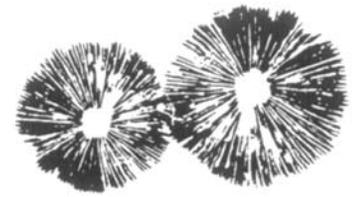


SPORE PRINTS

BULLETIN OF THE PUGET SOUND MYCOLOGICAL SOCIETY
Number 450 March 2009



PSMS TO HOST SPRING FORAY

Ron Post

Our spring foray is called the Ben Woo Memorial Foray and will be held May 29–31 at the Cispus Learning Center between Mt. St. Helens and Mount Rainier. The fun begins Friday, May 29, at 11 am and we pack up by 11 am Sunday, May 31.

There will be plenty of learning opportunities at the foray, plus book and art sales, displays of general interest, and two evenings of talks by the foray mycologist, Dr. Steve Trudell from the University of Washington. A silent auction will be held to benefit the society's Ben Woo Scholarship Fund and the Daniel Stuntz Memorial Foundation.

Members of any mushroom-related organization or any educational institution are welcome. The Cispus Center is located 11 miles outside of Randle, Washington, in the Gifford Pinchot National Forest.

Interested mushroomers can go to the PSMS website (www.psms.org) and download a registration form and other information. The deadline for early registration is April 30. Keep an eye on the PSMS website for more information about the program for the entire weekend. A full schedule of activities should be available by late March.

Questions? Call Ron Post in Seattle, (206) 370-4487.

FUNGAL GENOMES

Else C. Vellinga

Mycena News, Myco. Soc. of San Francisco, Oct. 2008

The publication of the human genome in 2001 was a milestone in our understanding of the human genetic make-up. The data shed light on the number of protein-coding genes (20–25 thousand, far fewer than expected), their position and composition, and the rest of the genome which lies between the genes and whose significance is still obscure. The data are a treasure trove for biomedical science. For example, they have been widely used to hunt for the genes that cause, or make us susceptible to, particular diseases.

What exactly is a genome sequence? It is the order, like letters in a text, of four different bases (bases being a particular kind of molecule) in a chain of millions, an order which scarcely varies from one individual to another in the same species. We say that this order is the genetic code of the species and different orders make different species. But the order is more than a name: it is a set of specifications for making the myriad chemical building blocks of life. The bases form the rungs of a twisted ladder which is the structure of the DNA molecule (the "sides" of the ladder, famously called the double helix, are made up of sugars and phosphates).

Does this mean that there are two orders, corresponding to the two sides of the ladder? Not really. Eukaryotes have four different DNA bases (adenine, cytosine, guanine, and thymine), which are paired (A-T and C-G) with one member of each pair on a different side (see Fig. 1). Because of this correspondence, the order of bases

on one side of the ladder can be read from the bases on the other side. A part of the ladder that codes for the making of a particular protein or enzyme is called a gene; three bases in a row code for one amino acid, and many amino acids (often hundreds) make up proteins and enzymes. There are patterns in the code that mark the beginning and end of genes and the intervening regions are called "noncoding," though their significance is not understood. DNA is organized in chromosomes in the cell nucleus, but also in organelles within the cell, like mitochondria, which were once bacteria.

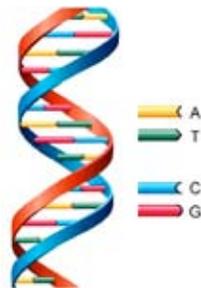


Fig. 1.

Humans were by no means the first species to have their genome sequenced. Bacteria, with their small genomes, were the forerunners, and the first eukaryotic (nonbacterial) organism was a fungus: baker's yeast (*Saccharomyces cerevisiae*). Next came three other genetic models: the first multicellular organism, the nematode *Caenorhabditis elegans* (colloquially called *C. elegans*) (1998); the fruit fly *Drosophila melanogaster* (2000); and the plant model, *Arabidopsis thaliana* (also in 2000). The *Homo sapiens* genome was ready in 2001.

The publication of the yeast genome in 1996, with the title *Life with 6000 Genes*, is still a very interesting read. The functions of many of its genes were not known at that time. In retrospect, the yeast genome seems very compact and low in noncoding regions. The work on that first sequencing project took many years and involved 600 scientists (only 16 of whom became coauthors of the paper) and many institutions worldwide. At that time it was daringly estimated that the human genome sequence would be ready in 2005. The invention of different, faster sequencing techniques, the development of faster computers and novel software, and the rivalry of two teams sped up the process. The human genome was done in 2001. Now, 12 years after the publication of the first fungal genome, over 70 species of fungi have been completely sequenced—including several strains for quite a few species—and many more are in the pipeline.

The choice of species to be sequenced was determined by several factors: those that cause human disease or considerable damage to crops were first, followed by some model organisms like baker's yeast, *Neurospora crassa*, and *Coprinopsis cinerea* (though the data for the ink cap are not yet publicly available). Now, costs have gone down considerably, and the time has come when almost anyone can dream of sequencing his or her favorite fungus (or even him or herself) starting at \$15,000 for material costs. For this amount of money you'll get very raw data produced in a week or so. Mainstream sequencing, analyzing, and annotating of the data still adds up to around \$400,000. Work is scheduled for the false truffle, *Rhizopogon salebrosus*, and the dyer's puffball, *Pisolithus microcarpus*, and is well under way for the button mushroom, *Agaricus bisporus*.

cont. on page 4

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PUGET SOUND MYCOLOGICAL SOCIETY

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SURVIVOR'S BANQUET AND ANNUAL MEMBERSHIP MEETING

Saturday, March 14, 2009, Center for Urban Horticulture, 3501 NE 41st Street, Seattle.

The social hour begins at 6:30 pm, followed by a potluck dinner at 7:30 pm. Please bring your favorite hors d'oeuvre, entrée, or dessert to share. List the ingredients and any wild mushrooms included in your dish. We will secure a liquor permit, so you may bring wine, etc., to enjoy with your food.

The speaker this year is PSMS member Jeremy Faber, who will present an informal, informative, and illustrated talk on life as a commercial mushroom harvester. Jeremy founded Foraged and Found Edibles, a chief supplier of wild fungi and wild edibles to Seattle's best restaurants. He is a regular vendor most Saturdays at the University Farmer's Market, selling what he has found the week before. He'll tell us what it takes to be a year-round professional forager, some of the places he visits, and what he finds there. Jeremy started out in forestry school, but soon followed his long-time interests in cooking and graduated from the Culinary Institute of America. Before starting his own business he worked at several top Seattle restaurants, including Bandoleone and The Herbfarm.



We will announce names of newly elected or appointed trustees and officers and disclose the recipient of the Golden Mushroom Award!

CALENDAR

- Mar. 10 No meeting
- Mar. 14 Annual Meeting and Survivor's Banquet, CUH, 7:30 pm
- Mar. 16 Board Meeting, 7:30 pm, CUH
- Mar. 19 Start of First Session, Beginners' Mushroom ID classes, 7:00–9:00 pm, Douglass Classroom, CUH (registered people only)
- Mar. 24 *Spore Prints* deadline
- Mar. 28 Field Trip, Tolt-MacDonald County Park, Carnation, 9:30 pm

BOARD NEWS

Dennis Oliver

Even in the cold of winter, the work of the PSMS board continues. The board approved a \$2,000.00 Ben Woo grant to Noelle Machnicki, a graduate student at the University of Washington, for field research on *Fusarium* and chili peppers in Bolivia. Mushroom Maynia! is in the early stages of organization, but ideas and enthusiasm for the event are very strong. There was an initial organizing meeting on January 18. Kevin Bernstein presented a proposal for a new Web-hosting site that would "cost less, get more." Brenda Fong will look into the reasons for the late arrivals of the last couple issues of *Spore Prints*. Last but not least, planning continues for this year's annual Survivor's Banquet.

SPRING FIELD TRIP

Hildegard Hendrickson

Our traditional first field trip of the year will be held March 28, 2009, at MacDonald Park in Carnation, Washington. Carnation is located about 30 miles east of Seattle. The park is located on State Highway 203 approx. ½ mile south of town. Watch for the sign of the park on N.E. 40th Street. Be sure to read the article "Field Trip Tips" and wear waterproof footwear.

We will meet at the main shelter at 9:30 am. Brian Luther and I will give brief introductions to mushroom hunting and discuss what fungi we can expect to find and what environment they need. After the short lectures, Brian and I and other experienced members will lead groups to gather specimens. We will return to the shelter at about 11:30 am, where all mushrooms found will be identified. Bring a sack lunch. After lunch the field trip is over, but you may want to hunt on your own.

This field trip will be held RAIN or SHINE, mushrooms or no mushrooms. This trip has been held annually for over 20 years to introduce new members to the cottonwood environment where the



earliest edible fungi fruit. The environment should yield *Verpa bohemica* and *Pleurotus ostreatus*. Even with this year's floods (and if the weather cooperated), we can expect to find fungi, because *Verpa bohemica* don't fruit in the primary flood plane.

Verpa bohemica

MUSHROOM ID AT CUH

Hildegard Hendrickson

PSMS will resume mushroom identification at CUH on Mondays from 4:00–7:00 pm starting Monday, April 20, until the end of the spring mushroom season.

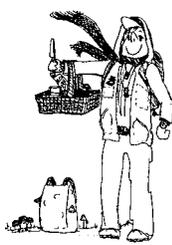


FIELD TRIP TIPS

Agnes Sieger

For those who joined PSMS at the Annual Exhibit in October, I thought it might be nice to review some basic mushrooming tips regarding the upcoming spring field trips.

Apparel: The Pacific Northwest is wet. Wear warm clothing, preferably in layers, and waterproof shoes or boots and bring your rain gear. Pacific Northwest vegetation is usually thick, and the sky is frequently overcast. Bring a compass and whistle and a map of the area—and remember to use them.



Mushrooming Gear: You will need a wide-bottomed container for your mushrooms. This can be a basket or bucket. Do not use plastic sacks; they tend to condense moisture and turn mushrooms into mush. You will need a sturdy knife suitable for cutting and prying and perhaps a soft brush to clean up the edibles; some people even bring a small garden trowel for digging (fill your holes!). To protect individual specimens for identification, take some wax paper sandwich bags or aluminum foil.

Collecting: If you know you have a good edible, cut off the stem cleanly and brush off as much soil and debris as possible. Store like species in a rigid container where they won't get crushed or pick up more dirt. Try to keep the mushrooms cool and dry, and process them as soon as possible. If you don't know what you have, the identifier will need to see the whole mushroom.

Field Trip Format: Most PSMS field trips are planned for Saturdays, since this is the most convenient time for many people. Almost all field trips have hosts, who set up by 9:00 am on Saturday with hot coffee and snacks. The hosts greet and sign in members, relay general tips on what is up and where to find it, and introduce newcomers to more experienced members. They also have a map of the area. After signing in, field trip participants gather their gear and head for their favorite hunting grounds. In the afternoon, they come back to the campsite to identify their finds, compare notes, and prepare for the potluck.

Potluck: The potluck starts at 4:00 pm (sometimes later when the days are longer in the summer). You need to bring your own eating



utensils and beverage and a dish to contribute to the table. This can be an appetizer, a salad, a main dish, or a dessert. The food is usually delicious, and the potluck is a great time to swap tales, collect recipes, and share mushroom information with friends old and new.

PRESIDENT'S MESSAGE

Patrice Benson

Please remember to attend the Survivor's Banquet on Saturday, March 14, instead of showing up on Tuesday, March 10, at CUH and have to go right home because there will not be anyone at a membership meeting that day. Bring a great dish to share, dress in the theme of forging, and be prepared to hear a different viewpoint about mushroom hunting from our speaker, chef/wild mushroom businessman Jeremy Faber of Foraged and Found Edibles.

We are working on a roster, possibly online, and certainly e-mailable to the majority. We will not forget about those of you without a computer and will also have an option of mailing a few printouts to those who need it. We are hoping to not have a dues increase and are being creative with operating cost options. The online

choice is being considered and security measures for protecting our information are being explored. Stay tuned!

Our Monday mushroom ID in the atrium at CUH from 4–7 pm will begin in mid to late April.

Mark your calendars and e-mail Joanne Young to volunteer to help with the second annual Mushroom Maynia! at the UW Burke Museum on Sunday, May 3, 2009. We need lots of volunteers, mainly from 10–4 to talk with the public about mushrooms and help with related activities.

Welcome to Calix Robertsonmeyer, son of Christie Robertson and Colin Meyer. All are well.

There will be two ID sessions for beginner mushroom hunters. March 19 to April 9 and April 16 to May 7. You must register to attend. Fee is \$35 for members. Nonmembers may enroll but will be charged \$70 and receive a membership. The recommended text is *Mushrooms Demystified* by David Arora. To register please send an e-mail to education@psms.org with your name or names. If you don't have access to e-mail, you may call (425) 678-8350, but e-mail is preferred.

Sign up for the Ben Woo Memorial Foray at CISPUS May 29–31. It will be an educational and fun event for all. Lectures, guided field trips, and a dyeing with mushrooms workshop are just a few of the things planned. Call Ron Post, chairman of the event, for info at (206) 370-4487 or e-mail mushroomgospels@gmail.com.

Please e-mail John Goldman, rose.gold@comcast.net, if you have a PSMS microscope. We are taking an inventory for insurance purposes. Also, return it if you are not using it so that others may check it out.

Thanks to Agnes Sieger for writing this newsletter year after year and thank you to Dick Sieger for his support in this endeavor.

Spring is just around the corner so take a mushroom class so that you are ready for the mushrooms when they surprise you and show up!

See you at the banquet on March 14, 2009!

RESTAURANT SUES DINER FOR €4,000 TRUFFLE BILL

Valentina Za

Reuters, Feb. 22, 2009

The Italian media has been abuzz with news about an unnamed top executive who refused to pay a 4,000 euro (\$5,058) bill after dining on truffles with five guests at Milan's two Michelin-starred Cracco restaurant. The diner said the truffle had not been weighed, newspapers reported, without giving details on his identity.

Chef Carlo Cracco denied that there was any confusion over the weight or price of the truffles before the diners commenced eating. Cracco said the party of six consumed about 300 grams of truffles. "They did not want to see the menus. They just said: 'We want the truffles,'" adding that they picked two large ones and were duly informed of the weight.

At the time the truffle price in Alba was about 4 euros per gram, said Alberto Cirio, head of the Association for the International Fair of the Alba White Truffle, adding that a 20 percent value-added tax is often charged twice as the "white gold" changes hands from the hunters to restaurants. "We are comfortable with the price the restaurant charged," said Cirio. "But we want to make sure we avoid misunderstandings of the sort in the future."

Fungal Genomes, cont. from page 1

Ascomycetes were the first fungi to be sequenced, as that group harbors many well known human pathogens, including *Aspergillus fumigatus*, *Candida albicans*, and *Coccidioides immitis*. Only a small number of basidiomycetes have been sequenced so far. The crust-forming fungus *Phanerochaete chrysosporium* was the first basidiomycete. This might be an unknown for the mushroomer, but it is a species with great industrial potential, both as a decomposer of lignin (that hard component of plants, trees in particular)—making it very useful in the paper and fabric industry—and in hazardous waste remediation. Number two was a human pathogen, *Cryptococcus neoformans*, another yeast. The disease it causes used to be rather obscure, but patients with AIDS, whose immune systems have been compromised, are susceptible to this pathogen.

The corn smut, *Ustilago maydis*, and most recently an ectomycorrhizal species, *Laccaria bicolor*, have also been completely sequenced. For all of these, publications can easily be found (see the list under “Further Reading”), and the data are publicly available on the Web. So, for a very varied but extremely limited group of basidiomycetes, the genome data are available.

At first the focus was to figure out what kind of genes there are and what they do. This is certainly a work in progress, as baker’s yeast has 6,000 genes and *Laccaria* around 20,000! Besides genes, the rest of the genomes contain lots of noncoding regions, repeated elements, and so-called junk DNA (all of which has to be sorted out, as well). These pieces can still be useful, though we do not know exactly why and how (that “junk” label may be premature).

The next step was to compare the genes of one species with the genes of others and relate the differences to lifestyle. The four basidiomycetes, which represent totally different lifestyles, provide a good example. For instance, *Phanerochaete chrysosporium* has many genes involved in the breakdown of lignin, but these genes are lacking in *Laccaria bicolor*. These comparisons also showed that a species often does not have just one gene to perform such an important task, but several, and these might be derived from a single shared ancestor gene. There are also studies looking specifically at those genes that are involved in the decomposition of plant material. These include ones that code for laccases and different types of peroxidases (lignin peroxidases and manganese peroxidases) and, indeed, *Laccaria bicolor* has not been equipped with genes for peroxidases. *Cryptococcus* cells are surrounded by a polysaccharide capsule, and this envelope is made by a series of 30 different genes, which are absent in the other basidiomycetes investigated so far. This information might be extremely useful in the battle against this fungus.

The smut fungus, *Ustilago maydis*, has, again, a different lifestyle. In one stage it lives as a saprotrophic yeast and in another grows inside a corn cob, forming the gall-like “huitflacoche,” an enlarged part of the cob full of smut spores. It is not a very aggressive pathogen and lacks the genes to make the enzymes that degrade the plant cell wall and give it access to the contents. But its genome sequence did reveal an unsuspected set of small genes that play a role in its virulence.

In contrast, the rice blast fungus, *Magnaporthe grisea*, an ascomycete, is well provided with genes that encode for cutinases, the enzymes that decompose cutin (the first barrier the plant uses to keep intruders at bay). Comparing the genetic composition of phylogenetically different fungi with similar lifestyles (e.g., the

ectomycorrhizal *Tuber*, an ascomycete, and its basidiomycete counterparts, such as *Boletus edulis* and *Amanita muscaria*) is another interesting research field.

Evolutionary histories of species can be determined by comparing complete genomes, but the small number of fungal genomes available means that these studies still have limited power. One such study, which was published a few years ago, was based on 42 different genomes, of which only four represented basidiomycetes. It would be great if whole-genome studies could indicate which single-gene sequences gave the same results as the more reliable genome-wide phylogenies, in order to validate which sequences to use in future phylogenetic studies. Gene phylogenies are not by definition the same as species phylogenies, as depending on the environmental pressure, genes undergo different changes. The current favorites are LSU and a few protein-coding genes for phylogenetic studies, and ITS as a fungal “barcode.”

Whole genomes can also reveal aspects of evolutionary history that no single gene can. For instance, they reveal where and when genome duplication took place (as happened once in a group of ascomycete yeasts close to the baker’s yeast), and they also show that a switch in the interpretation of the code of the base sequence “CTG” has occurred—in most species this translates into the amino acid leucine, but a group of *Candida* species makes serine out of it.

But up to now, only the surface has been scratched. Coming are more in-depth questions concerning gene function. Does a gene work on its own? When is it active? Does it always have the same function, or does it depend on the circumstances? And, of course, many more whole genomes will be sequenced. I’m looking forward to seeing the secrets of my own pet fungi, the beautiful parasol mushrooms, revealed!

Further Reading:

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- Espagne, E. et al., 2008. The genome sequence of the model ascomycete fungus *Podospora anserina*. *Genome Biology* 9: R77. [22 pages; open access at <http://genomebiology.com>]
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- <http://fungalgenomes.org/blog/>

http://fungalgenomes.org/wiki/Fungal_Genome_Links

<http://www.jgi.doe.gov/sequencing/statusreporter/psr.php?projetid=99190>
for updates on the *Agaricus bisporus* sequencing project

OREGON MUSHROOM HUNTER OKAY AFTER BECOMING LOST NEAR DORENA LAKE

The Register-Guard, Feb. 19, 2009

DORENA - A Lane County search and rescue team found a woman in good condition Wednesday night, four hours after she called 911 to say that she had become lost in the dark near Dorena Lake.

Yuli Larochelle, 59, of Eugene, used her cell phone to call 911 at 6:33 pm to report that she had become disoriented and was unable to find her way back to her car after she stopped to pick mushrooms, county search and rescue coordinator John Miller said in a news release.

Searchers found Larochelle's car near Dorena Lake at 8 pm, and located her about a mile south of the vehicle at 10:30 pm. Miller said Larochelle was "mildly hypothermic" but otherwise in good condition.

CAN SHIITAKE HELP FIGHT CANCER?

Alicia Di Rado

Pasadena Star-News, Jan. 21, 2009

As an avid cook, Dr. Marianna Koczywas knows just how delicious exotic mushrooms like shiitake (*Lentinula edodes*) can taste. As a medical oncologist at City of Hope, she also knows that many of her patients, especially those from Asian cultures, consume shiitake for its reputed immune-boosting powers.

Koczywas recently brought her interest in culinary ingredients together with her drive to find better treatment options for lung cancer patients. She serves as principal investigator at City of Hope for a new phase I clinical trial evaluating MM-10-001, an investigational drug that comes from the shiitake mushroom. The drug is a liquid that incorporates Lentinan, a beta-glucan derived from the main body of the mushroom. Lentinan does not attack cancer cells directly, but may produce an anti-tumor effect by activating different immune responses in the body.

"In the recent past," Koczywas explained, "clinical research showed that beta-glucans found in certain medicinal mushrooms could exert immune-enhancing activity." Laboratory studies show that these beta-glucans can stimulate white blood cells and increase production of cytokines, small molecules that send signals to immune cells.

As Koczywas notes, researchers see abnormalities in the immune systems of patients with advanced lung cancer, especially depletion of certain T cells and B cells, which are important to the body's defenses. Researchers want to find out if MM-10-001 can improve immune function for those with lung cancer.

Koczywas' study will test the safety and side effects for escalating doses of the substance among patients with advanced metastatic non-small-cell lung cancer. Study participants will take the liquid drug MM-10-001 orally every day. She and her colleagues will also look for signs of immune response in study participants, including changes in levels of cytokines such as interleukin 2 and interleukin 4.

Researchers also are testing the fungus' ability to stave off breast and prostate cancers.

CAN SCIENCE GIVE TRUFFLES A BOOST?

Adam Sage

condensed from *The Times*, <http://www.timesonline.co.uk/>
Jan. 20, 2009

The total annual European production of the black Perigord truffle (*Tuber melanosporum*) has fallen from 2,000 tonnes at the end of the 19th century to just 60 tonnes now. France's 20,000 or so truffle growers—mostly farmers who cultivate a few truffle oaks for a little extra winter revenue—contribute about 25 tonnes, which is only half of what their compatriots consume.



Tuber melanosporum

The slump is blamed on the rural exodus, which left woods unkempt and unsuitable for truffles, and global warming, which has upset the delicate balance of rainfall and sun. With specialists warning that French truffles could disappear altogether if the trend continues, growers have responded by seeking to upgrade ancestral methods.

One of the ways is to plant mycorrhized trees, the roots of which have been rubbed in a truffle paste to help the formation of mycelium, from which truffles develop.

But the results are poor, according to Jean-Charles Savignac, chairman of the French Federation of Truffle Growers. He says that only about 20 percent of mycorrhized trees actually produce truffles, and that these tend to be small and disappointing.

A breakthrough may not be far away, though, according to Jean-Marc Olivier, France's most celebrated truffle specialist, who says that scientists are making huge strides in unravelling the mysteries of la truffe.

One project in Corrèze, Central France, involves putting the culture of cloned truffles onto baby trees in test tubes. Researchers hope to gain an insight into the development of the precious fungi and improve tree selection techniques.

A second, at the Plant Genetic Institute in Perugia, Italy, has unlocked the DNA structure of the truffle and discovered that it almost certainly has the fungal equivalent of a sex life. Andrea Rubini, a researcher at the institute, told *The Times* that his team had found truffles to be a cross-fertilizing species and not a self-fertilizing organism, as previously believed. The truffle is developed from a cross between male and female strains of mycelia—and that is of huge significance to truffle growers and eaters.

If mycorrhized trees lack the key male/female mix, it might explain why so few of them produce truffles.

"We should get much better results by checking that both sexes are present," says Olivier. "There won't be a miracle recipe, but there's a lot of work going on and I'm confident that it will lead to an increase in production in France, maybe to about 60 tonnes a year."

YAHOO DISCUSSION GROUP

Want to stay in touch? The PSMS e-mail discussion group maintained by Yahoo Groups is an easy way to keep in contact with other members, circulate information about PSMS events, and post general mushroom information. To join, follow the directions on the PSMS website (<http://psms.org/members/index.html>) or on page 40 of the PSMS roster.

THE INTRICATE STORY OF LATE POTATO BLIGHT

Else C. Vellinga

Mycena News, Myco. Soc. of San Francisco, Jan. 2009

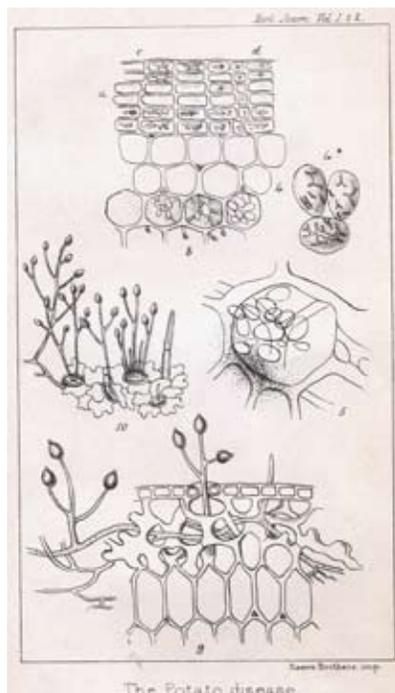
Potatoes: staple food for many! I grew up with them in the Netherlands, and when we talk about a Dutch dinner, it is potatoes, meat, and veggies—in that sequence. My home country is big in potato growing and is the world's leading exporter of seed potatoes. Apples of the earth is the Dutch word for potatoes, and like apples, they come in many, tasteful varieties.

But there is a darker side. Potatoes are a target for the late potato blight, a disastrous disease, with deep socio-economic consequences. This was the disease responsible for the infamous 19th century Irish famine and for the birth of plant pathology. The history of how this disease was understood reads like a layered detective story.

Potatoes are the tubers of *Solanum tuberosum* and related species. They grow naturally in the Andean countries of South America—Bolivia, Ecuador, and Peru—and were an important part of the food of the native people before the arrival of the Europeans. Ancient potato-shaped vessels still show the reverence in which they were held.

Potatoes were brought to Europe in the second half of the 16th century, but at first were looked at with suspicion. It did not help that eating the berries ended in disaster, as all above-ground and green parts of the plant are highly toxic. But, at some point, potatoes really took off, and became the main carbon and food source for many people, especially small poor farmers. All the potatoes cultivated in Europe at that time came from the same small selections brought from South America, and there was great genetic uniformity among them. Some years the crops did well, but some times there were minor disasters, and the potato harvest disappointed. However, what happened in the 1840s changed this dramatically; the potato plants, and most importantly the tubers, rotted until all that was left, over a wide area, was a putrid-smelling mess. The rot appeared first in northeastern North America in 1843, spread west, east, and north, and reached Belgium in the summer of 1845. In Europe that summer stood out because of its wetness and the relatively low temperatures. Within a few months, potato plants were affected from Ireland in the west to Germany in the east. At least a quarter of the potato harvest was ruined. The next year was even worse, and 90 percent of the potato harvest in Ireland failed. A catastrophic famine ensued as a third of the Irish peasantry was entirely dependent on potatoes.

The English clergyman M.J. Berkeley, who described so many mushroom species from all over the world, gave a detailed



Microscopic features of *Phytophthora infestans*.

description of the “potato murrain” and realized that the mold was the same species described by Montagne as *Botrytis infestans*. But it took some more time before it was generally accepted as the cause for the disease. The credit for swinging opinion in favor of the parasite goes to De Bary, a German scientist, who established the whole cycle of the organism on plants. De Bary also changed the name to *Phytophthora infestans*. He infected healthy plants which consequently showed the symptoms, while healthy noninfected plants stayed healthy, despite being exposed to the same wet weather as the infected ones. It was a milestone in the understanding of disease, whether of animals, humans, or crops. Phytopathology was born.



Potato plant infected with *Ph. infestans*

The culprit is not a fungus, but a water mold in the Straminopila, to which the giant kelps and the tiny diatoms also belong. Water molds differ from the real fungi because of the cellulose in the cell wall (fungal cell walls are made of chitin), and the fact that they store starch. The organism now ravaging the coast live oaks and tanbark oaks in California is a close relative of the potato blight mold.

The potato blight was so successful because of its rather simple life cycle. A spore lands on a leaf surface, grows into the plant, and emerges on the underside of the leaf. There it forms a branched sporangiophore, a small tree-like structure with sporangia at the tips. Each sporangium is a sack containing up to eight zoospores. In wet cool weather a sporangium disperses as a unit, which opens up and lets the zoospores out. In warm dry weather, the sporangium itself will germinate and the zoospore phase will be skipped. The zoospores have swimming devices in the form of two flagella and reinfect the plant. They can only survive on a wet leaf surface. The sporangia from the leaves get into the soil to infect the tubers, and they can spend the winters in stored tubers, to spread through the growing plants in spring. A potato plant can be turned to mush in less than three weeks.

The use of copper fungicides protected the potatoes from the blight, but in World War I, Germany needed copper to make bullets, not to protect the potatoes, and hundreds of thousands people died because of the failing potato harvest.

The blight proved to be particularly devastating in the cool and wet countries of Europe. In the Andes many genetically different cultivars were grown, some more, some less susceptible to the disease, but the weather there is not particularly cool and wet.

New potato cultivars were made with the help of a resistant Mexican close relative, but the arms race with the pathogen kept going.

In the 1970s, a new aggressive strain of the blight appeared with devastating effects. Till then the European version of *Phytophthora infestans* had lacked the capacity for sexual recombination, but this new strain, which originated in the central highlands in Mexico, was of a different mating type. The blight could now fulfill the complete life cycle with a sexual part, and through genetic recombination soon was resistant to the applied fungicides.

Debate on the origin of the original 1840s strain has kept researchers busy. Did it co-evolve with *Solanum tuberosum* in the Andes, as the original researchers suggested? Did it originate in Mexico where wide genetic variation in *Phytophthora infestans*

existed (this was the prevailing theory in the latter part of the 20th century)? Or did it migrate from Mexico to the Andes and, from there, to the rest of the world? Where do we have to go to find resistant potatoes or less virulent *Phytophthora*?

The problem of origin was solved only in 2007, by careful comparison of the genetic make up of *Ph. infestans* in the Andes, in Mexico, and in other parts of the Americas. These strains were then compared with ones found in Ireland and elsewhere. Fortunately herbarium material of some infected Irish plants had been preserved, and DNA could still be isolated from this one-and-a-half-century old material. Historic material from South America, not as old as that from Ireland but from before the second wave of pathogenic immigrants, was also instrumental in clinching the problem.

After the arrival of the new Mexican strain in Europe, the genetic diversity of *Phytophthora infestans* in the Netherlands became as great as that in Mexico—one reason to discard the out-of-Mexico theory. It is significant, too, that potatoes were not grown in Mexico in the first half of the 19th century. It is more plausible that the parasite came from South America in the 1840s, with the many new fast boats, than that it came with early potatoes. Even if it was on 16th century potatoes, the potatoes were likely to have been so affected by the long voyage that the diseased tubers were definitely not used for new plantings.

However, the most convincing evidence comes from comparison of nuclear and mitochondrial DNA of strains collected over a wide area. This shows that an ancestral population of *Phytophthora* diverged into different lineages in the Andes, growing on wild *Solanum* species; two of these developed into the present day types of *Phytophthora infestans* capable of infecting potatoes, tomatoes, and some other closely related *Solanum* species. Others evolved into several distinct species, one named *Phytophthora andinum*. The South American strains were transported to areas where potatoes were cultivated and wreaked havoc on a grand scale.

Late potato blight serves as the prototypical plant disease. Its story illustrates not only many of the hazardous aspects of agriculture—such as the role of the unwelcome companions who arrive with introduced species, the fragility of genetically uniform crops, and the social costs from the impacts plant diseases have on the lives of ordinary people—but also the strength of scientific evidence throughout the years. Alas, these stories can be told for many other equally devastating plant pathogens.

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THE CARNATION FOUR

Dick Sieger

Four mushroom species show up year after year at our first field trip of the year at Tolt-MacDonald County Park in Carnation: *Verpa bohemica*, *Verpa conica* sensu Tylutki, *Sarcoscypha coccinea*, and *Pleurotus ostreatus*.

Verpa bohemica

“The early morel” provides the first meals and toxicological statistics of the year. It is several inches tall with a phallic shape, an outsized white stalk, and a wrinkled brown fringed cap. It grows in the drip line of riparian trees but not in places that were flooded. At Tolt-MacDonald Park you’ll find these mushrooms hiding in leafy debris beneath fragrant cottonwoods when the trees’ new leaves are the size of mouse ears.



Sensitivity to the species isn’t uncommon, with reports of disorientation (potentially deadly when driving), sweating, cramps, and nausea. Cook them thoroughly and avoid overeating. I recommend parboiling because that removes some of the toxin and all of the flavor. Some people eat a soup made with fresh or dried verpas to relieve arthritis pain.

An early 20th century name, *Ptychoverpa bohemica*, is still found in some field guides, but *Verpa bohemica* is now the accepted nomenclature.

Verpa conica sensu Tylutki



This mushroom looks a lot like *V. bohemica*, but it is smaller and has a cap that is scarcely wrinkled. It is reported to be edible. However, you’ll find few at one outing and its flavor is no better than *V. bohemica*’s, so why bother.

Why the “sensu Tylutki?” Because for me, the true name is a puzzle. The appearance of our Northwest mushrooms is consistent with that of *Verpa conica* elsewhere, but the spore size isn’t.

Tylutki in *Mushrooms of Idaho and the Pacific Northwest, Vol 1, Discomycetes*, gives a spore size of 28–34 × 15–19 μm (microns), and that’s what I’ve observed in material from Washington.

Nancy Smith Weber in *A Morel Hunter’s Companion* gives a smaller spore size of 21–24 × 12–13 μm, well outside the range of Tylutki’s. That’s typical for eastern North America and Europe.

The name comes from European mycologists, so what we have here may be an unnamed species. We’ll have to see what the molecular biologists have to say.

Sarcoscypha coccinea

Here’s a frequently collected mushroom which is no wider than 2 inches and its population is small. You’ll see every one you pass, though, because its brilliant scarlet color contrasts with a sparsely covered dingy background.

These little showoffs are cup shaped with incurved edges and white, obscurely fuzzy outer surfaces. They grow on hardwood sticks later in winter and persist through early spring.

They’re inedible, so far as I know—and please don’t experiment with cups.



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Pleurotus ostreatus

“The oyster” is a fine edible mushroom that may appear in big clusters. It grows on alder logs and snags—usually perversely just higher than the longest pole you can find to knock it down with. Around here, it’s most common in spring. It looks kind of like...well...an oyster. It’s up to the size of your hand, fan shaped with regular or crinkly edges, and is attached to the wood by what Susan Libonatti calls a “pseudostipe,” a medial stalk that blends into the edge of the cap. The color of the top is...well...like an oyster—whitish to grayish brown. Underneath are white gills well attached to the pseudostalk.



Dead wood has little of the nitrogen needed by *P. ostreatus*, so it gets this nutrient by eating nematodes. It first drugs them and then penetrates their bodies.

Oysters are readily grown at home. Kits supplied by Fungi Perfecti produce mushrooms that taste even better than the wild ones. Avoid cultivating them in damp wooden buildings, which they will eat.

Attending the Carnation field trip years ago, I was walking along with my head tilted back hoping to see some oyster mushrooms growing high on alder snags. A fisherman, who turned out not to be a mushroom hunter, asked me what I was looking for. “Oysters,” I said without looking down.

Identification

The descriptions given here aren’t sufficient to separate these species from their look-alikes. Confirm your identification with a good field guide. Better still, show your finds to Brian Luther and Hildegard Hendrickson, leaders of the Tolt-MacDonald field trip on Saturday morning, March 28.

EASY MUSHROOM SQUARES

Hope Miller

Hope’s Mushroom Cookbook, Mad River Press, 1993

- 3 cups finely chopped mushrooms (approx. 8 oz.)
such as *Pleurotus* or morels
- ¼ cup finely chopped onion
- ½ tsp Worcestershire sauce
- 2 Tbs margarine or butter
- 2 cups Bisquick baking mix
- ½ cup margarine or butter, softened
- ¼ cup boiling water
- 1 (3-oz) package cream cheese, softened
- ¼ cup grated Parmesan cheese

Heat oven to 350°F. Grease 13 × 9 in. rectangular pan. Sauté mushrooms, onion, and Worcestershire sauce in 2 TBs of butter until brown. Mix baking mix and butter in small bowl until it forms small pieces about the size of peas. Add water and beat until soft dough forms. Spread dough in pan and then spread cream cheese over dough. Top with mushroom mixture and Parmesan cheese. Bake until crust is golden brown, approximately 20 to 25 minutes. Cut into squares about 1½ inches. Serve immediately. Refrigerate any leftover squares. They may be reheated in the microwave.



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