The Potomac Sporophore
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Cook at MAW's summer tasting event. See page 4 for details.

In This Issue

Q-and-A: Myco-Celeb Stamets

Marsha Johnston
MAW Member

Fungi Perfecti CEO and mushroom celebrity Paul Stamets has been collecting strains of rare fungi in the old-growth forests of the Pacific Northwest for 30 years and researching which strains, alone or in combinations, are useful for mycoremediation or other, often surprising, applications. Marsha Johnston originally interviewed Stamets for an article in *BioCycle* magazine and now is sharing the full interview with MAW's *Sporophore* newsletter.

Q: How did you come to mushrooms?

A: My parents warned me to stay away from mushrooms, which just got me more interested!

Q: When would you say was your first landmark that led fellow scientists to conclude their effectiveness at remediation?

A: Before I worked at Battelle Labs, I had a contract with Ecova, an environmental bioremediation company in Seattle, for breaking down petroleum. I did a presentation at MENSA, and scientists got excited and said, "Do you think your mushrooms could

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Dusty Yao-Stamets

Paul Stamets poses with an agarkion (*Laricifomes officinalis*), a polypore he is studying for its supposed medical value.

Fungus Notebook: Bicolor, the Red and Yellow Bolete

William Needham
MAW Secretary

Common Name: Two-Colored Bolete, Red and Yellow Bolete — The red of the pileus or cap is sharply contrasted by the yellow spore-bearing pore surface on its underside. Bolete is the general name for any mushroom-shaped (i.e. having a cap and a stem) fungus with pores instead of gills. It is also, in this case, a shortened form of the generic name *Boletus*.

Scientific Name: *Boletus bicolor* — The genus *Boletus* is one of two words for mushroom in Latin (the other is *fungus*, from which the Kingdom Fungi is derived). The likely reason for the duality of mushroom names is that *Boletus* is from the Greek word *bolites,* derived from *bolos* which means clod. Though likely apocryphal, this presumably refers to the appearance of mushrooms as clods (of dirt) in the forest. The species name is two-color.

The Two-Colored red and yellow bolete is variable to the extent of masquerade, a characteristic that it shares with the other pored fungi that are broadly called boletes. While it is universally described with a reddish cap and yellowish pores, all of its other attributes are subject to nebulous uncertainty. While some variance is related to the maturity of the individual mushroom, some is due to lack of specificity in form and coloration. The cap can be rose-red to pinkish, the pore surface under the cap can be bright yellow to pale olive yellow, and the stem or stipe can be equal in diameter along its length or club-shaped, dark red or rosy red at the bottom and yellow at the top or, if none of the above, almost all yellow. It is therefore only accurate to assert that if you find a mushroom with a red cap and a yellow pore surface, it might be *Boletus bicolor.* Then again, it might be something else altogether.

The boletes are notorious for their inconsistent field appearance, a fact mirrored in their torturous taxonomy. As a group, they are set apart from other

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William Needham

Boletus bicolor may have a rose-red to pinkish cap, with a bright yellow to pale olive pore surface. The stipe can be even or club-shaped and reddened or almost all yellow. Its easily confused with other mushrooms.

Science

Continued from page 1 mushroom-shaped fungi by the porosity of the ventral side of the cap; whereas most mushrooms have spore-bearing gills, boletes have pores. Each pore is an opening that marks the end of a tube that extends vertically upward; the walls of each tube support the hymenium, the name for the spore-producing structure of the fungus. In keeping with the exasperating inconsistency of the boletes, there is (at least one) bolete with gills: the oxymoronically named "gilled bolete" (*Phylloporus rhodoxanthus*). While a number of contradictory attempts have been made to work out the taxonomic details of the boletes, it has been generally accepted the bolete family (Boletaceae) has as many as 18 genera. The taxonomy in some texts is elevated to the order Boletales with several families, only one of which is Boletaceae. However, given the diversity of the bolete clan, it is best to concentrate on four most widely represented genera: *Boletus* is the largest genus with centrally located stems and the characteristic sponge-like texture on the underside of the caps; *Suillus* (Latin for swine) is characterized by mushrooms with glutinous or sticky caps; *Leccinum* boletes have mottled stems that are sometimes called scaber stalks; and lastly the *Tylopilus* species have pink spores in lieu of the normal boletaceous olive-brown spores with, for the most part, a very bitter taste.

However, all of this is moot in light of advances in DNA phylogenetic analysis. In a 2008 paper entitled "Molecular Phylogeny and Biodiversity of the Boletes," Rytas Vilgalys, Tim James and Dennis Drehmel from the Duke School of Biology evaluated the diversity of boletes by counting species and conducting phylogenic analyses. They concluded that there is "a deep divergence between suilloid (i.e. of the genus *Suillus*) fungi and *Boletus* and allies and a distinct *Leccinum* clade." In other words, only the relatively few pore-bearing boletes of the genera *Suillus* and *Leccinum* are monophyletic while the other so-called genera are polyphyletic, a farrago of tangled genetic interbreeding. Arguably the new order of fungi according to phylogenesis is in statu nascendi; over the course of the next several years, the true taxonomy of the boletes may be revealed. According to Michael Kuo of mushroomexpert.com, "it is clear that big taxonomic changes are coming soon to a Boletus in your viewing area." Until then, the two-colored bolete could be one mushroom or it could be many.

Boletes are for the most part edible; one of the world's most renowned edibles, second only perhaps to the morel, is *Boletus edulis*, the King Bolete. No boletes are known to be deadly; however a few can make you very sick. In *Mr. Bloomfield's Orchard*, Nicholas Money opines that *Boletus satanus*, understandably known as Satan's Bolete "can make people shit themselves senseless." Caution in bolete ingestion is thus in order. This is problematic since there is a lack of clear and reliable descriptions of the pore-surfaced mushrooms; they are simply too variable. The paucity of absolutes in field bolete identification conflated with the overarching desire of mushroom hunters to harvest edible species has resulted in the establishment of a workable standard for bolete edibility based on empirical evidence. It is considered safe to eat any bolete that: (1) Does not have a red pore surface; (2) Does not stain blue, and (3) Does not taste bitter. The red pore surface caveat prevents the unfortunate ingestion of the Red-mouth Bolete (*B. subvelutipes*) which would result in a similar (though perhaps less graphic) outcome to the aforementioned Satan's Bolete. The bluing caveat prevents eating the *Boletus sensibilis*, which is noted for turning to blue with great celerity, and, according to Bill Roody in *Mushrooms of West Virginia*, having "a sweet odor of fenugreek or curry." It is reputed to be poisonous, but this is conjectural, though perhaps anecdotal. The preclusion of bitter boletes, which largely rules out the genus *Tylopilus* (one of which is actually called Bitter Bolete),

William Needham

The Red Mouth Bolete (*Boletus subvelutipes*) should not be eaten. Its red pore surface is a dead giveaway that this mushroom can cause gastric upset.

William Needham

Boletus bicolor stains much slower than many of the inedible blue-staining boletes such as *Boletus sensibilis*.

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William Needham

B. bicolor's doppelganger is the toxic blue-staining B. sensibilis. It quickly stains a brilliant blue color when its flesh is exposed to oxygen in the air.

is mostly a matter of prandial concern. If you add a bitter bolete to an otherwise salubrious stew, it will result in a bitter experience. Bitterness can readily be discerned by placing a small piece of the mushroom on the tongue; the taste buds do the rest.

The Two-Colored Bolete is generally listed as edible; however it violates the "safe-to-eat" bolete rule. The problem with *B. bicolor* is that it stains blue; its doppelganger is the toxic blue-staining *B. sensibilis*. The bluing of boletes has long been a matter of some scientific interest. The French biochemist Gabriel Bertrand offered the explanation in a 1901 article "On the Blue Color Taken by Certain Mushrooms of the Genus Boletus" that the blue color "necessitates the cooperation of six different factors: oxygen and boletol; laccase; manganese; water; and, finally, an alkaline metal, magnesian or alkaline earthy." This is the basis for the version that has made its way into most books that discuss the subject of fungal bluing, the color purportedly the result of the oxidation when the mushroom flesh is exposed, much like the staining of an apple. The proffered chemistry is that the boletol and laccase are normally separate, becoming comingled by the incision of the mushroom or by its having been bruised — the compounded chemicals then turning blue by the oxygenation of the air. A 2010 article in the magazine *Fungi* entitled "Bluing Components and Other Pigments of Boletes" by S. Nelsen from the University of Wisconsin Chemistry Department provides the chemistry of the reaction according to modern and detailed analytical laboratory techniques. About the only thing that Bertrand got right was that it is complicated. A compound called variegatic acid is oxidized by oxidase enzymes to produce another compound called quinone methide, which is blue; if it is oxidized in air, you get variegatorubin, which is red. This complex chromatic chemistry is probably the root cause for the high variability of the palette with which nature paints the bolete.

Most field guides list *Boletus bicolor* as edible, though there are varying degrees of certitude. At one extreme is Charles McIlvaine's *One Thousand American Fungi* which offers the superlative "fine eating, one of the very best," while Gary Lincoff's *Audobon Field Guide to North American Mushrooms* is almost as effusive with the terse "choice edible." Roody's *Mushrooms of West Virginia* advises the more nuanced "edible with caution," noting further that "some individuals have reported having gastrointestinal disturbance from eating *Boletus bicolor* or a closely related species." (Jon Ellifritz, foray chair of the Mycological Association of Washington, D.C., asserts that one of the "some individuals" includes Roody, who became nauseous after eating a bicolor bolete and no longer eats them.) The most detailed accounting is provided by *North American Mushrooms, a Falcon Field Guide.* It lists three other species that turn blue that might be confused with the bicolor bolete (*B. miniato-olivaceus, B. fraternus and B. pulverulentus*) with potential deleterious side effects and concludes with "We strongly recommend consulting an expert if in doubt about the identity of a species in this group." The problem with this caveat is the bolete experts are few and far between, if they even exist.

For those inclined to a bold approach to mychophagy (akin to those who eat fugu — the Japanese pufferfish whose lethal parts first must be excised), eating red and yellow boletes might provide a level of anxious excitement to an otherwise dull meal — to say nothing of the gastrointestinal deluge that could result. Since *B. bicolor* does not have a red pore surface and does not taste bitter, it is only the bluing that stands in the way of a reliable identification (laying aside the inherent variability of the species). This can be addressed by determining the rate and degree to which the flesh of the mushroom stains blue. The poisonous *B. sensibilis* stains blue rapidly, the edible *B. bicolor* less so. A reasonable field test is to press the bottom of the pore surface with one's thumb. If it takes a few seconds to turn blue, it is likely that it is the edible *B. bicolor* and is safe to eat. As in all decisions about mushroom edibility, however, caveat emptor.

Meeting File

May 7 — Mikhail V. "Misha" Sogonov gives an overview of Gnomoniaceae and black mold

Jon Ellifritz
MAW Foray Chair

At MAW's May 7 meeting, Dr. Mikhail V. "Misha" Sogonov gave an overview of the family Gnomoniaceae, which he has studied extensively, as well as some insight into the problem of "black mold." Sogonov received his Ph.D. in biology in 2003 from Lomonosov Moscow State University (Moscow, Russia). He has had extensive experience in mycological labs in the U.S., Russia, and around the world. He has discovered and described 13 new gnomoniaceous species and one new genus.

Sogonov started his talk with charts of the major categories of fungi, probably excluding some of those that are not visible to the naked eye. There are three branches of basidiomycetes (those fungi which produce spores, usually two or four, at the ends of clublike structures called basidia) — Pucciniomycotina (including the rusts), Ustilagomycotina (corn smut and others), and Agaricomycotina (agarics, i.e., cap and stem mushrooms and just about everything else, from polypores to puffballs). Ascomycetes are the other large group of often (but not always) large, fleshy fungi, and they get their name from the spore-producing structures called asci, which are usually tubelike structures often containing eight spores. The best known are the Pezizomycetes, but the Dothidiomycetes contain the most common fungus in the world in terms of biomass.

Another group within the ascomycete world are the Sordariomycetes, which include the genera *Claviceps* (such as ergot, *C. purpurea*) and *Cordyceps* (many of which parasitize insects).

The genealogy, so to speak, of family Gnomoniaceae starts with Phylum Ascomycota, followed by Subphylum Pezizomycotina, Class Sordariomycetes, Subclass Sordariomycetidae, Order Diaporthales, and then the family. Many of the members of this family are in the genus *Gnomonia* or in genera with combination names such as *Ophiognomonia* and *Apiognomonia*, but some of the anamorphs, i.e., asexual forms of *Gnomonia* species are placed in genus *Discula*. *Discula destructiva*, as its species name suggests, is probably the most virulent member of the family, causing the dogwood anthracnose which has devastated dogwood trees in our Northeastern forests. (Chestnut blight, another virulent plant disease, is caused by *Cryphonectria parasitica*, which is not in the Gnomoniaceae family but is closely related.)

Aside from *Discula destructiva*, and perhaps a few more less serious infections, members of family Gnomoniaceae are relatively harmless and may even have a mutualistic symbiosis with the trees they grow on. During the growing season, they reside in the leaves of various deciduous trees, such as oaks, beeches, sycamores, hazelnuts, sweetgums, and pecans, and produce fruiting bodies only near the end of the season or even after the leaves have fallen.

Upcoming Events

July 26-27 - West Virginia Mushroom Club (WVMC) Foray. WVMC has an impressive slate of guest mycologists coming to their foray in the central highlands of West Virginia. Participants are responsible for their own lodging and meals; the cost for the Saturday forays and tastings is $35. Find out more at www.wvmushroomclub.org.

Aug. 4 — Photo contest deadline. Enter your best photos in NAMA's Digital Photo Contest. Find out more at www.namyco.org/photography.

Aug. 6 — MAW monthly meeting: Dr. Robert Hall, a program officer with the National Institutes of Health, presents "Mycology and Medicine." *Note: This meeting will be held at the Davis Library in Bethesda, Md.*

Aug. 17 - MAW tasting event. Join us on a Saturday afternoon at George Mason University's Nutrition Kitchen in Fairfax, Va., to share your culinary expertise with other members. This is the first time our tasting will be held on a Saturday. Cooks, please RSVP with Culinary Chair Cody Waisanen at culinary@mawdc.org.

Sept. 3 — MAW monthly meeting.

Sept. 6-8 - Second Annual Joint Appalachian Foray. This year's event is co-sponsored by MAW, the New River Valley Mushroom Club, and WVMC and will be held at the Mountain Lake Biological Station in Pembroke, Va., with guest mycologist Patrick Leacock. Registration is $45 (discounted to $30 for registration received by July 27). Accomodations are available separately at the biological station or on your own.

Oct. 1 — monthly meeting.

Sept. 27-29 - MAW's Annual Camp Sequanota Foray in Jennerstown, Pa. Join the club for a weekend full of forays, identification, cooking, and more. Plus, learn from guest mycologist Dr. Patrick Leacock. The weekend with room and board is $150 per member. Saturday only is $45.

Oct. 6 - MAW's annual Mushroom Fair gives club members a chance to give back to the community via educational programs, forays, demonstrations, and more. Join us at Brookside Gardens in Wheaton, Md., from noon - 5 p.m. Volunteers are needed and contact NAMA Liaison Connie Durnan at namatrustee@mawdc.org.

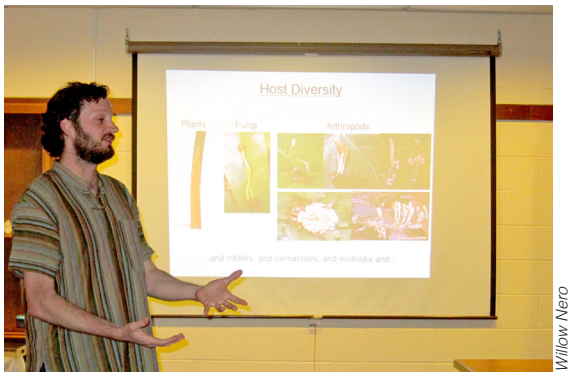
Oct. 24-27 - The NAMA Annual Foray will be held in Shepherd of the Ozarks, Ark. The stellar faculty includes chief mycologist Dr. Clark Ovrebo, Dr. Alan Bessette and Arlene Bessette, Dr. Andy Methven, Dr. Michael Kuo, Dr. Jean Lodge, Dr. Tom Volk, Dr. Britt Bunyard and the "Magnificent Mycologist of Texas", David Lewis. Find out more at www.namyco.org/events.

Nov. 5 — monthly meeting.

Monthly meetings are held at the Kensington Park Library in Kensington, Md.

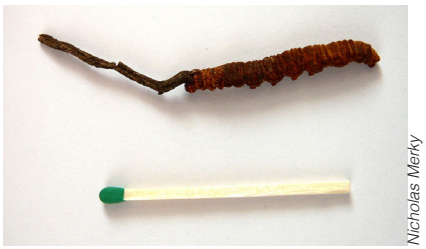
Forays

MAW regularly holds forays in the D.C. area. Many forays are announced on short notice. Check the listings at Meetup.com/MAWDC-Public or email forays@mawdc.org to receive email notices.



Willow Nero

Ryan Kepler explains some of the hosts various *Cordyceps* fungi have been known to attack. They include butterflies, beetles, plants, and other fungi.



Nicholas Merky

Ophiocordyceps sinesis has spawned a craze in China, where it sells for more than the price of truffles.

Sogonov also included a segment on "molds," which are not really a taxonomic group but fall into 10 different groups across the range of fungal categories, including ascomycetes and basidiomycetes. There is a large industry around mold inspection and remediation, often because of fears generated by media reports. The infamous "black mold," *Stachybotris chartarum*, can cause toxicosis, but mycoses happen rarely, although there are many species which can infect humans with weakened immune systems. Allergies and asthma are the most common adverse effects and can be caused by a number of species. Among the most common indoor molds are species in the genera *Penicillium*, *Aspergillus*, *Cladosporium*, *Stachybotris*, and *Chaetonium*.

June 4 — Ryan Kepler looks into the varied hosts of parasitizing Cordyceps and related fungi

Willow Nero
Sporophore Editor

By now we've all heard of the "zombie mind control fungus" *Ophiocordyceps unilateralis* that infects ants and causes them to climb to great heights before they die and the fungus fruits and sporulates.

Not surprisingly *O. unilateralis* isn't the only pathogenic actor in its genus and several closely related to it. Ryan Keplar, a research mycologist with the Department of Agriculture, visited MAW at the June 4 monthly meeting to introduce members to other tyrannical *Cordyceps* and related fungi, many of which are pathogenic on plants, insects, and even other fungi. His presentation "Of Molecules and Murder: The Evolution and Ecology of Insect Pathogenic Fungi" included discussion of *Cordyceps* and some of his original research on these pathogens.

Keplar started out with an introduction to the three families of *Cordyceps*: ophiocordycipitaceae, which typically have darkly pigmented fruiting bodies with rigid stipes and are found in the soil; cordycipitaceae, more brightly colored fungi with fleshy stipes preferring a shallow habitat in duff or litter; and clavicipitaceae, which are often green or yellow. All three families are found in forest habitats, usually in hot, moist, tropical climates. The southern Appalachians probably are good candidates for *Cordyceps*, Keplar advised.

Cordyceps has sparked special interest among mycologists because some are known to have medicinal properties, such as *Elaphocordyceps subsessilis*, source of the immunosuppressant drug ciclosporin A, and others have widely applicable biological control properties because of their ability to grow on insects.

"If you can have sugar on it, you can get these things to grow on it," Keplar said.

He also revealed the remarkable diversity of ways *Cordyceps* operate. Some species use mechanical pressure or chemical degradation, rather than passive methods like ingestion, to forcibly enter their hosts.

"Imagine if salmonella just hit you in the head and drilled into your brain," he said.

Categorization of these fungi families often yielded contradicting results before the advent of DNA sequencing. Some fungi were found only in either their sexual (teleomorph) or asexual state (anamorph), leading mycologists to give a name to each version, sometimes not even linking the two. With DNA databases like GenBank, it's simple to match a fruiting body to mycelium — or realize the whole fungus (holomorph) has yet to be identified. Keplar lamented that clubs like MAW will have to get whole new books as many of the names are eliminated, changed, and moved into their biologically correct groupings. This process will no doubt be challenging and interesting as scientists uncover evolutionary strategies and relationships that were not evident based on morphological characteristics alone.

One such fascinating discovery was a host shift Keplar documented where a fungi that previously only existed on scale insects jumped to a plant host and then opted for fratricide by attacking another *Cordyceps* that was pathogenic on grass.

"It went from attacking grasses to attacking grass pathogens," Keplar remarked, donning this specimen the "brother-slaying tyrant *Cordyceps*."

The evolutionary advantage here is pretty obvious, Keplar added. "If you are a fungus and you can evolve to get sugar straight from a plant — you are hooked up."

As an aside, Keplar also solved the mystery email sent to MAW President Bruce Boyer that talked of a "vegetable worm" phenomenon in China. Evidently, the bodies of worms colonized by *Ophiocordyceps sinesis* are highly valuable in China, drawing prices exceeding that of truffles. This "summer grass, winter worm" is supposed to act as an aphrodisiac, improve circulation, and even cure fatigue, though studies have yet to confirm these claims.

July 2 — Dennis Whigham works to save native orchids whose habitats and fungal associates are changing

Willow Nero
Sporophore Editor

Dr. Dennis Whigham, a senior botanist at the Smithsonian Environmental Research Center in Edgewater, Md., called orchids both smart and dumb, at times in his July 2 lecture "Terrestrial Orchids and Mycorrhiza: A Complex Relationship."

"I will tell you right up front they are the smartest plants on earth," Whigham said, referring to orchids' unique mechanisms of co-opting fungi and insects, especially how some species trick insects with their sexually appealing appearances, and in some cases pheromone-like substances, that cause the insects to cross-pollinate them.

As for those dumb orchids, the federally threatened Small Whorled Continued on page 7

MAW Members Teach Fungi Classes

Willow Nero
Sporophore *Editor*

Delve into the world of fungi further than available at MAW's monthly meetings, occasional forays, and other activities. These courses taught by members are a great resource.

Audubon Naturalist Society

Classes Held in July, August, October, and November

MAW member Tovi Lehmann, a master naturalist volunteer with the Audubon Society, teaches two fungi courses this summer and fall. The first, Window into the World of Fungi, is a basic introduction to the kingdom that relies on local examples. It comprises two days of instruction and includes a field trip.

The second course, Who Pulls the Strings in the Forest?, will be repeated starting in August with three areas of focus. Lehmann will teach students to study fungal diversity and their ecological significance to trees over time. Courses are free, though registration at www.audubonnaturalist.org is required. The courses are held at the Woodend Sanctuary in Chevy Chase, Md.

National Institutes of Health Foundation for Advanced Education in the Sciences

Graduate-Level Course and Lab Begin in September

This fall Dr. Robert Hall and MAW Webmaster Martin Livezey are offering through NIH's graduate school Introduction to the Kingdon Fungi and an associated mycology laboratory. Heavy on discovery and research, the laboratory will feature a semester-long engagement with a national mycoflora project and teach students to collect, characterize, and genetically identify fungi using a variety of microscopic, genetic, bioinformatics, and other techniques. Hall teaches other courses at NIH and heads research as the program officer for Cholera, other vibrios, Aeromonas, Enteric and Hepatic Disease Diagnostics, Enteric and Hepatic Diseases Branch. Find out more at www.faes.org./grad.

Courses Engross Students in Fungal Topics

Are you thinking twice about devoting all that time in a stuffy classroom? Livezey says think again — the Fall 2012 Mycology: Medicine to Miscellany course, the basis for this fall's Introduction to the Kingdom Fungi was highly engaging.

"It was not long before we were all impressed with Dr. Hall's infectious enthusiasm and his broad knowledge of fungi," Livezey says. "It was not just another class but an engaging and rewarding source of knowledge that we would all enjoy." In all, six MAW members attended the lectures, joined by several NIH students and employees.

Livezey started out a little hesitant to study human, animal, and crop pathogens but found them exciting after all. "Who wants to look at pictures of disfigured … " was his initial thought.

Getting away from the fire and brimstone mushrooms, the class also looked at more friendly applications for yeasts and molds that help create bread, beer, wine, and antibiotics.

In addition to the lectures, Hall brought the class to meet the head of fungal pathology at NIH, Michail S. Lionakis, M.D., Sc.D. No doubt, this introductory lab experience helped inspire this fall's course. "I was impressed with our questions — and everyone participated," says Livezey, "But no one was really satisfied — we wanted to get back there and ask some more questions!"

Grilled Chicken of the Woods

Lisa Espada shared this chicken of the woods (*Laetiporus sulphureus or cincinnatus*) recipe with MAW. She says be sure to catch the tender, young specimens in time. For the older dry mushrooms, try a marinade of beer or wine and Italian seasonings.

Gargoyle888

1/2 cup Olive Oil
1/4 Cup Dijon Mustard
1/8 cup White Wine Vinegar
1 pkg Good Seasonings Italian Dressing Mix (it's a dry mix)
1 Tbsp crumbled dried rosemary
2 tps Worcestershire sauce
1 Tbsp Soy Sauce
1/2 Cup White Wine
Dash of your favorite hot sauce

Use only very fresh, large pieces of tender chicken of the woods. Place all the pieces in a glass container, making sure they are covered in the marinade. Let this sit overnight. Grill for 2 to 4 minutes per side. Tastes just like chicken!

(Get Espada's recipe for Chicken of the Woods With Capellini and Feta at www.mawdc.org.)

Meeting File (cont.)

Continued from page 5

Pogonia (*Isotria medeoloides*) takes the prize of having making "some really dumb choices through evolution" and having gotten itself into a box. The plant goes dormant for years at a time and produces few fruit and seeds containing no stored food. It is thought to associate with specific Russulaceae necessary for the orchid's seeds to germinate and reach the protocorm "seedling" stage. Unfortunately these fungi appear to be being pushed north by climate change, and scientists are doubtful the orchid will follow.

Whigham commented that orchids are just the "canary in the coal mine." The absence of certain fungi, followed by the disappearance of many orchids, is changing entire ecosystems that include trees and animals as well.

Climate change is only one factor in the disappearance of native orchids. Other factors include the destruction of fragile habitats, predation and destruction by wild animals, off-road vehicles, vandalism, and collection.

Whigham's research is focused on identifying the fungi that associate with North American orchids to help find ways to propagate and conserve orchid species. The hope is that by simultaneously spreading both orchid seed and fungal spores, volunteers could rehabilitate entire orchid populations. Unfortunately, this work is not so easily done, says Whigham. Scientists have been able to identify and cultivate some of the fungi associated with a few species, including the federally threatened Eastern Prairie Fringed orchid (*Platanthera leucophaea*), but once seeds and spores are spread, the plants still prove to be incredibly temperamental.

To address this dire circumstance, Whigham and other scientists have created the North American Orchid Conservation Center, (www.northamericanorchidcenter.org) which has partnered with the Smithsonian Institute to educate the public about orchids and further the study, propagation, and restoration of native orchid populations.

Courtesy Dennis Whigham

In this photo taken in the field, Dennis Whigham takes samples and makes measurements of an orchid.

wackybadger

A rare Eastern Prairie Fringed Orchid (*Plantanthera leucophaea*) blooms in a field in Wisconsin.

Q-and-A: Myco-Celeb Stamets (cont.)

Continued from page 1

break down petroleum?" and they tried it in a lab, and were very excited. But Ecova was going out of business, so they encouraged me to pursue it. Battelle came along and we worked together.

Q: Why is it that some fungi will grow in the lab in agar, and decompose toxins but won't grow in soil?

A: Soil has lots of competing organisms, so we are tasked to find soil-dwelling fungi that have remediating properties, which we have found, lots of them.

Q: Aged mycelium from oyster mushrooms (Pleurotus ostreatus) mixed with 'compost' made from wood chips and yard waste (50:50 by volume) resulted in far better degradation of hydrocarbons than bacteria. Why?

A: As mycelium ages, you get both fungal remediation and bacterial remediation. Mycelium, after it produces mushrooms, becomes a web that fosters growth of bacteria.

Q: What are the biggest limitations to large-scale mycoremediation of contaminated soil? Their need for oxygen? Large-scale production of mycelium? What is needed for the latter?

A: Scalability and mobilizing various parties to work together, which we have done in Mason County [WA] with myco-bags. Mason County was losing between $2 and $10 million a month from *E. coli* pollution, but had no money available. We have a clever, innovative process [for producing myco-bags] that can reduce the cost of scaling it up. Because of what we did, Mason County opened up shellfish operations for first time in many years and the county economy improved.

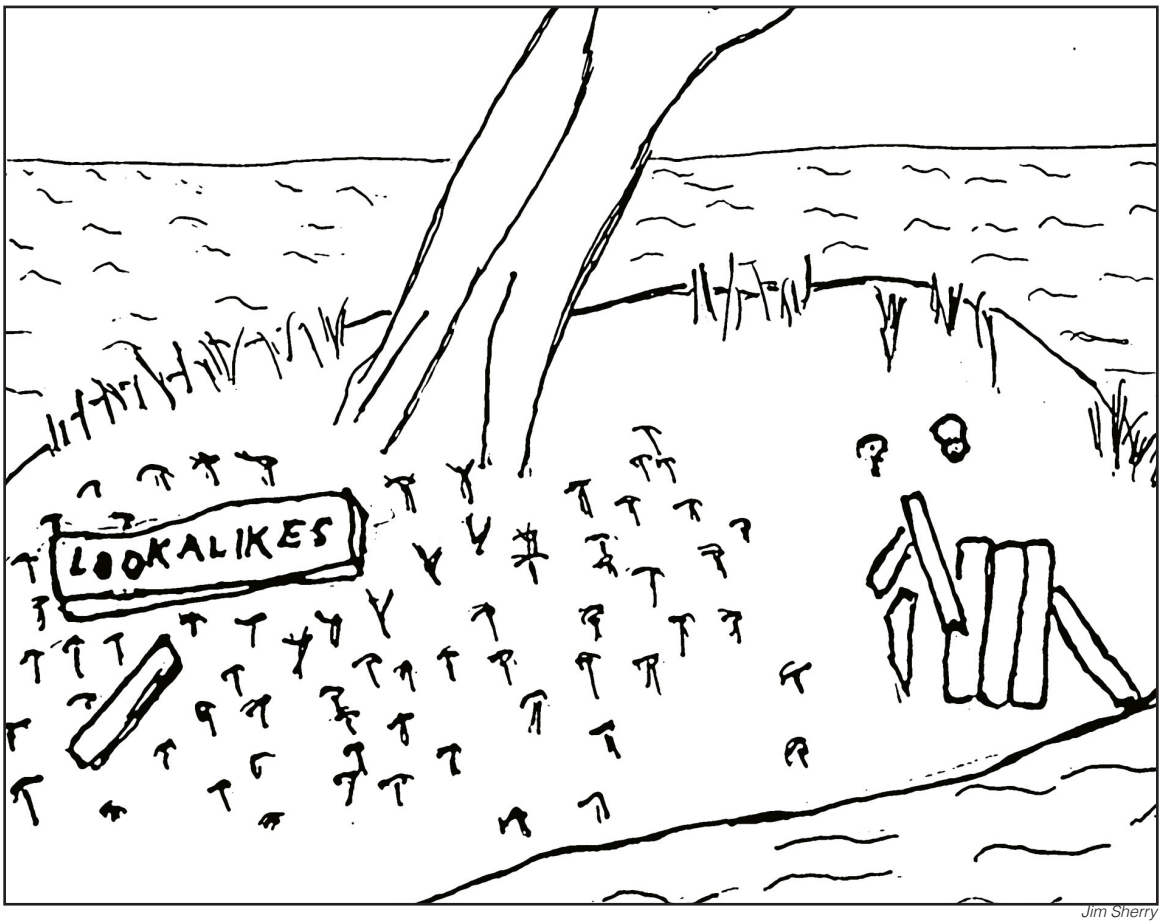
Paul Stamets

☐ In his 2009 TED Talk, Stamets presents six fascinating ways fungi can save the world: http://bit.ly/i1r7C. He also spoke at TEDMed in 2011 about fungi with antiobiotic properties and how they may have helped treat his mother's cancer: http://bit.ly/uxteX7.

☐ If you're not fully aware of Stamets, check out this 2009 Mother Jones article, "Return of the Fungi," a great introduction to the man who regards himself as "the voice of the mycelium": http://bit.ly/JfOkTF.

☐ Stamets' Internet emporium of all things fungi, Fungi Perfecti, is always worth a look: www.fungi.com. He carries the latest oyster mushroom growing kits, mushroom playing cards, and more.

☐ He has authored several books, including *Mycelium Running* and *Growing Gourmet & Medicinal Mushrooms*.



Jim Sherry