ISSN 0740-8161
Issue 120
Vol. 28, #4 - Vol. 29

Mushroom

The Journal of Wild Mushrooming

Cover Photo: *Panellus stipticus* glowing by its own light, photographed by Matt Schink. See article p. 40.

Features

Departments

Mushroom, the Journal of Wild Mushrooming. (ISSN 0740-8161) is published quarterly by Mushroom the Journal of Wild Mushrooming, NFP, 1006 E 62nd St, Unit C, Chicago, IL 60637.

Subscriptions are $32 for one year, $90 for three years, $250 for ten years, and $700 for a lifetime subscription. Checks should be sent to Mushroom the Journal, 1006 E 62nd St, Unit C, Chicago, IL 60637.

Checks drawn on Canadian banks should be marked

Periodical postage paid at Chicago, IL and additional mailing offices.
POSTMASTER: send address changes to Mushroom the Journal, 1006 E 62nd St, Unit C, Chicago IL 60637

The journal welcomes contributions of photos or articles, and will be glad to consider them for possible publication.

In the pocket (rot)

an interview with Bob Blanchette

Leon Shernoff: So how did you get started in mycology?

Bob Blanchette: Well, it started (smiling) a long time ago. I always had a general interest in biology. My grandfather had a farm, so I was interested in plants. I would collect insects, rocks and minerals, fungi – you name it, I was out there collecting it. And then progressed to an interest in trees and forestry, and then to tree diseases. I got my graduate degree working on fungi attacking shade trees and was always interested in identifying and finding out more information about fungi. And in particular, I have an interest – and always had – in the fungi that grow on trees and attack wood.

LS: So you were more into the conks, starting out, rather than the cap-and-stem mushrooms?

BB: Yes. It seems that I was always focusing on those that were on tree trunks, and root rots and things like that.

But you know, I was in forestry, and I have a degree from the University of New Hampshire in forestry. I saw the need for more information about *all* of these fungi that were in the forest, so many of them attack trees, and I just started to focus an interest on that.

LS: And are you from New Hampshire?

BB: I grew up in Concord, Massachusetts a few miles from Walden Pond.

LS: Now you work in a… I guess it's a forest pathology department?

BB: Actually, it's in the Department of Plant Pathology, and my laboratory is focused on forest pathology and wood microbiology. But it is in our college of agriculture here at Minnesota. And Minnesota being a very large agricultural state, we have a whole department of plant pathology, we have other departments working on entomology, forestry, another on horticulture, another on soils and climate, etc.

So within plant pathology, my focus is on trees.

LS: And the university… it isn't an ag school per se.

BB:We have an agricultural and forestry college. There is also a College of Biological Sciences, and there are several mycologists in that College. In the Plant Pathology department we have a large number of people that work on fungi, with several fungal biologists working on diseases of various crops and also trees.

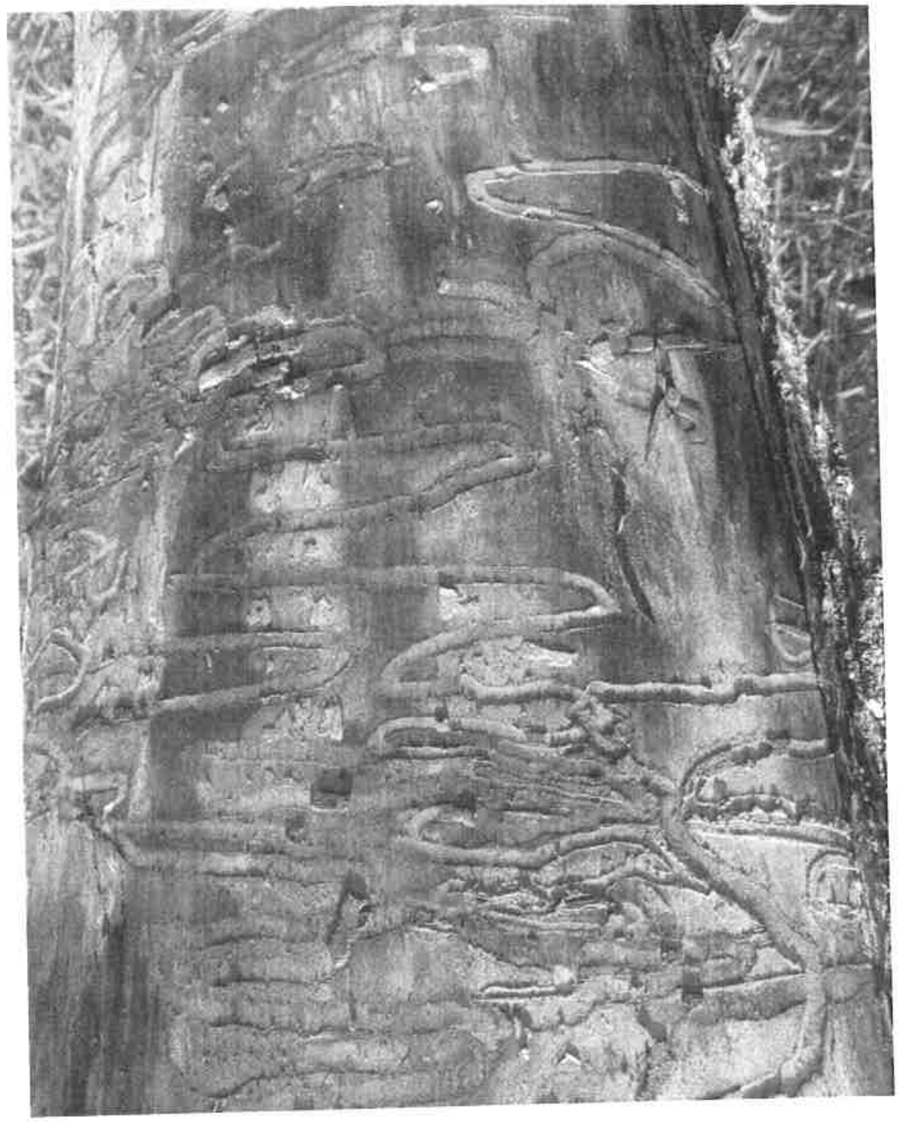
LS: So you're not – I alluded to this a little in the email – one of these mycologists who just heads out into the wilderness to seek out new taxa, and then write them up and use DNA to split them into fifteen different species to annoy the rest of us…

BB: Well… I do that too! I love getting out in the North Woods as well as other forests around the world.

But I also have projects looking at diseases. So I have worked on projects selecting elms for resistance to Dutch elm disease, we have projects on root rots – *Heterobasidion* and *Armillaria* root rot. I've worked on many different types of host-parasite interactions in trees as well as fungi that cause wood decay.

But also, I've studied mechanisms of fungal attack and the trees' defense responses. Some mechanisms that I've been very interested in are how wood decay fungi attack wood. For many years now, I've worked with many different kinds of fungi to figure out specifically how they degrade wood. And that has led to a lot of different projects: by getting this basic information, we have been able to use it to help other disciplines, especially in historic preservation, where I've worked on a lot of wooden structures, many of these world heritage sites. They need this information: what's affecting these buildings, these cultural properties… how do you control the decay? What's the current condition of the wood? Can we consolidate and prep this so we can bring it to the museum and allow it to be used for display and educational purposes and it won't just fall apart into hundreds of small decayed pieces? So there have been a lot of projects, and one has led to another and another. This includes the King Midas tomb, ancient Egyptian wooden statues from Abydos, Greathouses and pueblo dwellings in the southwestern US, historic expeditions huts in Antarctica and the Arctic and others.

But we also do a lot of fungal diversity studies. I've been working on the taxonomy of *Ganoderma*, and we've completed a large study of *Ganoderma* in the United States, andcurrently completing a study of the *Ganoderma* of Puerto Rico, and looking at the species there. So we do a lot of sequencing and identifying species and it seems we're always finding some new taxa.



▲ Emerald ash borer tunnels in a Minnesota tree killed by the beetles. Darker areas are caused by the fungus. Photo by Bob Blanchette.

But we also have been looking at fungi that… are in your back yard! We have the emerald ash borer killing our ash trees here in Minnesota, and no one has looked at the fungi associated with this borer. We've just completed a study where we've been looking at what fungi are associated with the beetle. We've got about a thousand isolates, so we have a pretty good understanding of what all the fungi are that are present with this beetle. And from those [thinks] I think there were about 170 taxa that we identified. Many of these fungi cause cankers and help the beetle kill trees.

But you know, there are also many unknown fungi that we found in the galleries and we have 36 isolates that didn't match any known species. So we have a lot of unknowns… just in our ash trees – in the galleries of these beetles – that need more study to identify them.

And this is something we see over and over again. We have a mine up in Minnesota, it's called the Soudan mine. It's an old iron ore mine. There's a lot of wood that was brought into that mine, to shore up the ceilings – and also for tracks for large carts that take the ore out.

The mine is full of fungi attacking the wood! And it's full of heavy metals. Yet there are fungi that are colonizing the wood, and growing well on it. We've made many many isolations from the mine and got a lot of taxa that we identified, and once again a lot of unknowns – in this case we ended up with 46 unknown species, just in the Soudan mine. So there's much more work to be done, and so many of these fungi that we need to know more about – we're just beginning to understand them. We are interested in their ability to tolerate the heavy metals in the environment but also looking at fungi that may have antimicrobial properties for potential use to control the white nose syndrome of bats, a disease causing serious losses of our native bat populations. There's so much to study with these organisms.

LS: If I could just follow up a moment with the emerald ash borer: you mentioned that and I realized that all the other... tree boring beetles that I know of, they don't actually eat the wood: they end up with fungi growing in their galleries that they eat; and it's the fungi in the tunnels girdling the tree that kills the tree. Is that true for the ash borer also?

BB: Well, the emerald ash borer tunnels and feeds on the phloem of the trees – that's the living tissue just under the bark that transports sugars and other photosynthesis products from the leaves to wherever they're needed in the plant. We're finding that there's a lot of fungi in those tunnels, and there's also canker-causing fungi associated with the beetles that extend out from those galleries to help kill the tree.

We also have found a lot of entomopathogens, and we're looking at these fungi like *Beauveria*, *Purpureocillium*, and some other pathogens of insects, to see if we can increase their population to try and control the emerald ash borer.

But to answer your question, the emerald ash borer is feeding on the phloem; it's not like some of the ambrosia beetles and some other beetles that actually eat the fungi that grow in their tunnels. The emerald ash borer isn't doing that – it's feeding on the tree's cells; but there are still many different fungi in there with it. There's even some very aggressive decay fungi that have come into those galleries. They come in very early and get a good start, and as the emerald ash borer kills these trees, and as arborists cut those trees down, they're actually very hazardous – there is a rapid loss of wood strength as these fungi decay the wood and they cause very serious hazardous conditions. They are especially dangerous when you're taking down the dead trees.

LS: Now from my... minimal previous contact with people who work on wood decay, I'm remembering – and I don't know if this is still considered correct – that if wood is... suddenly exposed in the forest (or is just *there* in the forest) there is a *succession* of fungi that attack it, and a lot of the very first ones are these little black spot ascomycetes and they soften it up for the next round, and then eventually we get the big fleshy fungi that most of us think of when we think of wood decay fungi. Are the ash borers getting a jump on that process, and letting in fungi that otherwise have to wait for other fungi to open up a way for them?

BB: Well there *is* a succession that occurs often in trees: if you wound a tree, you get a lot of reaction products, and those reaction products are the tree's defense: they're full of phenolics that inhibit decay – in fact, trees can also increase the pH in the wounded wood, and that helps keep out decay fungi as well.

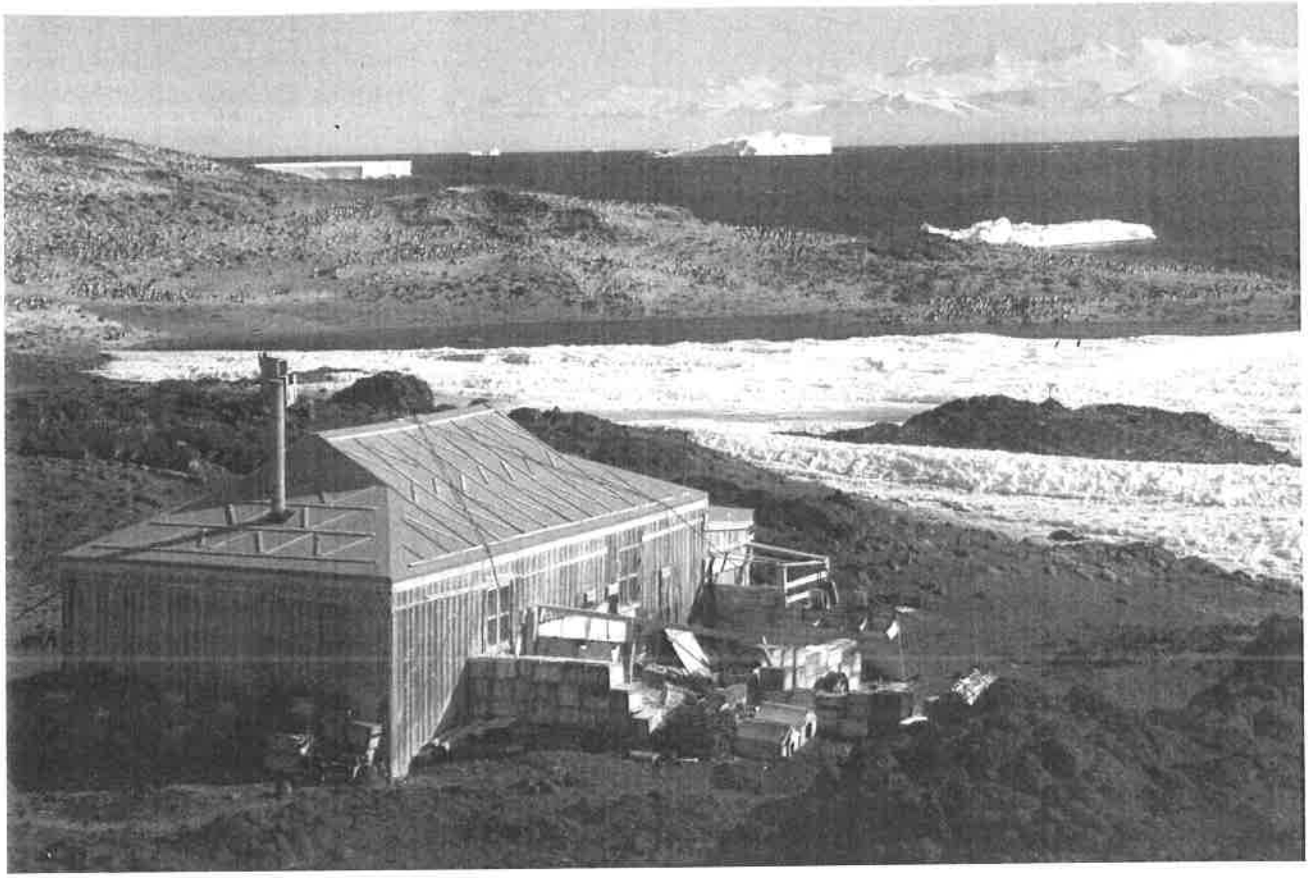
The toxic compounds produced by the tree for defense may not last long because as you mentioned, some of the ascomycetes can come in and these fungi will break down those defense compounds and once this takes place, decay fungi will follow. In the ash trees we also have some pioneer decay fungi, and these can come in immediately – they don't have to wait for a succession. There are several of these fungi that we have found, and they have the ability to tolerate these phenolics and cause rapid decay. In conifers, resinous substances are produced as a tree defense but aggressive pioneer decay fungi in those trees will actually grow in and degrade the resins.

So we have a lot of different types of decay fungi. Some of them can colonize early, and others have to wait for the succession to change the substrate and they come in later on. With the emerald ash borer, it seems that we have some very aggressive early pioneers that come in with it, and these fungi just take off!

LS: As far as you know, do the emerald ash borers also affect the substrate in physical ways? Like is water able to get in through these tunnels and that also makes it easier for these fungi to grow?

BB:The emerald ash borer makes the wounds that allow fungi to enter. But yes, you've also got moisture, and insect wounds are an avenue to the outside that will allow moisture to enter, so it's an opportunity for all sorts of things to start occurring. Of course, the larvae are in there eating and growing, and continually enlarging the wound; and the associated fungi, such as the canker causing fungi, are helping to kill tissue. As the borers and fungi work together to girdle the stem over time, the tree dies.

LS: You mentioned your work with archaeological artifacts, and I think your talk here in Chicago was about these explorer huts in Antarctica, and... was there some question of moving them back to some museum, or is it just that here are these huts that everyone used to visit as part of their initiation ritual when they came to stay at the station, and people noticed that they were starting to fall apart? What was the motivation behind your work there?



The Shackleton hut, in Antarctica. Photo by Bob Blanchette. More photos on p. 41

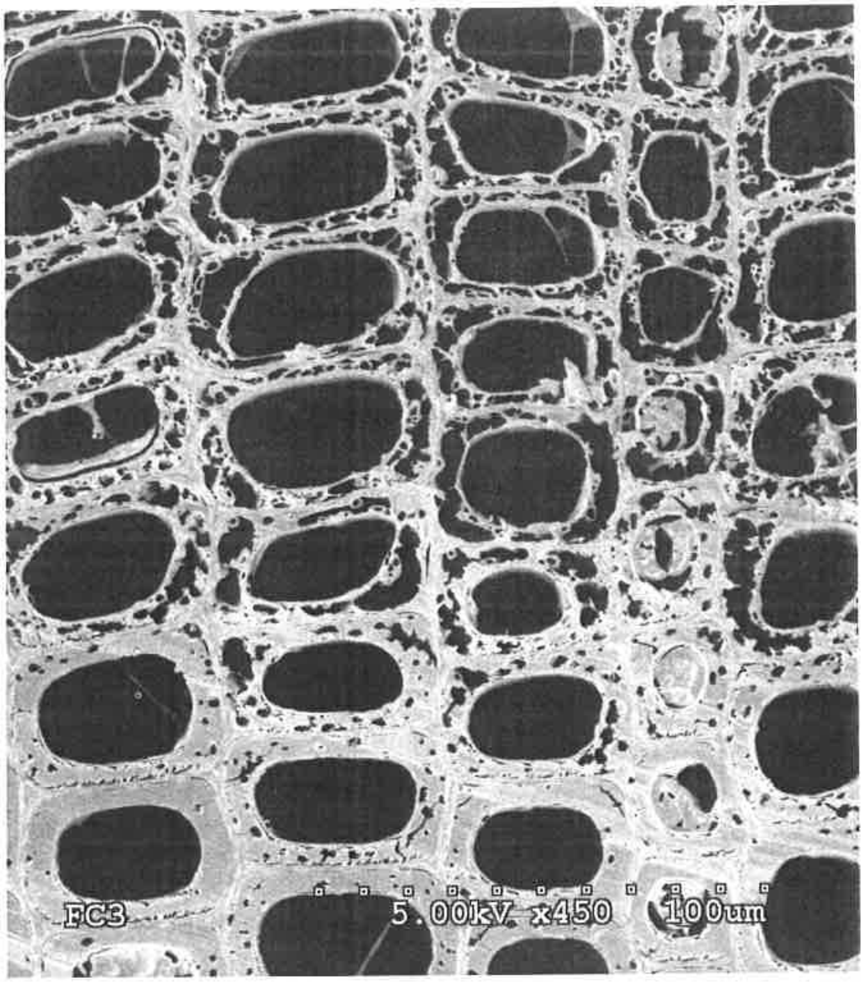
BB:As I mentioned, I have been working on conserving historic structures and studying the fungi attacking them.There are several of these huts in Antarctica that were used by Scott and Shackleton on different expeditions. We worked on three of these historic huts – located in three different places in the Ross Sea region.

The expeditions would have from 15 to 48 people, and they would be trying to reach the South Pole as well as doing lots of experiments and science. But to get to the South Pole they needed to lay food depots along the way, and then the next year they would use that food as they made their attempts to reach theSouth Pole.Since they had to be there for several years and needed shelter for the time they were there, they built huts.

These wooden huts were constructed originally in the UK and New Zealand, then numbered all the parts, disassembled them and brought them to Antarctica and rebuilt them in the field. The huts are about 100 years old and conservators noticed – the New Zealand Antarctic Heritage Trust is in charge of caring for them – that these huts were starting to decay, and there were blooms of fungi growing inside the huts. There was decay in the foundations as well as fungi growing on the artifacts inside the huts. These historic huts are full of materials left by the explorers. When the rescue ships came, the explorers left in a hurry and many things remain in the huts just as they were left there 100+ years ago so they're a magnificent view of what life was like for these explorers down in Antarctica. Lots of very important historical relics are still there inside the huts.

With the austral summers, you have 24 hours of sunlight, and it can heat up inside the huts. With this heating, some of the snow and ice that's down under the hut would melt, and that moisture would move up into the hut, so you'd have high relative humidity.

Over time you have lots of fungi growing. They were growing all over the walls, on the reindeer sleeping bags, the explorers boots that are still there, and all the other things that are still inside the huts. We went down to try and see what could be done to



▲ Microscopic view of wood cells degraded by soft rot. The cell walls are just beginning to be hollowed out at the bottom of the photo, and are more decayed towards the top. Photo by Ben Held.

stop this fungal growth, but also to look at the fungi that were attacking the foundation wood. Several of these huts, especially the Shackleton hut which is at Cape Evans, have lots of penguins living near it; so you also have lots of penguin guano as nitrogen sources around the hut.

We assumed when we started to look at the fungi there, that "Oh, these fungi were brought in." But instead they turned out to be fungi indigenous to Antarctica. These are somewhat unusual soft rot fungi and when we started looking around we found them also in the soils at great distances from where the huts are. So these fungi that are indigenous to Antarctica just took advantage of this new food source, which was the wood brought in by the explorers, and started to attack these structures.

We found a whole group of fungi down there that nobody knew anything about. And we found them when we were looking for what was causing the decay in these huts. Little is known about their ecology and biology so we have been studying these organisms. And this is important, because they appear to be the major carbon recycling organisms in Antarctica, and we know very little about them.

Our immediate mission was to figure out ways to control the fungi in these historic huts. They are resistant to all sorts of environmental factors: they survive freeze/thawing year after year, they can resist high salts, they resist high copper and other compounds that are used as fungicides so it's just not going to be possible to easily eliminate them. The best thing we determined would be to reduce moisture: if you can reduce moisture you can stop their growth. You may not be able to get rid of them, but at least you can inhibit their growth and arrest the decay.

So this is what the conservators did. They cleared out the ice from around the huts which increased drainage and they removed ice and snow from under the huts. As they were doing this at the Shackleton hut – as they were underneath, clearing out that snow and ice so you could get more air movement and it would dry out – they found Shackleton's stash of whiskey. There were several *cases* of whiskey left under the hut. It was an unusual find.

LS: Yeah, a friend was telling me about that and I thought, "Wow, that could pay for your whole conservation effort all by itself."

BB: Yes, the bottles were intact and a master blender from the same company that provided Shackleton with the whiskey for the expedition reconstructed a whiskey to mimic it: the master blender tasted it – it still was perfectly fine, of course, it was sealed – and created a whiskey that tastes exactly the same. This has been sold and a percentage of the sales goes back towards conserving the huts.

Most people who have heard about the discovery of Shackleton's whiskey do not know that it was because of fungi and efforts to stop the decay from continuing that allowed the whiskey to be discovered.

LS: So when you said that the fungi turned out to be local: it seems the huts turned out to be a big hunk of bait for them. I've seen this as a technique for researching soil fungi: you can do something like thread some seeds on a thread and put it in the ground, then pull it up and see what's growing on them; it seems like you've done something this with the huts.

BB: Yes, that's exactly correct. The huts were an introduced carbon source. Wood had not been there before, yet these fungi were able to colonize it, attack it, and decay it. And many of these are new species. One of the genera we find in particular is *Cadophora*, which causes a soft rot kind of attack–soft rotters cause distinct cavities to form in the wood cell walls, and this is a very different form of attack than from the white and brown rot fungi that we see occurring in temperate areas.

LS: Wow, so you're saying there are no woody plants there?

BB: Not in this region of Antarctica. There are no woody plants and there's no lignocellulose. There are some lichens in some places, and some moss, and that's it.

LS: Okay, so that was my next question: In spite of not having any naturally occurring lignin there, these fungi are able to decompose the lignin in this introduced wood?

BB: They're soft rotters, and we don't know a lot about the decay process of soft rot. We took these soft rotters back to the lab, and they can attack wood quite substantially in a relatively short period of time. Their method of attack is different, in that they attack the *inside* of the secondary cell wall. This may help them get around the problems in a hostile environment: if you have high salts, or other toxic substances, they can penetrate the cell wall, and sort of take shelter there, and then attack the cell wall from the inside out.

LS: So they're not as exposed to the environmental toxins.

BB: That's right. More recently, we have been working in the Arctic. There are some historic structures there; one of them is Fort Conger, which was a big wooden structure built in 1881 during the Greeley expedition. Nineteen members of that expedition died. Later, Peary, who was doing his own expedition and trying to get to the North Pole, used the wood from Fort Conger to make the small huts that we now call the Peary huts. This was in the early 1900s. Fungi are attacking those huts too, and we find that they are similar: *Cadophora* are in the Arctic as well, and the major decay type attacking these structures is soft rot – actually the only decay type in the high Arctic that we found was caused by soft rot fungi.

Another interesting thing scientifically is that the Greeley expedition took temperature readings, every hour, twenty-four hours a day for two years. So there's all this data – a tremendous amount of work over two years, and again nineteen of them lost their lives doing this work - because they ran out of food and the relief ships didn't arrive. We put data loggers in the huts, this done in cooperation with Parks Canada, and recorded the temperature there over a three year period. We found that we now have about 500 hours more per year above freezing, O°C, at the site as compared to temperatures in 1881-1882. This means there is a longer season for decay fungi to grow and the temperatures in general are higher resulting in more decay taking place each year. This accelerated decay in these Polar Regions due to climate change is a concern for the preservation of these historic structures.

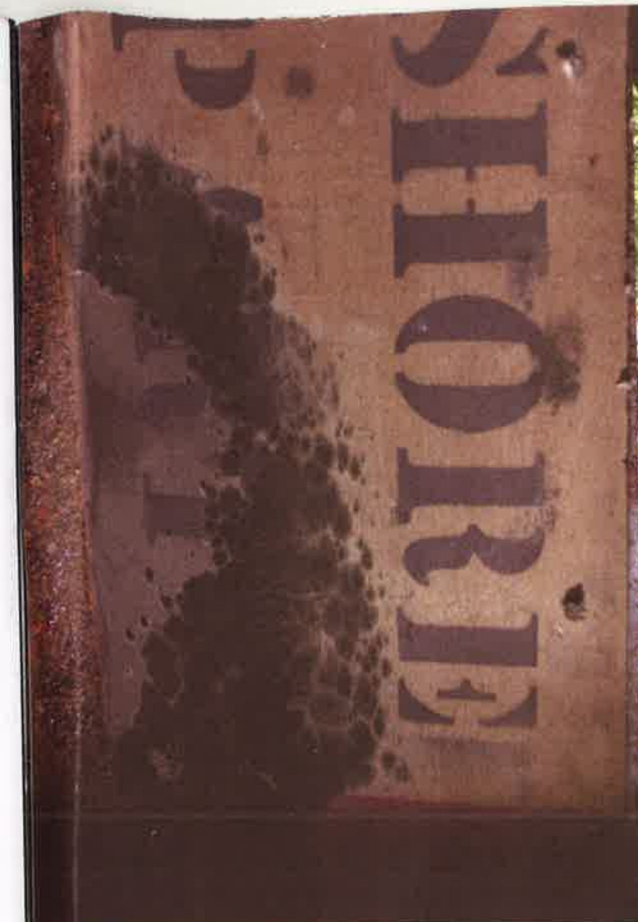
LS: And it's also thawing the permafrost around these huts, I imagine.

BB: Exactly. The soil around these historic huts is thawing, the fungi are present there, and they move in as free moisture is present to attack the wood. So it's a big problem, and there's also the question, "How do you control these fungi?" We really don't have a lot of information about the fungi growing in the Arctic but we do already know that they're heavily adapted to tolerate toxic chemicals and environmental extremes.

In one study that we just completed, and it was published in early 2021, we've identified all the fungi that are present in these Arctic huts, and we are now looking closely into understanding their unusual biology in hopes to find a good control. But until then, we are recommending a similar approach to that used in Antarctica which is to try and reduce moisture. Since all fungi need moisture to grow, if this can be reduced, fungal growth can be slowed and decay rates reduced.

Tune in next issue when we discuss artifacts from Abydos, sunken Roman warships, and more!

Mushroom



▲ Black mold growing on wood inside hut, Cape Evans, Antarctica. Photo by Bob Blanchette.

Bob Blanchette (with the chicken of the woods mushroom) in the North Woods of Minnesota. Photo by Nick Rajtar. ▼
See interview p. 34

Mold growing on explorer's boot from the Scott expedition, Cape Evans, Antarctica. Photo by Bob Blanchette. ▲

▼ Collecting fungi inside the Soudan Mine, Minnesota, 27th level (half a mile down). Photo by Bob Blanchette.