SPORE PRINTS

BULLETIN OF THE PUGET SOUND MYCOLOGICAL SOCIETY
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HOLIDAY EXTRAVAGANZA

Shannon Adams

The 2018 PSMS Holiday Extravaganza was well attended and enjoyed by 140 members. While good food and good company were the highlight of the event, there were also some impressive contenders for the best Edible Art and Photography, and some fierce bidding on events in the live auction. Paul Hill shared a vintage film about a journey to Mushroom Land which was animated in the year the club was founded. While a few members dozed off in the postprandial darkness, the film was surprisingly informative with plenty of ID tips and scientific context.

Throughout the night Derek Hevel was calling out for recipes and names to go with popular dishes. He and a photographer were taking photos for the upcoming PSMS cookbook. We would like to assure those whose dishes were not photographed, that everything we tasted, tasted great. We did notice Derek looking very crestfallen when a cake that won the Edible Art competition had been half-eaten before being photographed. I would not be surprised if Sweta and Christopher are called on for a repeat performance of their mycelium with delicious edible pins!

The most important club business of the night related to board elections. With the term of several board members coming to an end, there will be board openings. Members are encouraged to volunteer. We were excited to receive nominations from Debra Johnson and Kate Turner. If you are interested in being on the board, please contact Shannon Adams (moonshell@gmail.com) or Marian Maxwell (marianmaxwell@hotmail.com).

Spore Prints

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CALENDAR

Jan. 6	DNA workshop, 3–7 pm, BioSound Lab 1100 NE 47th St #103, Seattle
Jan. 8	Membership meeting, 7:30 pm, CUH
Jan. 9	DNA workshop, 6–10 pm, BioSound Lab 1100 NE 47th St #103, Seattle
Jan. 14	Board meeting, 7:30 pm, CUH board room
Jan. 22	*Spore Prints* deadline
Feb. 12	Membership meeting, 7:30 pm, CUH

NEW MUSHROOM MEAT ALTERNATIVE:

https://www.freshplaza.com/, Dec. 13, 2018

A new, mushroom-based meat alternative has been introduced by To-Jo Mushrooms, a family-owned mushroom farm operating out of Pennsylvania. The new "Pulled Port" line launched in October is described as a wholesome and flavorful product that looks and cooks just like meat. It is currently available in four varieties, including Original, BBQ, Carnitas, and Philly.

MEMBERSHIP MEETING — Daniel Winkler

Tuesday, January 8, 2019, at 7:30 pm at the Center for Urban Horticulture, 3501 NE 41st Street, Seattle

Alan Rockefeller

Our January speaker is Alan Rockefeller, who will be presenting "An Introduction to Fungal Sequencing."

Alan will give beginners an understanding of what can be learned via the analysis of mushroom DNA and why it is so cool. DNA barcoding helps us refine phylogenetics—understanding the true relationships between species at a deeper level of understanding. Practical implications include discovering new species and clarifying the relationships between those we know. You will learn the approach to sequencing DNA, which genes to examine, and how to turn the data you get back into useful information.

Alan Rockefeller is a mycologist living in Oakland. He spends half the year hunting mushrooms in Mexico, where he documents a wide variety of fungal species. His experience in the field focuses on mushroom identification, DNA analysis, microscopy, and photography. In the lab Alan sequences the DNA of mushrooms from all over the world, gaining new insights into existing species, discovering new ones, and eliminating duplicates in the taxonomic record.

The Sunday before the talk and the day after, Alan will teach a hands on DNA barcoding workshop at BioSound Lab where you can bring mushrooms to sequence and see the process first hand.

Would people with last names beginning with the letters L–Z please bring a plate of refreshments to serve after the meeting.

MUSHROOM DNA BARCODING WORKSHOPS — Shannon Adams

Alan Rockafeller will lead a practical hands-on lab session where we will extract DNA from mushrooms you bring, copy the gene we want to study with PCR (polymerase chain reaction), use gel electrophoresis to see if the PCR worked, and send the DNA off for sequencing. The **$20 course fee** includes one sequencing attempt; bring $10 extra each if you would like to sequence additional collections. Since we only can accommodate 10–15 participants per session, PSMS is offering two workshops:

Date &Time: Sunday, January 6, 3–7 pm
Wednesday, January 9, 6–10 pm

Location: BioSound Lab
1100 NE 47th St #103
Seattle, WA 98105.

PSMS will make ticket registration available. Duration: 4 hours each workshop. Please note: Since there will be a 2-hour period for PCR to do its magic, participants can go out for dinner, cost not covered by fee.

No previous lab experience is necessary. If we receive more interest than spots available, we will give preference to PSMS members who are volunteering in PSMS projects for which understanding sequencing is of benefit.

BEHIND THE SCENES AT A PSMS FIELD TRIP

Wren Hudgins

PSMS Trips Are Different

A good field trip is no accident, although to the casual observer, it could appear that way. PSMS field trips differ from field trips in many other clubs in that we have a dual focus on education and socializing/fun. Other clubs might meet somewhere and then head into the woods, possibly not to gather together again afterwards.

Since we often have beginners on our trips, we are careful to offer an orientation to collecting and then the possibility of joining an organized group led by an experienced guide both for the sake of education and also for safety. On the education side, the guides will explain about the characteristics of desirable habitat in which to hunt, and then we'll identify your specimens when you come back to base camp. Most of this identification is done by Brian Luther, chair of both PSMS Identification and Field Trips, but sometimes Brian has some help with the identification task.

Following all this, there is a potluck dinner, often with savory wild mushroom dishes. These potlucks are held early so participants can get back home at an early hour. A few field trips are multi-day events, but most are a single day.

It All Starts with Planning

Most participants are only aware of a fraction of what goes into the planning and production of these events.

It all starts about a year before the trip is scheduled with Brian Luther evaluating different possible locations for field trips the next season. He'll pick sites with promising hunting terrain nearby and talk with Forest Service (or other jurisdictional) personnel to reserve a particular site. He always has a site with shelter from the rain and often with a big fireplace as well. He'll book 4–6 trips each Spring season and again each Fall. When the schedule is complete, he'll write a field trip insert for *Spore Prints* so members can plan ahead accordingly.

As the trip date approaches, he cuts firewood. It may not sound relevant to mushrooms to spend time cutting firewood but when you show up wet and cold after being out in the rain and the woods for hours, you'll quickly see the relevance of firewood. Then, on "game day" Brian loads his car with extra group gear (cups, paper towels, etc.), a box full of mushroom reference material, and a splitting maul for splitting the wood he cut earlier. Then he drives to the site, often arriving an hour before the start. Once the field trip starts, he is usually fully occupied identifying specimens for members. After the potluck, he stays and cleans up, such that often he's the first to arrive for the day and the last to leave.

Field Trip Guides

The work of the field trip guides also starts a year ahead. We have training sessions in the summer, at which we practice wilderness navigation and review procedures for managing people in the woods, always looking for more efficient ways to do things. As the trip approaches the field trip guides consult maps and each other about good choices for hunting areas. Some field trip guides drive to the site a week early to scout for promising areas to take a group; others leave home very early in the morning to arrive at the trip site an hour or more ahead of when the event starts—again, to find promising areas for the groups they lead. In 2018 we led out into the woods and safely brought back, over 400 club members.

Field Trip Hosts

Also starting a year ahead, the Hosting Committee, currently co-chaired by Debbie Johnson (debjoh13@comcast.net) and Carolina Kohler (cakohler@ymail.com) aided by Carolina's husband, James, has been hard at work locating members willing to volunteer to host or co-host a field trip. We need a host for each trip. Duties involve purchasing breakfast goodies (later to be reimbursed), laying them out in the morning, then putting out some kitchen equipment to facilitate the potluck later on. After the potluck, they help clean up, make notes about which supplies need replenishment, and pack the gear into plastic bins for the next host to use the following field trip. Hosts are always needed, so please consider contacting Debbie or Carolina to volunteer.

A Successful Field Trip

It's the complete package of all these things that produces a successful field trip. We can tell this because pretty much everyone has a good time, regardless of whether they found mushrooms or not. If we can take members whose main goal for the day is to find good edible mushrooms, and they do not find them but still report having a good time, then I think we're doing a lot of things right.

FUNGI IN AMERICA: 44,488 SPECIES AND COUNTING

Nick Carne

https://cosmosmagazine.com/, Dec. 4, 2018

Scientists have compiled the longest list yet of known North America fungi, with 44,488 entries covering the U.S., Canada, and Mexico.

That may be just a start—mycologist Andrew Millar says less than a third of all fungi thought to exist on the continent has so far been documented—but it is a good start.

"Many fungi in North America have European names, and while they may be related to their European counterparts, they often are genetically distinct," he says.

"About half of the 44,488 fungi in the new checklist are type specimens, which means they are valid North American taxa."

Millar is from the Illinois Natural History Survey and the University of Illinois at Urbana-Champaign, and he led the team that compiled the data by searching more than 2.2 million records

cont. on page 4

Fungi List, *cont. from page 3*

using the Mycology Collections Portal, which includes data from numerous universities, botanical gardens and other institutions.

They first built a checklist of all North American fungal species and subspecies, then removed those categorized as lichens and organized things alphabetically by genus and species. The final list is published in the journal *Mycologia*.

About 20,000 of the fungi on the list are mushrooms; the rest are barely visible with the naked eye and are thus classified as microfungi. These include molds, mildews, and rusts, along with species that break down organic matter in the soil.

OREGON MAY VOTE IN 2020 TO LEGALIZE PSYCHEDELIC MUSHROOMS IN THERAPY

Kevin Kelleher

http://fortune.com/, Dec. 4, 2018

Oregon's Secretary of State this month approved language for a ballot initiative that would make psychedelic mushrooms legal among licensed therapists.

The initiative would make it legal for licensed people to produce, administer, and possess psilocybin mushrooms. It would also reduce criminal penalties for possessing it. Psilocybin is a Schedule I drug, defined as one with no medical use and the high potential for abuse. Possession of psilocybin mushrooms is a felony.

In recent years, some researchers have argued that psychedelic mushrooms may in fact have the potential to treat depression and anxiety. A NYU study showed they reduced those conditions in cancer patients. Other studies have shown the potential to treat alcoholism and other addictions. Researchers from Johns Hopkins University recommended last month that psilocybin be reclassified as Schedule IV, which would qualify it for medical use.

"The intent of the 2020 Psilocybin Service Initiative of Oregon is to advance a breakthrough therapeutic model currently being perfected in research settings at top universities around the world," Tom and Sheri Eckert, two counselors who authored the ballot initiative, said on a site devoted to the initiative's campaign.

The Eckerts and other organizers behind the ballot initiative need to collect 117,578 signatures to get it onto Oregon's 2020 ballot.

Compass Pathways, a startup with financial backing from Peter Thiel, has been developing psilocybin-based therapies to treating depression and other disorders. Compass recently received "breakthrough therapy" designation from the Food and Drug Administration for its psilocybin therapy.

WHITE TRUFFLE PRICES ARE HALF THE COST OF LAST YEAR'S

Chelsea Ritschel

https://www.independent.co.uk/, Dec. 3, 2018

White truffles [*Tuber magnatum*], some of the world's most coveted, and expensive fungi, are much cheaper than usual this winter—meaning those looking to indulge in this exotic treat should do so this year.

The more-affordable price, the lowest in more than a decade, according to the *Wall Street Journal*, is the result of a particularly rainy season in Alba, Italy, which led to a bumper crop of truffles.

Alba, located in Northern Italy, is the go-to destination for white truffles, which are available from early October through December and highly sought after for their distinct, musky flavor.

According to the newspaper, the average price for a kilo of fresh white truffles is currently €2,000–2,500 ($1,030–1,286 or £1,783–2,229 per pound)—nearly half the price of last year's crop of truffles.

Recently, an 850-g white truffle from Alba sold for $96,000 (£75,400).

This year's lower price means the beloved truffles may also become more affordable in restaurants—where truffles are often served shaved raw atop pasta dishes.

"If we can't find any truffles, then a high price isn't much use to anybody," Italian truffle hunter Maurizio Grazioso told the *WSJ*. "And we want the truffle to be available to everybody, not just the elite."

At Felidia in New York City, which boasts an entire menu dedicated to white truffles, the prices range from $103–320, with just a shaving of white truffle costing $75.

According to the *New York Post*, the average charged by a restaurant is typically $7.00 (£5.50) per gram of white truffle.

As for what to look for in a truffle dish, chef Eric Ripert of Le Bernardin recommends eating only fresh truffles—as they "lose a certain percentage of smell and flavor every day" so should be "prepared and eaten as soon as possible."

COPS DIDN'T KNOW ABOUT THE MUSHROOM STASH—UNTIL HIS COBRA BIT HIM, KANSAS POLICE SAY

Kaitlyn Alanis

Miami Herald, Dec. 5, 2018

Before animal control could take his exotic and venomous snake away, a Kansas man decapitated and buried it, police said in a statement posted to Facebook.

That didn't stop police from finding the coral cobra, though—or the man's "large quantity" of hallucinogenic mushrooms, according to the post.

Officers began investigating after 25-year-old Ari Hooley, of Great Bend, got medical attention for a venomous snake bite, police said. It was reported that a snake bit Hooley on Dec. 3.

Police then went to Hooley's home to "investigate the complaint," the statement says, and Hooley admitted that he owned the snake, since identified as a coral cobra.

Coral snakes have the second-most deadly venom of all snakes, but they are "generally considered less dangerous than rattlesnakes because coral snakes have a less effective poison-delivery system," according to LiveScience. The snakes usually only bite humans if they are "handled or stepped on," National Geographic reports, and there have been no coral snake bite deaths reported in the United States since the release of antivenom in 1967.

Owning an exotic and venomous snake violates city ordinance, the Great Bend Police Department said, but Hooley refused to cooperate with officers or let animal control take the snake.

The department then got a search warrant, and police found the snake at the home. The snake had been decapitated and buried before the search, according to the statement. That's not all police found, though. During that first search, police found narcotics inside the home.

Then, after officers received a second search warrant, police found "evidence of cultivation and distribution of a large quantity of hallucinogenic mushrooms," the post says. Marijuana and drug paraphernalia were also found. Hooley was arrested and booked into the Barton County Detention Center on a $300,000 bond. That was on Dec. 4, one day after the bite.

He now faces several charges including unlawful cultivation or distribution of controlled substances within 1000 feet of a school, possession of marijuana, possession of drug paraphernalia, and no drug tax stamp.

MISSOURI RESEARCHERS SHARE LESSONS FROM HUMONGOUS FUNGUS

Karina Zaiets

Columbia Missourian, Dec. 8, 2018

https://www.atlasobscura.com

Armillaria gallica, Michigan's "Humongous Fungus."

COLUMBIA, Mo. - It was discovered nearly three decades ago. At the time, it was thought to be heavier than a blue whale, bigger than 23 football fields, and more than 1,500 years old. The news of its discovery appeared in almost all the major media outlets and even made David Letterman's Top 10 list.

In July 2018, in a preprint paper posted on *bioRxiv*, scientists studying it announced that the so-called "humongous fungus," an individual of *Armillaria gallica* that lives in a forest in the Upper Peninsula of Michigan, is actually four times bigger and around one and a half times older than previously thought.

It's not just that it's so big and old. It's also about what "H.F.", as retired University of Missouri professor Johann Bruhn refers to it, can teach us. Bruhn has studied the *Armillaria* species for around 40 years as a research associate professor at Michigan Technological University first, and then at MU.

Fungal Characteristics in General

In the autumn, if it's not too dry, mushrooms pop up near a tree or grow from the stem. A person looking at one may think that there is nothing more to it. But that's not the case. A mushroom is just a piece of the puzzle—the "tip of the iceberg," so to speak, of a fungus.

The main "body" of most fungi—the part we don't usually see—is called the mycelium. One example is a fibrous or cottony growth that appears on fruit as it rots. Mycelium is composed of microscopic filaments called hyphae that look like tiny threads woven together, and in forests it mostly stays underground or within decaying wood.

So it lives unseen, until the time when it has enough nutrients and the weather is right for development of fruiting structures: mushrooms. As the mycelium exhausts nutrients from one food source, it grows outward seeking new ones. It usually expands as a ring that is known as a fairy circle. That's how separate mushrooms a couple of feet away may actually belong to the same fungus.

Characteristics of the Genus *Armillaria*

General

Fungi belonging to genus *Armillaria* act primarily as decomposers of roots of trees that are already under stress, as well as their stumps and fallen stems. Infected roots are no longer able to absorb water or nutrients, and so the tree gradually dies. By killing and decomposing stressed trees, the fungus makes room and nutrients available to healthier trees, thus serving as a sort of "gatekeeper."

Wood decayed by these species is white, and often spongy and wet. The mycelium of *Armillaria* is bioluminescent, especially in actively decaying wood. The bright white glow can be seen from a considerable distance and is commonly known as a fox fire. From one victim to the next, the fungus spreads by long black cords called rhizomorphs that develop from mycelium. These bootlace-like strands can travel great distances in search of a tree to infect and may form an extensive network. Shielded underground and in decaying wood, rhizomorphs are protected from high temperatures and drought.

Beentree/Wikimedia Commons

Rhizomorphs of Armillaria.

Armillaria gallica

Mushrooms porduced by *Armillaria gallica* have a pinkish-brown to reddish-brown cap and usually grow in late summer or during the fall. They are edible, but have to be cooked.

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Humongous Fungus, *cont. from page 5*

Armillaria gallica lives throughout much of forested North America, including in Missouri. Here, it may reveal to scientists how climate change could weaken even the most resilient trees. This could have implications for Missouri's economy and wildlife.

"So the average person walking through the woods would see clumps of mushrooms here, and they're separated by quite a distance often," Bruhn said. "And they think of it as being a small discrete organism with individual representatives scattered through the woods. And what we found was that, in fact, the *Armillaria* individuals in the forest floor are older than the trees. They're larger than the trees and they have incredible longevity."

One of the reasons for that longevity is its low rate of mutation. That, potentially, could improve understanding of the human genome and such diseases as cancer.

History of Discovery

U.S. Navy Project ELF

The discovery of the "humongous fungus" was a side product of a U.S. Navy effort called Project ELF.

The work began in 1982. The plan was to build miles-long antennae and bury their ends in the ground in Wisconsin and Upper Michigan. The antennae would send signals of extremely low frequency through bedrock to underwater craft around the world. The U.S. Navy conceived the project because it was having a problem: to receive an order, a submarine had to trail a buoy or buoyant antenna near the surface. Doing this made it easily detectable. The solution was to use the unique property of the radio waves: the lower their frequency, the more deeply they can penetrate the sea.

"So what they concluded was that they could send a very simple message through the water out to sea saying, 'Come to the surface to get new instructions' or 'Stay on the present course,'" Bruhn said. "Then the submarines wouldn't have to resurface so often or they wouldn't have to resurface at all."

The public was concerned about possible environmental impact, so the Navy established an elaborate environmental monitoring program to assess the effect of the electrical signals on wildlife, trees, etc. Bruhn was one of the participating scientists.

U.S. Navy

U.S. Navy's ELF facility, Clam Lake, Michigan.

Environmental Impact Study

"So what we concluded was that what we had to do was we had to establish small plantations of a fast-growing tree species that was very genetically homogeneous so that all the trees would be the same age," Bruhn told the *Columbia Missourian*. That would enable scientists to measure the trees and build a better statistical model of the effects of the electrical fields on their growth.

The researchers cut patches of mixed hardwood/conifer forest and planted red pines. As he expected, Bruhn soon noticed that two species of *Armillaria* were killing trees in the research plantations.

"The pine pathogen was focused on the pines, but there was this other species that came eventually known as the 'humongous fungus' that was decomposing the hardwood stumps," Bruhn said.

He observed that the *Armillaria* species seemed to occupy enormous territory. He wanted to understand how many individual organisms of each species were involved, and how they were spatially distributed in the forest.

He dug up the dead seedlings and cut a window through the bark to expose the fungus growing underneath, then sampled a piece of the fungus and grew it in culture. Then he mapped where the seedlings had been growing. Over about eight years, he ended up with a collection of hundreds of mapped cultures of the *Armillaria* species.

Discovery It was One Species

"One of the interesting things for me is that I cut the back of my finger, and I've got 10 stitches in it and the skin is going to grow back together because the skin on one side of the cut recognizes the skin on the other side of the cut as being compatible," Bruhn said. "Well, this mushroom can do the same thing."

When two cultures put in a Petri dish belong to the same genetic individual they will grow together without leaving a sign that they were once separated. In distinct individuals, there would be a dark brown line between them. But to prove that different samples came from the same individual some molecular tests had to be done.

So Bruhn asked his friend Jim Anderson from the University of Toronto to help. Anderson had the necessary expertise in molecular biology and had a graduate student, Myron Smith, who just happened to be looking for a graduate project to work on.

Original Study Results

They analyzed the samples, studied the rate at which the rhizomorphs (long black cords specific to *Armillaria* and related species that develop from mycelium—the main "body" of most fungi) grow, and published a paper with the results in *Nature* in 1992. At that time, they determined that it occupied at least 37 acres, weighed more than 100 tons, and by conservative estimates was more than 1,500 years old. Soon, it got the name "humongous fungus."

The researchers were sure it was even larger than that. Starting in 2015, they took samples annually, mapped them, did compatibility tests to determine if they had reached the limit, and extended the geographic area of the study.

"We could hardly believe that it was as big as it turned out to be and we can only handle so many samples in the laboratory each year," Bruhn said. "This is a large perimeter to be making collections."

Updated Results

This year, they reached the edge. It turned out the humongous fungus weighed more than 400 tons and is more than 2,500 years old. "We say 2,500 years, but that's a conservative guess. (It) could be almost as old as the forest that replaced the glaciers," Bruhn said. "What we wanted to understand was how the individual could get so large and so old and still retain its identity. For a human being, we would eventually contract cancer or something. People don't live to 2,500 years old. We wouldn't look like much."

The team also wanted to understand where it originated. Typically, fungi start from a single point and grow outward in a radial pattern, but obstacles and the development of new food bases would cause them to change direction. By gathering the samples and analyzing the number of mutations, researchers understood more about both the longevity and the growth of the humongous fungus.

"It's a great follow-up on the work that they did quite a long time ago," said Thomas Volk, professor of biology at the University of Wisconsin-La Crosse. "The methods are much more sophisticated now, and I think they have been able to glean a lot more interesting information from the current study."

So How Does It Live So Long?

The team found that the fungus had very few mutations, and this could be the key to understanding how it has maintained its identity for such a long time.

"Cancers involve huge rates of specific mutations, and *Armillaria* essentially represents the opposite end of the spectrum with just almost unbelievable genetic stability," Bruhn said.

"There may be a mechanism within the fungus that may be fixing mutations," Volk said, like a chemical, for example. "There is a possibility that something like that could help people to avoid mutations, and mutations are really what cause cancer."

Living underground is another factor, besides genetic stability, that has contributed to its longevity.

Change in *Armillaria* Resistance

Even healthy trees will have rhizomorphs wrapped around their roots "just waiting for a drought or an insect or epidemic or a fire or any kind of stress factor to weaken that tree and then it [*Armillaria* root disease] will infect it," Bruhn said.

One of the tree species Bruhn found to be resistant to the root disease *Armillaria* caused was white oak. But then he took a graduate student to a research site and saw a sign of *Armillaria* infection in a white oak tree. "That was the first time ever that I had ever seen *Armillaria* doing to white oak what it's been doing to (black and scarlet oaks) for decades," Bruhn said.

Simeon Wright was with Bruhn when they saw the white oak infected by *Armillaria*. Now a forest health specialist with the Michigan Department of Natural Resources, Wright said warmer temperature and increased heavy rainfall events over the past 30 years in Missouri could lead to increased periods of soil being saturated. That could make it difficult for roots adapted to drier conditions to get enough oxygen.

Conversely, warmer temperatures also increase drought at other times, which also damages roots. The tree becomes stressed and the *Armillaria* fungus can start attacking those roots. That can potentially lead to the change in the composition of the forest.

"If we see white oak replaced by species that are less valuable for timber or wildlife, that certainly could have a big impact on Missouri's economy," Wright said.

Prophesy Fulfilled

The sight of the enduring white oak dying from the root disease brought back Bruhn's memories of his senior year at Utah State University. He was taking a plant ecology course, and one day the professor came in and said: "You are too young to have seen this happen. You haven't lived long enough. We're in the early stages of being able to see what's changing. But I guarantee you that by the time you have retired, you will have seen changes you can't explain without including the greenhouse effect and climate change."

"He was right, boy was he right, and he was brave for bringing that up in 1970," Bruhn said.

[*Note: The humongous fungus of Michigan, while large, is not the world's largest. That distinction goes to an individual growth of Armillaria ostoyae in eastern Oregon, which covers 2,385 acres of the Malheur National Forest. This particular individual is estimated to be anywhere from 2,400 to 8,650 years old.*

By another measure, the largest organism could be the 13-million-pound clonal aspen forest of Utah, which, sadly, is now dying.]

VAST, ZOMBIE-LIKE MICROBIAL LIFE LURKS BENEATH SEABED

https://www.france24.com/, Dec. 10, 2018

Tampa (AFP) - Japanese scientists have drilled a mile and a half (2.5 km) beneath the seabed and found vast underground forests of "deep life," including microbes that persist for thousands, maybe millions of years, researchers said Monday.

Feeding on nothing but the energy from rocks, and existing in a slow-motion, even zombie-like state, previously unknown forms of life are abundant beneath the Earth despite extreme temperatures and pressure.

About 70 percent of Earth's bacteria and archaea—single-celled organisms with no nucleus—live underground, according to the latest findings of an international collaboration involving hundreds of experts, known as the Deep Carbon Observatory, that were released at the American Geophysical Union meeting in Washington.

This "deep life" amounts to between 15 and 23 billion tons of carbon, said the DCO, launched in 2009, as it nears the end of its 10-year mission to reveal Earth's inner secrets.

"The deep biosphere of Earth is massive," said Rick Colwell, who teaches astrobiology and oceanography at Oregon State University.

He described the team's findings so far as a "very exciting, extreme ecosystem."

Among them may be Earth's hottest living creature, *Geogemma barossii*, a single-celled organism found in hydrothermal vents on the seafloor. Its microscopic cells grow and replicate at 250°F.

"There is genetic diversity of life below the surface that is at least equal to but perhaps exceeds that which is at the surface, and we don't know much about it," Colwell said.

"Distinct" from Surface Life

Similar types of strange, deep life microbes might be found on the subsurface of other planets, like Mars.

"Most of deep life is very distinct from life on the surface," said Fumio Inagaki, of the Japan Agency for Marine-Earth Science and Technology.

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Deep Life, *cont. from page 7*

Using the Japanese scientific vessel *Chikyu*, researchers have drilled far beneath the seabed and removed cores that have given scientists a detailed look at deep life.

"The microbes are just sitting there and live for very, very long periods of time," Inagaki told AFP.

Brought up from these ancient coal beds and fed glucose in the lab, researchers have seen some microbes, bacteria, and fungi slowly waking up.

"That was amazing," said Inagaki.

Scientists have found life in continental mines and boreholes more than three miles (5 km) deep, and have not yet identified the boundary where life no longer exists, he added.

How Basic Biology Works?

Gaining a better understanding of subsurface life on Earth can also help us understand and better engineer climate-change fighting technologies that may one day sequester carbon from the atmosphere.

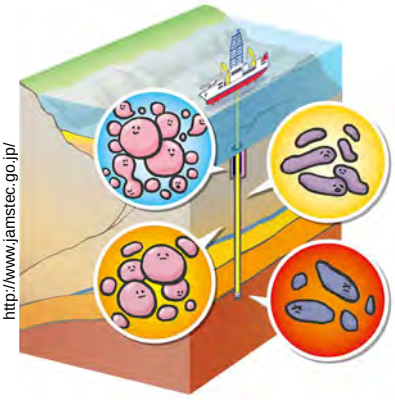
"What we learn here will help us understand what to look for on other planets or other systems where life could exist," said Colwell.

In any case, studying what some scientists have called the "Galapagos of the Deep," dramatically changes humans' perception of life on Earth, and their place in it.

Most of our planet's microbial life is deep beneath the surface, and it may have played a big part in the evolution of Earth's atmosphere by locking carbon dioxide underground and allowing air for people and animals to breathe.

"There is lots and lots of life on Earth that we did not know about. The fact that so much of it—at least in the marine sediment—is functioning at extremely low energy, it really changes our basic conception of how biology works," said Karen Lloyd, an associate professor at the University of Tennessee at Knoxville.

"They are new branches on the tree of life that have been on Earth, doing whatever it is that they do, for billions of years, but without us ever noticing them," she told AFP.



http://www.jamstec.go.jp/

"It is like looking beside you and finding that you have an officemate you never knew about."

Sketch of Japanese research vessel Chikyo deep seabed sampling experiment.

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