SPORE PRINTS

BULLETIN OF THE PUGET SOUND MYCOLOGICAL SOCIETY
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GARDEN MUSHROOMS

Joy Spurr
Washington Park Arboretum Bulletin, Fall, 2005

Starting in late August and continuing through the fall months, it does not require long drives to a mature forest to satisfy a mushroom hunter. After ten days of soaking rain, walk across your lawn or down your garden paths, and you may find a multitude of umbrella shaped mushrooms among the grasses, beneath trees and shrubs, and along pathways—and even a few puffball types at the edge of heather beds. The vegetative portion of mushrooms, known as mycelium, lies dormant under the soil for many months, or even years, until the favored moisture and warmth conditions cause fruiting bodies to form on the mycelium, to expand, and then to erupt above ground. Some larger sized mushrooms last for several days. Others are fragile and may decay within hours.

Mushrooms are fungi, members of the kingdom of living organisms that grow and fruit much the way plants do but which lack roots, stems, leaves, flowers, and seeds. They also lack chlorophyll, so they must get their food by absorption from living plants or animals or from their remains in decaying debris.

There are thousands of species of mushrooms throughout the world. You will soon discover that certain species always grow in a specific habitat or biological community. The mycelia of many form a beneficial relationship with other plants—particularly the roots of trees, shrubs, and grasses—that permits an exchange of nutrients and moisture and contributes to the health and growth of the host plant. There are mushroom species that have a mycorrhizal association with typical Pacific Northwest forest trees, such as western redcedar, hemlock, Douglas fir, and red alder.

If you live next to such a forest, the fruiting bodies of these fungi may pop above ground where these tree roots have invaded your lawn or garden.

Mushroom Identification

Not all mushrooms are edible. Many are poisonous, some extremely dangerous. Consult one of many available field guides, or better yet, ask an expert to correctly identify a mushroom before you consume it. The Puget Sound Mycological Society has a list of identifiers who can assist you in identifying fresh specimens. Most field guides list spore color as the first step in identification. (Mushrooms reproduce by means of spores, which range in color from white to shades of yellow, pink, brown, and black.) To determine the color of a mushroom's spore, cut the stipe (stalk) from the mushroom and place the cap gill-side down on a piece of white paper. Cover it with a glass or plastic bowl and leave for several hours. If the mushroom is sufficiently mature, spores will be deposited on the paper.

Edible Garden Mushrooms

A large, meaty mushroom, a good edible that grows in compost piles and orchards as well as in lawns, is *Agaricus augustus*, the Prince. It is easy to recognize, not only because of its large size, but also because of the somewhat squared shape of its cap, which is light tan covered with close pressed, small, reddish brown scales. It stains yellow, then orange-brown as it ages. The gills are cream, turning to rose and then purplish brown in age. The stipe is shaded with brown. Spores are purple brown. An interesting characteristic is its almond odor.

The mycelium of *Marasmius oreades* spreads evenly in all directions, seeking food, and forms a circle of fruiting bodies, often in the lawn, known as a fairy ring. Left undisturbed, such rings may, in time, become quite large. Cap color varies from white to tan; gills and stipe are of similar color. Spores are white. This species has good flavor and is easily dried for future use. If your lawn has been treated with weed killer, do not pick this mushroom, or any other edible mushrooms, for food.

Too Risky to Eat

In this same habitat there grows a poisonous mushroom known as *Clitocybe dealbata*, the Sweat-Producing *Clitocybe*. This mushroom contains muscarine, a poisonous compound which produces disagreeable cases of profuse sweating as well as other symptoms of poisoning. The cap, gills, and stipe are white to grayish; the spores, white to cream. Gills tend to run down the stipe, which helps distinguish this species from the fairy ring mushroom.

The tall, all-white *Lepiota naucina*, the White Lepiota, usually produces several fruiting bodies at the same time, an attractive contrast against a green lawn. It has white spores, and the gills are covered with a white veil, which breaks and forms a ring on the stipe. The White Lepiota is not recommended for picking as an edible, because it looks similar to several, deadly poisonous, white amanitas.

Hebeloma crustuliniforme, Poison Pie, has a cream-colored cap that is reddish brown at the center and smooth and slimy when wet, a white stipe, brownish gills, and brown spores; it gives off the odor of radish. It often forms a circle of mushrooms similar to the fairy ring of *Marasmius oreades*. Huge clusters of Poison Pie

J. Spurr

Hebeloma crustuliniforme, *Poison Pie, can make a beautiful lawn display, although it is poisonous to humans.*

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Spore Prints

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PUGET SOUND MYCOLOGICAL SOCIETY

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CALENDAR

Jan. 10	Membership Meeting, 7:30 PM, CUH
Jan. 16	Board Meeting, 7:30 PM, CUH
Jan. 18	Lichen Class
Jan. 21	Lichen Class Field Trip
Jan. 24	*Spore Prints* Deadline
Jan. 25	Lichen Class
Feb. 1	Lichen Class
Feb. 8	Lichen Class

What to Do with Mushrooms

You can cook them up in batter
in an antique frying pan.

You can make them into gravy
to pour over a flan.

You can stuff them fat with spinach
or chop them into dip.

You can pickle them and cream them,
to tantalize the lip.

You can stir them into chowder
or curry them with rice.

You can mix them up with veggies;
in a quiche they're very nice.

But one thing I will balk at
even for fashion's sake

I will refuse any time I'm offered
a piece of mushroom cake.

—Amy Belding Brown, *The Mycophile*,

MEMBERSHIP MEETING

Tuesday, January 10, 2006, at 7:30 PM at the Center for Urban Horticulture, 3501 NE 41st Street, Seattle

January's meeting will feature Alissa Allen and Patrice Benson, who will present an introduction to the use of mushrooms for color. This natural dye concept can be applied to fibers for papermaking and to wool and silk for knitting and weaving as well as for the production of ink for writing and painting.

The presentation will be in the form of slides and objects to peruse. Perhaps you may wish to try your hand at writing with mushroom ink! The multimedia potential of fungi will be apparent when you can taste the mushrooms which you are also using for color! Come get a glimpse of the science and art of using fungi for color.

If your last name begins with the letters M–Z, please bring some goodies to share.

STAMETS PATENTS FUNGAL PESTICIDE **Britt Bunyard**

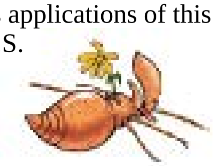
The Mycophile, North American Mycological Assoc.
November/December 2005

Many fungi are lethal to insects, and many attempts have been made to utilize such fungi as an environmentally friendly alternative to chemical pesticides. One of such fungi under investigation is *Metarhizium anisopliae*, whose spores are known to be toxic to social pests such as fire ants and termites. The problem is that the insects, sensibly enough, avoid the spores whenever they can. Thus the usefulness of spore-based bio-pesticides, which researchers have focused on in the past, has proved limited.

Mushroom guru Paul Stamets, founder of Fungi Perfecti in Olympia, Washington, discovered that before the fungus produces spores, the mycelium seems to produce a substance that serves as an attractant to the insects—therefore eliminating the need to spray onto or near the pests. The mycelium also has recruitment properties. The ants go tell others about their find, and the foraging ants carry the mycelium into their nest for further distribution throughout the colony, where it then serves as a food to the insects. Once spores emerge, the mycelium has already been widely distributed and ingested. The spores invade the insects and kill them within a matter of days. When the colony is eradicated, the stench of the spores remains and prevents recolonization.

Stamets knew he was on to something when he used *Metarhizium anisopliae* mycelia to treat carpenter ants in his house and they completely disappeared. He then gave his aunt some to use, and the carpenter ants completely disappeared from her house as well. After the mycelial bait had been taken away by the ants, his aunt found the carpenter ant queen and her worker ant minions in a swarming pile on the carpet. The colony had become so toxic that the ants abandoned it and brought the queen out into the open. After being flushed down the toilet, the ants didn't come back.

Stamets believes that there will be numerous applications of this process in agriculture. He has received U.S. Patent #6,660,290 for this invention, and the product is now being marketed by Yet2.com, a company which matches new technologies with bigger business partners.



Garden Mushrooms, *cont. from page 1*

fruited in a well watered lawn in an Issaquah subdivision for several years. Apparently weed killer chemicals applied to the lawn killed the mycelium, as it has not reappeared recently. Sad, because this was a spectacular display and did not harm the lawn, which remained green after the mushrooms decayed. As its common name indicates, it is poisonous to humans.

Conocybes are known as cone heads or dunce caps. They are fragile, are partial to warm weather, and fruit in great abundance on watered lawns. The edibility of most is unknown, but they are too small to be of food value, and some are known to be dangerously poisonous. Varying by species, the caps are white to brown and are bell shaped. There are more than 50 species in North America, largely differentiated by microscopic features. The most common conocybes in our area are *Conocybe tenera*, which is cinnamon brown or yellow, usually fading to cream in age, and *Conocybe lactea*, which is all white but darkens to cinnamon brown in age. *Conocybe lactea* is a frail fruiting body that usually appears in early morning but shrivels up by early afternoon.

J. Spurr

Conocybe tenera, *one of the most common conocybes in this area, is cinnamon-brown or yellow in color and fades to cream with age.*

Walking from the lawn into the garden, I am always excited to come across the tall *Lepiota rachodes*, the Shaggy Lepiota. As the tan cap expands, its surface breaks into pointed scales, giving it a shaggy appearance. Gills, stipe, and spores are white. The stipe thickens at its base and has a large, thick ring. Compost piles that contain grass clippings are one of its favorite haunts. The Shaggy Lepiota is considered edible, but be aware that some people have experienced gastric upset from eating it. This species is also similar in appearance to a poisonous mushroom that is prevalent in the Rocky Mountains, *Chlorophyllum molybdites.*

Don't Eat These Either

Dead trees and stumps harbor *Armillaria mellea*, the Honey Mushroom. Caps vary from tan to dark brown, the gills are cream to tan, and the stipe is tan to dark brown toward the base, with a small ring formed by the remains of a veil. It usually grows in dense clusters. Although it is considered an edible, do not eat it if the tree stumps or logs have been treated with a chemical to hasten decay. Unfortunately, because it often kills living trees, this pretty mushroom has a bad reputation among gardeners.

One of the most dangerous poisonous mushrooms that visits our gardens is *Galerina autumnalis*, which contains the deadly *Amanita* toxins. The caps are yellow-brown when moist, fading to buff when dry. The gills are a similar color, and the spores are rusty brown. The stipe is pale brown but becomes dark brown toward the base, and there is a narrow white ring on the stipe. It grows on wood and fruits in great quantities on wood-bark mulch in the garden.

J. Spurr

One of the most poisonous garden mushrooms is Galerina autunnalis, *which contains deadly* Amanita *toxins.*

A dingy yellow or brown, ball-shaped mushroom, known as *Scleroderma citrina*, the Thick Skinned Puffball, is often found fruiting among heathers. When it is cut in half, the thick, persistent rind and the dark gray to black interior spore mass distinguish this poisonous mushroom from several puffball species that are edible.

One of the prettiest mushrooms is *Aleuria aurantia,* the Orange Fairy Cup. It favors newly cultivated ground and the many, little cup-shaped fruiting bodies are bright orange. Although edible, there is very little substance to these cups. Just enjoy their charm.

In fact, given the risks involved in eating any garden mushroom, don't taste any of them. It is best just to appreciate the beauty, mystery, and important functions of these fungi—unless you choose to seek the help of an experienced mushroom identifier.

Joy Spurr, a charter member of PSMS, is also a member of the Arboretum Foundation, and her photographs often accompany articles printed in the Foundation Bulletin.

ON MUSHROOMS AND SQUIRRELS

Mary Johnston
Washington Park Arboretum Bulletin, Fall, 2005

My garden, like many others hereabout, sprouted a plethora of mushrooms last fall. This bounty brought to mind a time when my husband and I witnessed a most fantastic outdoor scene.

A red squirrel was racing up and down a tree in our garden. With binoculars I watched him as he skittered down the tree and across the ground about 5 or 6 feet from its base, where he stopped at a cluster of mushrooms. First, he bit off a chunk of one of the smaller ones; then he raced up the tree with it, parking it in the crotch of some branches. He hurried down the tree to repeat this trip several times, each time stashing chunks in different crotches. When he ran out of the small mushrooms in that particular clump, he started on the bigger mushrooms, some of them as big as salad plates!

Choosing a mushroom easily three times his size, he first broke the stem off at the ground and then half-carried, half-dragged the entire mushroom to the tree. He seemed to puzzle on this for a bit, trying to figure out how he could haul his huge treasure up the trunk. Then he separated the stem from the cap and took the stem up the tree in chunks. Even with this success, he often had frustrating mishaps, shattering pieces and scattering them below when he strove to carry his booty between branches. Down he would

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SARAH MIMS AND FUNGAL SPORES IN SMOKE

Forrest M. Mims III (http://www.forrestmims.org/)

extracted from "Mentoring Student Scientists: Four Case Studies," *Virtual Conference on Informal Science Education* conducted by the Society for Amateur Scientists (SAS)
1 May 2004 (http://www.sas.org/)

In the following article, Forrest M. Mims describes mentoring his high-school daughter Sarah in an experiment that discovered viable fungal spores in smoke arriving in Texas from Yucatan and Central America.

Background

All three of my children excelled at doing science projects in school. Therefore, some background is in order before describing Sarah Mims' rather amazing discovery of living fungal spores and bacteria in smoke arriving in Texas from Yucatan and Central America during the spring of 2002 and 2003.

During his senior year in high school my son, Eric Mims, built a novel kind of seismometer I had long thought about making myself. His most exciting results were detecting the p, s, and l waves from two underground nuclear blasts in Nevada. This achievement earned him a record number of awards at the Alamo Regional Science and Engineering Fair and a trip to the International Science and Engineering Fair.

My daughter Vicki Mims, now Vicki Mercer, had measured the Sun's rotation when she was a middle school student. When she wanted to do another Sun project during the peak of the last solar cycle, I suggested that she try to detect solar x-ray flares using a Geiger counter. Vicki eventually detected 12 X-class solar x-ray flares. Her findings are outlined in a chapter she wrote for a book (Joseph J. Carr, *Radio Science Observing*, Vol. 1, Delmar Learning, 1998) while she was still in high school.

Sarah Mims, a senior at New Braunfels Christian Academy, has continued the tradition Eric and Vicki established. In 2001, I suggested that she consider trying to capture some of the African dust that falls to the ground. Sarah was immensely successful at this, and she eventually validated the presence of Sahara dust in Texas using a $30 microscope, a piece of polarizing plastic film, and polarized sunglasses that she wore while using her microscope to inspect the many dust specimens she collected with various homemade air filters and collectors. This discovery earned Sarah many science fair awards, including First Grand Prize in Physical Science at the Texas Junior Academy of Science.

Sarah always said that she would like to do a biology project, so while we were driving home from the Texas State Science Fair in April 2002, I suggested that she consider trying to become the first person to find fungal spores in Asian dust that crosses the Pacific each spring. Sarah was very much aware that spores had been found in Sahara dust, so this idea appealed. A major Asian dust cloud was forecast to arrive over Texas in late April 2002, so she began setting out Petrifilms and microscope slides to capture dust. If fungal spores were present, perhaps some would grow into recognizable colonies on the Petrifilms.

Soon Sarah began finding large numbers of colony-forming units (CFUs) on her Petrifilms, but the Asian dust had not quite arrived at our site. An e-mail to Dr. Tom Gill, an aerosol specialist at Texas Tech University, revealed that only smoke from Central America was overhead.

Gill's e-mail led to serious discussions between Sarah and me about what might explain her findings. How could bacteria and fungal spores be embedded in the thick smoke that was over our site? Does not fire kill microbes?

An Experiment to Discover If Fire Kills Microbes

I suggested an experiment for Sarah to conduct, which she quickly prepared. First, she placed dried grass in an old metal trash can, which she had placed in a corner of our field. She then attached bacteria and mold Petrifilms to a pole using binder clips. When all was ready, she ignited the grass and then removed the covers from the Petrifilms. She then held the Petrifilms in the smoke from the fire for one minute. She repeated this exercise with a fresh set of Petrifilms away from the smoke to provide a control sample.

Sarah set the Petrifilms aside to incubate. Three days later the Petrifilms exposed to smoke were covered with scores of bacteria and fungi CFUs, while the control samples had only a few. Sarah had made a huge discovery: Fungal spores and bacteria are transported in the smoke from biomass fires. Some of the spores and bacteria probably come from unburned material near the flames and others probably arrive with air rushing in to feed the flames. In any event, it appears that the convection of a fire is sufficient to dislodge numerous spores and bacteria from soil and unburned plant matter. Those that are not pulled directly into the fire rise skyward with the warm plume of smoke.

Sarah validated her discovery by burning small amounts of various biomass on a steel plate. The smoke from every sample had many more spores than the adjacent air.

Meanwhile, Sarah continued to collect air samples using bare microscope slides placed on a small tower in our field every day for around two weeks. After the smoke season was over, she used her microscope to count the fungal spores and large carbon particles on each slide. The correlation coefficient of the spores and the carbon particles was impressively high ($r^2 = 0.79$), which provided strong support for the hypothesis that the spores had arrived with the smoke.

Sarah's science projects about her discovery earned her many awards, including two $10,000 college scholarships and First Grant Prize in Physical Science for the second year in a row at the Texas Junior Academy of Science.

Sarah Mims flew a homemade air sampler from a kite at Padre Island on the Texas coast to verify the presence of fungal spores arriving with smoke from Central America. From "Sarah Mims Wins Popular Mechanics 2005 Breakthrough Award," The Citizen Scientist, 21 October 2005 (http://www.sas.org/tcs/weeklyIssues_2005/ 2005-10-21/news2/index.html). *Photograph by Forrest M. Mims III.*

Confirming Fungal Spores in Smoke from Central America

None of our children ever studied the same topic for two successive years, but Sarah's discovery was different. She wanted to confirm that the spores had indeed arrived from Central America by taking samples from air at the Texas gulf coast before it passed over land. So in May and August 2003, my wife, Minnie, and I drove Sarah to Padre Island. There she collected air on a very smoky day in May and a very clean day in August. Her sampler on both occasions was a red plastic cup with a microscope slide slipped into slots cut in the bottom. She flew her 25 cent sampler from a kite to guarantee no contamination from possible spores near the beach. Sarah's kite samples confirmed her discovery, for the sample collected on the smoky day had many more spores and carbon particles than the one collected on the clean day. NOAA back trajectories showed that on both days the air had arrived directly from Yucatan.

Sarah's project earned her another round of science awards in 2004, including becoming a regional finalist in the Siemens Westinghouse Science Competition, third place at the National Science and Humanities Symposium, and presenting a poster paper at the American Association for the Advancement of Science's annual convention in Seattle. The project earned Second Grand Prize in Physical Science at the Texas Junior Academy of Science. Because this final project confirmed her discovery, I wondered why it didn't win first place again until I read one of the judging reports. While the judge was impressed by Sarah's work, she was not convinced that spores could survive fire.

Sarah had much better success with the peer reviewers of the journal *Atmospheric Environment*. I converted her Siemens Westinghouse paper into a formal scientific paper and added a few new paragraphs and references, and we submitted it to the journal as a potential Fast Track paper with Sarah as lead author. The editor was sufficiently impressed to send the paper out for priority peer review within only a day. The reviewers responded in 12 days, and we made the requested revisions over a weekend and resubmitted the paper. The editor accepted the paper only 21 days after we first sent it. It appeared as the first paper in the 3 February 2004 issue of the journal (Sarah A. Mims and Forrest M. Mims III, "Fungal spores are transported long distances in smoke from biomass fires," *Atmospheric Environment* 38, 651–655, 2004).

Sarah's project has been described in articles in Australian, Canadian, and U.S. science magazines. NASA's Earth Observatory website has a detailed feature about Sarah and her project at http://earthobservatory.nasa.gov/Study/SmokeSecret/smoke_secret.html.

THE FLOWER AND GARDEN SHOW IS COMING

Emily Routledge

Please join PSMS at the Northwest Flower and Garden Show on February 8–12, 2006, at the Washington State Convention and Trade Center in Seattle. Volunteers are needed to staff our educational booth. I am especially in need of strong, burly types (male or female) to help with moving and lifting as I am still recovering from a broken ankle. Also, creative types are encouraged to participate in the design of our booth. Additional details and shift sign-ups will be available at the January membership meeting. In the meantime, if you require more information, please contact me directly at emilyroo@hotmail.com or (206) 355-5221.

Mushrooms and Squirrels, *cont. from page 3*

come for another try. By this time he was running out of crotches. Finally, he tried, very hard, for some time, to drag the entire, huge cap up the tree. Then, dancing and chattering in frustration, he started eating chunks off the cap, gave up on the remainder of that one, and began the process all over again with another mushroom just as big as the first. When I finally gave up, after watching him for half an hour, he was still at it.

Later, when I went outside to look at the remaining mushrooms, they were all gone, and at the base of the tree a pile of caps, all about eight inches across, were scattered about, many half eaten. What a workout for that little creature.

Mary Johnston, a longtime member of Arboretum Foundation Unit 5, enjoys gardening and wildlife watching on Camano Island, Washington.

AMANITA—BEAUTY, DANGER, AND DIVERSITY ALMOST EVERYWHERE

Rodham E. Tulloss

NJMA News, New Jersey Myco. Assoc., Nov./Dec. 2005

From the most northern regions supporting miniature willow and birch to Tierra del Fuego off the southern tip of South America, there are amanitas. From the North American western high altitude desert to the Argentine Pampas to the highest places where ground-hugging willow grows in Europe to sand dunes on the coast of the Yucatan Peninsula of Mexico, there are amanitas.

In market places there are amanitas. Species of *Amanita* Pers. form a significant component in wild mushroom commerce in many countries around the world. There are amanitas on which whole populations of the Chepang people of Nepal depend for sustenance during certain periods of the year (*Amanita chepangiana* Tulloss & Bhandary). The American mycologist David Arora has told me of an African mushroom (*Amanita loosii* Beeli) considered so delicious that, seeing them for sale by the roadside, a bus full of people made containers of their clothing and filled them with the delicacy before the bus was allowed to proceed. In Tlaxcala, Mexico, I enjoyed amanitas in several dishes of a fifteen course meal with wild mushrooms in every dish prepared by Nahuatl-speaking indigenous people—descendants of the Aztec's next door neighbors.

In hospital emergency rooms there are victims seriously poisoned by *Amanita phalloides* (Fr.:Fr.) Link and *Amanita bisporigera* G..F. Atk. In remote villages of the Kamchatka Peninsula, there are still shamans who use *Amanita muscaria* (L.:Fr.) Pers. for divination and curing illness; and, around the Northern Hemisphere, similar taxa are employed to stun or kill flies in human habitations.

There are amanitas in grasslands without woody plants. There are amanitas growing in ancient oak forests under branches weighted down by epiphytes. There are amanitas growing with legumes and eucalyptus. There are easily exportable amanitas (e.g., *Amanita muscaria* and *Amanita phalloides*). There are amanitas restricted to very specific environments (e.g., *Amanita friabilis* (Karst.) Bas). There are "gasteromycetous" amanitas that have given up on actively dispersing their spores—the few species of the genus *Torrendia* Bres. There are amanitas with normal spore dispersal but which may grow almost entirely buried in sand (e.g., *Amanita cylindrispora* Beardslee). There are very small amanitas with very large spores (e.g., *Amanita pachysperma* G.F. Atk.); and there are large, elegant amanitas with two annuli (*Amanita cokeri* (E.J. Gilbert & Kühner) E.J. Gilbert). There are amanitas with spores that

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Amanita, *cont. from page 5*

are nearly round (e.g., *Amanita ceciliae* (Berk. & Broome) Bas) and amanitas with spores that are more than four times as long as they are wide (e.g., *Amanita roanokensis* Coker). There are amanitas with the odor of anise (e.g., *Amanita mutabilis* Beardslee), garlic (*Amanita alliacea* (Murrill) Murrill), and bread dough (*Amanita cinereopannosa* Bas); and there are amanitas with disgusting, penetrating odors (e.g., *Amanita nauseosa* (Wakef.) D.A. Reid). There is an *Amanita* that stains the color of American raspberry sherbet (*Amanita mutabilis*), and there is one that stains a deep blue-green (*Amanita pelioma* Bas). There is a species in the Appalachian mountains, still an area very little explored for *Amanita*, that is a narrow-spored member of *Amanita* sect. *Phalloideae* (Fr.) Quél. that has been reported to have a "midnight blue" pileus in early stages of expansion (*Amanita mediinox* Tulloss nom. prov.). And there is my candidate for the most beautiful *Amanita*, the graceful, delicately pink *Amanita pudica* (Beeli) E.J. Gilbert of central Africa.

Consider the great difference in morphology between, let us say, *Amanita vittadinii* (Moretti) Vitt. and *Amanita caesarea* (Scop.:Fr.) Pers. Is it not remarkable that we recognize them as all part of one genus? Even more remarkable, perhaps, is that Persoon and his contemporaries saw them as forming a genus that has (with the exclusion of pink-spored taxa) largely remained unaltered up to the present, despite some disassembly and reassembly. Still more remarkable is the fact that, when the study of micromorphology came of age, it was found that all the diverse species in *Amanita* shared the unique combination of divergent lamella trama and longitudinally oriented, elongate, inflated cells (acrophysalides) in the stipe tissue. Today, the first indications from DNA sequencing of a small part of the genus indicate that its species indeed may have had a single common ancestor.

The genus *Amanita* occurs on all continents except Antarctica (and probably occurred there, too, along with dinosaurs and mycorrhizal trees like *Nothofagus*, during the Cretaceous). Excluding Antarctica, only South America is thought to lack any of the six sections of the genus; and, there, only one—*Amanita* sect. *Amidella* (E.J. Gilbert) Konrad & Maubl.—is apparently missing. All six sections are found in lands that were part of the great southern continent, Gondwana. All six sections are likewise found in lands that were part of the great northern continent, Laurasia. *Amanita*, its two subgenera, and its six sections may all have a very long history. I don't remember seeing a recognizable *Amanita* in any of the recent films about dinosaurs. For the sake of accuracy, should the viewers have seen a tyrannosaur brutally stepping on an *Amanita*? It is entertaining to speculate, especially when one finds morphologically similar species in New Zealand and in Colombia, which also harbor morphologically similar "sibling" species in the Cortinariaceae and other groups.

Whatever their ancient history, the species of *Amanita* now are many and widespread. Perhaps, as was speculated in a recent e-mail exchange between Dr. Bas and myself, there are as many as 1,000 species in the world. According to a count of published names taking known synonymy into account, Dr. Bas and I have come up with about 600 provisionally accepted, currently described taxa in *Amanita*; nearly 500 of these had species rank. Beyond these, certain species-rich areas are insufficiently explored (e.g., south-central Asia, eastern Asia, the southeastern United States, and Mexico). In southeastern Canada and the northeastern United States, I have a growing list that includes approximately 200 probable taxa. About half are undescribed. In my home state of New Jersey, I have a list of over 100 species, and, again, half are undescribed. After working for a short time on amanitas from the southwestern U.S.A., Costa Rica, and Mexico, I have dozens of species in my notebooks that are very likely new to science and quite different from the more northern new taxa.

Among the sections of *Amanita* the one with the broadest distribution is *Amanita* sect. *Vaginatae* (Fr.) Quél. Several members of this section are found in the far north (e.g., *Amanita arctica* Bas, Knudsen & Borgen and *Amanita groenlandica* Bas ex Knudsen & Borgen). A probably undescribed member of the *Vaginatae* was found on Tierra del Fuego.

For a decade, I have been carrying out type studies in sect. *Vaginatae* and seeking the most reliable literature in an attempt to distinguish morphological groupings within the section. I recently traced on a map the geographic areas represented by some of the groupings that have been tentatively identified. Because I am not yet convinced that enough taxa have had their DNA sequenced in order to definitively justify segregation of *Amanita* sect. *Caesareae* Singer from the *Vaginatae*, I included the *Caesareae* in my experiment. The results were very interesting—many of the morphologically defined groups have clearly delimited geographic distribution.

For example, exannulate taxa with a pileipellis having an upper layer consisting of colored hyphae embedded in a colorless gelatinized zone have a strictly tropical distribution: *Amanita crebresulcata* Bas (Amazonian Brazil), *Amanita dunicola* Guzmán (State of Yucatán, Mexico), *Amanita flammeola* Pegler & Piearce (east central Africa), and *Amanita sampajensis* Sathe & Kulkarni (southwest India).

A very beautiful group comprises the annulate species with umbonate pileus and robust volval sac—the "slender Caesar's mushrooms." I have called this group "stirps *Hemibapha*" because it includes *Amanita hemibapha* (Berk. & Broome) Sacc. There is a profusion of very similar taxa in this group in southeast Asia, Oceania, and Australia (*Amanita chepangiana*, *Amanita caesareoides* Lyu. N. Vass., *Amanita egregia* D. A. Reid, *Amanita hemibapha*) and a smaller cluster in eastern North America (e.g., *Amanita arkansana* Rosen and *Amanita jacksonii* Pomerleau) and Central America. The group is distinguished from *Amanita caesarea* (Scop.:Fr.) Pers. microscopically by having a subhymenium including one or two layers of cells instead of three or more such layers.

So far as is known, the "stirps" including *Amanita vaginata* sensu auct eur. (excluding its varieties) is strictly Eurasian. The "stirps" including *Amanita mairei* Foley and another including *Amanita crocea* (Quél.) Singer and *Amanita flavescens* (E.J. Gilbert & Lundell) Contu are also Eurasian groupings.

Some taxa in the *Vaginatae* appear to have circumpolar distribution (e.g., *Amanita groenlandica*).

There are a few provisional groupings that have members in eastern North America and Europe. One of these might be called "stirps *Submembranacea*" which I propose would include *Amanita castaneogrisea* Contu nom. inval., *Amanita mortenii* Knudsen & Borgen, *Amanita sinicoflava* Tulloss, and *Amanita submembranacea* (Bon) Gröger. Another "trans-Atlantic" group is represented by *Amanita caesarea* in the Mediterranean region and a very similar taxon (*Amanita basii* Guzmán & Ramirez-Guillén) in eastern Mexico.

The Gulf of Mexico–Mediterranean connection is also seen in other sections of *Amanita*. In sect. *Phalloideae*, the European *Amanita gilbertii* Beauseigneur is strikingly similar to *Amanita cylindrispora* known from the Atlantic coastal plain of the U.S. from New Jersey to Texas. and both are well adapted to semi-tropical, sandy environments. There is an undescribed species of section *Amidella* in eastern Mexico that is strikingly similar to the

Mediterranean region's *Amanita ponderosa* Malenç. & R. Heim in Malenç.

As noted above, taxa from northern Australia (e.g., *Amanita egregia*) are often similar to taxa from southeast Asia or Oceania (e.g., *Amanita chepangiana*), very probably because of the relatively recent connection of the regions by a land bridge. On the other hand, some Australian taxa that do not have an obvious southeast Asian connection seem isolated within the genus (e.g., *Amanita illudens* Sacc., *Amanita murinoflammeum* Tulloss, Young & Wood, *Amanita punctata* (Clel. & Cheel) D.A. Reid).

In fact, in the current state of knowledge of the *Vaginatae*, only the slender Caesar's mushrooms seem to form a large, closely related group. Despite macroscopic appearances, *Amanita vaginata* and *Amanita fulva* (to take a European example) do not appear to be very closely related. If the current picture is unchanged by future research, *Amanita* section *Vaginatae*, which has seemed to comprise a set of taxa so closely related that they are difficult to separate, may be seen to derive from ancient lineage and be only a set of twigs distributed sparsely over long separated branches of a very large evolutionary tree.

In his thesis, Dr. Bas proposed trends in character states in *Amanita* evolution. Based on this schema, sect. *Vaginatae* would be a "young" section. If it is "young," imagine the antiquity of *Amanita* sect. *Lepidella* (E.J. Gilbert) Veselý emend. Corner & Bas and, especially, its subsection *Vittadiniae* Bas, which Dr. Bas hypothesized as the most ancient extant branch of the genus. My naive speculation wanders deeper into the past and becomes lost in time.

Amanita subsection *Vittadiniae* is indeed a fascinating group. Taxa in this subsection are known from very dry regions (e.g., high altitude plains of western North America) and very humid regions (e.g., the coast of the Gulf of Mexico). Many grow in regions where there are only herbaceous plants (e.g., the Argentine Pampas) or no obvious plants at all (e.g., desert in eastern Oregon and Idaho, U.S.A.). Apparently, some only occur after monsoon-like rains and in areas where there are few human observers. Perhaps, for these reasons, such taxa are thought to be rare.

In the North American literature, there are few mentions of collecting *Amanita prairiicola* Peck more recently than in the 1920s. But in the rainy season of the western Plains, I have had the good fortune to see this species and some of its relatives several times. The habitat ranges from high grass prairie to high altitude desert to a street corner in Denver, Colorado. A single collection of this species from a planted area in Buenos Aires is probably a case of exportation by humans.

Amanita singeri Bas, a member of the *Vittadiniae* which was originally described from Argentina, is known from Argentina only by means of the two collections cited in the original description; however, the species has proven to be rather common in southern France and Italy. The holotype apparently comes from a landscaped environment. The possibility that *Amanita singeri* is an Old World species that was exported to Argentina should be considered.

Before closing, I want to shift from distribution of groups and species to one example of how segregation of taxa might occur based on geology and climate change.

The effects of glaciation may have contributed to evolution of some taxa in *Amanita*. An example for which there is plentiful taxonomic and distribution data is that of *Amanita flavoconia* G..F. Atk. It has two named varieties. At present, the type variety is known from eastern North America north of the Mexican deserts and the vegetated area along the coast of the Gulf of Mexico that, at present, lacks appropriate ectomycorrhizal symbionts. *Amanita flavoconia* var. *inquinata* Tulloss, Ovrebo & Halling is known from Mexico south of the Mexican desert to Andean Colombia. The two taxa differ in color and spore shape.

The geographic separation of the ranges of the two taxa is striking. The habitat of the species having mycorrhizal associates in the *Pinaceae* and *Fagaceae* was repeatedly pushed south by glaciation—as though the forests were rain drops that were periodically pushed from the windshield of a car by a windshield wiper. During at least some of the periods of maximum glaciation, there were corridors of suitable vegetation extending across the eastern end of the Mexican desert region, and species migration between the two, now separated, regions could have occurred. In the present interglacial period, the two varieties are apparently isolated from each other. Apparently there has been enough time in isolation from one another that the small differences have evolved.

The study of *Amanita* taxonomy is replete with problems and frustrations, but also bears rewards. The complexity of *Amanita* morphology is daunting, but full of possibilities for improving understanding and classification. The importance of the genus to humans—for food and commerce, for forest health, for traditional uses by indigenous peoples, for human health and safety, for mycotourism—is a spur to improving our knowledge. The beauty of *Amanita* species in their natural settings is an enticing and entrancing reason for studying them. The diversity and widespread distribution is fascinating. Because of an initial, naive interest in the genus more than twenty-five years ago, I searched out Dr. Bas' thesis and found an enduring model of excellence in monographic style and substance that inspired me to attempt research in mycology. It also happened that I met the author who, as mentor, intellectual companion, and friend, has so enriched my life.

What a wonderful genus!

AGARICUS GREEK STYLE

Walter Bronowitz

1 lb	*Agaricus* (wild or store-bought) cut into quarters or eighths
¼ lb	onion, cut into 1-in. thin strips
4 TBs	extra virgin olive oil
½ cup	dry white wine
1 ea.	lemon's juice
2 tsp	salt
1 TBs	cracked black pepper

Tied in cheesecloth: 1 ea. bay leaf; ½ TBs dried thyme, crushed; 1 TBs fennel seed, crushed; 6 ea. garlic cloves, crushed.

1. Place all ingredients EXCEPT mushrooms and lemon juice in non-reactive pot and bring to simmer.

2. Add mushrooms and press down to immerse; weight down if necessary.

3. Cover and simmer for 5–10 minutes. Remove from heat and add lemon juice. Cool, remove cheesecloth bag, and store in the marinade.

20 YEARS OF CONSERVATION: MAINTAINING A LEGACY

Ron Post

In 1985, Citizens for Environmental Planning (CEP) produced a "white paper" for the Washington State task force studying the issue of wild mushroom exportation. This effort was the result of several years of work by Claude and Margaret Dilly of PSMS and members of other recreational clubs, who observed the destructive practices by commercial mushroom pickers. Their purpose

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Conservation, *cont. from page 7*

in forming CEP was to persuade pickers and harvesters to improve their practices in the forest, pay equitable fees and taxes for the material they took from public lands, and limit their harvest.

The effort was successful. Regulations went into effect for three years, providing permit fees payable to the state Department of Agriculture and limitations set by the Department of Natural Resources. The effort also resulted in data gathering and economic studies detailing for the first time the value and quantity of commercial mushroom production from Washington's forests. Many mushroom buyers also urged better picking practices.

Each year a few of us talk about furthering the efforts of CEP by beginning a new campaign to educate commercial pickers and government land managers. But so far no organized group has appeared to follow up on this work. The club has succeeded in its few educational endeavors, but it is limited in what it can do since lobbying is mostly prohibited by our nonprofit (501c3) status.

The future does not look rosy. Raking the forest soil has resumed, as matsutake export from our state expands. Dumping by commercial camps continues to be a big problem. Data-gathering efforts lag far behind the number of mushrooms freely being taken for commercial profit. Put these trends together, along with a resurgence of interest in wild foods, and the result is more pressure on our limited forest resources than ever before. And now, as well, drug manufacturers pay high fees for specimens of some species, without an inkling of what they are doing to ecosystems where these species are picked.

The U.S. Forest Service now publishes information in at least six languages about how and where to pick mushrooms commercially. But these publications give little more than lip-service to the idea of conservation, and do nothing to protect the species that are being grabbed up by corporations seeking new pharmaceuticals for the drug markets and their wealthy investors. Also, though the need is great, the survey of our wild lands for fungal diversity is still almost nonexistent. In practice, our remaining forests continue to suffer the whims of weather, human abuse, and commercial exploitation. How will you help?

THIS IS MY LAND

This is my land.
From the time of the first moon
Till the time of the last sun
It was given to my people.
Wha-neh Wha-neh, the great giver of life
Made me out of the earth of this land.
He said, "You are the land, and the land is you."
I take good care of this land,
For I am part of it.
I take good care of the animals,
For they are my brothers and sisters.
I take care of the streams and rivers,
For they clean my land.
I honor Ocean as my father,
For he gives me food and a means of travel.
Ocean knows everything, for he is everywhere.
Ocean is wise, for he is old.
Listen to Ocean, for he speaks wisdom
He sees much, and knows more.
He says, "Take care of my sister, Earth.
"She is young and has little wisdom, but much kindness.
"When she smiles, it is springtime.
"Scar not her beauty, for she is beautiful beyond all things.
"Her face looks eternally upward to the beauty of sky and stars,
"Where once she lived with her father, Sky."
I am forever grateful for this beautiful and bountiful earth.
God gave it to me.
This is my land.

Clarence Pickernell
Quinalt, Taholah

. . . and a Happy New Year!

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