayette, IN 479072; Centro Biotech., ITESM, 64849 Monterrey, NL, Mexico¹; Biol. Dept., Goshen Coll., Goshen, IN 465263.

Two slide culture chambers for high magnification study of fungal cell dynamics and growth meet several important criteria with respect to size, working distance, stability, and ease of assembly. For quantitative determinations, the cells must be "anchored" in a gelled medium such as nutrient gelatin (for phase contrast) or agar (for DIC). The first chamber involves a coverslip attached to the slide with a flexible hinge made of silicon compound and thin strips of fingernail polish on the slide to support the coverslip. A thin layer of growth medium is applied to the slide. This design has proved useful for studying cell growth and dynamics with minimal disturbance. When a very thin layer of medium of known thickness and constant cross sectional area is required, a modified chamber allows the coverslip to be supported by lithographic tape, and trace amounts of silicon grease attach the coverslip to the tape. These chambers are used for application of stresses such as electrical fields in which the field strength is related to the thickness and width of the growth medium. Also, windows can be cut in the tape support to allow insertion of a thin foil thermocouple to measure temperature next to the cells, and the medium near the tips of growing hyphae can be excised to allow application of xenobiotics so that the test solutions will contact growing hyphal tips within a few seconds, and measureable responses can be recorded in less than 1 minute.


Clark Rogerson has been collecting fungicolous fungi and isolating them into culture since 1959. A database has been constructed from this material through 1989. Clark has isolated from collections made by over 50 professional and amateur mycologists. Although much of this material came from Utah, there are collections from 37 different countries. Almost 400 unique genera are represented. Data will be presented from the database.

THE EFFECTS OF NOCODAZOLE AND CYTOCHALASIN D ON CYTOPLASMIC CLEAVAGE IN ZOOSPORANGIA OF *ALLOMYCES MACROGYNUS*: AN ULTRASTRUCTURAL STUDY. D. S. Lowry and R. W. Roberson, Dept. of Botany, Arizona State University, Tempe AZ. 85287-1601 USA.

Under control conditions, the cytoplasm of multinucleate zoosporangia of *Allomyces macrogynus* (Chytridiomycete) will produce precisely aligned cleavage membranes which divide the cytoplasm into numerous uninucleate, uniflagellate zoospores. To determine the functional roles of the cytoskeleton in this highly ordered cleavage process, control zoosporangia and zoosporangia treated with cytoskeleton disrupting compounds were fixed using the techniques of high-pressure freezing/freeze-substitution and processed for observations with transmission electron microscopy. In addition to control preparations, zoosporangia were prepared following treatment with either 0.33 μM (0.1μg/mL) nocodazole, an inhibitor of microtubule polymerization, or 5.0 μM (2.5μg/mL) cytochalasin D, an inhibitor of actin polymerization. Observations suggested that an intact microtubule cytoskeleton was not necessary for cytoplasmic division, although cleavage planes appeared to be slightly altered relative to the control treatments. Inhibition of actin polymerization produced extreme disruption of the cleavage process, i.e., cleavage membranes failed to divide the cytoplasm, resulting in multinucleate, multiflagellate zoospores.
THE PHYLOGENETIC POSITION OF THE TREMELLALES: A 25S rRNA GENE SEQUENCE ANALYSIS. Haisheng Lu, Eric C. Swann and David J. McLaughlin, Dept. of Plant Biology, Univ. of Minnesota, St. Paul, MN 55108 USA.

A portion of the 25S rRNA gene was sequenced from Tremella globospora and T. foliacea (Tremellales), and Dacrymyces stillatus and Dacryopinax sp. (Dacrymycetales). The sequences obtained were aligned with the available sequences of both heterobasidiomycetes and homobasidiomycetes from the gene database using Genetic Computer Group (GCG), and the data matrix was analyzed with Phylogenetic Analysis Using Parsimony (PAUP). Results suggested that the Tremellales was a group distantly related to both the Auriculariales sensu stricto and Dacrymycetales and that the Auriculariales s. s. was grouped loosely with the homobasidiomycetes. The latter conclusion is also supported with ultrastructural analysis. Additional research is needed to improve the statistical support.

RESPONSE OF GROWING HYPHAL TIPS TO THIOL REAGENTS. H. Lu, S. Bartnicki-Garcia, D. J. Morre, and C. E. Bracker. Depts. Botany and Plant Pathology and Medicinal Chemistry, Purdue Univ., W. Lafayette, IN 47907, USA.

Nearly two decades ago, an area of reducing power was discovered in the apical dome of growing fungal hyphae with cytochemical stains. This staining region corresponded to the position normally occupied by the Spitzenkörper. We have explored the nature of this localized redox activity to learn its role in hyphal morphogenesis. N-Ethylmaleimide (NEM), an alkylation and cross-linking reagent, and p-chloromercuribenzoate (PCMB), an enzyme inhibitor, both specifically block SH groups. These reagents were applied to growing hyphae of three fungi, Rhizoctonia solani, Neurospora crassa, and Trichoderma viride, to determine their influence on hyphal growth. At appropriate concentrations, NEM caused the Spitzenkörper to disappear in 1 to 5 min. and halted hyphal elongation. When the NEM was removed by washing, a new Spitzenkörper gradually developed, and cells of all three fungi resumed growth. PCMB similarly inhibited the cells, but its effect was not reversible with washing, and hyphal growth never resumed. Reduced and oxidized forms of glutathione were applied to influence the redox equilibrium in the hyphal tips, but tip growth was not significantly disturbed at concentrations up to 100 µM.

RECOMBINATION AND VARIATION AT THE A MATING-TYPE OF COPRINUS CINEREUS. L. Lukens, Huang Vicunia, G. May, Dept. of Plant Biology, Univ. of MN, St. Paul, MN 55108 and *Institute of Microbiology, Chinese Academy of Sciences, Zhongguancun, Beijing, P.R.China.

Recombination within the A mating-type of Coprinus cinereus to generate new mating-types was first demonstrated by Day over 30 years ago. We determined the correspondance of Day's genetic map and recent molecular maps. We made two crosses, used Day's method to select for recombinants in the A mating type region and then mapped recombinants using Southern blot techniques. Most recombination events occurred within the well-conserved, non-coding 7-8 kb region separating two gene clusters. Thus, the two gene clusters correspond to the α and β subunits mapped by Day. Two results were more surprising. First, in one cross, recombination hotspots were identified with many recombination events occurring within a 0.8 kb region. Second, finding two segregating regions differs from results of mapping experiments in natural populations where three segregating regions were observed. On the level of the entire A mating-type, recombination plays an important role in generating new A mating-types.

SEASONAL CHANGES IN PHOSPHORUS CONCENTRATION OF CENOCOCCUM GEOPHILUM X WHITE PINE ECTOMYCORRHIZAE. John Lussenhop and Robert Fogel. University of Illinois at Chicago, Chicago IL 60607, and Herbarium of the University of Michigan, Ann Arbor MI 48109 USA.

We tested the hypothesis that phosphorus concentration in the mantle of Cenococcum geophilum x white pine ectomycorrhizae changes seasonally. Every two weeks collections were made during the growing season from three sites under canopy trees at the University of Michigan Biological Station in northern, lower Michigan. Ectomycorrhizae were dried, frozen, planed, and observed with SEM, and phosphorus quantified by EDX microanalysis. Phosphorus distribution in longitudinal sections of ectomycorrhizae showed that phosphorus was distributed throughout appressed hyphae, rind, and mantle. The statistically significant seasonal differences in millimolar phosphorus ranged from a peak of 62 on 14 June to 10 on 13 August 1994. Phosphorus concentration was correlated with hyphal growth rate, sclerotium density, and shoot growth rate of pines. We conclude that in C. geophilum x white pine ectomycorrhizae that 1) phosphorus is not stored in tissue that is protected from herbivores, and 2) phosphorus concentration changes in response to seasonal availability rather than demand by the phycobiont.
Mutualistic interactions are widespread in the fungal kingdom and often associated with the diversification of at least one of the symbionts, suggesting that mutualism might have been a major speciation mechanism in the evolution of fungi. To study the evolutionary consequences of a transition to mutualism in fungal lineages, a group of closely related mutualistic and non-mutualistic species of Omphalina (Agaricales) and related genera were selected. Phylogenetic relationships of 30 representative omphalinoid species were estimated using sequences from ITS 1 - 5.8S - ITS 2 (= 700 bp) and the 5' end (= 1.4 kb) of the large subunit of the nrDNA. The different molecular data sets were tested using Rodrigo's method to determine if they could be combined. To detect significant differences in rates of nucleotide substitution, the likelihood-ratio test (pairwise method) and the generalized least-square approach (non-pairwise method) were used. Both methods suggest that an increase in rates of nucleotide substitution is associated with a transition to mutualism. This could be the result of a shift in selection pressure and/or an increase in mutation rate resulting from a transition to mutualism.

Variations on an Enigma: Some Genetic Anomalies in the Mixed Mating System of Cryphonectria parasitica. R. E. Marra and M. G. Milgroom, Dept. of Plant Pathology, Cornell University, Ithaca NY 14850 USA.

Cryphonectria parasitica, the ascomycete that causes chestnut blight, has been shown in laboratory crosses to conform to a heterothallic mating system. Curiously, when perithecia were sampled from North American populations, a significant portion (20-30%) appeared to be the result of self-fertilization, suggesting that C. parasitica has a mixed mating system. Ascospores from a single perithecium were considered the result of self-fertilization if there was no segregation at 5 to 7 vegetative compatibility (vc) loci, 6 unlinked RFLP loci, and 8-15 (or more) unlinked fingerprinting loci. However, we recently found that progeny arrays from putatively selfed perithecia segregate 1:1 for mating type alleles, even though the maternal parents of these perithecia express only one or the other mating type in the lab. Additionally, we have not observed self-fertilization from routine laboratory crosses. To test the hypothesis that the "selfed" progeny arrays sampled from natural populations are the result of either intense biparental inbreeding or true selfing, we have attempted to induce self-fertilization in the lab, by means of filtrates of germinating conidia of opposite mating type. An alternate hypothesis is that a silent copy of the opposite allele is expressed in the process of self-fertilization, which then segregates 1:1 with the original allele among the progeny. The importance of biparental inbreeding and self-fertilization to the population structure of natural populations of fungi will be discussed.

Molecular Evolution of Mating-Type Genes. G. May, L. Lukens, P. T. Gieser, E. Matzke, Dept. of Plant Biology, Univ. of Minnesota, St. Paul, MN 55108 USA.

Patterns of DNA sequence variation in highly variable alleles at the bl mating-type gene were examined. The results support the hypothesis that these genes are evolving in response to frequency dependent selection. DNA sequence was obtained from 1 to 3 alleles falling into each of 5 different functional classes for a total of 10 alleles. Having replicate alleles within a functional class allowed us to determine whether such replicate alleles demonstrate primarily neutral patterns of evolution while alleles falling into different functional classes demonstrate variation that can be attributed to frequency dependent selection. Genealogical analysis confirms this prediction and demonstrates an allelic phylogeny where different functional alleles are separated by many substitution events. Within a functional class, alleles are extremely closely related although retrieved from locations around the world. The variation we observe is not due to recent recombination events. These data are consistent with the hypothesis that frequency dependent selection on self-incompatibility genes retains a large number of different alleles in the population over long periods of time.


Pholiota alnicola and P. spumosa are species names central to two morpho-species complexes as defined by Smith & Hesler (1968). The Pholiota alnicola complex consists of 3 species with 2 varieties and the P. spumosa complex comprises 9 species. Selected taxa are being examined to provide information on sexual compatibility, morphological and enzymatic variation. These characters are being analyzed for each species complex using collections with cultures (mono- and dikaryons) from North America and Europe. To date they exhibit a variety of intercontinental sexual compatibility patterns, from complete incompatibility or complete interincompatibility, to several intersterility groups within and between North America and Europe. Electrophoretic data (ACO, ADH, EST, HEX, PGM, SOD, and extracellular laccase) show some geographical variation and some correlation with mating incompatibility, but are overall consistent within the species complexes. Morphological variation also shows some correlation with mating incompatibility and electrophoretic banding patterns. These results suggest a possible contraction of the number of acceptable names proposed by Smith & Hesler.

Many deuteromycete genera are closely related based on a limited number of morphological characters. Compounding this problem is the fact that many genera are pleomorphic and produce synanamorphs, causing confusion in their taxonomy. In this study, taxonomic and phylogenetic relationships between Phialophora, Leptodontidium, Ramichloridium, Fonsecaea, Rhinocladiella and Cladosporium isolates were determined using morphological and molecular characters. Nuclear ribosomal DNA internal transcribed spacers and 5.8S gene sequences were used to examine the isolates. Morphological data was analyzed separately and in conjunction with molecular data to determine the most precise relationships among these genera.

ULTRASTRUCTURE OF THE TELIAL STAGE OF CRONARTIUM QUERCUUM F. SP. FUSIFORME. C. W. Mims and S. F. Covert. Dept. of Plant Pathology and School of Forest Resources, Univ. of Georgia, Athens GA, 30602 USA.

A combination of SEM and TEM was used to examine telia and teliospores of C. quercuum f. sp. fusiforme, the cause of fusiform rust disease of southern pines. This is a macrocyclic, heteroecious rust fungus that cycles between pine and oak. Telial columns consisting of chains of thick-walled teliospores whose walls were laterally fused developed either singly or in clusters on the undersides of oak leaves that had been inoculated with uredinia. Many but not all columns emerged from old uredinia. Individual teliospores were slightly fusiform in shape and measured 15-20x30-40 μm. Teliospores developed from a layer of sporogenous cells that arose subepidermally near spongy mesophyll cells. Teliospores were initially binucleate, but became uninucleate as a result of karyogamy. Meiosis began soon after karyogamy as evidenced by the appearance of synaptonemal complexes (SCs) in the teliospore nucleus. SCs then disappeared and meiosis was not completed until the nucleus migrated into the metabasidium that developed from the germinating teliospore.

PROTOSTELID ECOLOGY. D. L. Moore and F. W. Spiegel. University of Arkansas, Department of Biological Sciences, Fayetteville, AR 72701 USA.

Protostelid ecology is still in its infancy but preliminary data suggest that protostelid communities on leaf litter and standing dead plant parts are distinct. A new technique has been designed so that protostelids may be collected on a sterile, standardized substrate initiated into each of these microhabitats. Substrates are attached to the leaf litter or suspended in the air. It appears that total propagules colonizing substrates are considerably lower in winter than in summer for both leaf litter and aerial microhabitats of a forest habitat. Moreover, Schizoplasmodiopsis pseudoendospora, Nematostellium ovatum, and Protostellium arachisporum occur in higher frequency on leaf litter than aerial substrates in a forest habitat. Protostellium mycophaga and Echinostellisiopsis oligospora, however, occur in higher frequencies on hanging substrates. Other species appear to have similar frequencies on leaf litter and aerial substrates. These preliminary data suggests that protostelid communities are distinct in leaf litter and hanging microhabitats.


Laccaria, Collybia, and Tricholoma have traditionally been treated as closely related genera in the Tricholomataceae (Agaricales) while the false truffle genera Sclerogaster, Octaviania, Hydnangium, and Podothydnangium have been placed in the Hymenogastrales (gasteromycetes). Most systematists now believe that Hydnangium and Podothydnangium are are closely related to Laccaria; this is supported by their identical basidiospore ornamentation and apparently similar basidiocarp pigments. However, this hypothesis remains untested and the relationships of these false-truffle genera to Laccaria has not been satisfactorily resolved. Sequence data from ITS1 and ITS2 plus Divergent Domain 2 of 25S rDNA were generated to test these conflicting phylogenetic hypotheses. One species each of Collybia, Tricholoma, Sclerogaster, Octaviania, and Podothydnangium, 3 species of Hydnangium and 16 species of Laccaria were sampled. Cladistic analyses of these data supported the monophyly of Hydnangium, Laccaria, and Podothydnangium. Based on this data set, these genera are paraphyletic with respect to each other. These analyses suggest an Australasian origin for this lineage. Future research will test this hypothesis by the inclusion of New Zealand and additional southern South American species.
INTERSTERILITY GROUPS IN COLLYBIA SUBNUDA. J. F. Murphy and O. K. Miller, Jr. Dept. of Biology, Virginia Polytechnic Institute and State University, Blacksburg, VA, 24061-0406.

Mating crosses among collections of Collybia subnuda ranging from NY to SC show a clear pattern of intersterility between two groups, with infrequent partial compatibility. The groups are morphologically indistinguishable, but have divergent ecological substrate preferences. Intersterility group (ISG) 1 tends to be associated with hardwood leaf litter (usually of Quercus), and ISG 2 is usually associated with woody detritus. Data from mating crosses and spore trapping experiments show the two ISG's to be sympatric throughout the sampled range, but there are indications that on a local level the two ISG's may segregate geographically by habitat. Random amplified polymorphic DNA (RAPD) approaches gave non-reproducible results. DNA sequence data from the intergenic transcribed spacer (ITS) region of the rRNA gene family will be presented and discussed in the context of the evolutionary divergence of the two ISG's.

FREEZE SUBSTITUTION OF HYPHAL TIPS AND PROTOPLASTS OF THE ZYGOMYCETE ENTOMOPHAGA AULICAE. F. Murrin, K. Hicks, and N. Lake. Department of Biology, Memorial University, St. John's, Newfoundland, Canada, A1B 3X9.

The insect pathogen Entomophaga aulicae grows by tip growth during conidium germination and initial infection, and later by the multiplication of a protoplast stage in the host hemolymph. We are interested in the transition from tip growth to the protoplast form and are using freeze fixation to investigate the cellular structure of these two stages. Cells on collagen and formvar coated loops were plunge frozen in a mixture of liquid propane and ethane and further processed for both transmission and scanning electron microscopy. Freeze substitution revealed cellular details not previously observed after chemical fixation in both germ tube tips and protoplasts, including the presence of endocytotic vesicles on the protoplast surface. Discussion will include a comparison of the ultrastructure of these two stages as preserved by freeze fixation.

SOILBORNE FUNGI ASSOCIATED WITH NATURAL EPIDEMICS AND STAND DECLINES OF EXOTIC RANGELAND WEEDS AND WITH RELATED SPECIES IN EUROPE. D. Nash, J. M. Henson, and A. J. Caesar, USDA/ARS, Range Weeds and Cereals Research Unit Montana State University, Bozeman MT 59717 USA.

Rangeland weeds cause economic losses exceeding 500 million dollars annually in the northern great plains of the U. S. and prairie provinces of Canada. Means of biological control of several rangeland weeds is being sought. Surveys indicate that soilborne pathogens, including Fusarium oxysporum, Rhizoctonia spp. and a clavarioid basidiomycete, are associated with epidemics and declines in density within stands of Centaurea, and Euphorbia spp. in the U.S. Such epidemics are rare, however. Surveys in Europe indicate that the natural suppression of the weed there is due to a similar complex of species. PCR was used to amplify rRNA genes of 9 foreign and 9 domestic Rhizoctonia spp. strains pathogenic to Euphorbia to compare their genetic relatedness. Six native and two foreign isolates shared identical restriction fragment patterns of digested, amplified rDNA. These results suggest the feasibility of utilizing foreign strains that are not too dissimilar to native strains for biological control in the U.S.

EVIDENCE FOR MEIOTIC REARRANGEMENTS IN BASIDIOBOLUS. R. T. Nelson, D. TeStrake and B. J. Cochrane, Dept. of Biology, University of South Florida, Tampa, FL, 33620 USA.

Basidiobolus (Zycomycotina, Entomophthorales) is a homothallic, saprobic fungus. Members of the genus can be readily isolated from the fecal pellets of amphibians and reptiles and less readily isolated from soil and detritus. Analysis of soil and lizard isolates of Basidiobolus collected in the university of South Florida Ecological Study Area and surrounding communities by Randomly Amplified Polymorphic DNA (RAPD) analysis indicates that each isolate is genetically unique. The observed variation cannot be explained by sexual out-crossing. RAPD analysis of genomic DNA isolated from monosporous cultures derived from zygospores indicates that isolates of Basidiobolus are capable of significant meiotic sequence rearrangement with a frequency approaching 1 in 10 viable meiotic products. Concomitant analysis of monosporous cultures derived from conidia by RAPD analysis demonstrates complete homogeneity when compared to the parent. Results of physical and biochemical analyses of the monosporous zygospore cultures will be presented and compared to the parent isolate.
TAXONOMIC VALIDITY OF Plicaria AND ITS
RELATIONSHIP TO OTHER MEMBERS OF THE
PEZIZACEAE. J. E. Norman and K. N. Egger, Department of
Biology, Memorial University, St. John's, NF, A1B 3X9
Canada.

Despite similarity in ascocarp morphology, Plicaria has been
separated from Peziza by some authors because it has
spherical rather than elliptical spores. Others merge Plicaria
with Peziza. Our objectives were to determine if Plicaria
forms a distinct lineage, and to infer the phylogenetic
relationships of Plicaria to Peziza and other members of the
Pezizaceae. DNA sequences were obtained from the 18S
gene, internal transcribed spacer region, and 28S gene of the
nuclear-encoded ribosomal DNA and subjected to parsimony
analysis. Results show that Plicaria is monophyletic but
closely-related to elliptical-spored Peziza species with
ornamented, guttulate spores and Chromelosporium
anamorphs. Together these taxa form a well-supported clade
that is distinct from Peziza species with mostly smooth,
eguttulate spores and Oedocephalum anamorphs. The phylogeny
also showed that Kimbropezia is not distinct from Peziza, and
that Peziza quelepodotia belongs in a separate genus.

SYSTEMATICS OF PNW PHAEOCOLLYBIA SPECIES:
MOLECULAR AND MORPHOLOGICAL COLLUSION. L.
L. Norvell and J. F. Ammirati, Department of Botany KB-15,
University of Washington, Seattle WA 98195, USA.

DNA has been extracted and amplified from the ITS1 & ITS2
regions associated with the 5.8S rRNA gene from 130 PNW
and extralimital collections of Phaeocollybia (Agaricales,
 Cortinariaceae). Informative polymorphisms have been
generated from nine different restriction enzymes (Cfo I, Eco
RI, Hinf I, Nde II, Pal I, Pvu II, Rsa I, Sal I, Xho I), and
compared with the morphological and ecological characters of
25 putative species. The molecular data appear to support
species hypotheses generated from the more traditional
morphological analyses. Phaeocollybia scatesiae has been
revealed as synonymous with P. califomica while four new
species are supported as molecularly and morphologically
distinct from other PNW species. RFLP generated groupings
of collections within the P. kauffmanii complex appear to be
linked to subtle anatomical and microscopical differences.
Chemical, developmental, and ecological investigations of
Phaeocollybia species in British Columbia, Washington,
Oregon, & California (1991-1994) continue to reveal the
unique biology of the genus and its integral place in the old-
growth Pacific coast mesic forest ecosystem.

ARE THERE COMMUNITIES OF ECTOMYCRRHIZAL
FUNGI? T. E. O’Dell and J. F. Ammirati, Dept. of Botany,
KB-15, University of Washington, Seattle, WA 98195, USA.

What is known about patterns of ectomycorrhizal fungus
species occurrence in unmanaged ecosystems? In North
America at least, the answer is: very little. We know that some
fungi occur only with particular host plants. We can point to
some species that are relatively widespread or endemic, rare
or common (although many =D2rare=D3 species may only be
rarely collected and identified). But, can we point to groups of
ectomycorrhizal fungi that predictably recur across a
landscape in similar habitats? So far, we cannot.

Understanding of ectomycorrhizal population and community
ecology is hindered by sampling difficulties. Most
troublesome are the seasonal and annual variation in
sporocarp production, and the unknown relationship of
sporocarp to mycorrhiza abundance. Presumably, those
species forming the most mycorrhizae have the greatest
impact on ecosystem processes. Studies of ectomycorrhizal
communities are needed for conserving biological diversity
and for identifying functionally important species. We will
present data on the abundance of ectomycorrhizal species in a
range of Pseudotsuga menziesii -Tsuga heterophylla forests,
effects of sampling design on detection of species diversity of
ectomycorrhizal fungi, and relationship of sporocarp to
mycorrhiza abundance. We will also discuss novel approaches
for determining how ectomycorrhizal fungi are distributed on
the landscape.

MULTIPLE GENE PHYLOGENIES REVEAL ITS2
POLYMORPHISMS PREDATE SPECIATION WITHIN
THE "GIBBERELLA FUJIKUROI-COMPLEX" OF
FUSARIUM. K. O'Donnell, and L. Cigelnik, NCAUR-USDA,
Microbial Properties Research Unit, Peoria, IL 61604 USA.

Phylogenetic relationships among 100+ isolates within
Section Liseola of Fusarium were investigated by comparing
sequences from four genes. Congruence between the
mitochondrial small rDNA and beta-tubulin gene trees
indicate that these likely represent species trees. Phylogenetic
signal within the nuclear large 28S rDNA is poor.

Surprisingly, the internal transcribed spacer gene tree is
incongruent with the true species tree because the common
ancestor of this species complex was polymorphic at this
locus. Based on phylogenetic evidence, Section Liseola is
paraphyletic with the exclusion of certain chlamydisporose-
forming species. Also other Sections are artificial and should
be abandoned. We recommend the adoption of a phylogenetic
species concept since current morphological and biological
species concepts fail to describe the phyletic diversity and
sister group relationships within this important group of fungi.
These studies will form the foundation of a phylogenetically-
based revision of Fusarium and its telemorphs.
Morels are arguably the best known wild macrofungi [Ascomycota: Pezizales] collected by mycophiles. In this study, the evolutionary history of the morel fungi was investigated by parsimony analysis of nuclear-encoded small genes amplified by the polymerase chain reaction [PCR] and sequenced directly where possible. Some PCR products had to be cloned to obtain readable sequences. Taxa were sampled from the family containing the true morels [Morchellaceae: Morchella, Verpa, and Disciotis] and the false morels [Helvellaceae] which includes both epigeous [Helvella, Gyromitra, Discina, Underwoodia, Wynella, and Rhizina] and hypogeous, truffle-like taxa [Dingleya, Hydnotrya, and Fischerula] to address three main questions: are these families monophyletic; what are their phylogenetic relationships within the Pezizales; and what can the rDNA gene phylogenies tell us about morphological evolution within the morel fungi?

**BIODEGRADATION POTENTIAL OF TROPICAL WOOD-ROT FUNGI.**

A. A. Ortiz-Vélez, Y. Blanco-Santiago, and P. Bayman. Dept. of Biology, Univ. of Puerto Rico-Rio Piedras, Box 23360, San Juan, PR 00931.

Biodegradation of toxic compounds by white-rot fungi has been studied extensively. Most studies have tested organisms from temperate climates, particularly Phanerochaete chrysosporium. Few biodegradation studies have used tropical white-rot fungi, even though many tropical woods contain secondary metabolites that may select for decay fungi with tolerance to toxic, aromatic compounds. We isolated fungi from rotting wood from Caribbean National Forest and Toro Negro State Forest in Puerto Rico. Biodegradation potential is correlated with ability to decolorize polymeric, aromatic dyes. Fungi were cultured in Czapek-Dox broth with the dye Poly R-478, and decolorization was measured by spectrophotometry. Wood-rot fungi able to decolorize Poly R-478 included isolates of Phanerochaete, Pleurotus, and Xylaria.

**NUCLEAR BEHAVIOR AS A COMPONENT OF COMPATIBILITY IN PLEUROTUS.**

R. H. Petersen 1 and G. S. Ridley 2, 1Department of Botany, University of Tennessee, Knoxville, Tennessee 37996-1100 USA; 2Forest Health, New Zealand Forestry Research Institute, Rotorua, New Zealand.

A collection of Pleurotus sp. from New Zealand (NZP) showed compatibility with four putative separate biological species of Pleurotus (P. ostreatus, P. pulmonarius, P. eryngii, P. populinus) and with an undescribed member of the P. ostreatus complex (P. "abieticola"). While compatibility between monokaryon strains of P. pulmonarius and NZP showed universal compatibility and production of stable, proliferating dikaryons, compatibility with P. eryngii and P. populinus was partial, with a mixture of incompatible matings, matings producing ephemeral dikaryons, and matings producing stable, proliferating dikaryons. Compatibility with P. ostreatus was not only partial, but produced only ephemeral, unstable, non-proliferating dikaryons. In all cases, nuclear donation/migration was into NZP, never from NZP into its mate. These nuclear phenomena are discussed in the context of sexual compatibility, biological speciation, and biogeographic considerations.

**AN rDNA PHYLOGENY OF THE GENUS ASPERGILLUS.**

Stephen W. Peterson, Microbial Properties Research, USDA, ARS, 1815 N. University St., Peoria, IL 61604-3999 USA.

rDNA sequences were obtained from ca. 500 strains representing more than 200 named species or varieties of Aspergillus. Variable regions D1 and D2 of 1-s rDNA (ca. 575 nucleotides) were analyzed using PAUP 3.1.1 and DNAPARS from PHYLIP 3.5. The consensus tree indicates some previously unknown relationships. H. acanthosporus is part of a clade including the members of section Clavati, the Neosartorya species and A. fumigatus form a sister group for sect. Clavati. Sect. Cremei includes several species previously placed in other sections, and is a sister group to species of Fennellia and some species previously placed in sect. Versicoloroles. Sects. Flavi and Nigri are sister groups largely composed of the species assigned there by Raper & Fennell (1965). Sects. Restricti and Aspergillus are sister taxa. Sect. Circumdati species are not monophyletic; although eight of the taxa form a clade, other species belong in one of several other sects. Sect. Cervini is a distinct group, but subgen. Ornati species occur in several clades. Sections Nidulantes, Versicoloroles and Usti species are paraphyletic.

1995 MSA abstracts, page 33
HELIICON SESSILE, THE ANAMORPH OF ORBILIA LUTEORUBELLA. D. H. Pfister, Department of Organismic and Evolutionary Biology and the Farlow Reference Library and Herbarium of Cryptogamic Botany, 20 Divinity Ave., Harvard University, Cambridge, MA 02138 USA.

When the ascospores of the inoperculate discomycete Orbilia luteorubella were grown in culture, an anamorph was produced which is referrable to the genus Helicoon. Orbilia luteorubella is an inhabitant of wet, well-decayed wood, and Helicoon, though often found in the conidial state in water samples, can also be found in the same type of habitat. Further study and comparisons of cultures and field collected material indicates that this anamorph is close or identical to Helicoon sessile. Teleomorphs have not previously been reported for Helicoon species. Other Orbilia anamorphs will be discussed in relationship to the ecology and systematics of the genus Orbilia.

IDENTIFICATION OF ARMILLARIA SPECIES WITH SEQUENCED CHARACTERIZED AMPLIFIED REGIONS (SCARS). M. D. Piercey-Normore, K. N. Egger, Department of Biology, Memorial University of Newfoundland, St. John's, NF, Canada, A1B 3X9, and J. Berubé, Canadian Forest Service, Newfoundland and Labrador Region, St. John's, NF, Canada, A1C 5X8.

North American members of the genus Armillaria have been segregated into nine interfertility groups corresponding to biological species. Species identification is important in this genus of root rots fungi. Randomly amplified polymorphic DNA (RAPD) fragments have been screened for all North American biological species of Armillaria. Species specific RAPD fragments have sequenced and used to generate SCARS to identify species. Specifity of these molecular markers will be presented and discussed.

HETEROKARYON FORMATION AND PARASEXUALITY IN FUSARIUM OXYSPORUM f.sp. CUBENSE. T. J. Pinto, and D. N. Kuhn, Dept of Biological Sciences, Florida International Univ., Miami FL, 33199 USA.

While many mycologists view parasexuality as a "rare accident", we have observed that the entire parasexual cycle (heterokaryon formation, karyogamy, recombination, and haploidization) occurs in Fusarium oxysporum f.sp. cubense. We induced heterokaryon formation between double auxotrophic mutants by five different methods, two of which allowed us to measure rates of heterokaryon formation. IntravCG heterokaryon formation was seen, as expected, in addition to inter-VCG and inter-forma species heterokaryon formation in particular strains. We are investigating intra-VCG, inter-VCG, and inter-forma species heterokaryon formation with scanning electron microscopy and screening for diploids with our methods.

IMAGING AND MEASUREMENT OF CALCIUM AND pH IN LIVING FUNGAL HYphae. Nick D. Read, Inst. of Cell and Molecular Biology, Univ. of Edinburgh, Rutherford Building, Edinburgh EH9 3JH.

In order to demonstrate that signal-response coupling is mediated by Ca2+ and/or pH, it is very useful to directly image and measure these ions in living cells. We have developed methods for confocal ratio imaging of pH in fungal cells using the SNARF-1. Considerable effort has been taken to understand and avoid the numerous artifacts which can arise during dye loading, imaging, image processing and image analysis. Using this technique, we have demonstrated that growing vegetative hyphae of Neurospora crassa and growing germ tubes of Magnaporthe grisea do not possess pronounced, intracellular, tip-focussed pH gradients. The pH of both cells is held remarkably stable at or close to pH 7.2. Unfortunately, routine methods for imaging cytosolic free Ca2+ in fungal hyphae using fluorescent dyes have been hampered because the dyes are rapidly sequestered within organelles. Strategies being used to overcome this problem will be discussed. An alternative approach to image and measure Ca2+ in cells is use organisms genetically transformed with the aequorin gene which encodes for a Ca2+-sensitive photoprotein. We have now successfully transformed N. crassa with this gene and recent results obtained using this method will be presented.

CYTOPLASMIC CONTRACTIONS, SPITZENKÖRPER BEHAVIOR AND APICAL BRANCHING IN ASPERGILLUS NIGER. C. G. Reynaga-Peña1, C. E. Bracker2, and S. Bartnicki-Garcia1. Dept. of Plant Pathology1, University of California, Riverside, CA. 92501 and Dept. of Botany and Plant Pathology2, Purdue University, West Lafayette, IN 47907-1057.

Apical branching was induced in a temperature-sensitive mutant of Aspergillus niger (AB1) after a shift from 23°C to 34°C. We followed the events leading to apical branching in videotaped sequences obtained by video-enhanced phase contrast microscopy. First, a localized momentary contraction lasting about 1 second causes the sudden unidirectional movement of visible organelles (esp. mitochondria, and spheroid bodies) towards the hyphal apex. At the peak of the contraction, a transitory sharp increase in refractive index occurs in a localized area of cytoplasm near the tip of the cell. During the next 10 sec., the Spitzenkörper retracts from its polar position at the apical pole and eventually "disappears" from view. During this period the rate of hyphal elongation is sharply reduced. After a period of relatively little activity, polarized growth again resumes, but instead of the original Spitzenkörper, two Spitzenkörper appear, each giving rise to a branch at the apex. Although not all cytoplasmic contractions result in a hyphal branch, they always affect the stability of the Spitzenkörper and branches do not form unless preceded by a contraction. The nature of the cytoplasmic contractions indicates an intimate organic association among the cytoskeleton, cytoplasmic organelles and components of the Spitzenkörper complex.

1995 MSA abstracts, page 34
PULSED HYPHAL GROWTH OF WILD TYPE
ASPERGILLUS NIGER AND AN APICAL BRANCHING
MUTANT. C. G. Reynaga-Peña and S. Bartnicki-Garcia,
Department of Plant Pathology, University of California,
Riverside, CA 92521.

Video-enhanced microscopy, including a digital image
processor and scaler, enabled precise measurements of fungal
growth, revealing that fungal hyphae do not elongate steadily
but grow in alternating pulses of fast and slow growth (1). We
have analyzed pulsed growth in detail in a wild type strain of
Aspergillus niger and a temperature-sensitive mutant which is
capable of apical branching at the restrictive temperature.
Hyphae from both strains showed pulses of similar frequency
(7-11 pulses per min.) despite substantial differences in
elongation rate. The apical branching mutant allowed us to
analyze growth pulses in adjoining branches arising from the
same parent hypha. The pulses in these closely connected
hyphal branches were of similar frequency but were not
synchronous (i.e. fast and slow growth periods did not occur
simultaneously). The similarity in pulse frequency suggests
that hyphal growth is largely regulated by a mechanism
common to all hyphae in a mycelium, while the lack of pulse
synchrony suggests a degree of growth independence for each
hyphal tip. Presumably, the final events in the discharge of
wall-building vesicles responsible for apical growth are
controlled locally at the growing point. (1) Lopez-Franco, R. S.

CAN FUNGAL HYPHAE SERVE AS ELECTRICAL
CONNECTIONS ON INTEGRATED CIRCUIT
Whidden, and S. E. Kersey. *Dept. of Botany, Dept. of
Electrical Engineering, Center for Solid State Electronics
Research, Arizona State Univ., Tempe AZ, 85285 USA.

Initial findings are reported from research involving the
directed growth of Uromyces appendiculatus germlings on
custom-designed integrated test circuits for the purpose of
creating a bio-hybrid integrated system. Germlings of U.
appendiculatus serve as excellent biological elements for this
work because of their precise topographical signal recognition
capabilities. The integrated circuit was fabricated using
standard semiconductor processing techniques, with guiding
elements etched into the final layer of metallization.
Urediospores germinated on contact pads in the circuit
resulting in germ tubes which were guided by the vectoring
elements toward other contacts. These vectoring structures
were capable of "steering" germ tubes to intended
connection/termination points through a wide range of angles.
Self-assembled monolayers of n-octyltrichlorosilane on the
circuit materials result in superior germination characteristics
compared to untreated surfaces. Potential applications of such
cell-circuit hybrids will be discussed.

CLADISTIC ANALYSIS WORKSHOP. S. O. Rogers1,
Yajuan Liu1, and Joe F. Ammirati2. 1Environmental and
Forest Biology, College of Environmental Science and
Forestry, State University of New York, Syracuse, NY 13210.
2Department of Botany, KB-15, University of Washington,
Seattle, WA 98195.

The workshop is aimed at those interested in being able to
interpret results from cladistics and phyllogenetics publications,
as well as those utilizing cladistic methods in their research.
The first part of the workshop will consist of a discussion of
the basic principles and methods used in cladistics. Parsimony
analysis, neighbor-joining, bootstrapping and other methods
will be discussed. Methods for integration of different types of
data sets will also be presented. Some more sophisticated
methods may be presented as time allows. The second part
will be computer demonstrations and (depending on
attendance and equipment) hands-on instruction of some of
the common programs (MEGA, NTSYS, PAUP and
PHYLIP). Those interested are encouraged to bring their own
laptop computers (IBM and Macintosh).

SPlicING OF A MINIMAL GROUP I INTRON. S. O.
Rogers, Z. H. Yan, M. L. Shinohara and C. J. K. Wang,
Environmental and Forest Biology, College of Environmental
Science and Forestry, State University of New York,
Syracuse, NY 13210.

A group I intron located near the 3' end of the nuclear small
subunit (SSU) gene from the deuteromycete Phialophora
americana is the smallest reported (68 bp). From phyllogentic
analyses, the intron appears to have been derived from larger
group I SSU introns. Although the pre-rRNA is accurately
spliced in vivo, the intron contains only three of the ten
regions thought essential for splicing. Additionally, group I
conserved regions P, Q, R, and S are all missing from this
intron. Of the remaining regions, base pairing brings all of the
necessary bases together to perform the self-splicing reaction.
A model for the splicing reaction of this intron will be
presented.

1995 MSA abstracts, page 35
EARLY MOLECULAR EVENTS IN THE DETERMINATION OF DIFFERENTIATION IN COPRINUS CONGREGATUS: EVIDENCE AND SPECULATION. I. K. Ross, J. J. Stevens, J. Mehew, M. Ma, J. Tsai and A. Shin. Dept. of Biological Sciences, Univ. of California, Santa Barbara, CA 93106 USA.

Mushroom formation in C. congregatus begins with the reception of blue light by competent hyphal cells. This is the first step in switching certain hyphal cells from the continuously replicative/proliferative pathway into one of committed, determinate differentiation and development. Competent cells are those with a membrane associated light receptor-protein complex in place, and are probably in the G1 phase of the cell cycle. In C. congregatus two short light exposures at least 3 hours apart are needed for full commitment. The first short exposure both activates and inactivates specific genes. One of those activated genes has been found to have significant identity to a known cytoplasmic receptor. Among genes repressed between commitment and final differentiation is the gene for telomerase, a ribonucleoprotein reverse transcriptase that is involved in longevity and senescence.

THE DIFFERENCE BETWEEN MALATE SYNTHASE SPECIFIC ACTIVITY OF LIGHT AND DARK SPORED AGARICS IS APPARENTLY OF TAXONOMIC SIGNIFICANCE. D. G. Ruch and K. Nurtijahjahja, Dept. of Biology, Ball State University, Muncie, IN, 47306 USA.

The significant difference in specific activity of malate synthase (SAMS) between light and dark spored agarics is apparently taxonomic and not due to phenolic contamination associated with dark wall pigments. This was determined by first finding the SAMS for individual species. Next, the SAMS was determined for combined homogenates (i.e., dark spored species combined with a light spored species). If there are no interfering phenolic compounds, the observed SAMS for the combined homogenate should equal the expected SAMS (i.e., the sum of the individual SAMS for the two species combined). Results of such assays found no difference between observed and expected SAMS for combined homogenates.

MORPHOLOGICAL AND MOLECULAR PERSPECTIVES ON THE HYPOCREALES. A. Y. Rossman, Systematic Botany and Mycology Laboratory, USDA-Agricultural Research Service, Beltsville, MD 20705 USA.

The ascomycetous order Hypocreales and its anamorphs include fungi of great economic importance ranging from virulent plant pathogens to effective agents of biological control and from producers of powerful antibiotics to the sources of potent mycotoxins. In the last twenty years, progress toward understanding the systematics of the Hypocreales has been made primarily through descriptive accounts of species including their related anamorphs centered around the Hypocrean, Hypomyces and Nectria complexes. Through a re-examination of type specimens, the number of genera has been reduced from over 300 to about 50. Recently, molecular studies have supported these revised generic concepts as well as presented new insights into traditional concepts of the order. Careful study of hypocrean fungi has revealed relationships among species that are based on suites of correlated characters. Characters of the anamorph often correlate with hypocrean genera and groups of species. Integration of teleomorph-anamorph taxa may be possible by combining results of morphological and molecular data.

PHYLOGENETIC RELATIONSHIPS WITHIN THE ORDER ERYSIPELAE BASED UPON THE NUCLEAR LARGE SUBUNIT AND ITS RDNA SEQUENCE DATA. Gregory S. Saenz, and John W. Taylor. Department of Plant Biology, University of California, Berkeley, CA 94720-3102.

Using nuclear small subunit rDNA sequences, we found the Erysiphales group with a basal assemblage of apothecial ascomycetes (Mycologia 1993. 86:212-216). Phylogenetic relationships within the order of powdery mildew fungi have been proposed using sexual and asexual morphological characters, but it is unclear as to which characters are ancestral and which are derived. We are using molecular characters to infer phylogenetic relationships within the order powdery mildews. The internal transcribed spacer (ITS) region of the rRNA gene was sequenced previously, but portions of the spacer regions were found to be too variable for generic analyses. We are now sequencing the nuclear large subunit for several genera of powdery mildew fungi (Blumeria, Cystotheca, Erysiphe, Microsphaera, Phyllactinia, Podosphaera, Sphaerotheca, and Uncinula). Results from the two genic regions will be presented.

1995 MSA abstracts, page 36
MELIOLACEAE: A FAMILY WITHIN THE PYRENOMYCETES, BASED UPON MOLECULAR SEQUENCE DATA. Gregory S. Saenz, and John W. Taylor. Department of Plant Biology, University of California, Berkeley, CA 94720-3102.


FUNGITOXICITY OF SULFURYL FLUORIDE TO CERATOCYSTIS FAGACEARUM IN VITRO AND IN WILTED RED OAK. E. L. Schmidt and R. P. Woodward, Dept. Forest Products, Univ. Minnesota, St. Paul, MN 55108 USA.

Red oak veneer logs exported to the EEC must be fumigated with methyl bromide to assure eradication of the oak wilt fungus. With pending EPA restriction on methyl bromide use, an alternate fumigant may be required for phytosanitation. Sulfuryl fluoride (SF-Vikane) is used extensively for insect eradication, but fungicidal reports are lacking. Fumigation of cultures of Ceratocystis fagacearum with SF killed mycelium and conidia at a dosage of approx. 3000g/hr/m3. Fumigation of end-sealed red oak log sections required six times higher levels to eradicate the fungus. Other fungi initially cultured (Graphium, Verticillium, Paecilomyces, Trichoderma) were also killed by the SF fumigation. These results suggest SF has potential for phytosanitation use on raw wood products.

DIVERSITY OF MACROMYCETES IN TEMPERATE AND TROPICAL OAK FORESTS. John Paul Schmit1 and Gregory M. Mueller2. 1The University of Chicago, Committee on Evolutionary Biology, 1025 E 57th Street, Culver Hall 402, Chicago, IL 60637. 2The Field Museum of Natural History, Department of Botany, Lake Shore Drive and Roosevelt Road, Chicago, IL 60605.

The diversity of macromycetes was measured in tenth hectare plots established in oak forests in the Indiana Dunes National Lakeshore and near San Gerardo de Dota, Costa Rica. The plot in Indiana was surveyed weekly throughout the summer of 1994, while the plot in Costa Rica was visited once in June and once in October of 1994. Overall the sporocarps of more than 60 fungi were collected in Indiana, compared to 160 found in Costa Rica. By measuring the abundance of the fungi as well as the species richness we were able to determine the shape of the species abundance curve for these communities and use this curve to estimate the true numbers of species. Further analysis allows us to determine the contribution of different ecological groups to the overall total. Wood decay fungi comprise almost half of the species from Indiana, whereas half of the Costa Rican species are ectomycorrhizae. Plant species diversity in both areas is considerably less than that of the fungi.

STRUCTURE AND DIVERSITY OF A COMMUNITY OF ARBUSCULAR MYCORRHIZAL FUNGI IN AN OLD FIELD. P. A. Schultz, Botany Department, Duke University, Durham, NC 27708 USA.

Arbuscular mycorrhizal (AM) fungal species in an old field in Durham, NC were surveyed repeatedly to evaluate the biotic and abiotic determinants of the richness and composition of the AM fungal community. Fungal diversity was determined through examination of spores extracted from field soil and by trap culturing on sorghum. Diversity estimates were enhanced when these two techniques were combined. More than 30 AM fungal species have been found at this site, a fourth of which are undescribed. Fungal species richness and densities of individual species are autocorrelated within the field. Seasonal differences were seen in sporulation, implying that fungal species activity are partitioned seasonally. Fungal diversity is correlated to plant species diversity. These results suggest that climate, edaphic factors, and plant species diversity all are important determinants of fungal species diversity and distribution.
A PRELIMINARY INVESTIGATION OF CHARACTER EVOLUTION IN TRICHOLOMA (TRICHOLOMATACEAE) BASED ON PHYLOGENETIC ANALYSIS OF rDNA. K. M. Shanks, Department of Botany, Duke University, Durham, NC 27708-0339.

Tricholoma is the type genus of a large and heterogeneous family of white-spored agarics, the Tricholomataceae. In this study representative species from 3 subgenera of Tricholoma, and several genera in tribe Tricholomateae were sampled to test initial hypotheses concerning evolution in Tricholoma and the Tricholomataceae including 1) monophyly of Tricholoma and the tribe Tricholomateae, and 2) homology of key characters used to define the subgenera of Tricholoma such as presence or absence of clamp connections, and pileipellis morphology. In order to provide an initial phylogenetic hypothesis for addressing these questions, data independent from morphology are being obtained from nuclear ribosomal DNA from 18 species of Tricholoma. A phylogeny based on molecular characters may provide insights into the evolution of morphological characters.

STRUCTURE AND ACTIVITY OF WATER EXPULSION VACUOLES IN ZOOSPORES OF MONOBLEPHARELLA SP. (CHYTRIDIOMYCOTA). J. P. Shields, Botany Dept., University of Georgia, Athens, GA 30602 USA.

Immunocytochemistry and cryofixation techniques were used to determine the structure and activity of the water expulsion vacuole (WEV) in zoospores of Monoblepharella sp. A model of WEV activity was developed from TEM micrographs of cryofixed spores. Membrane recycles from a large expulsion vacuole and the plasma membrane during expulsion, while smaller vacuoles accumulate at various sites in the anterior region of the spore. Disruption of the WEV by antibodies recognizing the spore surface led quickly to lysis of the spore, indicated that components of the plasma membrane are important for spore viability. Immunolocalization of clathrin to coated pits and vesicles suggested membrane recycling from the large expulsion vacuole and plasma membrane. Filamentous actin was seen in the region of WEV activity, while microtubules were not as prevalent in this region. Various cytoskeletal inhibitors were used to determine the role of microtubules and microfilaments on WEV activity.
Changes in osmolarity of the external medium provided additional information on WEV activity.

PREFERENTIAL INHERITANCE OF NON-PARENTAL MTDNA GENOMES IN A PODOSPORA ANSERINA CROSS. M. E. Siliker, J. Monroe and M. Liotta, Department of Biological Sciences, DePaul University, 1036 West Belden Avenue, Chicago IL, 60614 USA.

Podospora anserina undergoes senescence when grown vegetatively at rates characteristic of the strain. The mitochondrial DNA (mtDNA) of senescing individuals is typically rearranged, deleted, or contains amplified regions. However, isolates derived from ascospores produced by matings between senescing individuals appear rejuvenated and have intact mt genomes. Previous workers have suggested that ascospores might only arise from the genetically intact portions of the mycelium. We reported previously that six rare homokaryotic progeny from a cross between a deleted strain and a rearranged strain inherited only intact, wild type, mtDNA. We now report the germination rate, viability, longevity and inheritance of mtDNA defects for 212 ascospores from 53 asci of the same deletion/rearrangement cross. Of the 103 isolates from which DNA was obtained, none inherited the deletion, but all had the wild type configuration instead of the rearrangement. About 20% inherited trace amounts of the mitochondrial DNA rearrangement in addition to the wild type configuration. These results provide further evidence that the mtDNA in the ascospores is not just a reflection of the mtDNA in the mycelium that produced it. In fact, our results suggest that the majority of progeny inherited mtDNA that had undergone recombination.

DESCRIPTION OF CHAETOMIDIIUM HETEROTRICHUM FROM VENEZUELA. D. M. W. Silva, and R. T. Hanlin, Dept.of Plant Pathology, University of Georgia, Athens, GA, 30602-7274.

A species of the genus Chaetomidium with 4-spored ascii was isolated from fallen leaves of an unknown tree during a mycofloral survey of materials from the 'Gran Sabana' region in Southeastern Venezuela. The species was identified as C. heterotrichum. It is characterized by a peritheci um without a neck or ostiole, a peridium composed of textura angularis, and covered by hairs and setae (mostly at the apex). The asci are evanescent, with obovate ascospores with a distinct germ pore. A phialoconidium-t ype anamorph is present. This is the first report of this species in Venezuela and the second time C. heterotrichum has been found. An illustrated description and a key to species of Chaetomidium, based on morphologic characters in the literature, are provided.
LEPTOGRAPHIUM PYRINUM IS A MYCANGIAL FUNGUS OF DENDROCTONUS ADJUNCTUS. Diana L. Six and T. D. Paine, Department of Entomology, University of California, Riverside, CA 92521 USA.

Several species of Dendroctonus (Coleoptera: Scolytidae) have structures developed in the integument called mycangia that are specialized for carrying specific symbiotic fungi. The mycangium of Dendroctonus adjunctus is located under a callus that surrounds the thorax. The mycangial fungus carried by D. adjunctus has not been identified prior to this time. In this study, fungi from mycangia of D. adjunctus were isolated and compared morphologically and genetically with Leptographium pyrinum and Ophiostoma adjuncti, two species of fungi known to be present in D. adjunctus colonized trees. Fungi isolated from D. adjunctus mycangia were morphologically and genetically identical to L. pyrinum.

TERRESTRIAL ORIGINS OF THE HALOSPHAERIALES FROM INSECT-ASSOCIATED FUNGI. J. W. Spatafora, B. Volkman-Kohlmeyer and J. Kohlmeyer, 1Dept. of Botany and Plant Pathology, Oregon State Univ., Corvallis, OR, 97331 USA and 2 University of North Carolina, Institute of Marine Sciences, Morehead City, NC, 28557 USA.

Partial sequences (~2000bp) were determined for the small and large subunits of the ribosomal DNA repeat unit for representatives of the Halosphaeriales. At least two phylogenetically distinct groups were identified in parsimony analyses. One large group comprised isolates sampled from the eight genera including Corollospora and Halosphaeriopsis. This group was placed as a member of the Microascales including Ceratocystis. The second group of halosphaerianan taxa consisted of isolates sampled from the genera Ludworthia and Lindra. This latter group was placed as a sister group to Sphaeronaemella fimicola and was basal to the Microascales. Both groups of halosphaerianan taxa sampled grouped with fungi with insect dispersed ascospores. The putative phylogenetic affinities of the Halosphaeriales with terrestrial insect-associated lineages provides new insights into potential morphological homologies among these fungi and evolutionary trends of perithecial marine ascomycetes.

A RECLASSIFICATION OF THE PROTOSTELIDS. F. W. Spiegel. Department of Biological Sciences, Univ. of Arkansas, Fayetteville, AR 72701, USA.

The microscopic mycetozaans known as protostelids were classified in an admittedly artificial classification by L.S. Olive in The Mycetozaans in 1975 because not enough information was avaialble for a system that was phylogenetically consistent. Work in the last twenty years has added greatly to our knowledge of the characters of the group. More complete light microscopic and ultrastructural studies have provided a greater number of characters to assess. There is a greater understanding of life history and ontogenetic characters. Some molecular systematics work is consistent with Olive's hypothesis that the protostelids, myxomycetes, and dictyostelids represent a monophyletic group, the Eumycetozoa. An appreciation of the principles of cladistic classification has led to the realization that the Protostelia is a paraphyletic taxon with respect to the Myxogastria (myxomycetes) and Dictyostelia. A new classification of the Eumycetozoa is presented in which protostelids are placed in monophyletic taxa to the extent possible. Taxa of uncertain status are identified and suggestions are offered to help resolve their phylogenetic and taxonomic positions.

EVOLUTIONARY RELATIONSHIPS AMONG RHABDOCLINE SPECIES ON PSEUDOTSUGA MENZIESII AND MERIA LARICIS ON LARIX SPP. J. K. Stone and D. S. Gernandt, Dept. of Botany and Plant Pathology, Oregon State University, Corvallis OR, 97331 USA.

Rhabdocline parkeri, a nonpathogenic, intracellular foliar endophyte with an associated Meria anamorph, is ubiquitous in foliage of Pseudotsuga menziesii in the Pacific Northwest. The congeneric species R. pseudotsugae and R. weirii are defoliating pathogens with anamorphs in Rhabdogloeum. The three species are known only from Pseudotsuga menziesii foliage. Meria laricis, a defoliating pathogen of Larix spp. is virtually identical morphologically to the Meria anamorph of R. parkeri, but has no known teleomorph. We are using ITS1 and ITS2 sequence data to infer the evolutionary relationships among Rhabdocline spp. and specifically to test the hypothesis that R. parkeri and M. laricis are sister species that have diverged through host-mediated isolation. Because the pathogenic species of Rhabdocline grow poorly in culture, we are using the size differential between ITS1 of conifers (ca 2600 bp) and fungi to selectively amplify fungal DNA directly from infected foliage.

1995 MSA abstracts, page 39
PHYLOGENETICS AND MOLECULAR EVOLUTION OF ASPERGILLUS AND RELATED TAXA: DIVERGENCE AND CONVERGENCE. J. Sugiyama, M. Tamura, and H. Ogawa, Institute of Molecular and Cellular Biosciences, Univ. of Tokyo, Yayoi, Bunkyoku, Tokyo 113, Japan.

Phylogenetic systematics of Aspergillus is controversial. This talk will focus on the phylogeny and molecular evolution of Aspergillus and related taxa based on 18S rDNA sequence analysis. Our polyphasic study to elucidate the identity of Aspergillus penicilloidei, the typical xerophilic species, will serve as an example for a discussion of divergence and convergence. In a dendrogram to emphasize the similarities in the enzymatic patterns by a computer-assisted procedure, 16 isolates of A. penicilloidei in sect. Restricti and 26 isolates of related taxa in subgen. Aspergillus formed 22 clusters at a 60% similarity level. Strains of A. penicilloidei were scattered into 11 clusters. The zymogram indicates great divergence of isolates assigned to A. penicilloidei. All isolates of A. penicilloidei, except for IFO 8155 (originally identified as A. vitriolae), had Q-9. Our rDNA sequence-based tree shows that Aspergillus and related teleomorphs may be monophyletic. It also suggests that phylogenetic divergence among the selected isolates of A. penicilloidei. The results of an expanded analysis will be discussed.

CONVERSION OF FERULIC ACID TO 4-VINYLGUAIACOL BY YEASTS ISOLATED FROM FROZEN CONCENTRATED ORANGE JUICE. J. B. Sutherland, L. A. Tanner, J. D. Moore, J. P. Freeman, J. Deck, and A. J. Williams. National Center for Toxicological Research, Food and Drug Administration, Jefferson, AR 72079, USA.

Yeasts isolated from ten different brands of frozen concentrated orange juice were grown in Sabouraud dextrose broth at 25 C and tested for the ability to cometabolize ferulic acid, a naturally occurring constituent of orange juice. Strains identified as Rhodotorula sp., Candida lambica, Trichosporon pullulans, and Candida intermedia transformed ferulic acid to an off-flavor compound. The metabolite was purified by thin-layer chromatography and identified by UV absorption spectrophotometry, gas chromatography/mass spectrometry, and nuclear magnetic resonance spectroscopy as 4-vinylguaiacol. Even at 50 to 75 µg/L, this compound causes detectable changes in the flavor of orange juice. By decarboxylating ferulic acid, these and other yeasts have the potential to contribute to off-flavors in improperly stored fruit juices.

THE PLATYGLOEALES AND SPORIDIALES ARE POLYPHYLETIC. Eric C. Swann and David J. McLaughlin, Dept. of Plant Biology, University of Minnesota, St. Paul, MN 55108 USA.

The Sporidiales was erected to segregate saprobic, teliospore forming basidiomycetous yeasts at the ordinal level from the plant parasites of the Ustilaginales. The separation of Sporidiales from the Ustilaginales was an improvement in that it recognized the separateness of the two groups, and as a result has received a considerable amount of usage, especially in the yeast systematics community. The order Platygloeales was erected to accommodate certain basidiomycetes having simple septal pores and transversely seattle metabasidia. The Platygloeales has not been widely used. Phylogenetic analysis of the 18S rRNA gene sequence demonstrates that not only are the Platygloeales and Sporidiales polyphyletic, but that they are actually intermixed with each other and with members of other orders. Orders based on a combination of genomic sequence information and sound ultrastructural studies are suggested to be more reflective of phylogenetic relationships than those based solely on light microscopic observations.

COMPARISON OF TWO WETLAND ECOSYSTEMS AT DIFFERENT STAGES OF SUCCESSION. J. Tamasi¹, I. Charvat¹ and R. Jacobson², Dept of Plant Biology, Univ. of Minnesota, St. Paul, MN 55108 USA¹ and Minnesota Dept of Transportation, Oakdale, MN 55128 USA².

This study determined the amount of arbuscular mycorrhizal (AM) fungal spores and several physical characteristics at two sites: 1) a newly created wetland at an early stage of succession and 2) an undisturbed wetland at a later stage of succession. Soil cores were collected during the summer and the AM fungal spores were isolated and characterized from the soil. Other characteristics which were determined include nutrient composition, amount of organic matter, percent water, density, pH, and preliminary identification of vegetation. A significantly quantity of spores and a high degree of diversity of spores were found at both sites. The amount of total carbon, the percent organic matter, and the percent water by volume of the soil was greater at the undisturbed wetland. The biological and physical tests employed in this study will be used in the future to evaluate the condition of the newly created wetland at progressive stages of succession.
**TUBAKIA DRYINA**: CONIDIUM FORMATION AND THE INFECTION PROCESS. J. Taylor, S. Pursley, and S. Clark, Dept. of Biology, Stephen F. Austin State Univ., Nacogdoches, TX 75962.

The imperfect fungus *Tubakia dryina* was isolated from infected sweet gum (*Liquidambar styraciflua*) leaves and grown in pure culture. Nomarski differential interference contrast light microscopy, epifluorescence light microscopy, scanning electron microscopy, and transmission electron microscopy were used to study spore formation, infection, and the host-parasite relationship. Conidiogenous cells were phialidic and produced enteroblastic conidia. Conidia grown in pure culture.

**ECTOMYCORRHIZAL EPIPARASITISM AND HIGH SPECIFICITY IN THE MYCORRHIZAL ASSOCIATIONS OF THE PHANTOM ORCHID.** L. Taylor and T. D. Bruns, Dept. of Plant Biology and Dept. of Environmental Science, Policy and Management, Univ. of California, Berkeley CA, 94720 USA.

Specificity in the phantom orchid, *Cephalanthera austinae* was rigorously tested by sampling throughout the geographic range of the orchid. Symbiont identification and phylogenies were obtained using PCR amplification and sequencing of two ribosomal gene regions which have complementary levels of conservation. These regions were amplified from DNA extracted directly from anatomically "endomycorrhizal" orchid tissue. All symbionts were found to belong to the Thelephoraceae. A search was then made for ectomycorrhizal tree roots in soil cores taken below orchid flowers. Ectomycorrhizae with matching molecular fingerprints were consistently found, showing that the orchid is indirectly linked to immediately adjacent ectomycorrhizal roots of photosynthetic hosts. The mycorrhizal morphology of the same fungus on orchid and tree hosts is strikingly different.

**LICHEN SECONDARY METABOLITES INHIBIT CELL WALL-DEGRADING ENZYMES PRODUCED BY THE LICHEN PARASITE NECTRIA PARMELIAE.** A. P. Torzilli and J. D. Lawrey, Dept. of Biology, George Mason University, Fairfax VA, 22030 USA.

Cell wall-degrading enzymes of the lichen parasite *Nectria parmeliae* exhibit sensitivities to the secondary compounds of two lichens, *Punctelia rudecta* and *Flavoparmelia baltimoresensis*, that reflect known differences in the parasite's ability to degrade these lichens. In the case of *Punctelia rudecta*, which is apparently well-defended chemically from *N. parmeliae*, the activity of wall-degrading polysaccharidases produced by *N. parmeliae* was reduced by half in the presence of secondary compounds. In the case of *Flavoparmelia baltimoresensis*, which is apparently poorly-defended, there was an initial suppression of growth and enzyme production on walls containing secondary compounds. However, growth was observed to increase during the second week, at which time no effects of secondary compounds on enzyme activity were evident. These results are significant because: (1) they are the first demonstration that the degradative ability of a lichen parasite is based on the production of wall-degrading enzymes; and (2) they indicate an important role of lichen secondary metabolites in modulating this degradative ability.

**GLOBAL CLIMATE CHANGE EFFECTS ON ECTOMYCORRHIZAE.** A. R. Tuininga1, P. T. Rygiewicz2, and K. J. Martin3. 1Department of Botany and Plant Pathology, Oregon State University; 2US EPA Environmental Research Lab; 3ManTech Environmental Services, Inc., Corvallis, Oregon 97333.

Global climate change, including increases in temperature and levels of CO2, may cause changes in carbon allocation in plants. Changes in carbon allocation along with changes in soil moisture and soil temperature due to global climate change may affect fungal species distributions as well as species interactions and colonization. Ectomycorrhizae provide nutrients to and increase growth of forest trees in temperate forests. Some mycorrhizal fungi are relatively more host specific than others. Changes in distribution of mycorrhizal fungi could affect mycorrhizal formation. A two by two factorial design is used to investigate effects of elevated temperature and increased CO2 on mycorrhizal colonization, distribution, and succession in chambered terracoms. Gross morphology is used in conjunction with PCR-RFLP analyses to determine species composition. RFLP patterns are used to determine validity of morphotypes and variation within morphotypes. After one year, elevated temperature has increased dominance and elevated CO2 has increased overall numbers of types.

*1995 MSA abstracts*, page 41
A dematiaceous Coelomycete with hyaline β-conidia colonized basal portions of stalks of *Zea mays* growing in a continuous corn and minimum cultivation field. Morphologically, the fungus can be identified as *Phaeocytostroma ambiguum* but differs in the possession of beta-conidia. The presence of β-conidia in a *Phaeocytostroma* appearing fungus suggests a need for taxonomic reconsideration of the genus. This paper reports the presence of β-conidia in *Phaeocytostroma*, and the recurrence of the fungus on corn in the United States.

**LIGHT AND ELECTRON MICROSCOPE STUDY OF THE DEVELOPMENT OF RESISTANT SPORANGIA IN "ALLOMYCES MACROGYNUS."** M. M. Vargas, J. M. Aronson and R. W. Roberson, Dept. of Botany, Arizona State University, Tempe, AZ 85287 USA.

Light and electron microscopy were used to study the cytoplasmic changes during the development of resistant sporangia (RS) in "Allomyces macrogyinus." An aggregation of organelles (lipids, mitochondria and vesicles of different sizes) were observed in the center of the cytoplasm during early development of RS. Papilla-like structures were observed in the walls of RS. Darkening areas of electron-opaque layers were observed in the wall, presumably as a result of melanization. Different layers of cell wall were observed. Lipid droplets increased in size and number while the size of mitochondria decreased. Vesicles increased in size and number in early stages but were not seen in later stages.

**CONTRIBUTION TO STUDY OF SOIL MICROMYCETES OF DIFFERENT AREAS OF ISRAEL.** P. Volz and S. P. Wasser, Mycology laboratory, Eastern Michigan Univ., Ipsiatlanti MI, 48197 USA and Institute of Evolution, Univ. of Haifa, Mt. Carmel, Haifa 31905, Israel.

Species content of soil micromycetes of different areas of Israel (Haifa, Akko, Caesarea, Cana, Nazareth, Tiberias, Jordan River shore, Jericho, Jerusalem, Bethlehem, Masada, Dead Sea shore) were studied. A total 83 species belonging to 59 genera were found in 74 soil samples collected in Israel during February-March 1994. Many species belonging to the Deutermycetes were discovered, plus a few species belonging to other classes including Zygomycetes and Ascomycetes. 18 of them are new and rare for the biota of Israel. Peculiarities of species and genera content of soil micromycetes of different regions of Israel are mentioned. The dermatophyte, *Microsporum gypseum* (Bodin) Guiart et Grigorakes, and keratinophilic species of genus *Chrysosporium* (*Ch. asperatum* Carmich., *Ch. evolceanui* (H.S. Randhawa et D.K. Sandhu) Garg., *C. indicum* (H.S. Randhawa et D.K. Sandhu) Garg., *Ch. keratinophilium* (Frey) Carmich., *Ch. pannorum* (Link.) Hughes) were commonly isolated in Israel soil.

**DECONSTRUCTING WESTERN GALL RUST.** D. R. Vogler, Dept. of Environ. Sciences, Policy, and Management, 108 Hilgard Hall, University of California, Berkeley, CA 94720-3110 U.S.A.

Western gall rust (*Peridermium harknessii* J.P. Moore; syn. *Endocronartium harknessii* (Moore) Y. Hiratsuka) was first found infecting ponderosa pine at Colfax, California in April or May of 1876, but was not officially described until 1884, when it was reported infecting pine species both in the Sierra Nevada and Coast Ranges. The type specimen, which was stored at the California Academy of Sciences in San Francisco, was lost during the 1906 earthquake and fire. Since then, questions have persisted about this rust fungus: What was the host species of the original type specimen? Are the Sierra Nevada and Coast Range gall rusts separate species? Is the pathogen capable of facultative heteroecism? If so, does it infect *Quercus* or *Castilleja* spp.? What heteroecious *Cronartium* sp. is its most recent ancestor? Because of insufficient data, there has been much speculation about this fungus. A perusal of published and unpublished literature on western gall rust suggests that relativism has often prevailed where realism should dominate. I review the history of attempts to characterize this rust fungus, compare it with what we know from isozyme and nucleotide sequence studies, and suggest that a dose of historical analysis may remind us of some of the shortcomings of our science.

**1995 MSA abstracts**, page 42
RIVER BASIN. N. S. Weber, Department of Forest Science, Oregon State University, Corvallis, OR 97331 USA.

Label data on Pezizales collected in the portion of the Columbia River Basin in the United States east of the crest of the Cascades and deposited at BPI, ID, MICH, NY, OSC, WSP, and WTU were analyzed. About 400 names were encountered; about 200 names remained once obvious synonyms were recognized. The number of collections per name was determined, and each taxon was assigned to one or two likely functional groups (e.g., mycorrhizal, coprophilous). Number of collections per name proved to be of relatively little value as an estimate of abundance. Certain functional groups (e.g., coprophilous and phoenicoid taxa) were poorly represented in these herbaria. The number of collections per decade, per state, and per major collector were calculated. The data on number of collections per decade indicate more about the abundance of collectors than about the fungi themselves.

A NEW SPECIES OF OPHIOSTOMA WITH A LEPTOGRAPHIUM ANAMORPH FROM LARCH IN JAPAN. K. v.d. Westhuizen, M. J. Wingfield, Y. Yamoaka, G. H. J. Kemp and P. W. Crous*, Dept. of Microbiology and Biochemistry, Univ. of the Orange Free State, P.O. Box 339, Bloemfontein 9300, South Africa; *Dept. of Plant Pathology, Univ. of Stellenbosch, P. Bag X1, Stellenbosch 7602, South Africa.

Recent surveys of felled Larix logs infested with Ips cembrae (Coleoptera: Scolytidae) in the Mount Fuji area of Japan have yielded numerous ophiostomatoid fungi. One of these Ophiostoma species superficially resembles Ophiostoma penicillatum in having allantoid ascospores with sheaths. However, the conidia of the Leptographium anamorph are small obovoid, and distinct from those of O. penicillatum, which are characteristically large, and cylindrical to allantoid. On the basis of the morphologically distinct anamorphs, we conclude that this collection from Larix represents a new Ophiostoma holomorph. It is consequently described as Ophiostoma laricis, with Leptographium laricis as anamorph.

SAPROLEGNIASIS IN SALMON. H. C. Whisler, Dept. of Botany, Univ. of Washington, Seattle, WA. 98195.

Species and sub-species variation in isolates of Saprolegnia from salmon in the Pacific NW, USA, has been examined with RAPD and SWAPP genomic DNA markers. These techniques permit discrimination between new isolates of this water mold at the sub-specific level from both wild and hatchery locations. The large majority of our isolates fall within the "species" S. parasitica, as defined in other recent reports on saprolegniais.

COMPARISON OF BLACK SPOT INFECTION ON RESISTANT AND SUSCEPTIBLE ROSE VARIETIES. R. J. Wiggers, J. Taylor, and J. G. West, Dept. Biology, Stephen F. Austin State University, Nacogdoches, TX 75962 USA.

The infection process of Diplocarpon rosae, the causal organism of black spot, was compared on two resistant species roses and two susceptible hybrid tea roses using light and electron microscopy. No difference in spore germination rates were observed. Scanning electron microscopy revealed no differences in germ tube formation between resistant and susceptible varieties. Time course studies using detached rose leaves indicate that germ tube penetration occurs on the resistant varieties and that resistance appears to be due to a hypersensitive response rather than inhibition of fungal spore germination as previously reported.

COSTS AND BENEFITS OF HARBORING ACREMONIUM- AND P-ENDOPHYTES IN AGRICULTURAL AND NON-AGRICULTURAL GRASSES. D. Wilson and E. N. Feuerbacher, Dept. of Zoology, Arizona State University, Tempe AZ, 85287.

Clavicipitaceous systemic endophytes are widespread among species of Festuca. Many studies have illustrated the benefits of infection to the host plants. However, most studies examine the Acremonium endophytes which infect agricultural grass cultivars which have undergone intense artificial selection for agriculturally desirable characteristics. Very little is know about the consequences of infection by the less widespread p-endophytes, or how these endophytes affect non-agricultural grasses. We compared growth characteristics of Festuca arundinacea cv Georgia Jessup with the following infection status: (1) Acremonium infected, (2) Acremonium and p infected, (3) p only infected, and (4) endophyte-free, growing under nitrogen fertilized and non fertilized conditions. Feeding trials were then conducted to test how nitrogen limitation interacted with infection status to affect the plants susceptibility to herbivory. Comparative feeding trials were conducted with Acremonium infected, and uninfeclted Festuca arizonica, a non-agricultural grass. We found depressed growth of grasses infected with the p-endophyte under nitrogen limitation. In addition, enhanced herbivore resistance of Acremonium infected plants was only detected in nitrogen fertilized plants.
ENDOGONALES OF TAIWAN: *PERIDIOSPORA* Gen. Nov. and *P. PIERIS, P. UNDULATA, P. ARACHIS, SPP. NOV.* (ENDOGONACEAE). Chi-Guang Wu and Suh-Jen Lin, Soil Microbiology Lab, Dept. of Agricultural Chemistry, Taiwan Agricultural Research Institute, Wu-feng, Taichung, Taiwan, and Dept. of Soil Fertilizer, Hualien District Improvement Station, Chi-an, Hualien, Taiwan.

A new genus *Peridiospora* in the Endogonaceae is described. *Peridiospora* is characterized by producing a pigmented sporocarp with one zygospore enclosed by a hyphal mantle. Zygospores were first isolated from the mountain area of National Yu-shan Park, Central Taiwan. *Peridiospora* is mostly associated with *Pieris taiwanensis*. Three species are described, *P. piersis, P. undulata* and *P. arachis*. *Peridiospora arachis* was collected from the rhizosphere of peanut in Eastern and Western Taiwan. This is the first record of Endogonales in Taiwan.

SOME *LACHNUM* SPECIES NEW TO TAIWAN. M. L. Wu, Dept. of Natural Sciences, Taipei Municipal Teachers' Coll., Taipei, Taiwan, R. O. C.

The tropical, long-spored, lignicolous and short-spored foliicolous species of *Lachnum* have been collected from Fushan with elevations between 700-1400 m. *Lachnum abnorme* and *L. patena* from decaying wood, *L. virginianum* from fallen leaves and *Dasyscyphus oncosperrmatis* from petioles of *Gymnosphaera podophylla* and *Histiopteris incisa*, are reported from Taiwan for the first time. The four species are described and illustrated based on materials collected from north-eastern Taiwan between 1994-1995.


An affinity between the mycotas of eastern North America and eastern Asia has been suggested due to the number of taxa that presumably occur in both areas, including several that are reported to have disjunct distributions. However, the degree of similarity between eastern North America and eastern Asia varies among taxa. For example, the Simpson Coefficient of similarity calculated on the basis of documented taxonomic treatments for *Amanita, Lactarius, Pleurotus, Ramaria*, and *Boletaceae* range from low to a value that is comparable or higher to that between eastern and western North America. While many genera of macrofungi are widely distributed in the Northern Hemisphere, disjunct distributions of macrofungi are usually only seen at lower taxonomic levels. Additionally, genetic divergence between morphologically similar but geographically isolated species have been detected. Further study at both morphological and molecular levels to assess the relationships between the mycotas of the two areas are warranted.

GLOMALES OF TAIWAN: VII. *TRAPPEA* GEN. NOV. and *T. MACROSPORA* SP. NOV. Chi-guang Wu and Suh-Jen Lin, Soil Microbiology Lab, Dept of Agricultural Chemistry, Taiwan Agricultural Research Institute, Wu-feng, Taichung, Taiwan, and Dept. of Soil Fertilizer, Hualien District Improvement Station, Chi-an, Hualien, Taiwan.

A new genus *Trappea* in the Acaulosporaceae is described to honor Dr. J. Trappe, who first introduced the knowledge of mycorrhizae to Taiwan in 1972. *Trappea* was isolated from the mountain area with average altitudes of 2500 meter in the National Yu-shan Park of Central Taiwan. *Trappea* is characterized by producing spores directly within the sporiferous sacculle and includes one species *T. macrospora*. Spore ontogeny among the genera of Glomales is compared to a key to the genera in the Glomales is also provided.

ISOLATION AND CHARACTERIZATION OF A FREE-LIVING SPECIES OF *PIROMYCES* FROM A POND. D. A. Wubah and D. Kim Department of Biological Sciences, Towson State University, Towson, MD 21204.

The genus *Piromyces* consists of obligately anaerobic fungi that produce a monocentric thallus and a monoflagellate zoospore. To date, the species of *Piromyces* described were isolated from the rumen and dung of herbivores, especially cattle and sheep. We have isolated a new species of *Piromyces* from the sediment collected from a pond located in a cow pasture in Frederick, MD. The depth of the water in the pond was 18-24 inches. The organism was obtained by a modification of the methods used to isolate the rumen fungi. Its single flagellum is directed toward the posterior and the diameter of the zoospore is 9-14 µm. Encysted zoospores produce a single germ tube that develops into the main stalk of the young thallus. Unlike other *Piromyces* species, the cyst does not persist after germination in this isolate. The thallus consists of a highly-branched rhizoidal system, a stalk and a zoosporangium with a diameter of 45-90 µm. No apophysis has been observed between the stalk and the zoosporangium. At maturity, zoospores are released through a pore in the wall of the zoosporangium.
MORPHOLOGICAL AND MOLECULAR CHARACTERS OF A NEW PHIALOPHORA SPECIES. Zhonhua Yan*, Yajuan Liu, S. O. Rogers and C. J. K. Wang. SUNY College of Environmental Science and Forestry, Syracuse, NY 13210, and *National Institute of Environmental Health Sciences, P.O.Box 12233, Research Triangle Park, NC 27709.

Several isolates of a Phialophora sp. from decaying southern pine utility poles produced a blue-green diffused pigment in culture media. Microscopic characters of these isolates are distinct from other known Phialophora species. They were also different in morphology from two blue-green pigmented fungi, Phialocephala virens Siegfried & Seifert and Chlorociboria aeruginascens (Nyl.) Kar. ex Ram., Korf & Bat. Two type strains of P. virens, two multi-ascosporic cultures of C. aeruginascens, and two isolates of Phialophora from poles were subjected to DNA sequence analysis. The molecular data support the morphological conclusions that these taxa are different. A new species of Phialophora is proposed.


The influence of habitat location within a landscape context on fungal community dynamics and decomposition rates was examined using three locations within the Chihuahuan Desert. Wood from woodrat middens was collected over a two year period and fungal communities and enzymic activities determined. Although fungal species composition was similar among sites, enzymic activities in the wood differed among sites and between sample times. Using Van Valen's modification of Levene's test to estimate variability in the suite of enzymic activities, middens located in an upland juniper-oak habitat exhibited increasing variability over time, while the other two locations from mesquite dominated sites exhibited less variability and remained consistent over the two year period. Decomposition rates were also higher in the juniper-oak site than in the mesquite dominated locations. While small scale differences in either abiotic conditions or biotic interactions within woodrat middens at the three locations may not be sufficient to modify fungal species composition, environmental differences may be sufficient to alter fungal enzyme activity and subsequently decomposition. At the landscape level, small differences in fungal activity may contribute to significant changes in ecosystem processes in an arid ecosystem.


An examination of the spatial and temporal patterns in fungal community development, and enzymic activities during root decomposition were conducted in a sand-shinnery oak community in West Texas. Fungal species diversity peaked for all transects 1 year after field placement, and then declined. At all sampling times over the 15 months, only Aspergillus niger, Penicillium spinulosum, and Trichoderma harzianum were dominant taxa at all sample sites. Other taxa were codominant, but exhibited high spatial and temporal variability. Fungal species community similarity coefficients were high at the 3 month decomposition stage and subsequently decreased as decomposition progressed. Differences in fungal community composition among transects were reflected in differences in enzymic activities associated with the decomposing roots. However, the spatial and temporal variability in fungal community composition and enzymic activities had no significant effect on decomposition rates. Fungal species diversity was significantly and positively correlated to litter moisture.
<table>
<thead>
<tr>
<th>Author index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams, T. H. 22</td>
</tr>
<tr>
<td>Ahn, Young-Mee 1</td>
</tr>
<tr>
<td>Allen, E. B. 1</td>
</tr>
<tr>
<td>Allen, M. F. 1</td>
</tr>
<tr>
<td>Alvarez-Buylla, E. 26</td>
</tr>
<tr>
<td>Ammirati, J. F. 1, 26, 32</td>
</tr>
<tr>
<td>Ammirati, Joe F. 35</td>
</tr>
<tr>
<td>Anagnostakis, Sandra L. 1</td>
</tr>
<tr>
<td>Anderson, J. B. 2</td>
</tr>
<tr>
<td>Antonovics, J. 4</td>
</tr>
<tr>
<td>Armstrong, E. A. 2</td>
</tr>
<tr>
<td>Arnold, Michael L. 15</td>
</tr>
<tr>
<td>Arnott, H. J. 2</td>
</tr>
<tr>
<td>Aronson, J. M. 42</td>
</tr>
<tr>
<td>Bacon, C. W. 2, 16</td>
</tr>
<tr>
<td>Baroni, T. J. 3</td>
</tr>
<tr>
<td>Bartnicki, D. 4</td>
</tr>
<tr>
<td>Bartnicki-Garcia, S. 3, 4, 11, 28, 34, 35</td>
</tr>
<tr>
<td>Bayman, P. 4, 33</td>
</tr>
<tr>
<td>Bennett, J. W. 13</td>
</tr>
<tr>
<td>Berbee, M. L. 4, 26</td>
</tr>
<tr>
<td>Berubé, J. 34</td>
</tr>
<tr>
<td>Bettucci, L. 9</td>
</tr>
<tr>
<td>Bever, J. D. 4</td>
</tr>
<tr>
<td>Birdwell, D. 5</td>
</tr>
<tr>
<td>Blackwell, M. 21</td>
</tr>
<tr>
<td>Blanche-Santiago, Y. 33</td>
</tr>
<tr>
<td>Boerner, R. E. J. 5</td>
</tr>
<tr>
<td>Bourret, T. M. 5</td>
</tr>
<tr>
<td>Boyd, M. L. 5</td>
</tr>
<tr>
<td>Bracker, C. E. 4, 6, 11, 27, 28, 34</td>
</tr>
<tr>
<td>Bruns, T. D. 6, 14, 19, 24, 41</td>
</tr>
<tr>
<td>Caesar, A. 31</td>
</tr>
<tr>
<td>Caesar-TonThat, T. 6</td>
</tr>
<tr>
<td>Camacho, F. J. 7</td>
</tr>
<tr>
<td>Cantrell, S. A. 7</td>
</tr>
<tr>
<td>Capitano, B. 7</td>
</tr>
<tr>
<td>Carrero, A., Jr. 4</td>
</tr>
<tr>
<td>Carris, L. M. 5</td>
</tr>
<tr>
<td>Carroll, G. C. 7</td>
</tr>
<tr>
<td>Castellano, M. 25</td>
</tr>
<tr>
<td>Castlebury, L. A. 7</td>
</tr>
<tr>
<td>Chan, J. Y. H. 9</td>
</tr>
<tr>
<td>Chang, S. T. 8</td>
</tr>
<tr>
<td>Chapela, Ignacio H. 8</td>
</tr>
<tr>
<td>Charvat, I. 40</td>
</tr>
<tr>
<td>Chen, A. W. 8</td>
</tr>
<tr>
<td>Chen, M. J. 8</td>
</tr>
<tr>
<td>Chen, S. F. 8</td>
</tr>
<tr>
<td>Chen, Weidong 12</td>
</tr>
<tr>
<td>Cheung, W. M. W. 8</td>
</tr>
<tr>
<td>Chien, C. Y. 8</td>
</tr>
<tr>
<td>Chiu, S. W. 8, 9</td>
</tr>
<tr>
<td>Chu, C. C. 22</td>
</tr>
<tr>
<td>Chung, K. -R. 9</td>
</tr>
<tr>
<td>Cibula, W. G. 13</td>
</tr>
<tr>
<td>Cigelnik, L. 32</td>
</tr>
<tr>
<td>Clark, S. 41</td>
</tr>
<tr>
<td>Clay, K. 23</td>
</tr>
<tr>
<td>Cobb, F. W. 14</td>
</tr>
<tr>
<td>Cochrane, B. J. 31</td>
</tr>
<tr>
<td>Coggin, Steven J. 21</td>
</tr>
<tr>
<td>Correa, A. 9</td>
</tr>
<tr>
<td>Correll, J. C. 9</td>
</tr>
<tr>
<td>Covert, S. F. 12, 30</td>
</tr>
<tr>
<td>Crane, J. L. 12</td>
</tr>
<tr>
<td>Cripps, Cathy L. 10</td>
</tr>
<tr>
<td>Crous, P. W. 10, 43</td>
</tr>
<tr>
<td>Danell, E. 10</td>
</tr>
<tr>
<td>Davidson, G. R. 11</td>
</tr>
<tr>
<td>de Cock, Arthur W.A.M. 22</td>
</tr>
<tr>
<td>Decher, M. 1</td>
</tr>
<tr>
<td>Enkerli, J. 12</td>
</tr>
<tr>
<td>Enkerli, K. 13</td>
</tr>
<tr>
<td>Eversmeyer, M. G. 13</td>
</tr>
<tr>
<td>Ellis, Richard 12</td>
</tr>
<tr>
<td>Enkerli, J. 12</td>
</tr>
<tr>
<td>Enkerli, K. 13</td>
</tr>
<tr>
<td>Eversmeyer, M. G. 13</td>
</tr>
<tr>
<td>Feibelman, T. P. 13</td>
</tr>
<tr>
<td>Feuerbacher, E. N. 43</td>
</tr>
<tr>
<td>Fisher, P. J. 27</td>
</tr>
<tr>
<td>Fogel, Robert 13, 28</td>
</tr>
<tr>
<td>Frederick, B. 6</td>
</tr>
<tr>
<td>Freeman, J. P. 40</td>
</tr>
<tr>
<td>Freitag, M. 14</td>
</tr>
<tr>
<td>Frieders, E. M. 14</td>
</tr>
<tr>
<td>Fukumasa-Nakai, Y. 19</td>
</tr>
<tr>
<td>Garbelotto, M. 14</td>
</tr>
<tr>
<td>Gardes, M. 6</td>
</tr>
<tr>
<td>Gargas, Andrea 15</td>
</tr>
<tr>
<td>Garrison, R. A. 15</td>
</tr>
<tr>
<td>Geiser, David M. 15</td>
</tr>
<tr>
<td>Gerandt, D. S. 7, 15, 39</td>
</tr>
<tr>
<td>Gierz, G. 4, 11</td>
</tr>
<tr>
<td>Giess, P. T. 29</td>
</tr>
<tr>
<td>Giess, Paul T. 16</td>
</tr>
<tr>
<td>Glenn, A. E. 16</td>
</tr>
<tr>
<td>Goins, T. 6</td>
</tr>
<tr>
<td>Goodnight, S. 16</td>
</tr>
<tr>
<td>Goosen, Theo 23</td>
</tr>
<tr>
<td>Grove, S. N. 27</td>
</tr>
<tr>
<td>Grube, Martin 15</td>
</tr>
<tr>
<td>Gruhn, C. M. 16</td>
</tr>
<tr>
<td>Guerber, J. C. 9</td>
</tr>
<tr>
<td>Gunasekaran, M. 17</td>
</tr>
<tr>
<td>Gunasekaran, S. 17</td>
</tr>
<tr>
<td>Haddock, Amy A. 17</td>
</tr>
<tr>
<td>Hahn, M. G. 13</td>
</tr>
<tr>
<td>Hanlin, R. T. 7, 38</td>
</tr>
<tr>
<td>Hardt, T. A. 17</td>
</tr>
<tr>
<td>Harsney, S. 1</td>
</tr>
<tr>
<td>Harrington, F. A. 17</td>
</tr>
<tr>
<td>Harrington, T. C. 18, 20</td>
</tr>
<tr>
<td>Hatano, T. 2</td>
</tr>
<tr>
<td>Hawkins, L. K. 18</td>
</tr>
<tr>
<td>Hemmes, D. E. 11, 18</td>
</tr>
<tr>
<td>Henson, J. M. 6, 31</td>
</tr>
<tr>
<td>Herrera, Jose 18</td>
</tr>
<tr>
<td>Hibbett, D. S. 19</td>
</tr>
<tr>
<td>Hicks, K. 31</td>
</tr>
<tr>
<td>Hinton, D. M. 2</td>
</tr>
<tr>
<td>Hodge, Kathie T. 19</td>
</tr>
<tr>
<td>Horn, B. W. 19</td>
</tr>
<tr>
<td>Horton, T. R. 6, 19</td>
</tr>
<tr>
<td>Hothersall, J. 20</td>
</tr>
<tr>
<td>Howard, R. J. 5</td>
</tr>
<tr>
<td>Hsiang, Portia T. W. 20</td>
</tr>
<tr>
<td>Hu, W. W. L. 8</td>
</tr>
<tr>
<td>Huang, Yicun 28</td>
</tr>
<tr>
<td>Huhndorf, S. M. 20</td>
</tr>
<tr>
<td>Hung, L. L. 20</td>
</tr>
<tr>
<td>Hwang, B. C. 8</td>
</tr>
<tr>
<td>Imbayagwo, M. 17</td>
</tr>
<tr>
<td>Iturriaga, T. 20</td>
</tr>
<tr>
<td>Jacobson, R. 40</td>
</tr>
<tr>
<td>Janse, B. J. H. 10</td>
</tr>
<tr>
<td>Jeng, R. S. 24</td>
</tr>
<tr>
<td>Johnson, Jacqui 21</td>
</tr>
<tr>
<td>Johnson, N. C. 21</td>
</tr>
<tr>
<td>Johnson, S. 7</td>
</tr>
<tr>
<td>Jones, K. G. 21</td>
</tr>
<tr>
<td>Jones, Tammy Jo 21</td>
</tr>
<tr>
<td>Jung, H. S. 22</td>
</tr>
<tr>
<td>Kang, Y. W. 22</td>
</tr>
<tr>
<td>Keller, H. 2</td>
</tr>
<tr>
<td>Keller, N. P. 22</td>
</tr>
<tr>
<td>Kemp, G. H. J. 43</td>
</tr>
<tr>
<td>Kersey, S. E. 35</td>
</tr>
<tr>
<td>Kim, D. 44</td>
</tr>
<tr>
<td>Kim, Y. H. 22</td>
</tr>
<tr>
<td>Kimbrough, J. W. 22, 25</td>
</tr>
<tr>
<td>Klassen, Glen R. 22</td>
</tr>
<tr>
<td>Klein, A. S. 7</td>
</tr>
<tr>
<td>Kich, M. A. 22</td>
</tr>
<tr>
<td>Klironomos, J. 1</td>
</tr>
<tr>
<td>Koehn, R. D. 15</td>
</tr>
<tr>
<td>Kohli, Y. 23</td>
</tr>
<tr>
<td>Kohlmeyer, J. 39</td>
</tr>
<tr>
<td>Kohn, L. M. 23</td>
</tr>
<tr>
<td>Kovacs, R. L. 23</td>
</tr>
<tr>
<td>Kover, P. X. 23</td>
</tr>
<tr>
<td>Kozicki, M. N. 35</td>
</tr>
<tr>
<td>Kramer, C. L. 13</td>
</tr>
<tr>
<td>Kramer, C. L. 18</td>
</tr>
<tr>
<td>Kramer, Cas 23</td>
</tr>
<tr>
<td>Krasinoff, Stuart B. 19</td>
</tr>
<tr>
<td>Kretzler, A. 24</td>
</tr>
<tr>
<td>Krug, J. C. 24</td>
</tr>
<tr>
<td>Kuehn, K. A. 24</td>
</tr>
<tr>
<td>Kuhn, D. N. 34</td>
</tr>
<tr>
<td>Kurtzman, R. H., Jr. 24</td>
</tr>
<tr>
<td>Lake, N. 31</td>
</tr>
</tbody>
</table>

1995 MSA abstracts, page 46
Law, A. S. C. 9
Law, L. A. 25
Lawrey, J. D., 41
Leacock, P. R. 25
Lebel, T. 25
Lebrbn, L. L. 4
Lee, F. N. 9
Lewis, F. A. 20
Li, Li-Tzu 22.25
Li, Y. 24
Lin, Suh-Jen 44
Liotta, M. 38
Liston, A. 7, 26
Liu, Y. J. 26
Liu, Yajuan 35, 45
Lizon, P. 20
LoBuglio, K. F. 26
Lodge, D. J. 3, 27
Lodge. D. J. 4
Lopez, L. E. 2
L6pez-Franco, R. 4, 27
Lowen, Rosalind 27
Lowry, D. S. 27
Lü, H. 28
Lü, Haisheng 28
Lukens, L. 28, 29
Lussenhop, John 28
Lutzer, F. 28
Ma, M. 36
Marra, R. E. 29
Martin, C. A. 16
Martin, K. J. 41
Matzke, E. 29
May, G. 28, 29
May, Georgiana 16
McClenehan, S. C. 29
McKemy, J. M. 30
McLaughlin, D. J. 14, 25
McLaughlin, David J. 28, 40
McMurray, K. M. 16
McNew, D. M. 18
Melew, J. 36
Miles, P. G. 8
Milgroom, M. G. 29
Miller, O. K., Jr. 31
Miller, Orson K., Jr. 10
Mims, C. W. 13, 30
Monroe, J. 38
Moore, D. 8
Moore, D. L. 30
Moore, J. D. 40
Morre, D. J. 28
Morton, J. B. 4
Moser, M. 1
Mueller, G. M. 30, 44
Mueller, Gregory M. 37
Murphy, D. J. 6, 27
Murphy, J. F. 31
Murrin, F. 31
Nash, D. 31
Nelson, R. T. 31
Newbury, Jane A. 23
Norman, J. E. 32
Norvell, L. L. 32
Nurtijahja, K. 36
O'Dell, T. 1
O'Dell, T. E. 32
O'Donnell, K. 32, 33
Ogawa, H. 40
Ortiz-Veléz, A. A. 33
Paine, T. D. 39
Palm, Mary E. 8
Peberdy, J. F. 20
Peberdy, John F. 23
Petersen, R. H. 29, 33
Peterson, Stephen W. 33
Pfister, D. H., 34
Pine, E. M. 30
Pinto, T. J. 34
Popenuck, T. 14
Potter, Daniel 17
Pursley, S. 41
Read, Nick D. 34
Reynaga-Peña, C. G. 34, 35
Richman, O. J. 18
Ridley, G. S. 33
Rillli, M. 1
Roberson, R. W. 27, 35, 42
Robertson, L. D. 15
Rogers, S. O. 26, 30, 35, 45
Ross, I. K. 36
Rossman, A. Y. 36
Ruch, D. G. 36
Rygiewicz, P. T. 41
Sachs, M. S. 14
Saenz, Gregory S. 36, 37
Saville, B. J. 2
Scharld, C. L. 9
Schmidt, E. L. 37
Schmit, John Paul 37
Schultz, P. A. 4, 37
Seid1, M. 1
Shanks, K. M. 38
Shearer, C. A. 1
Shields, J. P., 38
Shin, A. 36
Shinohara, M. L. 35
Silliker, M. E. 38
Silva, D. M. W. 38
Sinsabaugh, R. 45
Six, Diana L. 39
Slaughter, G. 14
Spatafa, J. W. 39
Spiegel, F. W. 2, 30, 39
Stevens, J. J. 36
Stone, J. K. 7, 15, 39
Stutz, C. 16
Suberkropp, K. 24
Sugiyama, J. 40
Sundberg, W. J. 23
Sutherland, J. B. 40
Sutton, B. 27
Swann, Eric C. 28, 40
Szaro, T. 24
Tamasi, J. 40
Tamura, M. 40
Tanner, L. A. 40
Taylor, J. 5, 41, 43
Taylor, J. W. 26
Taylor, John W. 36, 37
Taylor, L. 6, 41
Tekler, Anders 15
TeStrake, D. 31
TeStrake, Diane 17
Timberlake, William E. 15
Torzilli, A. P. 41
Trappe, J. 25
Trappe, J. M. 33
Tsai, J. 36
Tsuneda, A. 19
Tuininga, A. R. 41
Vakili, N. G. 42
Vargas, M. M. 42
Victor, D. 10
Walgaly, R. 25
Vogler, D. R. 42
Volkmann-Kohlmeyer, B. 39
Vozl, P. 42
Wang, C. K. J. 30, 35, 44
Wasser, S. P. 42
Weber, N. S. 33, 43
West, J. G. 43
Westhuizen, K. v.d. 43
Whidden, T. K. 35
Whisler, H. C. 43
Wiggers, R. J. 43
Wildman, H. 45
Williams, A. J. 40
Wilson, D. 43
Wingfield, M. J. 10, 43
Wong, G. J. 11
Woodward, R. P. 37
Wu, Chi-Guang 44
Wu, M. L. 44
Wu, Q.-X. 44
Wubah, D. A. 44
Wynn, S. R. 15
Yamoaka, Y. 43
Yan, Z. H. 35
Yan, Zhonhua 45
Yang, R. 17
Zak, J. 45
Zampiello, F. A. 20
Zhang, Q. 45

1995 MSA abstracts, page 47
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_____ Student $30 (includes Mycologia and MSA newsletter, Inoculum) (needs endorsement from major professor or school)

_____ Family $60 + $30 for each additional family member (fill out form for each individual) (includes one copy of Mycologia and two copies of Inoculum)

_____ Sustaining $250 (benefits of Regular membership plus listing in Mycologia and Inoculum)

_____ Life $1,000 (one-time payment; includes Mycologia and Inoculum)

_____ Associate $30 (includes only Inoculum)

_____ Emeritus $0 (benefits of Regular membership except Mycologia; $30 with Mycologia)

AREAS OF INTEREST: [Mark most appropriate area(s)]

_____ Cell Biology – Physiology (including cytological, ultrastructural, metabolic regulatory and developmental aspects of cells)

_____ Ecology – Pathology (including phytopathology, medical mycology, symbiotic associations, saprobic relationships and community structure/dynamics)

_____ Genetics – Molecular Biology (including transmission, population and molecular genetics and molecular mechanisms of gene expression)

_____ Systematics – Evolution (including taxonomy, comparative morphology molecular systematics, phylogenetic inference, and population biology)

PAYMENT:

_____ CHECK [Payable to The Mycological Society of America and drawn in US$ on a US bank]

_____ CREDIT CARD: _____ VISA _____ MASTERCARD

Expiration Date: ________________________

Account No.: ________________________

Name as it appears on the card: ____________________________________________