SPORE PRINTS

BULLETIN OF THE PUGET SOUND MYCOLOGICAL SOCIETY
Number 460 March 2010

AN UNUSUAL SPECIES OF *HYGROPHORUS* FROM THE NORTH CASCADES

Brian Luther

I needed to get out for some fresh air and exercise, so on November 11 Larry Baxter and I got together and took the Mountain Loop Hwy. out of Granite Falls, Washington, following the Stillaguamish River up into the North Cascades. It was getting to be the end of the mushroom season for the lowland, and we could see a line of heavy snow and frost just another couple of hundred feet above us on the trees. I ran across a fruiting of a very viscid, long stemmed species which turned out to be *Hygrophorus megasporus*.

It's rarely collected, but is known from Northern California, from a few locations in Oregon, and from the Lake Quinault area of the Olympic Peninsula here in Washington State. I used to find it years ago when PSMS had forays to Kamp Kiwanis on the north shore of Lake Quinault. Here's a brief description of my collection.

Brian Luther

Hygrophorus megasporus Smith & Hesler

Pileus 2–6 cm wide, warm brown or olivaceous brown with a darker brown central disc or umbo, margin much paler in color, especially noticeable on mature caps, convex to slightly to prominently umbonate at first, margin tightly inrolled when young becoming convex, later plane or more often with a noticeably upturned outer margin and slightly irregular at maturity, thickly viscid, leaving a slightly thicker viscid partial veil area on the stipe after the cap expands away from the stipe. Pileal context white, unchanging when cut or bruised and without any noticeable odor or taste. *Lamellae* at first adnate or adnate with a tooth, becoming subdecurrent to slightly decurrent, somewhat narrow, white, subdistant, waxy and unchanging when bruised, regularly alternating with lamellulae. *Stipe* 5–15 cm long, 0.5–1.5 cm wide, often slightly curved, twisted or bent, normally equal or sometimes slightly enlarging toward the base or apex, white, sometimes with a slight tinge of faint brown here or there, but mostly white overall, viscid, lacking any color under the slime, context solid, white and unchanging when cut or bruised. *Spores* very large 12–20 × 7–9 µm, ellipsoid, smooth (unornamented), hyaline when mounted in 3% ammonium hydroxide or 3% KOH, inamyloid. *Basidia* 50–70 × 7–12 µm. *Pleurocystidia and cheilocystidia* none. *Lamellar trama* divergent. *Pileal surface* with a thick layer of gluten over interwoven and radially arranged hyphae. *Clamp connections* present.

Habit and habitat: scattered to gregarious in deep conifer duff in a second growth mix of Douglas Fir, Western Hemlock and Western Red Cedar at 600 ft. elevation. FS Road 4020 off of the Mt. Loop Hwy, east of Verlot, Snohomish Co., WA.

The distinguishing features of this fungus are the beautiful brown caps, with much darker umbos and a paler margin, stems that are pure white overall and lack any streaks of dark pigments under the slime, extremely long stems—approximately three or more times the diameter of the pileus in some cases, white subdecurrent gills, very viscid cap and stem (making it difficult to pick up), a complete lack of any distinctive odor or taste, and microscopically the very large spores. *H. olivaceo-albus* is somewhat similar, but has very conspicuous dark brown, olivaceous or blackish streaks of pigment under the slime on the stems from the glutinous veil downward, contrasting with the bright white stem above the veil; also it has much smaller spores.

Hesler & Smith (1964, p. 296) show a black and white photo of the long stems on this species, and Largent (1985) says that Smith only found one collection in northern California.

The old genus *Hygrophorus* is divided into different genera based on the microscopic characters relating to the arrangement of cells in the gill trama, colors, and whether it is mycorrhizal or not. For example, species of *Hygrophorus* have divergent (bilateral) gill trama, many have subdued colors, and are all mycorrhizal. *Hygrocybe* species usually have parallel (regular) gill trama, are normally not mycorrhizal, and often are brightly colored; *Camarophyllus* has interwoven gill trama, etc. However, many new genera have been added to the family Hygrophoraceae as a result of DNA studies and some surprising re-adjustments are being made. Refer to Moncalvo, et al. (2002).

For those of you interested in studying the local *Hygrophorus* flora, I would suggest the PNW Key Council Key (2003) originally done by Dan Stuntz, but subsequently enlarged and available on-line.

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Spore Prints

is published monthly, September through June by the

PUGET SOUND MYCOLOGICAL SOCIETY
Center for Urban Horticulture, Box 354115
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(206) 522-6031 http://www.psms.org
User name: Password:

Annual dues $25; full-time students $15

CALENDAR

Mar. 13 Annual Meeting and Survivors' Banquet, 6:30 p.m., CUH

Mar. 15 Board Meeting, 7:30 p.m., CUH Isaacson Boardroom

Mar. 16 *Spore Prints* deadline

Mar. 27 Learning field trip (see insert)

Mar. 28 Needle felting workshop, 1–4 p.m., CUH Douglas classroom

DAY AT THE MUSEUM: Mushroom Maynia!

Joanne Young

The third annual Mushroom Maynia! will be Sunday, May 2, from 10 a.m. to 4 p.m. at the Burke Museum on the UW campus. This is a fun, one-day event to raise awareness of the role of fungi in our lives and world. Mushroom Maynia! needs volunteers to help with displays and activities. These will include family-oriented cultivation workshops, art activities, and a variety of displays to introduce the public to the Kingdom of Fungi. Volunteers with all levels of mushroom expertise are needed, including beginners.

Mycology is intimately connected to the study of forestry, botany, ecology, medicine, and the culinary arts. It is the goal of the Daniel E. Stuntz Memorial Foundation and PSMS to keep these connections alive by supporting the study of the natural science of mushrooms. Mushroom Maynia! is made possible by the Daniel E. Stuntz Memorial Foundation and volunteers of the Puget Sound Mycological Society.

Please save the date and, if you wish to join in the fun, contact Joanne Young at mushroommaynia@psms.org.

ANNUAL MEMBERSHIP MEETING AND SURVIVORS' BANQUET

Saturday, March 13, 2010, Center for Urban Horticulture, 3501 NE 41st Street, Seattle.

It is time again for the Annual Membership Meeting and Survivors' Banquet, an opportunity to gather and congratulate each other for making it through another season of finding and eating mushrooms. The social hour will begin at 6:30 p.m., followed by a potluck dinner at 7:30 p.m. Please bring your favorite hors d'oeuvre, entrée, or dessert to share. Please list the ingredients and any wild mushrooms included in your dish. We will secure a state liquor permit, so you may bring wine, beer, etc., to enjoy with your food. The theme of this year's banquet is "The Joy of Mushrooms," honoring, and in fond memory of, professional nature photographer, charter PSMS member, and the first Golden Mushroom Award recipient Joy Spurr, who passed away in December. We will include a slide show, door prizes, and stand-up comedy for your entertainment. We will also present the "Golden Mushroom Award" honoring a fellow member's long-term service to the club, and announce our newly elected trustees and officers.

THANKS FOR THE HELP

David Pippin

On Thursday, January 21, volunteers from PSMS attended the first-ever Hamilton International Middle School Science Night in the Wallingford neighborhood of Seattle. I was one of the parent volunteers and recruited PSMS to be one of the exhibitors. When Kim Traverse responded to my request for help on the PSMS list-server, I was extremely grateful. Little did I know that he would also recruit five other people to join him: Marian Maxwell, Daniel Winkler, Joanne Young, Stewart Wechsler, and Linda Haba. Mid-winter is not the best time to exhibit fungi, but perhaps owing to the warm temperatures we've been experiencing, folks were able to round up some nice specimens of two species of *Hygrocybe*, a *Psathyrella*, and *Xylaria hypoxylon.* They also brought with them a mini-library of mushroom books, dissecting scopes, and microscopes. Attendees were not intimidated by the three flights of stairs to get to the fourth floor exhibit, and when they got there they were welcomed by a big ol' poisonous fungi poster. It seemed that the volunteers talked with more parents than students, but a steady stream of people of all ages came through the classroom. Some people were embarrassed to admit they didn't even know that mycology was the study of fungi. Many asked about edible species, but most were quite fascinated to learn what an important role fungi play in the environment—about mycorrhizal relationships with plants, the biomass of mycelium, and the number of spores produced. All agreed that it was a fun evening, and we hope to do it again next year when Hamilton moves into its newly remodeled building.

MUSHROOM IDENTIFICATION AT CUH

Hildegard Hendrickson

PSMS will resume mushroom identification at CUH on Mondays from 4–7 p.m. starting, Monday, April 26, 2010 (or earlier, depending on the weather) and continuing until the end of the spring mushroom season. You may call Hildegard Hendrickson (206) 523–2892 to find out if mushroom identification will be held.

INDUSTRIAL-STRENGTH FUNGUS **Adam Fisher**

Time Magazine, Feb. 8, 2010

At an organic farm just outside Monterey, California, a super-eco building material is growing in dozens of darkened shipping containers. The farm is named Far West Fungi, and its rusting containers are full of all sorts of mushrooms—shiitake, reishi, and pom-pom, to name a few. But Philip Ross, an artist, an inventor, and a seriously obsessed amateur mycologist, isn't interested in the fancy caps we like to eat. What he's after are the fungi's thin, white, rootlike fibers. Underground, they form a vast network called a mycelium. Far West Fungi's dirt-free hothouses pack in the mycelium so densely that it forms a mass of bright white spongy matter.

Mycelium doesn't taste very good, but once it's dried, it has some remarkable properties. It's nontoxic, fireproof, and mold- and water-resistant, and it traps more heat than fiberglass insulation. It's also stronger, pound for pound, than concrete. In December, Ross completed what is believed to be the first structure made entirely of mushrooms… . The 500 bricks he grew at Far West Fungi were so sturdy that he destroyed many a metal file and saw blade in shaping the 'shrooms into an archway 6 ft. (1.8 m) high and 6 ft. wide. Dubbed Mycotectural Alpha, it is currently on display at a gallery in Germany.

Nutty as "mycotecture" sounds, Ross may be onto something bigger than an art project. A promising start-up named Ecovative is building a 10,000 sq. ft. myco-factory in Green Island, N.Y. "We see this as a whole new material, a woodlike equivalent to plastic," says CEO Eben Bayer. The three-year-old company has been awarded grants from the EPA and the National Science Foundation, as well as the Department of Agriculture—because its mushrooms feast on empty seed husks from rice or cotton. "You can't even feed it to animals," says Bayer of this kind of agricultural waste. "It's basically trash."

After the husks are cooked, sprayed with water and myco-vitamins, and seeded with mushroom spores, the mixture is poured into a mold of the desired shape and left to grow in a dark warehouse. A week or two later, the finished product is popped out and the material rendered biologically inert. The company's first product, a green alternative to Styrofoam, is taking on the packaging industry. Called Ecocradle, it is set to be shipped around a yet-to-be-disclosed consumer item this spring.

http://www.philross.org/

Mycotectural Alpha, a "tea house" built of Ganoderma lucidum *bricks. The building will slowly be boiled down in the form of a tea over the course of the exhibit and served to the visitors of the museum. A very literal tea house.*

One of the beauties of Ecocradle is that unlike Styrofoam—which is hard to recycle, let alone biodegrade—this myco-material can easily serve as mulch in your garden. Ecovative's next product, Greensulate, will begin targeting the home-insulation market sometime next year. And according to Bayer's engineering tests, densely packed mycelium is strong enough to be used in place of wooden beams. "It's not so far-out," he says of Ross's art house. So could Bayer see himself growing a

http://www.philross.org/

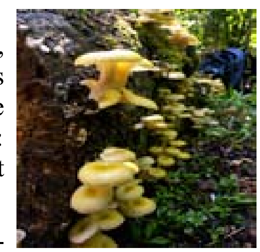
Mycelium brick with fruiting Ganoderma lucidum*, also known as reishi.*

http://www.philross.org/

Construction detail.

TAMING THE TAMOGITAKE **Takayuki Nishizawa**

The Spore Print, L.A. Myco. Soc., Dec., 2009



Japan-Three-B Co., based in Nanporocho, Hokkaido, rapidly expanded its business after it had succeeded in cultivating the tamogitake (*Pleurotus cornucopiae var. citrinopileatus*), a yellow mushroom that grows wild on the northern island.

The mushroom, which has become popular for its firm texture and richness that makes good broth, is now sold at department stores and high-end supermarkets in the Tokyo metropolitan area.

Before the firm developed ways of cultivating the mushroom, the tamogitake had been quite rare in the market, as it grows wild only in Hokkaido and can be harvested only in summer.

Tokushiro Yoshinari, 71-year-old chairman and founder of the company, started exploring techniques to grow the mushroom in 1985. In the process, he found that the mushroom includes beta-glucan. which boosts the immune system, and ceramide, which is reportedly effective in retaining skin moisture and controlling atopic dermatitis.

With the cooperation of the Hokkaido Forest Products Research Institute, the firm successfully developed a strain of fungus with the mushroom's original constituents and had it officially registered in 2005.

The firm's technique made possible the mushroom's mass-production, as it is harvested in about 20 days after it is planted. The firm produces about 65 percent of the tamogitake produced nationwide.

The firm successfully got its business off the ground after developing products made with the mushroom's constituents; cosmetics with ceramide and health food containing beta-glucan.

The company, which employs 45 people, marked 430 million yen in sales in the business year ending March 2009.

President Masami Ishida, 55, is aggressive in pursuing further expanding the business.

RESUPINATE FUNGI OF WASHINGTON

Brian Luther

In my continuing effort to provide interesting and educational information on fungi, I'm starting a new monthly series in *Spore Prints* featuring resupinate fungi. Each month I'll select a different species and provide a photo (in color if accessed on-line) and a brief description of the fungus, including line drawings I've made of microscopic structures and a discussion of habitat, etc. We have hundreds of species of resupinates here, and I will discuss something different each month. I hope you will at least find these monthly allotments informative.

What are resupinate fungi? Resupinates are highly diverse fungi in many different and unrelated families that simply share the same general growth habit—namely growing over, or confluent on (adhering closely to the woody surface), or more often underneath on decaying woody debris. Some resupinate fungi also form pilei (caps) which arise from the resupinate portion of the fruiting body, but the vast majority do not. Thus, most just look like crusts or patches growing on or underneath branches, logs, or other woody substrates. They can be found in every color of the rainbow and may be smooth or bumpy or have pores or teeth-like structures. They can be tough and firm, gelatinous, or very soft and cottony. Normally in order to see these fine features (except color) you'll need some form of magnification, such as a hand lens or dissecting microscope, unless you have 10× vision like Dr. Stuntz had at close range.

Resupinate fungi are usually completely overlooked by amateurs and mushroom enthusiasts for several reasons. First of all they are found on or under woody debris and are therefore obscure and not looked for. Many appear very similar or indistinguishable to the unaided eye. They're not fleshy and mushroom-like and have no culinary appeal, so someone looking for a contribution to the dinner meal will not get any satisfaction from this group at all. Many mushroom enthusiasts are barely aware that they exist. Second, identifying them requires training in and experience with the use of both dissecting and compound microscopes and the use of many reagents, stains, and macrochemicals for testing, as well as sectioning techniques and proper slide preparation, depending on what you're looking for. Many look very similar—as, say, white patches under logs—and their distinguishing features are mostly observable only with a microscope. All of these facts tend to discourage mycophiles.

But this group has a real advantage in that they can be found fruiting at any time of year even in winter, say, for example, by lifting up a dead fallen tree limb covered with snow.

Resupinates are, without a doubt, the most amazing fungi in terms the unusual variety of marvelous, weird, unique, and fascinating microscopic structures found within this group. It is my goal to at least introduce you to some of these fungi, and, I hope, give you a better appreciation for the diversity of the Kingdom of Fungi all around you.

RESUPINATE FUNGUS OF THE MONTH: *Cristinia helvetica* (family Stephanosporaceae)

Brian Luther

I find this species most frequently on the underside of soft, well rotted Bigleaf Maple (*Acer macrophyllum)* debris, but it's known to grow on many kinds of wood, mostly hardwoods. It is common and is found year round. The light colored, wispy cottony basidiocarp is typical, but there are many unrelated fungi that look similar to the naked eye.

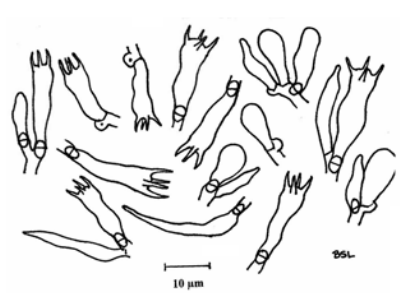
Larsson (2007) did an extensive DNA analysis of the resupinate fungi and concluded that the genus *Cristinia* belongs in the family Stephanosporaceae. Previously, it was put in the Corticiaceae by Christiansen (1960), Eriksson & Ryvarden (1975), Lindsey & Gilbertson (1978), and Breitenbach & Kranzlin (1986) and in the Lindtneriaceae by Hansen & Knudsen (1997).

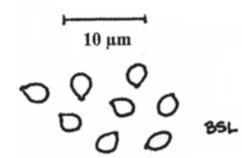
Fruiting body: resupinate, very thin, fragile, loosely attached, flocculose (loosely downy or cottony), with the surface slightly minutely bumpy or tuberculate under magnification, creamy whitish, dirty whitish or grayish-white with a slight ochraceus (pale yellow-brown) tint, with occasional rhizomorphs (strands) crossing through or around it, margin fibrillose. Readily rubbed off from the surface of the wood.

Microstructures*: Hyphal system* monomitic, generative hyphae thin-walled, frequently branching, 2–7 µm wide, with abundant clamp connections. *Spores* 3–3.5 × 2–2.5 µm, globose to only slightly subglobose, smooth, thick-walled, uniguttulate, noticeable apiculus present, inamyloid and lightly cyanophilous (staining blue in Cotton Blue). *Basidia* 16–25 × 5–7 µm, cylindrical or elongate clavate, often with a central constriction, hyaline, thin-walled, basally clamped, four sterigmate, contents strongly cyanophilous. *Cystidia* none, but hymenial cystidioles sometimes present, narrowly fusoid, the apex slightly rounded to acuminate, thin-walled, sometimes extending beyond the basidia, basally clamped.

My collection described here is actually slightly different from typical *C. helvetica* by virtue of the smaller, more globose spores, which stain only lightly in Cotton Blue. The spores for this species reported in the literature are normally 3.5–4.5 × 3–4 µm, and show a greater tendency to be distinctly subglobose, rather than globose, and they stain darker in Cotton Blue. Also, cystidioles are sometimes present (in some mounts and not others), a feature not usually seen in this species; however, Eriksson & Ryvarden (1975, p. 309) mention a form of this species, called form cystidiolata, with this characteristic.

Cristinia helvetica causes a white rot of wood. Application of tincture of Guaiac Resin to the fruiting body resulted in a dull gray blue (positive) color change after about 20 minutes. Application of tincture of Syringaldazine resulted in a very dull, pale reddish color after an hour. These are just two of many reagents I use to test for the presence of extracellular polyphenol oxidase enzymes, produced by white rot fungi (see Luther, 2007).





Christinia helvetica *basidio spores (above right) and basidia, basidioles, and cystidiodes (left).*

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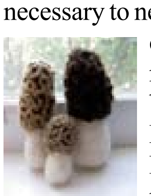
PRESIDENT'S MESSAGE — Patrice Benson

Thank you to the many volunteers who are working on updating our website's functionality! Soon we will be able to register for classes, renew memberships, and sign up for forays on our PSMS website, www.psms.org. Our database keeper, Pacita Roberts, and Ann Polin, the membership chair, are working with Molly Bernstein and Denise Banaszewski plus three others to make the changes necessary to increase this functionality.

Intermediate ID sessions will start on April 15 and run three additional weeks. Please e-mail education@psms.org to sign up. There is limited space so sign up soon if you are interested. We need more identifiers! The cost of this series will be $35 for four sessions.

There will be a one day beginner's microscope workshop on Sunday, April 11, 2010, from 9 a.m. to 3 p.m. This will be taught by Judy Roger from the Oregon Mycological Society. The location TBD. Microscopes and equipment are provided.



Molly Bernstein will return to Seattle to teach a needle felting workshop on March 28, the day after our first field trip. For $30 You will have all supplies necessary to needle felt a mushroom or object of your choice. Cost includes tools to keep. So make it a combo weekend and attend both! The workshop is from 1–4 p.m. at the CUH Douglas classroom and is limited to 30 participants. Perhaps Agnes will put a photo of a needle felted mushroom so you can see what this is all about!

Joanne Young is chair of the third annual Mushroom Maynia! to be held on Sunday, May 2, 2010, at the Burke Museum on the UW campus. This event is from 10 a.m.–4 p.m. and is hosted by PSMS volunteers. We need lots of volunteers for this fun event. E-mail mushroommaynia@psms.org to volunteer.

Our March meeting will NOT be on the usual second Tuesday. Instead we will have our Annual Meeting and Survivors' Banquet at the Center for Urban Horticulture. This year's banquet will be our 45th and will be a potluck. In honor of our first Golden Mushroom Award winner, Joy Spurr, who recently passed away, the theme will be "The JOY of Mushrooming." Bring a dish to share and dress joyfully. There will be door prizes and stand up comedy. Your bags will be searched for rotten fruit at the door. BYOB.

Thanks to Agnes Sieger for solving the problem of how to best display the wonderful and interesting articles contained in our *Spore Prints* bulletin to the world while maintaining some of the information meant for members in the members section of the PSMS website. Details concerning field trips and class information will be on an insert in the printed version of the *Spore Prints*. This insert will then be stored on the members page of the PSMS website. The main body of the newsletter will be posted on the website as soon as it is available from the editor.

See you at the Survivor's Banquet!

CORAL ROOT — ONE EXAMPLE OF A FLOWERING PLANT INVOLVED IN A THREE-WAY MYCORRHIZAL RELATIONSHIP — Brian Luther

By now you should all be aware of the critical role that mycorrhizal fungi play worldwide.

Mycorrhizal fungi provide water and dissolved nutrients to tree and shrub roots at a much greater rate and volume than the plants could take in on their own, and in return get a share of some of the carbohydrates produced by the photosynthetic plants, whose roots they are intimately associated with. There are two basic types of mycorrhizae: endomycorrhizae (=inside fungus root) and ectomycorrhizae (=outside fungus root). We rarely encounter endomycorrhizae because they are entirely within the living roots of trees and shrubs, but 80 percent of our forest fungi are ectomycorrhizal and those are the conspicuous forest fungi fruiting bodies that we so frequently collect. The hyphae of ectomycorrhizal fungi grow partially into and around the living roots, producing a peculiar and characteristic appearing fungus and root symbiosis, which we call mycorrhizae. Mycorrhizae keep our trees and shrubs alive and vigorous, providing for viable forests and other essential ecosystems without which we would not have a habitable earth to live on. It's as simple, yet profound as that. It also doesn't hurt that this mycorrhizal relationship allows us to find and collect some of our most cherished edible fungi, which would otherwise not fruit without this association. Trying to collect *Cantharellus* mycelium in a former Douglas Fir forest that was recently clear-cut somehow just doesn't have the same appeal as filling your basket with plump chanterelles.

The mycorrhizal association between fungi and vascular plants was first established when land plants originally colonized the earth's solid ground back in the Devonian Period, at least 350 to 400 million years ago, with the fossil record as proof. In order to colonize terra firma, the evolving land plants had to form specialized vascular cells and tissues so they could conduct the essential water and nutrients throughout the plants as they grew upward, because gravity was working against this. Because of this, we have the evolutionary development of xylem and phloem cells—vascular tissues—to conduct or transport solutions of materials from one part of the plant to another, as well as providing necessary structural support. Going hand in hand with this was the formation of morphologically distinct roots, stems, and eventually leaves to carry out specialized functions. Countless evolutionary alliances between fungi and plants have had a really long time to establish, specialize, and co-evolve since the Devonian, with this "march forward" taking place even through all of the horrific natural catastrophic disasters that occurred on earth, such as at the end of the Devonian (356 million years ago), the end of the Permian (248 mya), toward the end of the Triassic (199 mya), and at the end of the Cretaceous period (60 mya), with a combination of widespread volcanism, comet or asteroid collisions with the earth, along with major plate tectonic rearrangements and significant

cont. on page 6

Coral Root, *cont. from page 5*

climate change, causing dramatic and widespread extinctions. The K-T or end of Cretaceous extinction (the last major, worldwide extinction) was so dramatic that it is estimated that a full 85 percent of all organisms (species) living at the time perished. But, surprisingly, vascular plants were not as strongly affected as other organisms.

Flowering plants, the most recently evolved group of vascular plants, first started arriving on the scene during the Cretaceous Period, the last of the three great periods of the dinosaurs, which spanned from about 120 to 60 million years ago. This co-evolution between the more advanced vascular plants, called flowering plants, and fungi has continued. You think of flowering plants as not only having flowers but having chlorophyll and being photosynthetic, with the ability to make a living by being able to convert atmospheric CO_2 in the presence of certain visible spectrum wavelengths of blue light from the sun into carbohydrates and proteins, thanks to the magnificent chlorophyll molecule with its central magnesium atom. In the process, a water molecule is split and oxygen is released to the atmosphere. Organisms capable of making their own food, such as photosynthetic plants, are called *autotrophic*.

This is in contrast with saprophytic organisms, which derive their nutrition by decomposing or breaking down organic matter that has already been formed. Fungi are primarily saprophytic and many also are mycorrhizal or parasitic as well. In simple terms, most fungi release enzymes that break down organic material in their immediate environment, putting it into a usable form that is then absorbed by the vegetative tissue, mostly mycelia. Because saprophytic organisms cannot make their own food, they are called *heterotrophic*.

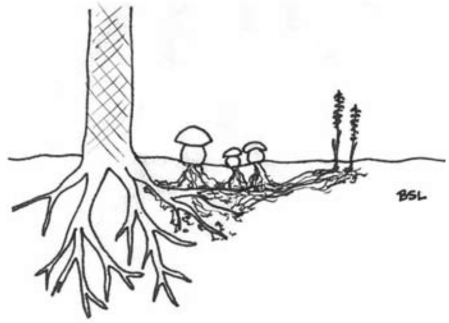
Some species of flowering plants, especially in deep woodland ecosystems, have lost their ability to photosynthesize. One of many examples of this situation can be seen in the Coral Root, an achlorophyllous member of the Orchidaceae (orchid family). The beautiful Coral Roots (*Corallorhiza* spp**.**) are flowering plants that no longer have chlorophyll and have become wholly dependent upon the mycorrhizal fungi they're associated with and therefore also upon the living trees.


Brian Luther

Coral Root,
Corallorhiza maculata

This is called a *mycotrophic* association, and such plants are referred to as *mycotrophs* or *myco-heterotrophs*. They are obligately associated with the forest mycorrhizal fungi for their livelihood and therefore also indirectly so with the living, photosynthetic mycorrhizal symbionts. This association has specialized to the point that these non-photosynthesizing flowering plants cannot live (grow, flower, set seed, or germinate) by themselves. However, unlike the mutually beneficial relationship between living trees and mycorrhizal fungi, which is truly symbiotic, Coral Roots are contributing virtually nothing to this three-way relationship. These *myco-heterotrophs* are essentially parasitic on the mycorrhizal fungi and therefore also indirectly on the trees and shrubs from which their mycorrhizal associates partially derive some nutrition.

The Coral Root is just one example of several genera of flowering plants in both the Orchidaceae and the Ericaceae (heather family) that occur in our area that have lost the ability to photosynthesize. Other genera of mycotrophic flowering plants found here in the Pacific Northwest include *Allotropa* (Candy Stick), *Hypopitys*, *Monotropa* (Indian Pipe), *Pityopus*, *Pleuricospora*, *Hemitomes* (Gnome Plant), and *Pterospora* (Pine Drops) in the Ericaceae as well as *Cephalanthera* (Phantom Orchid) in the Orchidaceae (Hitchcock & Cronquist, 1973).



Coral Root and its obligate association with the myselium of mycorrhizal fungi.

Why did these plants evolve to lose their photosynthetic, or self sufficient, abilities to begin with? It probably was a progression of continuing to adapt to a dark forest floor, where little or no direct sunlight penetrates, with the subsequent gradual loss of chlorophyll over time and increased dependency on a free ride. It happened over a long time and it's certainly an easy way of life now for the Coral Roots and others with the same nutritional dependency adaptation, because almost everything is being provided by the fungi and their photosynthetic symbionts, except some water and minerals that these plants take in.

Some of these myco-heterotrophs have evolved relationships only with particular species of fungi, becoming highly specialized in their relationship.

Thinking about it, you can see that the same fate would befall these mycotrophic plants when a forest is clear cut as it would for chanterelles—without the living trees, shrubs, and fungi in this three-way myco sortie the Coral Roots would also disappear.

Our mighty forests are at the same time imposing, yet fragile, in terms of so many things being dependent on mycorrhizal symbiosis. If you were to take away the fungi, then the trees and shrubs would barely grow, and we would get but a fraction of the mushrooms we now get because only those that were endomycorrhizal (saprophytic only) would fruit. We'd also be smothered in dead, un-decomposed forest debris. Clear cut the forests and the fungi don't produce mushrooms to pick.

The next time you're in the woods and run across an Indian Pipe, Pine Drops, Gnome Plant, Coral Root, or other related organisms, stop and contemplate the significance of the mycorrhizal fungi, the living forests involved, and the complexity of the specialized physiological dependence all these organisms possess.

Reference

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SLIME MOLD DESIGNS NETWORK

Henry Fountain

The New York Times, Science Times, Jan. 25, 2010

Researchers in Japan have shown that a slime mold can design a network that is as efficient as one developed by humans over many years: the Tokyo rail system. Furthermore, the slime mold can build its network in a day.

A slime mold is what scientists refer to as a single-celled amoeboid organism. When foraging for food, it spreads out as an amorphous mass and then builds tubular connections between the food sources.

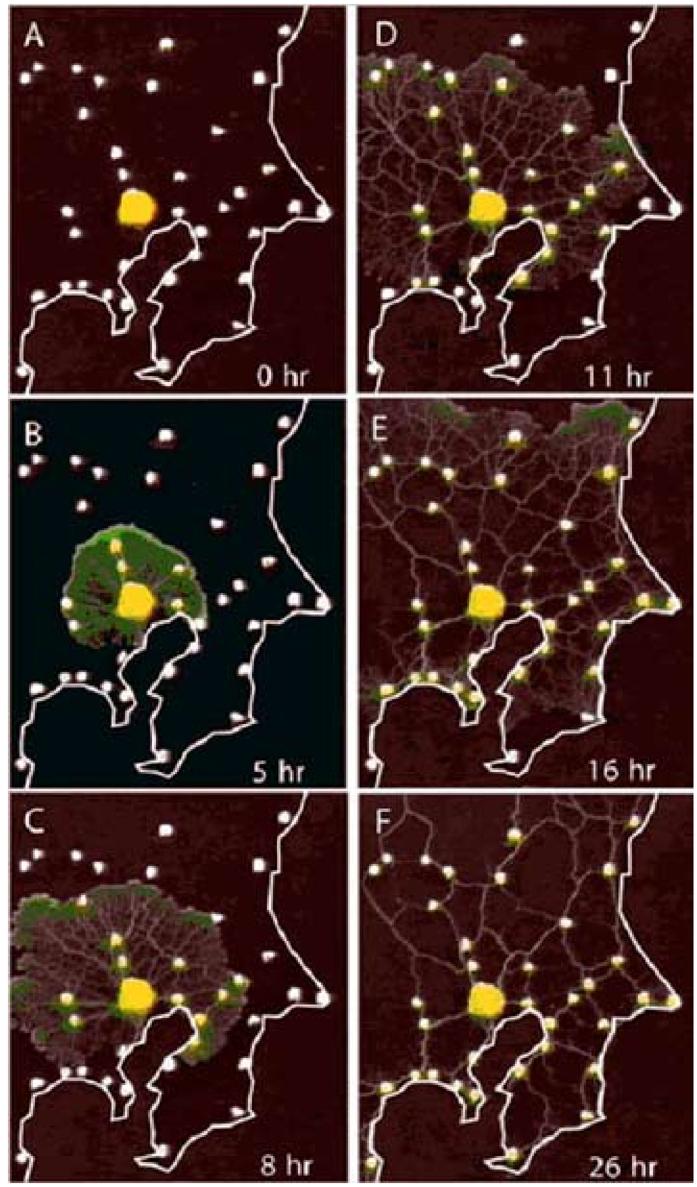
It may be just a blob, but it is a smart one. "We've found an unexpected high ability of information processing in this organism," said Toshiyuki Nakagaki, a researcher at Hokkaido University who has long studied slime molds.

"I wanted to pose a complicated program to this slime mold, to design a large network," Dr. Nakagaki said. "This kind of program is not so easy, even for humans."

So he and his colleagues set up an experiment where they laid out 36 bits of food in a pattern corresponding to cities in the Tokyo area and put a slime mold, *Physarum polycephalum*, at the spot corresponding to Tokyo.

As they report in *Science*, after 26 hours the slime mold had created a series of tubular connections that matched, to a great extent, the rail links among these cities. The researchers found that the slime mold network was as efficient as the rail network, it tolerated breaks in the connections just as well, and it was created at reasonable cost to the organism.

Of course, a series of small tubes is far different from a large network of rails. "But behind the differences there is a common principle from a math point of view," Dr. Nakagaki said. Using the slime mold's performance as a guide, the researchers created a mathematical model that they say may help people design other networks, like those used in mobile communications.



Slime mold network.

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MUSHROOM USAGE AROUND THE WORLD

Joel Horman

L.A. Sporeprint, via *Boston Mycological Club Bulletin*, 64(3)

Commercially, *Boletus edulis* (aka the penny bun mushroom, cep, cepe de Bordeaux, porcino, Steinpilz) is a complex of at least five species (or subspecies) of mycorrhizal fungi which cannot be commercially cultivated. In 1998 total annual consumption was estimated as between 20,000 and 100,000 tons, while chanterelle consumption was estimated at 200,000 tons—making it the most popular wild mushroom worldwide. However, *B. edulis* is not esteemed as a food in Asia and is exported. But in some Chinese provinces it is used in traditional Chinese medicine and is reputed to stimulate blood circulation and to relax muscles and joints.

Another popular wild mushroom is the matsutake complex (incl. the American *Tricholoma magnivelare*) which is revered in Japan, where 3000 tons are consumed annually, most of it imported. This mycorrhizal species complex has also never been successfully cultivated or introduced, although research continues in Japan. Wholesale prices in Japan (as of 1997) varied from $27 to $60 per kilogram. In some years (1992) over a million pounds can be harvested along the North American west coast, most of which is exported to Japan.

While we would consider it odd, in Nagano, Japan, *A. muscaria* is considered a delicious food. Writing in the special mushroom issue of *Economic Botany* (Oct. 2008), the source of much of this article's data, William Rubel and David Arora accept parboiling as a safe method for detoxifying it for the table. It seems that cultural elements can affect the determination of mushroom edibility. To give another example, wild mushrooms are revered on the Russian side of the Bering strait and feared and avoided in Alaska.

Attitudes toward mushrooms can cause suspicion between groups. The Bisa people of central Africa, according to legend, split into different groups, one called the mushroom clan, because some of them refused to share edible mushrooms with the others. Some of us may find this completely understandable.

Mushroom usage occurs through south-central Africa, where termite-mound mushrooms are prized in nearly all countries.

cont. on page 8

Mushroom Usage Around the World, *cont. from page 7*

Termitomyces titanicus occurs here and is possibly the largest edible mushroom in the world with a cap diameter that can exceed three feet.

Desert (Kalahari) truffles are also widely appreciated. The Aborigines of Australia collect seven species of truffles, which are either eaten raw or roasted in ashes.

But in some parts of West Africa knowledge of mushrooms is declining among the younger generation, as older people (women especially) recognize many more species. Gathering and consumption of wild edible mushrooms is dying out, because of declining mushroom populations due to disappearing forest.

A wide variety of wild mushrooms is eaten in Mexico and Guatemala, but this practice seems not as popular in South America, except perhaps for southern Chile and Argentina. Darwin noted that the natives of Tierra del Fuego ate large quantities of *Cyttaria* species (an ascomycete related to *Chlorociboria),* which are still being marketed. *Suillus* species which occur with introduced pine plantations in the Andes are dried and exported, but the natives make little personal use of them. Mexico, with 53 known species of hallucinogenic psilocybes, has a centuries old history of ceremonial usage by indigenous cultures.

Cordyceps sinensis is a mushroom that parasitizes larvae of moths which inhabit the alpine grasslands of the Tibetan Plateau. Tibetans have used the mushroom, which they call yartsa gunbu ("summer-grass, winter-worm"), for many centuries, if not millennia. The increase in the price paid to pickers has turned this tiny mushroom into the single most important source of cash for rural households in Tibet. Forty percent of rural cash income is derived from its collection, which was estimated at 50,000 kg in 2004, contributing $225 million to the Region's GDP. The income from sale of *Cordyceps* often accounts for 70–90 percent of a family's annual cash income in areas where it grows. It has become a glamour item among the wealthy Chinese, reaching an astounding price of $32,000 per kg in 2006. Fears of overharvesting and sustainability have been raised by conservationists.

Indeed, in various countries around the world, as well as several states in the U.S., these concerns, coupled with the increased trade in wild mushrooms and the disappearance of forest habitat, have led to increasing state control and restriction of both commercial and personal collecting. Whether these restrictions are well thought out or effective is another matter.

MUSHROOM MISSIONARY

On Thursday, February 11, 2010, Hildegard Hendrickson gave a lecture on Hunting Wild Mushrooms to the Broadview Garden Club.

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