The Nova Sclerotium

Winter 2020

scle·ro·ti·um : the hard dark resting body of certain fungi

Overview

Presidential Welcome

Gavin Kernaghan

Dear NSMS members, I imagine that most of you share my anticipation of the coming year. As you may know, our 2020 foray was quite different from previous ventures, in that it was our first "virtual foray". Members collected fungi in their favorite local spots, and then presented them to the rest of the group over Zoom in the evening. Although we could not smell the mushrooms, it worked surprisingly well, and we were able to see the fungi collected by other members and discuss their identities. I do want to stress however, that "zoom mushroom identification" is not sufficiently accurate for safe consumption of the mushrooms in question.

Given our dispersion across the province, we are thinking that this is an idea that we could return to in the future. Not that Zoom would replace in-person forays, but we could integrate more on-line activities into our program. For example, attendance at our upcoming Annual General Meeting (TBA) will likely be higher on-line than in person, given that members will not need to drive to any particular corner of the province. Keep an eye on the society's website and your e-mail for more information.

Happy New Year!

Message from the Editor

Tom Clair

Welcome to the second Nova Sclerotium issue. I hoped you enjoyed reading the first and will also enjoy this one. With the articles included, we're trying to give a full flavour of the ways mycology contributes to our lives: the good, the bad, and the ugly. Any suggestions on future articles or subjects are also greatly appreciated as I'm trying to ensure our articles are relevant and interesting to the members.

In this issue, we continue our series on taxonomy with an article from Dr. Alfredo Justo, the Head of Botany and Mycology at the New Brunswick Museum, describing the ongoing efforts to describe the fungi biodiversity of the Maritimes in a more global context. It seems that there's an awful lot of work to be done.

Most websites which describe mushrooms always begin with a disclaimer that you should not eat mushrooms

when just using taxonomic keys for identification. It is most important for new mushroom pickers to learn from experienced ones because the identification of fruiting bodies can often be very tricky. Considering the number of species which can make you sick or worse, this is advice that bears repeating. In this issue however, I will describe a source of mushrooms guaranteed to be happily and safely consumed, while helping the local agricultural community.

Finally, over the last few years, I've been following stories in the news describing bat mortality caused by a fungus, which to me seemed bizarre, though really interesting. I tracked the story down and was led to Karen Vanderwolf, a Research Associate at the New Brunswick Museum and PhD student at Trent University, who has studied this problem in western Nova Scotia and New Brunswick while working for the Canadian Wildlife Federation. In the article, she gives a short background on how some fungi species are injuring animal populations and then focuses on the situation with bats in Nova Scotia.

I hope you enjoy these articles and as I mention above, article suggestions from the membership are greatly appreciated. We want to make this newsletter relevant to all of you.

Maritime Gourmet Mushrooms: A success story

Tom Clair

Walking through a nearly empty Halifax Seaport Market shortly after it reopened under new COVID-19 rules, I noticed a small stand selling mushrooms. I couldn't help it of course, so I wandered over to see what they had for sale. The small booth was selling Shiitake (*Lentinula edodes*), Lion's mane (*Hericium erinaceus*), Hen of the woods (*Grifola frondosa*) and even Lobster (*Hypomyces lactifluorum*) mushrooms. I was impressed and bought some shiitakes to bring home to cook. I also brought home the business card of Jason Giffin, the president of Maritime Gourmet Mushrooms. I thought that this operation and its products would be of great interest to the membership with all the joys of eating interesting fungus without the hassle of foraging (just kidding, as foraging is part of the fun for many of us, but it's very seasonal and not always possible even during the season).

Figure 1. Main growing building for Maritime Gourmet Mushrooms. An expansion is already being added to it.

I arranged a visit to their operation in Great Village, where I was blown away. In my naivety, I expected to see a dark barn with horse manure on wooden racks where the clumps of these mushrooms were growing. Instead, I found a new steel-coated building (Figure 1) containing brightly lit, sterile rooms. In the rooms were stainless steel racks holding plastic bags containing wood chips (Figure 2). Many of the bags had slits cut into the sides, where interesting-looking mushrooms were growing out of them (Figure 3). The place looked sleek, modern, and very professional.

A native of Halifax, Jason explained that he began his interest in mushroom farming after a stab at running a permaculture farm in PEI with his cousins. That project didn't work out, but he realized that the mushroom portion of the project had potential and he began a small operation in Herring Cove that quickly overcame the size of the facilities. He soon bought another, larger property in Great Village, which he is already expanding due to increased demand.

It turns out that his stand at the Seaport Market reflects only a portion of their mushroom output. The company also has a stall at the market in Fredericton, NB. It also sells it's products via the Farmacy store in

Figure 2. Jason Giffin examining seeded bags in his growth facility.

Charlottown, PEI and the Warehouse market in Halifax. The main part of the business though, is providing mushrooms for restaurants in the Maritimes, Quebec, and Ontario. Another line of the business is to provide seeded bags to other growers, some as far away as New England. These other growers finish off fungus maturation to provide fresh mushrooms where they live. These go to restaurants as well as other farmer's markets. To top this, Jason also has trained pickers in the region who provide him and his clients with species that can't be grown commercially, especially Chanterelles. I was particularly taken with Lobster mushrooms (*Hypomyces lactifluorum*)

Figure 3. Seeded bag with more mature mushrooms. Slits were cut in the side allowing the fruiting bodies to emerge from the hyphal mass.

Figure 4. Wood chip sterilizing and fertilizing equipment.

collected in New Brunswick and on sale at the Seaport Market.

So what mushrooms does his company grow, and how does the operation work? All the mushrooms grown at Maritime Gourmet Mushrooms are saprobic, so feed on dead organic matter, which in this case is wood chips. Oak and maple chips are sterilized in a large autoclave (Figure 4), then minerals and nutrients are mixed in. The sterilized and enhanced wood chips are then packed in specialized plastic bags (Figure 5) until spores are added. Under controlled temperature conditions the magic happens, and when enough hyphae are seen, slits are cut in the sides of the bag to allow fruiting bodies to emerge.

The results are amazing! Not only are the products tasty, but they're also beautiful to look at (Figures 6 to 10).

Currently, the operation produces eight or nine species of mushrooms and has been a great success due to the hard work of Jason and his employees. The future looks bright for the company and for mushroom lovers in eastern Canada and USA.

Figure 5. Prepared bags waiting to be inoculated in sterilized room.

Figures 6 to 10. Mature mushrooms ready for shipping. (6) Hen of the woods, (7) Chestnut , (8) Lion's mane, (9) Pearl oyster, (10) Shimeji

Mycoflora of Atlantic Canada: recent progress and the long road ahead

Alfredo Justo

Figure 1. Some of the mushroom collections during the 2019 Continental Mycoblitz in New Brunswick. All collections are now part of the NBM herbarium at the New Brunswick Museum in Saint John.

Fungi are hyper-diverse organisms, but they are extremely understudied when compared with animals and plants. A common estimate of fungal diversity, made by mycologist David Hawksworth through extrapolation of fungal species associated with other organisms (Colwell & Coddington 1994), puts the number of species at 1.5 million. A recent revision of this estimate by Meredith Blackwell (2011), taking into account recent work on fungal molecular (DNA) systematics, brings the number up to 5.1 million fungi species on the planet. The actual number of described fungi is much lower (approximately 130,000 species), which gives an idea of the magnitude of the work still ahead for taxonomists. If we keep at the current rate of species description, it will take us 1,000 years (not a typo!) to reach 1.4 million described fungal species (Hibbett et al. 2011). Mushroom-forming fungi are only a small part of the fungal kingdom. About 20,000 of the described fungi are mushrooms, and despite being the more visible members of the group, their state of knowledge is not much better than the rest.

Our knowledge of mushroom biodiversity in North America is constrained by several factors (Bruns 2012). First, there are a large number of species (anywhere between 3,000 and 5,000 by current estimates). Secondly, the fruiting structures (mushrooms) are ephemeral, and not always easy to find. Third, the basic taxonomic work is far from complete, even for very familiar mushrooms such as boletes, amanitas, and chanterelles. Finally, there are very few people trained to do taxonomy, and their numbers are dwindling. To address this situation, professional and amateur mycologists met in New Haven, Connecticut in 2011 to launch the "North American Mycoflora Project". At the time, it was emphasized that "within the entire continent of North America there was not a single regional, state, or local catalogue of the macrofungal species that presented credible accounts of the species present and their distributions" (Bruns 2012).

Studies which integrate data from taxonomy, morphology, biogeography, and phylogenetics are sorely needed to document species-level biodiversity in mushroom

-forming fungi, but such studies are very rare. This is unfortunate, because these provide essential resources for ecologists and biodiversity resource managers. For example, to predict species' responses to climate change, it is necessary to have precise definitions, range, and habitat information on these species. Research also provides excellent opportunities for outreach to citizen-scientists, and it connects to collection-digitization efforts.

Atlantic Canada is no exception to the precarious situation of fungal taxonomic knowledge in North America. The New Brunswick Museum currently holds approximately 41,000 plant specimens, representing the 1,600 plant species occurring in the province. By contrast, there are currently only 9,000 fungal collections, representing about 600 species, even though the estimated mushroom diversity in New Brunswick is thought to be somewhere between 2,500 and 3,000 species. So, what can we do to speed up mycological discovery in Atlantic Canada? Here are some recent and current projects:

Since 2012, the North American Mycoflora project has held additional meetings to coordinate the efforts of professional and amateur mycologists towards its goals (Sheehan 2017). The project has recently been renamed as "The Fungal Diversity Survey". The project webpage (https://fundis.org/) summarizes the most current information about the national, regional and local efforts towards a North American mushroom catalogue. Currently, only one mycodiversity project for New Brunswick is listed within Atlantic Canada.

In 2019 a Continental Mycoblitz was held across North America under the umbrella of the project (https://www.inaturalist.org/projects/continental-mycoblitz-2019). People were asked to collect mushrooms across the continent, take photos to create an iNaturalist observation (e.g. https://www.inaturalist.org/observations/3100212), preserve voucher specimens from the find, and select the most interesting collections for DNA sequencing, paid for the project. The New Brunswick Museum personnel and research associates participated in the Mycoblitz, collecting in different areas in the southwest of the province (Figure 1).

Events like the Mycoblitz clearly show that platforms like iNaturalist, Mushroom Observer (https://mushroomobserver.org/) and others, can be powerful tools when trying to bring together professional and amateur mycologists. The project Mushrooms of New Brunswick

Figure 2. One of the original observations of *Pluteus orestes* Vellinga & Justo at Mushroom Observer (https://mushroomobserver.org/77970). This species was described as a new to science in 2014, based solely on collections made by citizen-scientists across different localities across in the mountain ranges of western North America.

BiotaNB 2019 – Kennedy Lakes PNA

Figure 3. Some of the mushroom collections during the 2019 BiotaNB foray at Kennedy Lakes PNA (NB). All collections are now part of the NBM herbarium at the New Brunswick Museum in Saint John.

(https://www.inaturalist.org/projects/mushrooms-of-new-brunswick) automatically incorporates any mushroom observation made in the province. A similar project for the Fungi (including lichens) of the Maritimes is also available (https://www.inaturalist.org/projects/kingdom-fungi-maritimes). These efforts increase the public's awareness about mushrooms, and in many cases, interesting collections can make its way to a mycologist with a focus on a particular group. Participation from citizen-scientists has led to exciting findings. For example, *Pluteus orestes*, an endemic species of the western North America mountain ranges was described in 2014 based solely on collections made by citizen-scientists (Figure 2).

Making new voucher collections and depositing them in established herbaria for long-term curation and study is a fundamental part of any mycofloristic project in Atlantic Canada. Since 2009, the New Brunswick Museum has an annual 2-week foray to visit the different protected areas in the province and document the diversity of fungi, plants, and animals. This BiotaNB project, formerly called Bioblitz, brings together professional scientists and interested naturalist in the area. You can see some of the past forays at https://www.nbm-mnb.ca/field-work/. In June/July 2019 we visited Kennedy Lakes PNA in northern New Brunswick, and collected many interesting mushrooms (Figure 3). In 2020 we were scheduled to visit again, this time later in the season (August), but COVID-19 got in the way of that. We will continue with our BiotaNB project in 2021!

Further North, the Foray of Newfoundland and Labrador has been hosting an annual fungal foray since 2003. This has brought many international experts to the region to collect with the local mycologists and has resulted in many interesting finds, including newly described species based on material from Atlantic Canada. There is an extensive amount of information on their webpage: http://www.nlmushrooms.ca/index.html, including their newsletter Omphalina. The recently described Newfoundland yellow chanterelle *Cantharellus enelensis* (Thorn et al. 2017) is

Figure 4. *Cantharellus* cf. *enelensis*. A recent collection made in New Brunswick, currently under study to confirm that it is the same species as the Newfoundland yellow chanterelle.

probably a widespread and common species across Atlantic Canada (Figure 4).

In summary, to produce an Atlantic Canada Mycoflora catalogue, we need to extensively collect across the region, photograph and annotate the collections, deposit the voucher specimens in established herbaria for further morphological and DNA work, and establish a network of professional and amateur mycologists interested in achieving this goal.

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Fungi are killing bats

Karen Vanderwolf

Figure 1. A hibernating bat in a New Brunswick cave with fungal growth on the muzzle characteristic of WNS.

Although not as common or as well-known as fungal diseases in plants, wildlife diseases caused by fungi seem to be getting worse, but are now starting to be better understood. They can be devastating to animal species. This escalation is likely due to increasing global travel and the accompanying inadvertent transport of microbes by humans and animal cargo. Just as Dutch elm blight, chestnut blight, and various crop diseases can have severe long-term effects on plant species, fungal diseases are threatening the health of animal species and may lead to broader disruptions to our ecosystems.

First it was chytridiomycosis, caused by the fungus *Batrachochytrium dendrobatidis*. It infects over 500 species of amphibians, has been found in 54 countries and is highly pathogenic across a wide diversity of species, driving some to extinction. Newer fungal diseases found in animals include snake fungal disease, caused by the fungus *Ophidiomyces ophiodiicola*, and salamander chytridiomycosis, caused by the fungus *Batrachochytrium salamandrivorans*. Fungal diseases are comparatively rare in mammals, likely because of our warm body temperatures and robust immune systems. However, in 2006, hibernating bats were discovered with fungal growth on their faces and wings in a tourist cave in New York State (Figure 1 and 2). Some of the bats had already died, to the shock of surveyors. Nothing like this had ever been seen before. This new fungal disease was called white-nose syndrome (WNS), as the white fungal growth on the noses of bats (who roost hanging upside down) is easy to see in the dark of caves. An estimated 5.5 – 6.7 million bats have since died of this disease in North America. The fungus that causes WNS, *Pseudogymnoascus destructans*, is an invasive species thought to have been transported to North America from Eurasia by humans. WNS has spread to

all provinces in Canada except Saskatchewan, Alberta, British Columbia, and the northern territories. It was first documented in Canada in 2010 and in the Maritimes in 2011. The onset of this disease represents a stark change for bat populations in North America since before WNS, fungal diseases of bats were completely unknown. WNS is a particularly devastating disease for a few reasons: one, aside from human-mediated spread, the fungus is also spread by the bats themselves who can fly hundreds of kilometers between roosts. Secondly, the fungus can persist in caves without bats for years or even decades, complicating efforts to eradicate it. Thirdly, unlike other fungal skin infections of mammals, such as athlete's foot, that only grow across the surface of the skin, the fungus that causes WNS penetrates *into* the skin to infect living tissue. Disturbingly, the fungus replaces muscle fibers and blood vessels and fills the wing with hyphae, making it hard to fly. The holes created by the fungus cause wings to leak water and electrolytes, leading to dehydration and irritation of the bat, which disrupts their hibernation in the winter. Bats with WNS are more likely to wake up during hibernation to groom off the fungus and drink water, which increases the bats' metabolism, depletes their fat reserves, and can cause death. WNS only occurs during winter and if bats survive long enough, they can groom most of the fungus off the surface of their skin before leaving caves in the spring.

Bats do not have active WNS in the summer for a few reasons. During hibernation, bats decrease their metabolism, down-regulate their immune system, and lower their body temperature to the temperature of their environment to save energy for the long winter. The fungus that causes WNS cannot grow above 20°C, and bats in Nova Scotia hibernate in caves and mines that are 5 - 6 °C in winter, which means a bats' body temperature is 5 - 6 °C during hibernation. As noted earlier, high body temperatures and robust immune systems are thought to be the main reasons why fungal infections are comparatively rare in mammals. Therefore bats can survive WNS if they endure until warm spring temperatures arrive and if they can still fly well enough to catch food for energy to heal.

Three species of bats hibernate over the winter in caves and mines in Nova Scotia: little brown bats, northern long-ear bats, and tricolored bats. The Government of Canada has listed all three species as endangered due to the number of bats that have died of WNS in Canada. Bats cannot easily recover from such high mortality, as bats can live over 30 years and females only have one pup per year. The impact of the loss of so many bats on ecosystems is unknown but may result in increased insect populations since all bats in Nova Scotia are insectivorous (i.e. they only eat insects). This means that a higher number of pests that can have profound effects on agriculture, forestry, and human health. Little brown bats are persisting in Nova Scotia despite the presence of the disease, but in much lower numbers than pre-WNS.

To date there is no cure for WNS, although efforts to reduce disturbances to bats by avoiding visiting caves during winter may help. Roosting habitat in the summer is also critical. Some bats in Nova Scotia will use buildings or bat boxes as maternity colonies to raise their young in June

and July. If you know of a roost be sure to register it at batwatch.ca or report your bat sighting! This will help researchers to better understand the habitat needs of bats and population patterns in the wake of WNS.

Figure 2. Surface of a bat wing showing the fungus that causes WNS growing across the skin.

2020 Nova Scotia Mycological (virtual) Foray

Tom Clair

Because of the pandemic restrictions on large gatherings, the regular annual Foray in the field obviously had to be cancelled. So, no cold fingers, wet boots, muddy knees, and long drives to a site somewhere in the Province this year. Instead, the Executive opted to join with the rest of the world and organized a virtual mushroom identification session using Zoom, a first for the Society. The meeting was chaired by Gavin Kernaghan with three taxonomic experts, Gavin, Keith Egger and Logan Gray. It was moderated by Adèle Bunbury-Blanchette and Amanda Griffin.

Logan Gray was the meeting host, which meant that the meeting was run from his computer and he also handled the picture downloads.

At it's peak, thirty-three people were on the meeting. The session began with members of the executive showing mushrooms that they had collected the previous Sunday, giving descriptions and identifying them as well as they could. It became obvious that generally, most of the samples could be identified to genus, but identification to species wasn't easily done. About 30 mushrooms were

looked at, and it was made painfully aware at times that seeing the samples' relevant identification characteristics wasn't easy because of limitations of lighting and quality of the computer cameras. As usual, there were two specimens that the panel couldn't identify, but sometimes, you just need to have the mushroom in hand to figure things out.

Overall though, the participants agreed that the session was a useful learning experience and was worth repeating with some modifications. The main conclusion was that downloading good quality pictures would be more useful than holding a mushroom near the computer camera. This way, lighting would be improved and submitters could also show the top, gills and spore prints if these were available. With better descriptive pictures, experts would feel much more confident about ID's and the Society would have a better record of what was growing in the Province.

https://www.facebook.com/groups/NSMycologicalSociety/

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