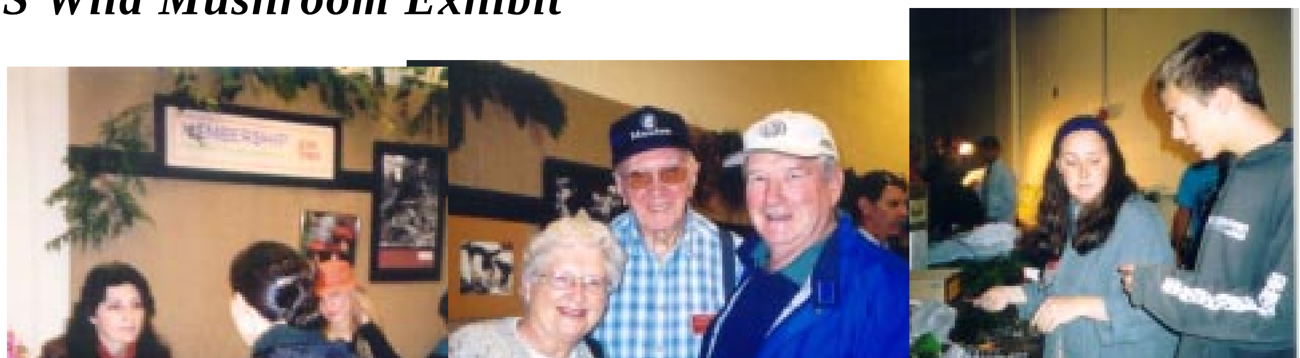
SPORE PRINTS

BULLETIN OF THE PUGET SOUND MYCOLOGICAL SOCIETY
Number 406 November 2004

PSMS Wild Mushroom Exhibit

2004




Photos by Agnes Sieger and Ron Post

Spore Prints

is published monthly, September through June by the

PUGET SOUND MYCOLOGICAL SOCIETY

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Annual dues $25; full-time students $15

CALENDAR

Nov. 6	Field Trip, Twanoh State Park
Nov. 9	Membership Meeting, 7:30 PM, CUH
Nov. 13	Field Trip, Bowman's Bay, Deception Pass State Park
Nov. 15	Board Meeting, 7:30 PM, CUH
Nov. 16	*Spore Prints* Deadline (early)
Nov. 20	Field Trip, Seward Park, Seattle
Dec. 14	Membership Meeting, 7:30 PM, CUH

BOARD NEWS

Dennis Oliver

Wow! What an exciting and packed mushroom show. The monthly board meeting was shifted from its traditional Monday evening to Tuesday to allow everybody to decompress. John Goldman presented the treasurer's report for the month and will have the final exhibit totals for next month's meeting. We had 155 new members join the society at the show, which is almost double from last year. The fall mushroom class schedule was presented. Ideas for the Website were solicited, and Ron Post, John Goldman, and Steve Bigelow will discuss possible new features. The board approved shifting our Deception Pass field trip from Cranberry Lake to Bowman's Bay to join with Margaret Dilly and Larry Baxter's Whatcom County club.

PICKERS GO ON STRIKE

Joseph B. Frazier
The Sporeprint, LA Myco. Soc., October 2004

Oregon Matsutake pickers went on a five-day strike, asking $15/lb for premium matsutake rather then $12/lb. Instead, the price fell to $2. "The pickers are cold and hungry," says Kerry Ellington, who opened a soup kitchen of sorts for 40 or so people a night. "Some of them are trying to borrow from each other for gas money to get home. Others are buying ice like crazy to try to keep their mushrooms fresh until the price goes up."

MEMBERSHIP MEETING

Tuesday, November 9, at 7:30 PM at the Center for Urban Horticulture, 3501 N.E. 41st Street, Seattle

The permitting system on state and federal land was a hot topic at the exhibit. We will address these issues at the November meeting, when PSMS member Mick Mueller, a Fire Ecologist with the US Forest Service who works on the Wenatchee River Ranger District in the Okanogan and Wenatchee National Forest, will give us the most recent insider info (from the ranger's side) on regulations and ecology of the forest. For the past four years Mick has also worked for USFS Region 6 (Oregon/Washington) office in Portland on the Survey and Manage Fungi Taxon Team, one of several teams responsible for reviewing the annually collected data from BLM and FS units for new and existing sites of rare species.

Would persons with last names beginning with the letters A–L please bring a plate of refreshments to share after the meeting.

UPCOMING FIELD TRIPS

November 6 — Twanoh State Park

Alas, this lovely park on Hood Canal is closed for camping. We will meet in the day use/picnic shelter. Washington State collects a $5 per car parking fee. Host: Harold Schnarre.

Driving Directions: Take the Bremerton Ferry (a half hour ride) from downtown Seattle, take Hwy. 3 southwest to Belfair, and go west 8 miles on Hwy. l06 from Belfair to the park.

November 13 — Deception Pass State Park *(changed)*

Meet at the **Bowman's Bay campground**. A $5 parking fee is required unless you are camping, in which case your camping receipt includes parking. This saltwater campground is open year round. No potluck as it gets dark so early. There are several delicious restaurants in LaConner for a friendly dinner. Host Ron Post.

Driving Directions: Head north on I–5 to exit #230, and then go 18 miles west toward Oak Harbor. The park entrance is on the right, approx. ½ mile north of the Deception Pass Bridge, one of the most photographed scenic places in the state.

November 20 — Seward Park, Seattle

For die-hard mushroom hunters, we have added a new field trip this year—a late outing to a large Seattle city park on Lake Washington where a variety of mushrooms is known to flourish. With a little luck, the weather will remain mild, and mushrooms will still be flourishing for a late season thrill that doesn't require a long drive home. Host: Tony Tschanz.

Driving Directions: From Seattle, take I-5 to I-90, get off at exit 3 (west side of Lake Washington), go south on Rainier Ave S. about 3 miles, and take a left onto S. Orcas Street, heading east. South Orcas Street ends at Seward Park after intersecting Lake Washington Blvd. S. Once in the park, follow the PSMS signs up the hill to the shelter.

CIRCLE 8 FIELD TRIP REPORT **Brian Luther**

We were blessed on September 25 with a beautiful, sunny fall day, a wonderful facility, an enthusiastic and delightful crowd of members, and tons of mushrooms. What a combination, huh? Mushrooms were covering two full picnic tables when I arrived at 9:45 in the morning. People already had partial baskets of treasures and were eagerly milling around the tables looking at the array of interesting fungi that others had found. We had to bring over more picnic tables, and at the end of the day all five were smothered with collections. We had to resort to using all the bench sections as well, and then people had to spread their mushrooms out on the grass for me to look at. I had intended to just stop briefly in the morning to check in before making my mandatory run to the Cle Elum Bakery, but so many people already needed help that I wasn't able to get away until about 1:30 in the afternoon.

Special thanks to Elizabeth Lisaius for hosting and making new arrivals feel welcome. She set up in the shed at the edge of the woods, which had been recently renovated. They took out the old wood stove, which I thought was a nice comfort, but finished the walls and added a very useful sink and kitchen counter top. Thanks, Elizabeth, for making the day go right for everybody.

One hundred and forty species of fungi were displayed on the tables, which is above average for a field trip but not nearly enough for a record. Only a small collection each of white and yellow chanterelles came in and a couple of *Boletus edulis*. A lot of *Lactarius rubrilacteus* was found, but only one *L. deliciosus.* A few Matsutake and a small group of Gypsy Mushrooms (*Rozites caperata*) were also found. *Leccinum* and *Suillus* were found in large quantities; everyone found *Suillus*. It was definitely bolete day, with five different species of *Boletus*, one of *Leccinum*, and seven of *Suillus*. Several large clumps of the Fried Chicken mushroom (*Lyophyllum multiceps*) also were found by some very happy mushroom hunters.

Beautiful collections included several color forms of *Amanita muscaria*, gorgeous *Suillus cavipes*, brilliant *Hygrophorus conicus*, Mycena *adonis*, *Armillaria albolanaripes*, *Cortinarius mutabilis,* and a stunning group of several, very large *Phaeolepiota aurea* , which amazed many people. Surprisingly, there were no Lobster Mushrooms, whereas the weekend prior, at Squire Creek, they were found by everybody.

Rare or unusual finds included two sporocarps of *Hygrophoropsis olida*, the tutti-frutti mushroom, which smells like fruit drops, one specimen of *Stropharia kauffmanii*, a single specimen of *Limacella glischra*, some *Agaricus semotus*, and a single *Hygrophorus singeri*. Several collections of the very large *Hebeloma sinapizans* were found as well.

The potluck was small but good, with perhaps a dozen staying to eat, all sitting around in lawn chairs and enjoying the delightful evening. Afterward, everybody pitched in to clean up, and it took most of the remaining members to help me go through all the specimens on the tables documenting what was brought in and wrapping up what I needed to save and look at further. There were so many mushrooms that we were using a lantern and flashlights at the end. Thanks to Josh Birkebak for doing a great job helping with ID. There were lots of non-PSMS RV campers using the campground. Many came over during the day to look at out display and were amazed to see so many mushrooms. Lynne Elwell came in her RV and was invited to join the others that night.

BIG FOUR PICNIC SHELTER FIELD TRIP REPORT **Brian Luther**

This is one of the more interesting locations for a field trip, being directly at the base of Big Four Mountain which juts straight up 6135 ft from the valley floor on the Mountain Loop Highway. Besides having a small glacier on it, the mountain is popular because of its ice caves, on a trail just a few minutes away.

We were fortunate to have Steve and Adriana Haynack as our hosts for the day. They had a very welcome assortment of goodies and hot coffee set out for everybody to get them going in the morning and were also familiar with the area, directing people to good areas. Thanks, Steve and Adriana. We couldn't have done it without you !

October 2 was a fabulously warm, sunny day, and members who came expecting good collecting weren't disappointed, because there were mushrooms everywhere. For the first couple of hours I was working with everybody, having them try to key out their own collections from whatever mushroom book they had with them and providing needed guidance if they got stumped . Thirty people signed in, but I think we had others who didn't. Many nonmembers saw what we were doing and went out mushrooming so they could get their collections identified while we were there, and we also had a park ranger stop in who was completely fascinated with all the mushrooms we had found—106 different species of fungi. Concerning edibles, a little bit of everything came in. Many found Chanterelles, and some found *Boletus edulis*, Angel Wings, and Gypsy Mushrooms. Many different color forms of the Woodland Russula (*R. xerampelina*) came in. The most beautiful find of the day was the colorful *Hygrocybe ceracea*, and the rarest was the fragrant polypore conk *Ischnoderma resinosum*, which smells like anise or licorice.

Quite a few stayed for potluck and almost everyone enjoyed sharing a couple of bottles of red wine (Merlot). Another wonderful day of getting out in the woods, looking for myco treasure, hopefully learning some new fungi, and enjoying the invigorating fresh air with friends.

BRIDGEOPORUS NOBILISSIMUS TRIP **Karen Behm**

About 12 of us were treated to a gorgeous morning west of Snoqualmie Pass on October 2, when Dr. Ammirati graciously gave us a lesson on the rare fungi *Bridgeoporus nobilissimus*, which is growing on a large dying Noble fir in this area. *Bridgeoporus nobilissimus* is noteworthy because it is the first fungus officially declared an endangered species. This polypore grows on only a small number of sites in old growth forests and prefers *Abies procera* 1–2 m or more in diameter at breast height. It is also found rarely on *Abies amabilis* or possibly *Tsuga heterophylla*. Its position on the host is variable. It has been found near the root collar of living trees or snags, on the sides of snags not far from the ground, and on cut stumps, but is not known to occur on downed logs. PSMS President Ron Post wrote a good short synopsis of this fungus in the June 2004 issue of *Spore Prints*.

While the fruiting body we viewed was about the size of a football, a mere baby compared to what it can grow to, it was very striking with its furry surface. One of the characteristics of *Bridgeoporus nobilissimus* is its association with brown rot, and we were shown examples of this and how it breaks down wood into blocks. I look at rotting tree snags with a new perspective now!

We all learned a bit more about fungi and their role in forest ecosystems. Thank you, Dr Ammirati!

PRESIDENT'S MESSAGE — Ron Post

Mushrooms and mushroomers are resilient, like the rains. It was a fine exhibit, once again. My appreciation goes out to all our identifiers and tray people as well as all others who worked on the show. Remember, if you spent something on the show, ask John Goldman or me for reimbursement!

Our exhibit brought in more than 100 new members, and I'd like to ask all of you who joined to contact me if you are interested in helping with any of the following committees and tasks.

Library: After the arson at CUH took away our use of the office and library, we are almost ready to have it back (January). Beginning in December we need a person or two to help our new librarian staff the office for an hour or two once or twice per month, in the evening before the meeting and maybe on a Saturday. Call me at (206) 527-2996 if you are interested.

Education committee: There will a number of things to do next year, including the coordination of a regional educational foray if we decide to participate in that. A member education survey will be out soon, and we can use help tabulating the results.

Reconstruction of exhibit trays: We have a volunteer who is willing to refurbish the trays that are in bad shape. Coordinating this will involve purchasing materials, etc. (The club will reimburse all expenses.)

Banquet committee: In March, we celebrate at our annual Survivor's Banquet. Need I say more? It's a big job and needs a chair to begin planning now.

Conservation committee: The permitting system on state and federal land was a hot topic at the exhibit, and it's the subject of our meeting this month. Chairwoman Karen Behm might like to talk to you if you are interested in having an impact in this important arena.

Scrapbooks: The PSMS scrapbooks need work. Your experience with home scrapbooks nay be invaluable. Please call me to help get ours in better shape.

Cultivation: Someone suggested we revive classes in cultivation. Anyone willing to take that on?

Thanks for all the help at the exhibit, everyone, and I hope to see you at the November meeting.

MYCOPHAGY AT THE ANNUAL EXHIBIT

Patrice Benson & Colleen Compton

Cooking and Tasting was a good place to be at our exhibit this year. The culinary creations were delicious and the visitors enthusiastic. We want to thank Grand Central Bakery and Great Harvest Bread for donating bread products and Whole Foods for donating specialty grocery items.

The chefs outdid themselves this year. Special thanks to Michael Blackwell, whom we can always count on for good food and cooking tips during preparation. He is a long time PSMS member and chef, and also Whole Food's chef and director of cooking classes. We also sampled the cooking talent of Cynthia Nims, recent mushroom cookbook author. Jamie Notman did a good job of feeding the crowd a wide variety of delicious tidbits. We enjoyed the food and hunting tips of Jeremy Faber. Thanks also to Amos Prudhhon (your smoked mushroom chowder was popular) and to Luis Felix.

A special thanks to all the many PSMS volunteers who cleaned mushrooms, served food samples and washed oh-so-many pots and pans. It's members like you who make our exhibit a success.

BOG BLOG — Alissa Allen

Collybia Racemosa—Not Your Ordinary LWM

A few weeks ago while collecting at the bog, I happened across a very odd fungus. It was one of the first days of fall, and Christie and I had only a couple of hours to collect. There were all kinds of mushrooms everywhere; we saw at least ten different types of little white mushrooms (LWMs) within the first ten feet of the boardwalk. I knew we couldn't collect them all, so I decided to limit my collections to larger fungi. Christie and I went to separate ends of the boardwalk and collected as fast as we could.

We went over our two hours in what seemed like minutes. After we decided that we simply had to stop collecting and pack up our specimens and gear, I was compelled to peek under the hawthorn branches into one of my favorite little microhabitats at the bog, a shady place that hosts a wonderful combination of Spruce, Hemlock, Cascara, and Hawthorn trees and a unique blend of small plants, like the sweetly fragrant wax flower. This tiny flower is so fragrant in the spring that the bog air is heavily perfumed by it, which is one of the reasons I am drawn to this spot. Even though it was a blustery fall day, and the flowers long gone, I was beckoned to spy on what might be hiding there.

At first glance I thought it was another *Collybia tuberosa*, a very common mushroom in the bog that grows on the plentiful remains of mummified Russulas. If I had seen this mushroom anywhere else that day, I would have passed it by. But because it was in this sacred spot, it deserved a closer examination. Under the small tan cap, I could see its long stem was ornately decorated with miniature mushroom-shaped structures. These diminutive structures lacked gills but, as I later learned in the lab, do produce asexual spores. Apparently this form of reproduction is so effective that is common for many of the stems to lack the larger cap entirely. The stems that lack gilled caps blended well with the spruce debris which they sprouted from. If the mushrooms are collected carefully, one will find a sclerotium attached to the base of the stems.

I was very lucky to come across this mushroom. *Collybia racemosa* is truly the most macroscopically interesting and easy to identify of LWMs. In a world rich in tediously difficult LWMs, that is a relief. *Collybia racemosa* is rarely collected, but I have a feeling it is much more common than we think. Next time I collect in the bog, or anywhere else for that matter, I will think twice about stepping over all of those potentially satisfying little white mushrooms. Remember: Don't judge a mushroom by its cap.

CHEMICALS AND FUNGI — Ed Mena

Bulletin, Boston Mycological Club, June 2004

I have a Ph.D. in biochemistry, but don't let this fool you. I am really a naturalist in disguise. I have always been trying to find ways to combine the two fields of study. [Among other studies] I also spent time researching compounds from fungal cultures.

All living organisms produce an extremely varied list of chemicals. These chemicals fall into two very large (and arbitrary) groups: primary and secondary metabolites.

Primary and Secondary Metabolites

Primary metabolites are those that are needed by organisms for their basic cellular functions such as metabolism, energy production, breakdown of damaged molecules, and synthesis of new ones. Cells also need the chemical machinery to make proteins, DNA, RNA, and many other complex molecules that are absolutely essential for all life. Producing each of these large molecules is a complicated process that can include 50 or 60 different smaller chemicals and a similar number of enzymes (large proteins). To make these, the cell requires yet another series of reactions, a list of which could become quite lengthy, depending on the organism. For example, most typical cells, from yeast (a fungus) to mammals, can oxidize sugar (glucose) and produce energy (ATP) in addition to more specialized tasks, such as dining on decaying wood or savoring fresh dung. You soon get the general idea that many chemicals are needed to keep the basic biochemical machinery of a cell operating properly.

Secondary metabolites are usually spoken of in association with plants, fungi, bacteria, and other lower forms of life, such as invertebrates. (I really dislike the term "lower form of life," but elaborating here would digress too much.) The term secondary was originally given to this class of compounds largely because no primary role was known for most of them. They were chemicals that didn't seem to have any essential role for the organism. If the organism or cell did not produce these compounds, there was no reason to believe it would not continue happily onward. This was especially true if the organism found itself in a monoculture in some scientist's lab.

Most researchers now believe that they play a critical role in the organism's life; it's just that frequently the functions of these compounds may be difficult to ferret out among other activities that are being studied. Moth sexual pheromones, for example, are considered secondary metabolites. The individual moth does quite well without them. However, they are vitally important to the survival of the species. Another classic example of a secondary metabolite is the antibiotics produced by some fungi and bacteria. When growing a fungus as a sterile monoculture in someone's laboratory, the organism has little use for antibiotics and usually ceases to produce them. However, in its natural habitat, their production is not a luxury.

Most of the compounds classified as secondary metabolites are not synthesized continuously but in what could be described as an on-demand fashion. One reason perhaps for them not to be synthesized continuously is that many of them are extremely complicated chemicals. Any cell that synthesizes complicated molecules such as ivermectin, taxol, and other secondary metabolites is investing a significant portion of its resources in that synthesis. If the production of these compounds were not carefully regulated, individuals that wasted their resources on unnecessary synthesis would be rapidly squeezed out. So, instead, their production is turned off and on by environmental cues.

If we restrict our study to fungi, we are discussing organisms that can't see, smell, hear, or feel. So how do they detect their environment? How do they become aware of essential events such as moisture in their surroundings or the presence of friendly and not-so-friendly companions? These events are likely mediated by chemical communications.

Defensive Chemicals

Pheromones and antibiotics are examples of what I believe are the two major functions of all secondary metabolites made by lower life forms: defense and communication.

Let's first consider fungal fruiting bodies and their defense. Fungi live in very intense environments, surrounded by other fungal types, bacteria, and all manner of predatory soil inhabiting invertebrates. Chemical warfare among organisms with clearly different agendas is the rule, not the exception.

I'm sure that everyone is familiar with the story of the discovery of penicillin. With the benefit of hindsight, it seems obvious that soil microbes would be synthesizing antibacterial compounds. They are literally surrounded by billions and billions of bacteria that are doing their best to find their next meal. Without antibacterial weapons, soil fungi would have a tough and short existence.

By now, thousands of antibacterial compounds have been identified from soil microbes, and it's a good bet that all fungi have some type of antibacterial response. So, how do these bacteria that are being slaughtered by antibiotic-producing fungi respond? Fungi may be clever chemists, but so are bacteria. When this warfare was getting started a few hundred million years or more ago, some bacterial enzyme that split proteins modified itself to split an important chemical bond in penicillin, making it harmless to bacteria. The code for the enzyme, penicillinase (also referred to as β-lactamase) ended up on a piece of DNA called a plasmid. A plasmid can be spread through bacteria populations rapidly and even be transmitted to different species of bacteria. The result was that the party was over for penicillin-producing fungi. They were back on the defensive.

Over the course of an eon or two and after probably many chemicals were synthesized and found wanting, a fungus hit on the compound, clavulanic acid. This compound was an inhibitor of the bacterial enzyme penicillinase. With the clavulanic acid to back it up, penicillin was now once again a potent weapon. There are many other examples of chemical warfare and coevolution combatants.

The full appreciation of this process is also important for the medical treatment of bacterial infections. Initially, few human pathogenic bacteria carried the penicillinase plasmid. These bacteria were concentrating on more important issues, such as how to combat our immune system, and not on penicillin resistance. However, the widespread use of penicillin created strong selection pressure for a pathogen that managed to pick up the penicillinase plasmid from a soil bacterium. This eventually occurred, and the plasmid rapidly spread through pathogenic bacteria, severely impairing the effectiveness of penicillin. Between 1941 and 2002, penicillin resistance in *Staphylococcus aureus* rose from less than 1% to greater than 99%.

It took fungi millions of years to come up with clavulanic acid. Luckily, the pharmaceutical industry found a fungus that produced it a lot sooner. Beecham introduced it as Augmentin (clavulanic acid plus amoxicillin, semisynthetic penicillin) in 1981.

1 think we would be discounting the creativity of bacteria if we did not assume that for every naturally occurring antibacterial, there is a bacterium somewhere that has figured out a way to beat it. Bacterial resistance to antibiotics has been around for a long time; it didn't evolve because of our use of antibiotics. Our rampant use of antibiotics created a strong selection pressure for pathogenic bacteria that learned new tricks from soil bacteria.

The existence of some compounds from fungi that are used as drugs doesn't seem to have a ready explanation. For example, the first cholesterol-lowering agent, mevalonin (lovastatin, Merck) came from a fungus. This might initially seem odd, because there seems to be little if any reason for a fungus to make this compound (we all know that mushrooms are cholesterol free). The secret is that the fungus needs a chemical named ergosterol which, as it turns out, is very closely related to cholesterol (which means that mevalonin is also an ergosterol lowering agent).

Nearly every cell in a human body needs cholesterol for proper membrane functioning and has the ability to manufacture it. Humans are also fortunate (and sometimes unfortunate) enough to be able to obtain significant amounts of it from dietary sources.

All fungal cells need ergosterol and can also make it. However, fungi do not have the option of going out and consuming the fungal equivalent of a Big Mac. If a fungus can't make ergosterol, it dies. So if one fungus is able to stop ergosterol production in neighboring fungi, it ends up with a bigger piece of the pie. This fungus uses its mevalonin-like compound to block its neighbor's ergosterol production. The neighbor dies, and the fungus has fewer competitors for the food supply.

Even Lipitor, which everybody on the planet is taking or probably will take, is a derivative of a natural product. Other types of drugs that are natural products are the immunity-suppressing drugs, which have been a major factor in the increase in the number of, and the success of, organ transplants. 78% of the antibacterials and 74% of the anticancer compounds are natural products or are derived from them, and the majority of the compounds in these two therapeutic classes were isolated from fungi. Additional examples could easily develop into endless and boring lists.

Communication Chemicals

There is another interesting category of molecules produced by fungi and other organisms: communication molecules. What are communication molecules? The air we breathe, the water in a lake, and the soil and leaf litter are highways through which all sorts of communication molecules course.

We as humans are challenged, to say the least, in detecting all but a scant minority of these chemicals. Many species of insects use them to advertise themselves to mates. Plants attract (or repel) insects with chemicals. Various species of animals announce their presence with communication molecules. Take your pet dog for a walk and witness first hand the signs of an olfactory world from which we are excluded.

The lives of millions of animals are synchronized by chemical signals. I'm sure that many of you have seen the remarkable scenes of millions of coral spawning on the same night from one of David Attenborough's shows from Life on Earth. I can't resist one more example, that of the stinkhorns, which we have the (mis)fortune to detect, as do many insects. Clearly, the chemical signal emanating from the stinkhorn has a very different meaning to you and me compared to the many species of insects encircling its tip.

We live in a sea of chemicals. I heard an analogy once that I've become very fond of. Communications chemicals can be looked at as postage stamps. You put a stamp on a letter or package to transmit something to the addressee. The stamp ensures that the message will be received but says nothing about the message or the reaction of the addressee. Communication molecules also ensure that a message will transmitted; the exact meaning of the message will depend on the sender and recipient.

Another interesting feature of communication molecules is that once Mother Nature found a chemical that could be used for communication purposes, she stuck with it. Similar classes of molecules are used throughout a wide phylogenetic range. Communication chemicals (e.g., hormones) can act to send a message from one part of an organism to another or they can send communications to organisms of the same species (pheromones) or to different species (stinkhorns). A flower's smell says "come here," a skunk's smell says "go away," etc.

Since we are talking about mushrooms, what are some of the things that are likely to be mediated by communication chemicals? Let's start at the beginning. A spore responds to certain chemical cues to germinate. It may need to know if it has landed on a suitable substrate. Mycelia respond to other mycelia of the correct mating types of the same species to form diploid mycelial organisms. The growing mycelia need to be able to detect and utilize proper nutrients. In addition, mycorrhizal species need to colonize (or be colonized by) the appropriate type of tree root for survival and growth.

The selectivity of many types of mushrooms has always amazed me. How does *Suillus granulatus* tell the difference between a pine and a maple tree? How do the many other mycorrhizal species recognize their hosts? Also consider the selectivity of the wood-rot polypores. *Piptoporus betulinus* always colonizes dead birches. It is rarely found on other species of trees. What signal or signals allow this fungus to selectively grow on this wood? Many species are selective for either hardwoods or conifers. When we speak colloquially about these interactions, we make statements like, "they are attracted to dead birch trees," or "*Suillus granulatus* prefers to grow in association with pine."

Statements like these seem to give decision-making qualities to organisms that consist of a very limited number of cell types. While they do make a decision in a manner of speaking, it is their responses to the various chemicals that they encounter, either positively, negatively, or both, that underlies this apparent decision. These chemicals interact with cell-surface or intracellular receptors and induce metabolic changes in the fungus.

As I mentioned previously, Mother Nature is very fond of the communication systems that fungi developed a billion or so years ago. Many of them have been refined and elaborated upon as eukaryotic systems increased in complexity. Once evolution found some molecules that were good postage stamps and some receptors that were good mailboxes, it stuck with them and refined them over an eon or two. The result is that many chemicals that are used by higher organisms have their roots in fungal metabolism.

Mammals, of course, have many more pressing communication needs than fungi. In the central nervous system, at least 40 to 50 chemical transmitters have been identified. In the immune system, many types of communications proteins, the cytokines, have been discovered. These are two broad examples of mammalian communication molecules. What is also true with higher organisms is that the type of message that a molecule sends depends on the receptor that the cell has. An organism may have many different types of receptors for chemicals, and the message that a cell receives depends on the receptors on that cell.

For example, compounds that interact with mammalian serotonin receptors have been isolated from fungi. The introduction of Prozac has made many of us experts in neuropharmacology, and we all know about serotonin's involvement in mood and depression. There are several types of serotonin receptors in our central nervous systems and elsewhere throughout our bodies. Serotonin and/or its receptor are apparently also involved in some aspect of fungal communication, and serotonin may have been used as a communication molecule long before people realized that they were depressed.

The cholinergic system provides another example. At one time, before the cloning of receptors became commonplace, two types of mammalian cholinergic receptors were recognized: nicotinic and muscarinic. The nicotinic receptors were activated by nicotinic acid (found in tobacco), and the muscarinic receptors were activated by muscarine (found in *Amanita muscaria*).

Amanita muscaria is a particularly rich source of a variety of mammalian communication compounds. It also contains muscimol, which activates mammalian inhibitory transmitter receptors for gamma-amino butyric acid and ibotenic acid, which stimulates a mammalian excitatory receptor for L-glutamic acid and is a potent neurotoxin. While these chemicals act at mammalian neurotransmitter receptors, in the case of *A. muscaria,* they are probably defensive chemicals. Because of their immediate action, muscaria chemicals would probably persuade potential predators such as mammals, insects, soil nematodes, and other fungi to dine somewhere else. We should resist the egocentric notion that these chemicals are directed at our species.

As I mentioned above, when nature finds a way to do something well, it usually sticks to it. Fungi synthesize chemicals that act as cytokines, compounds that mimic various peptide transmitters and gut hormones; they produce compounds that release insulin from mammalian cells. No one believes that fungi had *Homo sapiens* in mind when these chemicals were first synthesized.

The take-home message from all of the above is that many receptors and metabolic systems used by fungi overlap with those used by more complex organisms (I'm resisting using the term higher). As a result, there are thousands and thousands of chemicals synthesized by fungi for their own purposes that will also affect mammalian systems, some for better and others for worse. I'm trying to find the better ones.

A MAJOR FUNGUS FIND

Rick Weiss

The Washington Post, September 15–21, 2003

Scientists probing the frozen soil beneath Colorado's Rocky Mountain snowpack have found a world of microbes no one knew existed—a world dominated by microscopic fungi unlike any others previously found on Earth.

So numerous and diverse are these newly discovered organisms that scientists are having to rewrite the book on the ecological importance of fungi—life forms that are neither animals nor plants but which, as nature's premier recyclers, do a big share of the work of keeping Earth in biological and chemical balance.

Indeed, scientists say, if other regions of the world have similar fungal communities thriving under their winter snows, as now seems likely, climatologists will have to revise their models of global warming to accommodate fungi's surprisingly massive role in the winter production of greenhouse gases, such as carbon dioxide.

Industrial chemists are eyeing the peculiar tundra fungi, too. They want to take advantage of the organisms' ability to perform biochemical reactions at temperatures that would put most microbes to sleep.

"The dogma was that not much biology goes on under the snow," says study leader Steven Schmidt, a microbiologist at the University of Colorado in Boulder. "But obviously, there's quite a bit going on." Suspicions that something was cooking beneath the world's snowfields arose in recent years when scientists detected carbon dioxide and methane escaping into the winter air over Siberia and other arctic regions. The gases were exactly those that scientists would expect if bacteria and fungi in the soil were going about their usual summertime business of breaking down decaying plant matter—a process that scientists thought came to a near-standstill under snow.

To see what was going on, Schmidt and his co-workers took a series of core soil samples at their 2½-mile-high study site. Common methods of spotting microbes in soil, including using microscopes and trying to grow them in laboratory dishes, turned up little. But when the team used molecular tools to detect microbial DNA in the soil, they hit, well, pay dirt.

Analysis of those DNA samples indicated the presence of countless species of fungi invisible to the eye and too finicky to grow in standard laboratory preparations. Some are genetically similar to known fungal species, indicating they are simply new species, the team reported September 5 in the journal *Science*. Many others, however, have enough similarities to identify them as fungi but are otherwise completely novel, indicating they constitute entirely new groupings and probably perform unique biological functions.

Equally surprising, tests showed that the density of these organisms per gram of soil climbed dramatically in midwinter, when the researchers had predicted they would be at their minimum.

"At first I thought I wasn't reading the [researchers'] paper right," says Jo Handelsman, a plant pathologist and Howard Hughes Medical Institute microbiologist at the University of Wisconsin at Madison. "It shows a vast increase in fungal biomass in winter, with more than twice as much under the snow as in summer soil. That's really surprising."

Both she and Schmidt are part of a unique, decentralized effort known as the Microbial Observatory, funded by the National Science Foundation. The goal is to find new life forms on earth, especially in extreme environments, in many cases by trolling for traces of their DNA.

"What we know about the microbial world comes from the tiniest chip off the microbial iceberg, the little bit we've been able to see and grow," Handelsman says. "Most of what's out there is still unknown and will offer us a tremendous amount of information about how the world works."

Fungi are of particular interest to scientists studying biogeochemical cycles—the big natural cycles through which organic (or carbon-containing) compounds are broken down and rebuilt, which keeps the planet in biological and chemical equilibrium.

Although some fungi are visible—bread mold, lichens, and mushrooms among them—most are microscopic. They sport delicate and tangled hairlike hyphae that exude digestive chemicals that allow them to penetrate and dissolve even the toughest components of plant cells, including cellulose and lignin.

Fungi can convert those compounds into stable molecules that effectively lock up carbon atoms in the soil for years, slowing their conversion into methane and carbon dioxide ($C0_2$)—major contributors to global warming. But fungi also release carbon dioxide themselves, just as people do when they exhale.

It remains to be seen whether these newly discovered communities of fungi—not to mention all the other kinds of microbes yet to be found—will dampen or strengthen predictions about rising temperatures on Earth. But global warming models can no longer ignore fungi in snowy regions and seasons as they have, scientists say—especially because about 40 percent of Earth's landmass is covered with snow for at least part of the year.

"We're living in a world where global warming is a constant threat, but in fact we have relatively little knowledge of what the inputs and outputs are for $C0_2$," says Steven Miller, a mycologist at the University of Wyoming.

ALTHOUGH THE ECOLOGICAL impact of these cold-hardy fungi remains uncertain, Miller says, their industrial potential is clear. Chemists are ever on the lookout for microbes that thrive in the cold, because these organisms are sure to harbor enzymes that have evolved to work best at low temperatures. Researchers want to put these enzymes to work driving chemical reactions that normally require big inputs of heat or caustic chemicals.

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CROATIAN MUSHROOM SOUP WITH BUCKWHEAT

Michael Blackwell

1½ oz	Onions
2	Cloves garlic
6 oz	Fresh mushrooms or 1 oz dried mushrooms
1 oz	Buckwheat groats
4 Tbsp	Sunflower seed oil
1	Bay leaf
½ tsp	Salt
1 Tbs	Vegetable seasoning or liquid aminos
1 qt	Water or vegetable broth
To taste	Salt and pepper
2 Tbsp	Chopped parsley
1 Tbs	Vinegar
1 cup	Sour cream

Chop the onion and garlic, slice the mushrooms, and wash the buckwheat.

Heat the oil and lightly sauté the onion until clear.

Add the mushrooms and the garlic and continue to sauté.

Add the salt, vegetable seasoning, buckwheat, and the bay leaf and cover with water.

Simmer gently and just before it is completely cooked give it a taste. Add salt, pepper, chopped parsley, and vinegar to taste.

Serve topped with sour cream (optional).

MUSHROOM MISSIONARIES

Marian Maxwell gave a lecture Tuesday, October 19, at Renton Park Elementary School for two 4th grade classes. On Wednesday, October 20, she gave a lecture at Cross and Crown Preschool in Renton, and on Thursday, October 21, she lectured on "The Role of Fungi in the Ecosystem" for two classes per period, for all six periods at McKnight Middle School.

Fungus Find, *cont. from page 7*

Some envision using the microbes or their enzymes to make paper pulp from wood in ways that are cooler and less polluting than current techniques. Others hope to use them to clean up toxic waste in places too cold for standard biological detoxification processes to work.

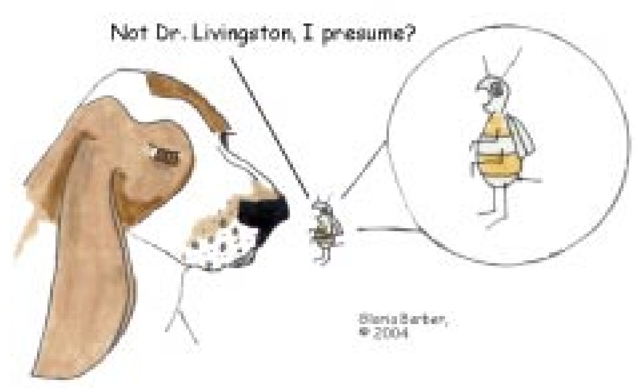
To take fullest advantage of these strange life forms, though, scientists will have to figure out how to grow them, so they can study them in the flesh. That will require a special kind of experimentalist—part scientist, part chef—to come up with the customized recipes that will appeal to each of these specialized species.

Schmidt's team has taken a few stabs. It has placed bits of Rocky Mountain soil in lab dishes filled with nutrients and tasty tundra plant extracts, then incubated them in refrigerators in the hope of hitting on a recipe that the fungi find palatable.

So far, no luck, Schmidt says, sounding a bit like a parent with a fussy child.

So for now, at least, most of the world's microbial menagerie will continue to work in anonymity.

McGee, MS



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The 2004–2005 membership rosters will be available for pick-up at the November meeting.