OMPHALINA

Newsletter of FORAY NEWFOUNDLAND AND LABRADOR

ISSN 1925-1858 | July 2021 • Vol XII, No. 3

FORAY NEWFOUNDLAND AND LABRADOR

Foray Newfoundland and Labrador

is an amateur, volunteer-run, community, not-for-profit organization with a mission to organize enjoyable and informative amateur mushroom forays in Newfoundland and Labrador and disseminate the knowledge gained.

www.nlmushrooms.ca
ForayNL
info@nlmushrooms.ca
@foraynl

Foray Newfoundland & Labrador
21 Pond Road
Rocky Harbour NL A0K 4N0 Canada

OMPHALINA, newsletter of Foray Newfoundland & Labrador, has no fixed schedule of publication, and no promise to appear again. Its primary purpose is to serve as a conduit of information to registrants of the upcoming foray and secondarily as a communications tool with members.

Issues of Omphalina are archived in:

Library and Archives Canada's Electronic Collection
http://epe.lac-bac.gc.ca/100/201/300/omphalina/index.html

Centre for Newfoundland Studies, Queen Elizabeth II Library (printed copy also archived)
https://collections.mun.ca/digital/collection/omphalina/

The content is neither discussed nor approved by the Board of Directors. Therefore, opinions expressed do not represent the views of the Board, the Corporation, the partners, the sponsors, or the members. Opinions are solely those of the authors and uncredited opinions solely those of the Editor.

Please address comments, complaints, and contributions to the Editor, Sara Jenkins at **omphalina.ed@gmail.com**

Accepting Contributions

We eagerly invite contributions to Omphalina, dealing with any aspect even remotely related to NL mushrooms. Authors are guaranteed instant fame—fortune to follow. Issues are freely available to the public on the FNL website.

No picture, no paper. Material should be original and should deal with the mycota of Newfoundland and Labrador and their concerns. Detailed Information for Authors is available on our website.

OMPHALINA

ISSN 1925-1858
Vol XII, No. 3
July 2021

CONTENT*

* Page numbers continued from previous issue.

Cover: A pair of *Cortinarius violaceus* show off their characteristic deep purple hues. A relatively uncommon find in these parts, these were found in the Corner Brook area. Photo: Maria Voitk.

Message from the Editor

Hello again, friend of fungi!

This is a challenging time of year for nature enthusiasts in Newfoundland and Labrador because ALL of the things that we love to observe and catalogue are competing for our interest. Do we look to the treetops for birds, or down in the moss for the fungi?? Should I take binoculars to spot whales, or a basket and a knife for foraging? Oh, the decisions!

This is also the time of year when we start checking brushing up on our fungal knowledge and check our foraging equipment inventory—from baskets, to books, to bright orange hats. If you are new to learning about the beauty and science (not to mention, gastronomic intrigue) of fungi, perhaps I might suggest a few resources to kick off your new obsession:

First: skip the mushroom ID apps and hit the BOOKS! The beauty of learning your mushrooms from books is that you can take notes in the margins. Learning from books takes time and dedication; it encourages us to bring our interesting finds back home, make spore prints, cut them to check for staining, compare them against illustrations of key identifying features, and pour over their descriptions in detail.

Second: connect with your fungal community online! There are amazing community groups on Facebook for enthusiasts of every level of expertise. And of course, we recommend following ForayNL on Facebook and Instagram to get our updates. These online communities help us stay connected in these socially-distant times.

Third: Grab the free iNaturalist app for your phone. *I know, I just suggested books over screens...* but this app gives you the ability to document your mushroom discoveries in space and time, complete with photos and notes. Note: the app is not a quick ID tool; iNaturalist is best used as a research and learning tool. Don't know what you found? Do what I do: take a detailed series of photos (top, sides, gills/pores, cut it in half, document any staining) and upload them. Check out similar reports posted in the region around the same time. Maybe take a crack at the family or genus. Within a week or two, someone much smarter than me usually suggests a probable genus, which helps me build my own mental taxonomic map, and narrow down my options for species.

And lastly, and most importantly: Come foraging with us when we can finally meet up again and learn from each other in person. Happy Hunting!

Sara

My first mushroom find this year, growing in moose dung. I can comfortably admit that I have no idea what species this is, but I'm certainly thankful to be connected to a brilliant community of fungal fans who can help me ID it!

Foray Matters &

Message from the President

Hello Omphalina Readers,

Once again our newsletter is sharing a bag full of interesting fungal finds and reflections with you. Andrus's article on mushrooms from the firepit in his back yard is a happy reminder that we don't have to go very far to be explorers. Don and I have been enjoying the biodiversity of our large garden over the past 15 months, but I hadn't thought to look by our own firepit for mushrooms after snow. I will look closer next year.

And now to Foray matters…

I'm sure many of you are appreciative of all the online learning sessions that have been available to us over the past year through our 2020 Series of Online Mushroom Learning Events and the wonderful series of lectures brought to us by the ad hoc collective of North American Mushroom Societies. However, if you are like me, you are itching to get away from screens and be outdoors more to observe mushrooms in real life. Sadly, once again, the pandemic has thrown a wrench in our annual Foray NL planning because, with the uncertain time of Newfoundland and Labrador's borders being open again, we could not invite experts from out of the Province to our foray. Therefore, the board is hatching some alternate plans that we hope will provide you with the mushroom celebration and learning that we are accustomed to each year.

This year, we will be offering short online information and training sessions that will prepare us to become explorers and scientific contributors in our own backyards and beyond—from the beautiful woods and bogs to the bays across our province—as we search for particular mushrooms and lichens of interest. Our goal is to engage everyone, from the mushroom ID novice to the seasoned forager. As Andrus has rightly pointed out to me, much of the fun is in the hunt and not just the find!

We will send more information to members as soon as we can. I hope you will enjoy being part of this alternate foray challenge. Surely in fall 2022, we will be able to safely Foray together again.

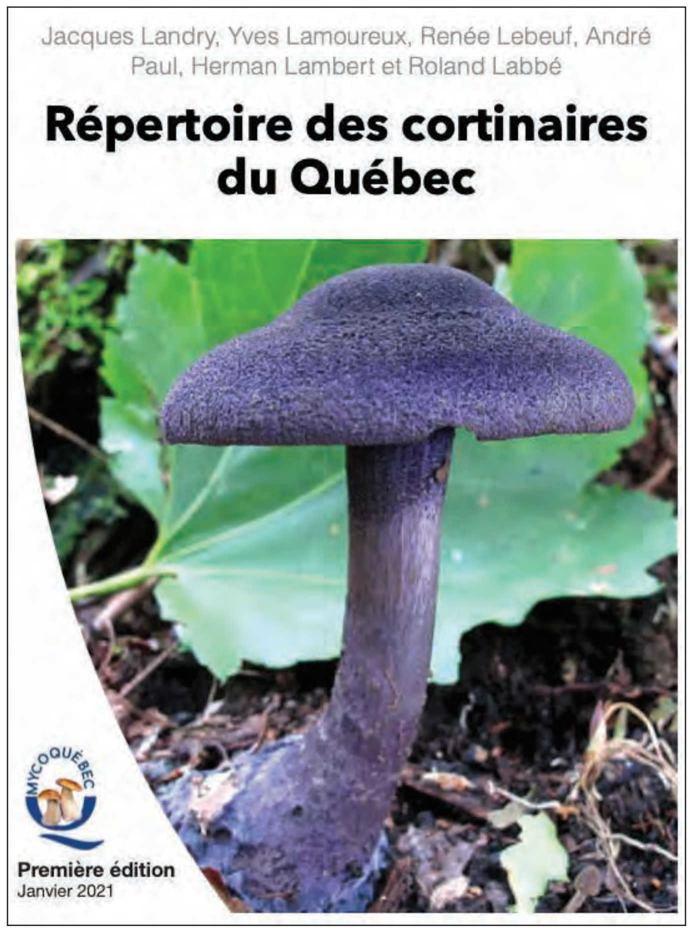
Have a great summer!

Helen Spencer

Review:

Répertoire des cortinaires du Québec

Jacques Landry, Yves Lamoureux, Renée Lebeuf, André Paul, Herman Lambert & Roland Labbé. 2021. Répertoire des cortinaires du Québec, 1re edition: Janvier 2021. Mycoquébec, 252 p. Available at https://www.mycoquebec.org/publications/Repertoire%20Cortinarius%20Quebec.pdf



By Dave Malloch

For this remarkable report, more than 1000 collections of *Cortinarius* species made in Quebec between 2018 and 2020 were sequenced and analyzed phylogenetically. The results are presented as a summary of the current knowledge of *Cortinarius* in Quebec and are enhanced with photographs and short descriptions of each species. The authors caution that this is a first report from an ongoing project and is, as yet, incomplete and insufficient for identifying species.

Cortinarius has traditionally been divided into 6 subgenera: *Cortinarius*, *Dermocybe*, *Leprocybe*, *Myxacium*, *Phlegmacium* and *Telamonia*. Although this framework still largely holds up, DNA studies have revealed that the *Cortinarius* story is really a lot more complicated. Most books for mushroom identification tend to avoid *Cortinarius* or use the traditional classification. The most useful guide for now is the Funga Nordica[1], which strikes something of a compromise between old and new classifications. The authors of the Cortinaires du Québec have tried to fit their collections into the most modern classification scheme possible, making it difficult to reconcile with most current field guides. Funga Nordica is probably the best place to start, comparing your identification there with the illustrations and descriptions from Quebec.

As a preliminary exercise, I attempted to use the Quebec study to clarify my identification of a species of *Cortinarius* collected on my property in New Brunswick (Fig. 1). The first task was to narrow the identification down to one or more most likely species using Funga Nordica. My collection fit well into the subgenus *Telamonia*, and then, because of its blue lamellae, smooth cap, yellowish universal veil and very broad basidiospores, it keyed out to the section *Anomali* but was difficult to identify, so I turned to the Quebec study to see what has been collected there. Within section *Anomali* there were photographs and short descriptions of several species. As it turned out, my mushroom most closely resembled a species that has yet to be named. Although inconclusive, the result was more satisfying than just guessing at a name in Funga Nordica.

Figure 1: *Cortinarius sp.* (Malloch 29-09-20/02) examined against the new Quebec report.

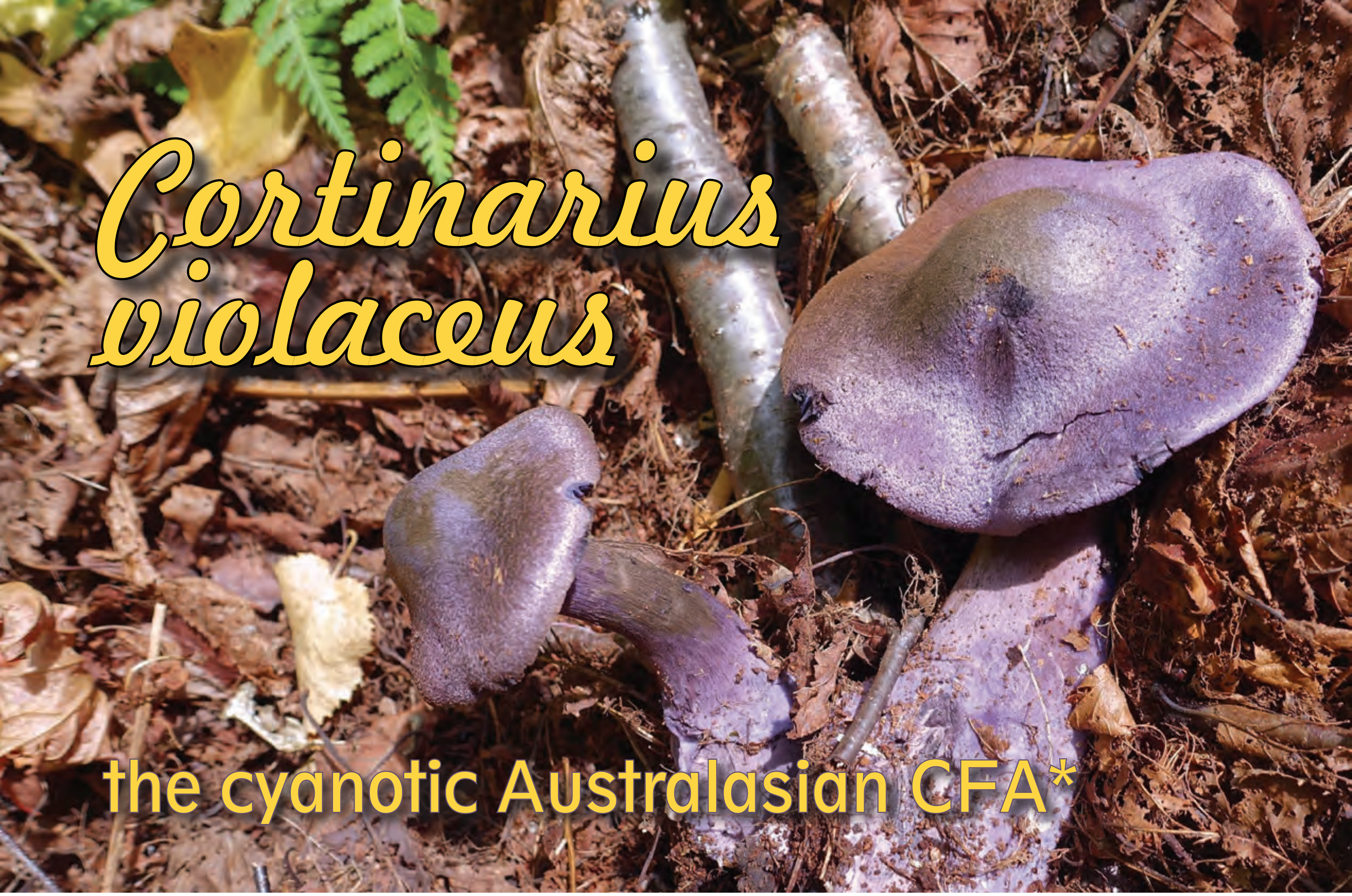
So, what can the mushroom enthusiast and reader of OMPHALINA do with this publication? It cannot be used easily as a guide for identifying *Cortinarius* species. It serves as a genetically-based checklist for the province of Quebec. Basically, it's not for the faint-of-heart. But it would be wrong to dismiss this publication as of limited use to the average mushroom enthusiast.

Newfoundlanders, Labradorians and other Atlantic Canadians can use it to compare it with their own *Cortinarius* mycota and to fill in the dots on an eastern Canadian distribution map. Individual species of *Cortinarius* do not occur everywhere and the best way to determine what is unique or special about one's region is to compare it with a list from another region. There will be species found in Newfoundland and Labrador that are rare or absent in Quebec. Ideally, we should have a similar collecting and sequencing project for Atlantic Canada that shines some light on these regional differences.

This report's importance cannot be overemphasized. No other region in North America has produced such a comprehensive genetically-based account of any group of fungi. This report should inspire the rest of us to get to work and start looking closely at our own mycota. **Quebec has thrown down the challenge with *Cortinarius* and it's up to the rest of us to take it up!**

References

1. Knudsen H, Vesterholt J, eds. 2018. *Funga Nordica: Agaricoid, Boletoid, Clavarioid, Cyphelloid and Gastroid Genera*. 2 Vols. Nordsvamp, Denmark, 1083 p.



Cortinarius violaceus

the cyanotic Australasian CFA*

by Andrus Voitk

Cortinarius violaceus (title banner, Fig. 1), the type species for the genus *Cortinarius*, is an uncommon species in our province. In 21 seasons my wife Maria just found our second collection in a birch forest not far from our house in Humber Village. The first she found in 2004 in a pre-commercially thinned balsam fir forest near Bonne Bay Big Pond. The species was described in 1753 by Linnaeus as *Agaricus violaceus*,[1] and although he did not specify the tree associates (neither did his cited other sources), the name has been applied to a species growing in broadleaf forests. Forty-one years later Persoon described *A. hercynicus*, a somewhat similar species (he said the cap was a bit scalier and stem a bit longer), which he specified grew in coniferous woods.[2] Persoon's species has been reduced to a subspecies and then a variety of the Linnaean taxon. In the past 16 FNL forays *C. violaceus* has been collected three times: 2004, mixed forest near Gros Morne; 2005; mixed forest in the Labrador Straits; and 2008, mixed forest near Konrad Brook, Labrador. The mixed forests do not permit determination of the host with certainty, but because Maria's finds were from monocultures, we can document both known varieties of the species on the west coast of Newfoundland.

Moving from the eras of Linnaeus and Persoon to the present, we know that molecular studies have shown that many infraspecific taxa form genetically well supported clades that are recognized as separate species, while other infraspecific taxa are found to be different versions of a single genetic entity. A third situation is also known to us: European names applied to North American species that turn out to be genetically distinct from their transatlantic relatives. To learn which of these

---

*CFA, short for come-from-away, is a Newfoundland expression to denote anybody whose family has not lived on the Rock or The Big Land for a minimum of 72 generations, but excluding Beothuk, Innu, Migmaw and Inuit.

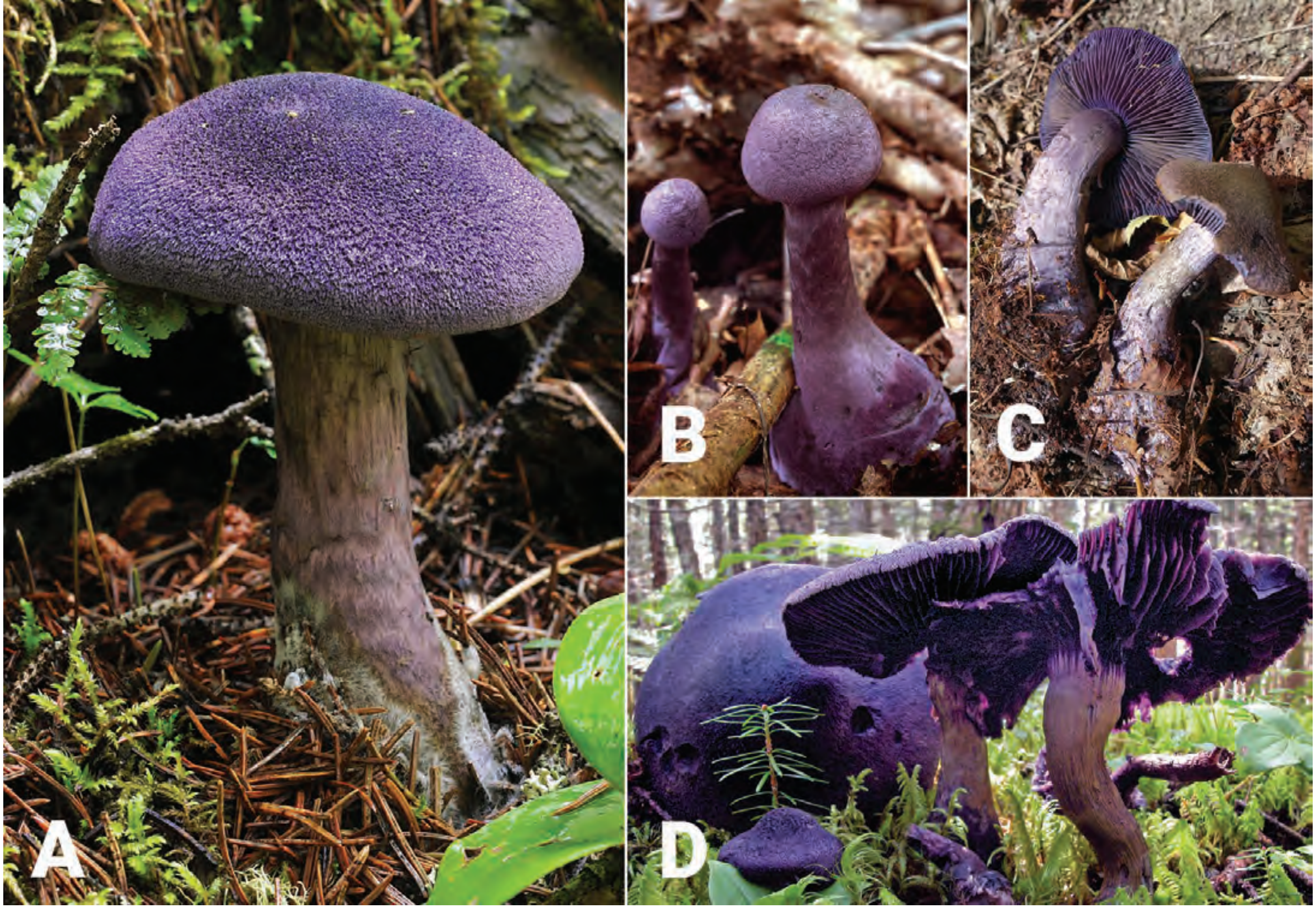


Figure 1. Canadian *Cortinarius violaceus* from (A) coniferous woods near Fernie, BC. Photo: Ian Gardiner. The significance of Fernie to this story is that should you go there, and drop in at the Raging Elk Hostel, you may run into John Howse, who travelled to Canada from Australia, just like our featured mushroom. John drops in from time to time to look after the Raging Elk, owned by his son, when the latter needs to be away. Should you be so lucky, invite John for a beer in the Kodiak Lounge, and ask about his journey for a first hand opportunity to compare with our mushroom. B) From Ontario deciduous woods. Photo: Vello Soots. C) The NL 2020 collection from deciduous woods, prompting this story; same collection as in the title banner. Both photos: Maria Voitk. D) The 2004 collection from NL coniferous forest.

three situations hold for these two entities found in our province, we turn to recent molecular studies of the species. Not every species is studied yet, but in this case we are in luck, because Emma Harrower of Vancouver, BC, devoted the best years of her youth to a doctoral study of this species,[3] preceded by two preliminary publications.[4,5] According to Emma's findings, the species in Canada is the same as the species in Europe, and grows with both coniferous and broadleaf trees. In other words, the correct name for our species, regardless of host, is *C. violaceus*; the varieties are genetically conspecific making their names synonymous. This is all we wanted to know, so we could now be finished. But were we to leave it here, we would surely miss the most exciting part of the story. A story of adventure, travel and derring-do, which only becomes evident if we ask, "Was it always thus?"

It was not. The story is captured for you in Figure 2, taken from Emma's work: a phylogenetic tree tracing the history of the *Cortinarius violaceus* complex, documenting the sequence of events (in red numbers) as it spread across the globe. The earliest events are to the left, moving progressively to the right in a cascading pattern of incrementally newer events. As you can see, from a common progenitor the earliest currently known member of this clan arose in Australasia (1), and the lineage continued to diversify, giving rise to a newer species in Australia and another in New Zealand (2). The sister pathway (3) to that lineage led to species in South America, Mesoamerica and southern North America. Finally, a sister pathway from the last such evolutionary split leads to our *C. violaceus* (4). The green D and C indicate deciduous or coniferous partners. These species began as deciduous partners in Australasia, switched to different deciduous partners in Mesoamerica and environs, and then switched to coniferous hosts, while retaining their deciduous associations, when *C. violaceus* moved through North America and Eurasia. An adaptable, if fickle group, with an eye always out

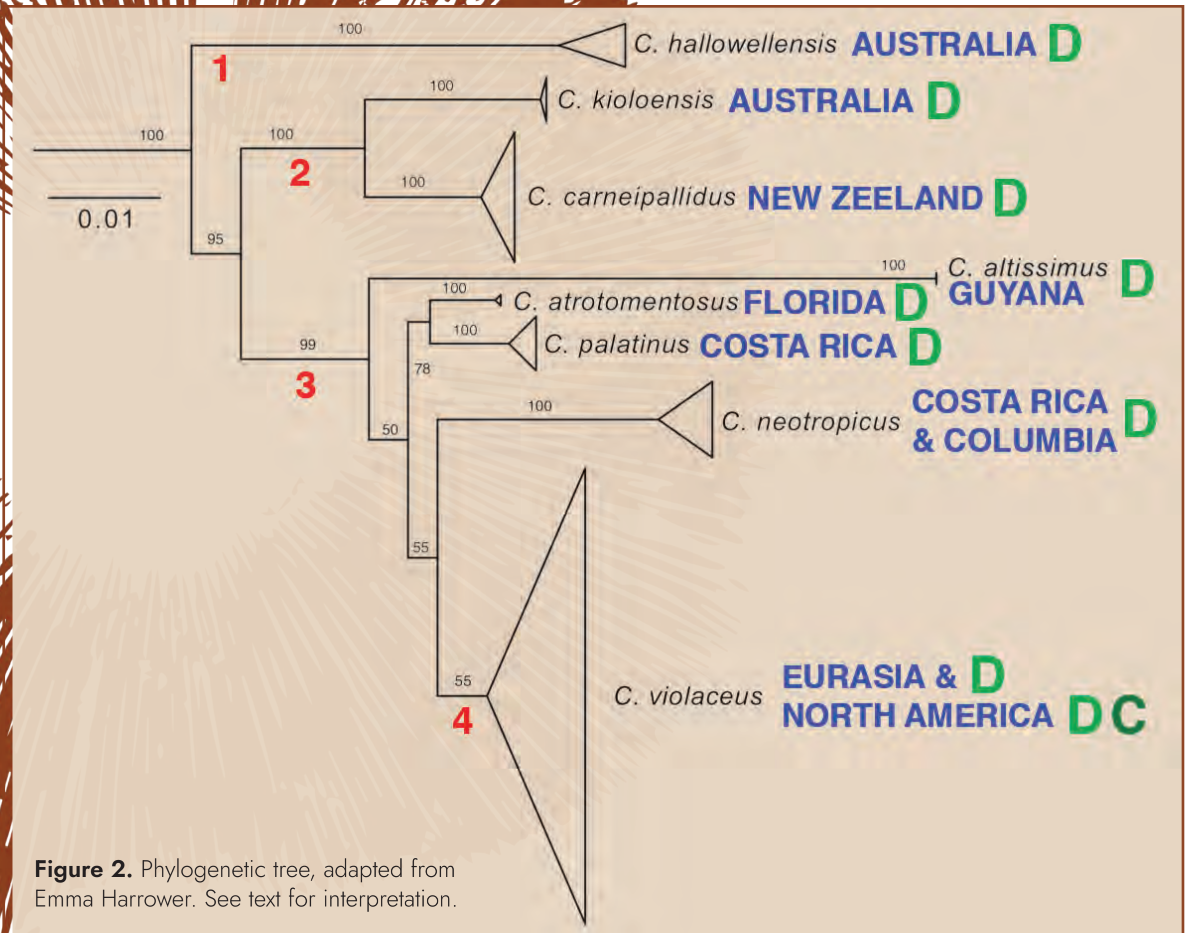


Figure 2. Phylogenetic tree, adapted from Emma Harrower. See text for interpretation.

for the main chance. How ready are they to drop their partners? Well, Emma told me that *C. kioloensis*, one of the Australian hardwood associates, has been found in a monoculture pine plantation in Australia! And, of course, although described as an angiosperm partner in Europe, indeed in the Harz Mountains** where Persoon saw it, it was clearly a practicing gymnospermist, a habit it had picked up on its trek through North America.

The phylogenetic tree tells us the sequence of events, but not the time or duration. It is tempting to assume that the transition from Oceania to South America occurred while both were part of the supercontinent Gondwana, but Emma's estimate of the time these changes occurred is much later, well after the continents had already separated. Figure 3 shows a speculative concept of the epic journey taken by this Australasian to reach us in Newfoundland and Labrador—and on. What a journey! From Australasia to northern Europe over sea and Polynesia, up through the three Americas, South, Meso- and North, all the way across the entire continent to the Pacific, Asia and Europe. Circumnavigation with a near arc north-south.

To understand this journey in human terms, we need to look at some classic tales of travel and adventure. Although there are several thrilling accounts of circumnavigating the world, apparently even in 80 days, I have found none to equal the geoevolutionary journey of this violaceous mushroom. However, some legs of its journey have very uncanny parallels to human travel lore. For example, anybody aware of Heyderdahl's Kon-Tiki expedition[6] cannot escape noticing the similarity of the route from Australasia to South America—except the Kon-Tiki journey was half as long and in the other direction. Heyderdahl studied the prevailing winds and ocean currents and postulated that the Polynesian islands were populated by peoples

** Not to be confused with the Hartz Mountains of Tasmania. The homonymic is unlikely to represent scientific evidence for an Australio-European tie for this species complex. However, the find in the Harz forest is reflected in the root for Persoon's epithet, which he initially gave as *harcynicus* (= the Harzian).

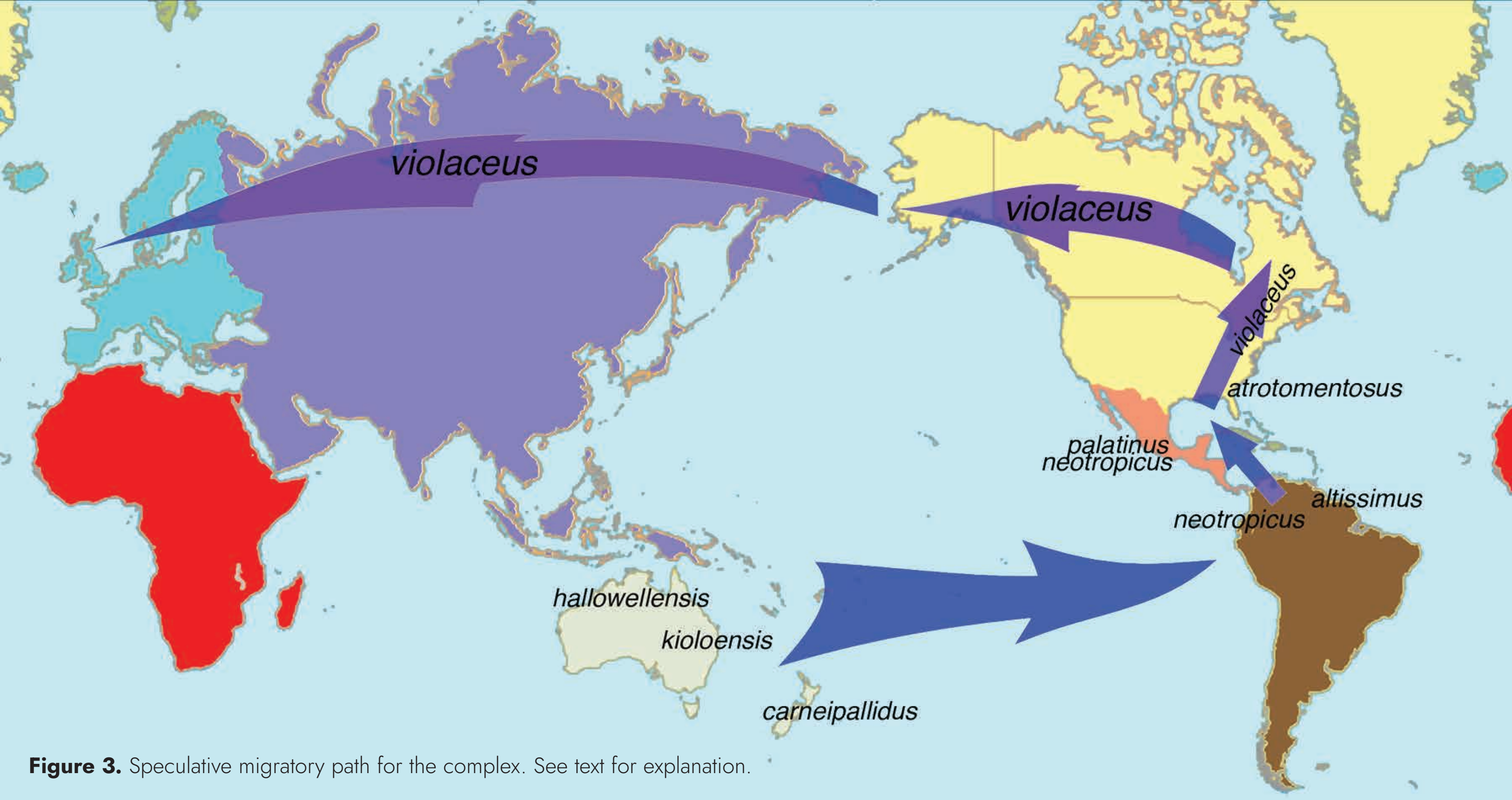


Figure 3. Speculative migratory path for the complex. See text for explanation.

from the Americas, float-sailing on craft carried by these currents. Heyderdahl's east to west drift theory was based on the premise that primitive Polynesian natives lacked the navigational skills to navigate actively and accurately against prevailing currents, a commonly held belief of western civilization of the time. Current scientific thinking, supported by linguistic and DNA studies, no longer accepts this theory, but supports the concept of active and skilled navigation by native Polynesians against wind and current to South America. Accounts, such as Finney's "Hokule'a: the way to Tahiti", make for very exciting reading, including the societal travails of entwining the goals of "western scientists" to those of emergent native reawakenig.[7] Ethnologists and anthropologists may still wonder who taught the ancient Polynesian mariners the art of navigation to enable them to sail for weeks against prevailing currents to make accurate landfall, but Emma and her team of stellar mycologists have now provided the answer: clearly they followed the teachings of our violaceous cort, who was the first to voyage against the currents through Polynesia to south America. And you read it here first.

The epic nature of the journey from Florida to Newfoundland is almost paralleled in one of the greatest migration accounts ever, Antonin Maillet's "Pélagie-la-Charrette",[8] documenting a ten-year journey by cart from Louisiana to Québec. If you have a smattering of French, try the original, written in a recreated Acadian of the time, a major tour de force by itself. It is neither the Acadian French of to-day, nor the joual of Québec, but with a little familiarity of either and the admixture of English, it is not beyond reach. An English translation also exists, probably created for those whose French is limited to Parisian argot.

Before leaving the North American francophone route, our hero left some of its members in La Belle Province, where they have made their way to the cover of the most recent publication treating local species of the genus *Cortinarius*.[9] The reason to mention this cover girl penchant, is that the book is available on-line for absolutely FREE. *Cortinarius* is a very big and difficult genus to wrap your head around. This book has the most recent and up to date information and helps to break it down into manageable sections. Because we share isotherm with Québec, we should also share much of the mycota. Hence the book should be of help to any Newfoundlander and Labradorean interested in recognizing these species. Just ignore whatever grows with oak. Go to the website (Reference 9) and download the book. Now, back to our journey.

John Howse put the east-to-west journey from Australia to western Canada in contemporary terms in his "Suitcase letters".[10] The Australia-to-Canada leg followed the more traditional trans-European route, but once in this country, you see several parallels with *C. violaceus*. As a young man wishing to go to university, Howse shared the concerns of our mushroom, how to make a living. *Cortinarius violaceus* solved it by learning to partner with conifers, in addition to the deciduous trees, thus allowing this progeny of the South Seas to move to the very northern edge of the boreal treeline. Howse also had to do several jobs to keep alive, serving bar at a ladies' club in Montréal in the winter, and working in the bush of northern Québec (not far from the Labrador border) in the summers. A trip across the continent from McGill to UBC presented fiscal and logistic problems for Howse, as it did for *C. violaceus*, whose livelihood depends on partnership with trees: the treeless Great Plains and deserts of the Midwest stop most tree-dependent fungi from moving either way. *Cortinarius violaceus* solved this, thanks to its newly acquired northern nature—which we documented by collecting it near Konrad Brook, Labrador. There is a relatively narrow bridge of forest below the treeline and above the Prairies, used by several cold-tolerant species to cross the continent with their tree partners, and it appears that *C. violaceus* used it. In addition to an unspecified northern site (https://imgur.com/gallery/w7Gio), the species has been documented on iNaturalist above Slave Lake, near the southern border of the forest bridge (https://www.inaturalist.org/observations/30169094), and in Wood Buffalo National Park, near the northern edge of the forest bridge (https://www.inaturalist.org/observations/49152313). The parallel with Howse and *C. violaceus* ends at the shore of the restless, troubled, and criminally misnamed Pacific Ocean. A few swims in that cold water that makes your skin blue, and Howse turned around to settle in Alberta's oil country, whereas the somewhat earlier traveller, *C. violaceus*, was nowhere near finished with its migration, crossed the Bering Strait in a trice,*** and continued all the way across Asia to Europe, across Europe, eventually to be collected, described and named by Messrs Linnaeus and Persoon.

Here I conclude my attempt to humanize science and segue into the Acknowledgments and References to conclude this tract.

Acknowledgement

I thank Emma Harrower for reviewing this MS and contributing ideas and new data to this travelogue. Thanks to Emma, you get unpublished new data, as is the custom for Omphalina. I thank Maria for her sharp eye in finding both collections, and Maria, Vello Soots, and Jim Gardiner for their photos, and Emma and Suzanne Visser for locating the Alberta photos of the species.

References

1. Linnaeus C. 1753. Species plantarum, Laurentius Salvius, Stockholm, 2: 1173.

2. Persoon C. 1794. Agaricus hercynicus. Neues Magazin für die Botanik 1: 100. 1794

3. Harrower E. 2017. Systematics and biogeography of the Cortinarius violaceus group and sequestrate evolution in Cortinarius (Agaricales).

4. Harrower E, Bougher LN, Henkel TW, Horak E, Matheny PB. 2015. Long-distance dispersal and speciation of Australasian and American species of Cortinarius sect. Cortinarius. Mycologia 107(4): 697–709. doi:10.3852/14-182

5. Harrower E, Bougher NL, Winterbottom C, Henkel TW, Horak E, Matheny PB. 2015. New species in Cortinarius (Agaricales) from the Americas and Australasia. MycoKeys 11: 1–21. doi:10.3897/mycokeys.11.5409

6. Heyderdahl T. 1950. Kon-Tiki expedition. Rand McNally, Allen & Anwin, London.

7. Finney BR. 1979. Hokule'a: the way to Tahiti. Dodd, Meade & Co, New York.

8. Maillet A. 1979. Pélagie-la-Charrette. Grasset, Paris.

9. Landry J, Lamoureux Y, Lebeuf R, Paul A, Lambert H, Labbé R. 2021. Répertoire des cortinaires du Québec. Mycoquébec, Québec, 252 p. https://www.mycoquebec.org/publications/Repertoire%20Cortinarius%20Quebec.pdf

10. Howse J. 2020. Suitcase letters: a memoir of travel, adventure and new beginnings. Friesen Press, Victoria.

*** Trice is not a nautical vessel for fungal vagabonds. Also, not a short form for a trivolvic velociped. A real word, it means a brief period of time. Honest.

On the Intricacy of Mushrooming in Public Spaces

Phallus duplicatus, **a study in two pieces. Photo: Renée Lebeuf**

by Michel Savard

Résumé

Comment l'observation de champignons sphériques et blanchâtres dans un espace public du centre-ville de St. John's a fait croire à notre mycologue amateur qu'il tenait une récolte de vesses-de-loup, et comment quelques observations, notamment la texture de l'enveloppe et une simple section en deux des spécimens, lui ont fait réaliser sa méprise; après consultation, il a appris qu'il avait cueilli, au lieu du comestible espéré, de jeunes spécimens de deux autres espèces de champignons, soit *Scleroderma citrinum* et de *Phallus duplicatus*. Suivi de quelques considérations sur les similarités entre organismes pourtant fort différents du point de vue de la systématique, d'une description des métamorphoses du *Phallus duplicatus*, des modes de reproduction distincts des deux espèces en cause et d'une conclusion à caractère gastronomique.

In early August, a pleasant perambulation through the expansive lawns of Government House (St. John's, NL) planted with giant beech, maple and chestnut trees allowed me to pluck a little bag of mushrooms to accompany my breakfast scrambled eggs. My appetite whetted by this pleasant discovery, I proceeded to walk down Kings Bridge Road to a familiar grocery store, ready to face the social distancing and vague hostility of my fellow humans... Little did I know that I was to add two species to my ever-growing list of spore-bearing organisms!

As I turned the corner of Lake Ave, following the old concrete wall that encloses a small grassy park, I noticed several whitish egg-like structures about the size of ping-pong balls... "Puffballs!", thought I, not believing my luck! I proceeded to pick them without further ado, but noticed a few features that instilled a level of doubt in my mind, like the fact that some of my puffballs outer skin appeared to be soft, breaking in places to reveal a translucent jelly-like layer, while the others were firm to the touch...

Back in the comfort of home, I laid my finds on the kitchen table, and proceeded to slice my 'puffballs' with fungivorous excitement… but bitter disappointment was all I got! Instead of the pure white flesh I was expecting, I observed that my eggs were sporting two types of innards: the smaller ones sported a black or greyish-veined black flesh under their thin white skin; the somewhat larger ones had a gooey inner skin over a dark flesh with a hollow white central area with tendrils spreading into the surrounding flesh. Quite a startling sight, I will confess, yet I didn't know what to make of it.

Figure 1: Harvest, halved.

Thus, I decided to share my discovery with someone with more know-how than I and emailed a few pictures to our local specialist, Andrus Voitk, for some enlightenment. Andrus was his usual gracious self and answered me before the end of the day. Among other things, he said: *"Do not eat the hard balls with black spores inside. These are the toxic* Scleroderma citrinum. *Smell the non-hard fungi with more than a black spore-mass inside. They should be foul as hell. However, you can eat them, and some people find them a delicacy. These are the "eggs" of* Phallus duplicatus."

I had indeed picked two different types of ball fungi, the common earthball or Scleroderma *(Scleroderma citrinum/aurantium)*, of the *Sclerodermataceae* family, and the netted stinkhorn *(Phallus duplicatus)*, of the *Hysterangiaceae* family, neither even remotely related to the puffball, of the *Agaricaceae* family. Curiously, both earthball and stinkhorn were sharing the same unlikely environment of a grassy roadside square shaded by a mature chestnut tree, and both were at a similar stage of

Figures 2 & 3: Inside/outside *Phallus duplicatus* (upper) and *Scleroderma citrinum* (lower).

growth—that is, the early whitish egg-form, hence my confusion with the puffball.

Now, another characteristic these two characters share is their pungency… Having lost my sense of smell years ago after an otherwise victorious bout with cancer, I cannot perceive olfactory clues, with the notable exception of lemony/balmy. The earthball is known to emit a strong unpleasant odor, acidic, metallic, rubberlike, so distinctive that it is known as "scleroderma smell". As for the stinkhorn, it is said that its odor of rotten meat can be smelled (by some) from up to 10 meters away.

In his answer to my ID inquiry, Andrus suggested that I return to the site to witness the change in the stinkhorn, and so I did, six days later. If the characteristic phallic shape was clearly on exhibit on my second visit, I was too late for the amazing spectacle of the short-lived lacy ovoid skirt (indusium) that hangs under the cap. What was left was the fruit-body, white-footed with a slimy pitted greenish-brown cap. And indeed, I spotted a fly (lower left) feasting in the slime (gleba), which is the ingenious way this fungus recruits insects to help disperse its spores mixed in the goo!

The earthball reproduction strategy will be more familiar to those who know puffballs: its truffle-like (but toxic) gray-purple flesh eventually dries up into a powdery mass of spores which will then escape through a tear in the shell and spread on air currents.

And thus ends this account of a gluttonous amateur left without a meal, but so much the richer for the lessons learned. Actually, had I known at the time of picking, I could have consumed the egg-like stage of the stinkhorn, which is cultivated by the Chinese and served braised in a broth—history has it that president Richard Nixon was served some at a banquet during his official visit to China! I guess his hosts avoided giving him a head-start on this detail of the menu!

Figure 4: *Phallus duplicatus*, six days later.

Haïkus *de circonstance*

de l'oeuf au cadavre
le satyre à dentelle a
l'appui bleu des mouches

the stink says it all
plus the joyful flies buzzing
yet the phallus is choice

COLOR IN MUSHROOMS

Part 2

by Jim Cornish

The first part of this two-part series on mushroom colouration[1] dealt with the ecology of colour, particularly in aposematism—the use of conspicuous colours to signal that an organism ***may*** be defended by secondary defenses such as toxins, poisons or bitter tastes. While little research has been done to support widespread warning colouration in fungi, there are plenty of studies that support the use of pigmented secondary metabolites to deal with stresses on mushrooms unrelated to mycophagy. This is the subject of part two of this series.

Colour as Photoprotectors

The vegetative bodies of most fungi live inside a substrate and often in the dark.[2] When it comes time to reproduce sexually, most fungi must push their fruiting bodies into the air, sometimes into well-lit open spaces such as lawns, fields and trails or below gaps in forest canopies. This type of fruiting exposes mushrooms to the sun's ultraviolet rays, which are known to damage DNA and cellular structures.
The ubiquitous pigment melanin, which can vary in colour from black to red to yellow, as well as betalins, quinoes, carotenoids (Fig. 1) and terpenoids, all offer protection by blocking these UV-rays.[3] It is believed that some of these pigments may have been crucial to the diversification of fungi, especially as they emerged from the sea and colonized the barren continents in a toxic atmosphere quite unlike the one that exists today.[2]

Figure 1: *Amanita flavoconia*. Carotenoid rich colours in this mushroom offer protection from the sun's damaging UV rays. Photo credit Pieter van Heerden.

Another group of fungi known to use pigments as photo-protectors are the lichens. The most widespread lichen pigment is usnic acid which gives *Alectoria* (Fig. 2a) and *Usnea spp.* (hair lichens) their pale yellow colour and bitter taste. Other pigments include brown melanins, yellowish xanthones, bright yellow pulvinic acid derivatives and bright red, orange, or yellow anthraquinones. The bright pigments commonly occur in lichens of the *Xanthoria* (Fig. 2b) and *Rhizocarpon*

Figure 2: (A; left) Yellowish pigmentation by usnic acid protects many hair lichens, such as *Alectoria sarmentosa* growing on tree branches from the sun's rays. (B; right) The bright colouration of *Xanthoria elegans*, typical of many crustose lichens, help them to survive on exposed rocks throughout the world. Photo credits: (A) Jim Cornish; (B) Jeff Hollett.

genera that can grow on exposed surfaces like boulders and rock outcrops. Studies have shown that pigments in the lichens' upper cortex absorb the sun's damaging ultraviolet rays, thus protecting the sensitive photosynthetic partner in the underlying layer. Generally, where radiation is more intense, lichen pigments appear darker in colour. Pigments can also colour and protect lichen apothecia (fruiting bodies) like those found on some *Cladonia spp*.[4] (Fig. 3) Colour in lichens is the subject of a future article.

Figure 3: The red apothecia of *Cladonia cristatella* provide protection from the sun's rays in this and many other fruticose lichens. Photo credit: Sara Jenkins.

Colours as Metabolic Thermoregulators

Back in the 1940s, a new theory called "thermal melanism" suggested that coloration in ectotherms (organisms that do not regulate their body temperature internally) varied with climate. The study found that the darker pigments in some cold climate ectotherms absorbed solar radiation, while lighter colored ectotherms in warmer environments reflected much of the same radiation. A 2019 study of European mushroom assemblages tested this theory on mushrooms, particularly saprotrophic varieties that experience seasonal colour shifts. Researchers found that melanin-rich saprotrophs were indeed darker in colder climates than in warmer ones. They concluded that one of the purposes of melanin in mushrooms growing in cold seasons and cold climates and microclimates was to better absorb infrared radiation to help regulate the mushroom cap temperature, giving the mushrooms an adaptative advantage for spore development and discharge (Fig. 4 & 5). Conversely, lighter capped mushrooms growing in warmer climates and in exposed locations tended to fare better than the darker capped varieties.[5]

Figure 4: *Exidia glandulosa*. The black colouration this *Exidia* is likely due to high concentrations of light absorbing melanin, a well-known photoprotector and thermoregulator in fungi. Photo credit Pieter Van Heerden.

Figure 5: *Dacrymyces chrysospermus.* Seasonality suggests mushrooms have varying tolerances for warm and cold temperatures. While the appearance of many mushrooms seems restricted to specific seasons, varieties of some jelly fungi can appear throughout the year, often after a rainy period from spring to fall and during an extended wet thaw in winter.

Photoreceptors: the Hidden Pigments

Life, as we know it, could not exist on Earth without the sun, our primary source of energy. Sunlight is also an essential cue for daily and seasonal changes that affect organisms across all kingdoms.[6] Filamentous fungi use sunlight not as energy, but as a signal to stimulate or inhibit morphogenesis and as a signal to regulate the production of primary and secondary metabolites during developmental periods.[7] Although photosensitivity has been observed in fungi for a long time, scientists have only discovered of the mechanisms controlling light-related responses recently.[8] Fungi "see" light via specialized protein molecules equipped with one or more light absorbing pigments (chromophores) that, despite their presence, do not contribute to visible fungi pigmentation.[8] Called photoreceptors, these photo-sensitive proteins help fungi to anticipate their physiological needs based on the changes they sense in the quality, colour, intensity and direction of the full colour spectrum of sunlight. This information is then communicated to the genes responsible for photo-related responses that could include growth and reproduction.[9] Light and fungi is the subject of a future two-part article in Omphalina.

Colours as Antioxidants and Anti-virulents

Pre-Darwinian naturalists believed God created colour in nature solely for the pleasure of man. Darwinians, however, believed that colour had a functional benefit that was not always visible. The biosynthesis of pigments, as well as toxins, poisons, flavours and odours, requires a lot of metabolic activity in the vegetative and fruiting structures of both plants and fungi. This activity comes at a cost, often in the form of metabolic by-products such as pro-oxidants that, if left unchecked, can be detrimental to the health of any organism. To inhibit or delay cell and DNA damage from these unstable and reactive oxygen molecules, plants and fungi neutralize them with the antioxidant properties of flavonoids, carotenoids and melanin pigments.[10] Some of these same pigments, and other secondary metabolites, may also to protect fungi from parasites, viruses, bacteria, diseases and even other fungi. This pigment/antioxidant interaction has implications for human health and has caught the attention of the

Figure 6: *Cantharellus* species are wild mushrooms rich in carotenoids containing canthaxanthin, an antioxidant.[13] Photo credit Pieter Van Heerden.

pharmaceutical industry whose search of new substances to create the next generation of medications has increasingly turned to fungi.[11–13]

Colour Changes

It is not unusual to see colourful chemical reactions when some mushrooms' stems, caps and gills are wounded. When these mushrooms are handled, rubbed, bruised or cut, otherwise colourless secondary metabolites released from damaged cell walls become oxidized or hydrolyzed, resulting in either a staining or a bruising of the traumatized area. Wound-activated stains commonly appear clear, blue, green, yellow, red, brown or black (e.g., Fig. 7–8). Staining may vary in intensity, and with time, can change hue, fade, or disappear altogether. The stains may also be toxic, bitter and/or pungent, sometimes more than the mushroom flesh itself.[14] Although changes attributed to wounding have been known for centuries, the potential ecological role of these compounds has not yet been recognized.[15]

Chemical changes that can be quite colourful and possibly related to anti-mycophage responses occur frequently in the genus *Lactarius*. Cutting the gills of these "milky cap"

Figure 7 (right): *Hygrocybe conica*. (A; upper) The bright red and orange colouration in juveniles contain some of the same pigments as in *Amanita muscaria*. Bruising exposes the mushroom to oxygen, causing bruises to turn black. Photo: Pieter van Heerden. (B; lower) Age blackens *Hygrocybe conica* completely.16 Photo credit (A) Pieter van Heerden, (B) Jim Cornish.

Figure 8: Colour stains in some common boletes. (A) *Boletus huronensis*; (B) *Boletus subvelutipes*; (C) *Porphyrellus porphyrosporus*; (D) *Tylopilus nebulosus*; (E) *Suillus clintonianus*. Photo credits (A–D) Andrus Voitk; (E) Pieter van Heerden.

mushrooms, quickly, and sometime profusely, releases a milky emulsion commonly called latex (Fig. 9). This emulsion is a mixture of several inactive chemical compounds stored within specialized hyphae called lactifers. When a *Lactarius* is wounded, exposure to the open air oxidizes the emulsion, causing it to coagulate and take on a colour.[17] Congealed latex is known to act like a scab, likely protecting the mushroom from contaminants and virulent microbes.[18] Could the colour change and often resulting acrid taste be a strategy for diematism—a recoiling of the startled mushroom disturber that leads to avoidance and further contact with the mushroom?[17] Since the latex is also very sticky, it can clog the mouthparts of invertebrates.[19] Slugs, which otherwise show no inhibitions to feeding on all sorts of mushrooms, have been observed feeding less on *Lactarius* caps than on the caps of latex-free species.[17]

Some colour changes in mushrooms are related to parasitism. Two familiar species common in our woods, *Lactarius piperatus* and *Russula brevipes*, undergo very visible changes due to parasitism by the ascomycete fungus *Hypomyces lactifluorum*[20] (Fig. 10). In *R. brevipes*, for example, the parasitic fungus first forms on the gills of its young host and then spreads to the rest of the mushroom's surface with age. When fully parasitized, the host is left with sterile blunt ridges instead of gills and the sporocarp's white outer surface is transformed to a finely pimpled and bright orange or reddish-orange crust.[21] This colouration, and a shellfish smell when the mushroom is cooking, has earned it the common name Lobster Mushroom. While visual comparisons of *R. brevipes*' interior flesh before and after parasitism reveals the same texture and colour, molecular analysis shows that the host sporocarp's DNA diversity and metabolite profile are completely altered, changing the once bitter flavoured mushroom into a delicious edible with little trace of the host's original DNA.[22]

Conclusion

Evolution has selected colour as an important facet of ecosystem and organism interactions. Despite 150 years of study, the mysteries surrounding these interactions and their ecological significance are only now being unraveled. With little of this research focusing on mushrooms, can we truly extrapolate what we are learning about colour in plants and animals to the enigmatic fifth kingdom? Maybe, but who knows. Maybe interactions between mushrooms and other species are less about "survival of the fittest" and more about how nature instead cooperates to survive.[23]

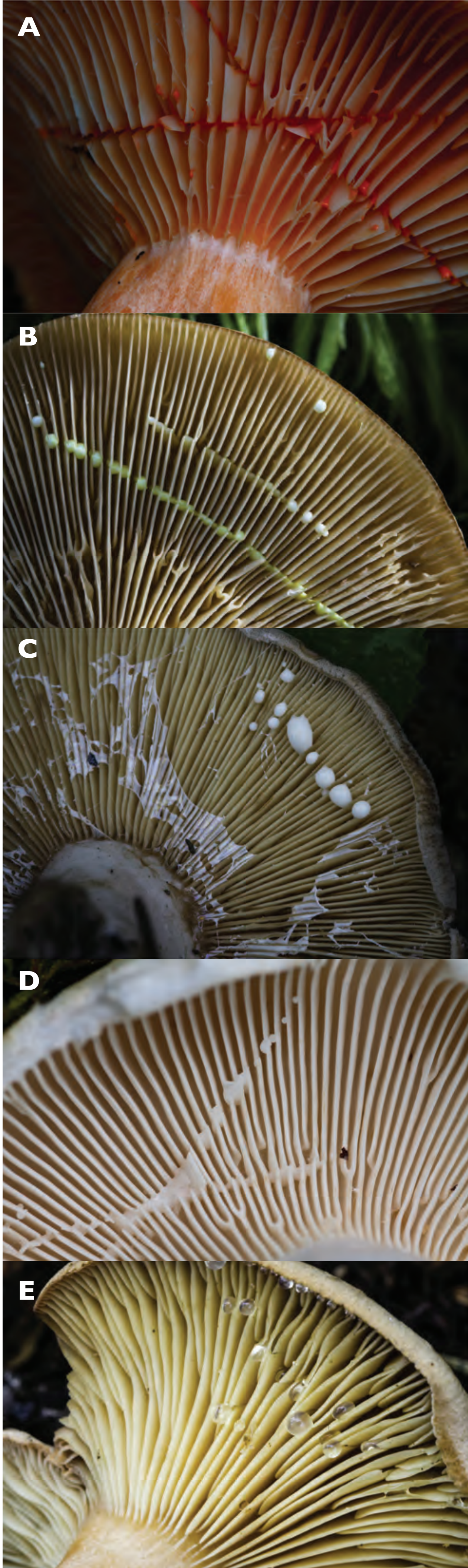


Figure 9 (right): Latex colours in some common *Lactarius* species. (A) Orange in *L. thyinos;* (B) green in *L. vinacerufescens;* (C) white in *L. hibbardae* and *L. pubescens;* (D) colourless in *L. helvus*. Photo credits (A) Jim Cornish; (B–E) Pieter van Heerden.

Figure 10: *Hypomyces lactifluorum* parasitizing a *Lacterius* or *Russula spp*. Photo credit Renée Lebeuf.

Acknowledgement

Special thanks to Dr. Greg Thorn and Andrus Voitk for their corrections and suggestions and to Pieter van Heerden, Andrus Voitk and Renée Lebeuf for additional images.

References

1. Cornish J. 2020. Colour in Mushrooms Part 1. Omphalina 11(2):36-43.

2. Idnurm A, Heitman J. 2005. Light Controls Growth and Development via a Conserved Pathway in the Fungal Kingdom. PLoS Biol 3(4):615-626. doi:10.1371/journal.pbio.0030095

3. Avalos J, Pardo-Medina J, Parra-Rivero O, et al. 2017. Carotenoid biosynthesis in Fusarium. J Fungi 3(3). doi:10.3390/jof3030039

4. Brodo IM, Sharnoff SD, Sharnoff S. 2001. *Lichens of North America*. Yale University Press, 828 p.

5. Krah FS, Büntgen U, Schaefer H, et al. 2019. European mushroom assemblages are darker in cold climates. Nat Commun 10(1):1-11. doi:10.1038/s41467-019-10767-z

6. Fischer R, Aguirre J, Herrera-Estrella A, Corrochano LM. 2016. The Complexity of Fungal Vision. Microbiol Spectr 4(6). doi:10.1128/microbiolspec.FUNK-0020-2016

7. Yu Z, Fischer R. 2019. Light sensing and responses in fungi. Nat Rev Microbiol 17(1):25-36. doi:10.1038/s41579-018-0109-x

8. Purschwitz J, Müller S, Kastner C, Fischer R. 2006. Seeing the rainbow: light sensing in fungi. Curr Opin Microbiol 9(6):566-571. doi:10.1016/j.mib.2006.10.011

9. Rodriguez-Romero J, Hedtke M, Kastner C, Müller S, Fischer R. 2010. Fungi, Hidden in Soil or Up in the Air: Light Makes a Difference. Annu Rev Microbiol 64(1):585-610. doi:10.1146/annurev.micro.112408.134000

10. Ferreira ICFR, Barros L, Abreu RM V. 2009. Antioxidants in wild mushrooms. Curr Med Chem 16(12):1543-1560. doi:10.2174/092986709787909587

11. Rahi DK, Malik D. 2016. Diversity of Mushrooms and Their Metabolites of Nutraceutical and Therapeutic Significance. J Mycol Published online 2016:Article ID 7654123. doi:10.1155/2016/7654123

12. Narsing Rao MP, Xiao M, Li WJ. 2017. Fungal and bacterial pigments: Secondary metabolites with wide applications. Front Microbiol 8(1113). doi:10.3389/fmicb.2017.01113

13. Kozarski M, Klaus A, Jakovljevic D, et al. 2015. Antioxidants of Edible Mushrooms. Molecules 20(10):19489-19525. doi:10.3390/molecules201019489

14. Bessette AE, Roody WC, Bessette AR. 2016. *Boletes of Eastern North America*. First. Syracuse University Press, Syracuse, NY, 504 p.

15.Spiteller P. 2015. Chemical ecology of fungi. Nat Prod Rep 32(7):971-993. doi:10.1039/c4np00166d

16. Velíšek J, Cejpek K. 2011. Pigments of higher fungi: A review. Czech J Food Sci 29(2):87-102. doi:10.17221/524/2010-cjfs

17. Taskirawati I, Tuno N. 2016. Fungal defense against mycophagy in milk caps. Sci Reports Kanazawa Univ 60:1-10.

18. Agrawal AA, Konno K. 2009. Latex: A Model for Understanding Mechanisms, Ecology, and Evolution of Plant Defense Against Herbivory. Annu Rev Ecol Evol Syst 40(1):311-331. doi:10.1146/annurev.ecolsys.110308.120307

19. Roehl T. Fungus Fact Friday #176: The Genus Lactarius. Accessed June 6, 2021. https://www.fungusfactfriday.com/176-lactarius/

20. Mann H. 2011. Lobster Mushroom. Omphalina 2(9):4-5.

21. Beug M, Bessette A, Bessette AE. 2014. *Ascomycete Fungi of North America A Mushroom Reference Guide.*, 502 p. Accessed June 6, 2021. https://utpress.utexas.edu/books/beuasc

22. Laperriere G, Desgagné-Penix I, Germain H. 2018. DNA distribution pattern and metabolite profile of wild edible lobster mushroom (Hypomyces lactifluorum/Russula brevipes). Genome 61(5):329-336. doi:10.1139/gen-2017-0168

23. Simard S. 2019. Mycelium: The Source of Life. In: Stamets P, ed. *Fantastic Fungi*. Earth Aware Editions.

Gratitude for a new attitude to the platitude about latitude and altitude

By Andrus Voitk

This article was prompted by a discussion with Don Pfister during the review of *Peziza nivalis*, published in the next article of this issue. That putative species was found on a burn site on our lawn along the Humber River and in the garden of Renée Lebeuf, near the St. Lawrence River in Québec. These riparian sites are the only records I know of this species from a non-alpine setting. I have not found a treatment of arctic mycota that describes *Peziza nivalis*, only reports from high mountain habitat, suggesting that the species is solely alpine, not arctic.

Often, on encountering alpine taxa here, I have referred to a conveniently loose formula, LATITUDE = ALTITUDE. This concept arises from the observation that some psychrophilic (cold-loving) species are found both in the high arctic and high mountains. Both regions have similar harsh environments: exposed barren land at the mercy of high winds, full sun, little shelter, limited water and nutrients, and periods of bitter cold. However, on closer examination the LATITUDE = ALTITUDE formula does not seem to fit here, spurring a more critical search for better explanations.

Why does LATITUDE = ALTITUDE not fit? First of all, the term is misleading. Despite the similarity of these habitats, they also have significant differences. Because glaciation is a central landmass phenomenon, uberous land in the high arctic is littoral, with a coastal climate. Most mountain ranges, on the other hand, are at least somewhat inland, and have, therefore, a more continental climate. Continental climates can become very arid, and have very wide temperature fluctuations, getting much hotter than coastal areas both at midday and the summer, and much colder at night and in the winter. In contrast, the surrounding sea keeps coastal regions relatively humid, and the large water mass modulates their temperature fluctuations to avoid midday and midseason extremes. These seem sufficiently significant differences that some species may evolve to thrive in one, but not the other. More to the point, the LATITUDE = ALTITUDE formula does not apply at all to the collections under discussion. The elevation of my lawn, 20 m above sea level, falls shy of alpine levels by a factor of 100, and, located south of 49°N, it is not even remotely arctic. West Street in Corner Brook, NL (our closest major metropolis), is on about the same parallel as the Avenue des Champs-Élysées in Paris (another major metropolis somewhere in Europe), and both host parades of world renown (Santa Claus Parade on West Street and Bastille Day military parade on the Avenue des Champs-Élysées). Neither parade (Fig. 1) has ever been confused with an alpinist march or arctic cortège. Ergo, invoking LATITUDE = ALTITUDE to explain the presence of a specimen on my lawn, which is neither arctic nor alpine, is unconvincing.

The foregoing suggests that similar temperature, rather than arctoalpine habitat, might provide a better explanation for psychrophilic species in Newfoundland. Lines that join regions with the same temperature across the globe are called isotherms (iso = similar, therm = heat). These were conceived by the incredibly gifted, curious, productive and complex Alexander von Humboldt (lesser known by his full name, Friedrich Wilhelm Heinrich Alexander, Freiherr (baron) von Humboldt) in 1816. An early map based on his concepts was published in 1830 by William Channing Woodbridge, a Connecticut school teacher, but without the benefit of global temperature measurements. It took a few years to collect data before the concept could be mapped accurately; this story is presented in a blog by Klein.[1] The title banner shows the first isotherm map based on Humboldt's meticulously collected temperature data, published by Heinrich Berghaus in 1838. Lines above the Arctic Circle are for the cold season (Dec–Feb) and below for the warm season (Jun–Aug). I have highlighted the band containing most of Newfoundland (Map source: public domain, courtesy of the US Library of Congress).

From then, these matters were pursued eagerly, and knowledge accumulated apace. Eilif Dahl listed three main phytogeographic factors— climatic, edaphic and biotic—that govern plant distribution.[2] Of these, he held climatic factors to be most important, and of the climatic parameters, he considered the mean temperature of the coldest month (January–February) as the most meaningful, critical to survival of organisms in a region. I suspect that these principles are equally applicable to fungi, but even if they are not, fungi and plants are so interdependent that any factor affecting plant distribution will, at least, affect that of fungi indirectly. This topic has been skirted on the pages of Omphalina before. In a description of the northern species of *Chromosera* in NL, it was noted that the landscspe surrounding Havøysund, Norway, high above the Arctic Circle, looked very similar to our own coastline (Fig. 2), even though Havøysund is over 2,000 km closer to the North Pole.[3] In a discussion of the similar mycota

Figure 1: Processions of world renown in two major metropolises on the same parallel of latitude. (A) Kinsmen's Santa Claus parade in Corner Brook, NL. Photo: Scott Grant. (B) Bastille Day parade, Paris, France. Photo: Collections École Polytechnique / Jérémy Barande, CC BY-SA 3.0, via Wikimedia Commons

Figure 2: Similarity of NL coastline with that of Norway. (A) Saint Carols, NL, at the approximate parallel of Bruxelles; (B) View of Great Caribou Island from Battle Harbour, NL, at the approximate parallel of London; (C) Havøysund, Norway, some 1000 km closer to the North Pole from the other two. Modified from previous publication.[3]

of Battle Harbour, Labrador, and northern Norway, reference was made to thermal sea currents as great temperature equalizers across thousands of kilometres of longitude.[4] Following Dahl's principles, I shall use the January isotherm for Newfoundland to see how well it correlates with regions where other "northern" species thrive.

The following discussion will be based primarily on Figure 3A, a map of the upper Northern Hemisphere. The Arctic Circle is marked by a cyan line, and the main ocean currents warming (the Gulf Stream) and cooling (The Labrador Current) the adjacent land are shown. The Labrador Current splits over the Greater Northern Peninsula of Newfoundland, cooling both sides of the Island. However, the lesser branch (western) loses its frigid bite when it encounters the warmer waters spilling from the mouth of the St. Lawrence River. This is why icebergs do not get south beyond the shallow waters by Port au Choix on the west coast. Along the east side of the Island icebergs float all the way past the south shore out to sea, to melt in the warm waters of the Gulf Stream, putting a significant southeastward dent in it. Mixing of the cold and warm waters over the Grand Banks results in an almost permanent fog, where lurking icebergs present a hazard of titanic proportions to shipping.

Note that as mentioned, Corner Brook, NL, and Paris, France, are on the same parallel. A seaport, Corner Brook's elevation begins at 0 and averages around 28 m asl, whereas that of Paris begins at 35 and averages around 48. Their comparable non-arctic latitude and non-alpine altitude may suggest these metropolises should be isothermal, but in fact they have a significant difference in their mean January temperature: -6ºC for Corner Brook and 5ºC for Paris. The light blue band covering the Island (save for the tip of the Greater Northern Peninsula) represents the mean January isotherm for Newfoundland. The map

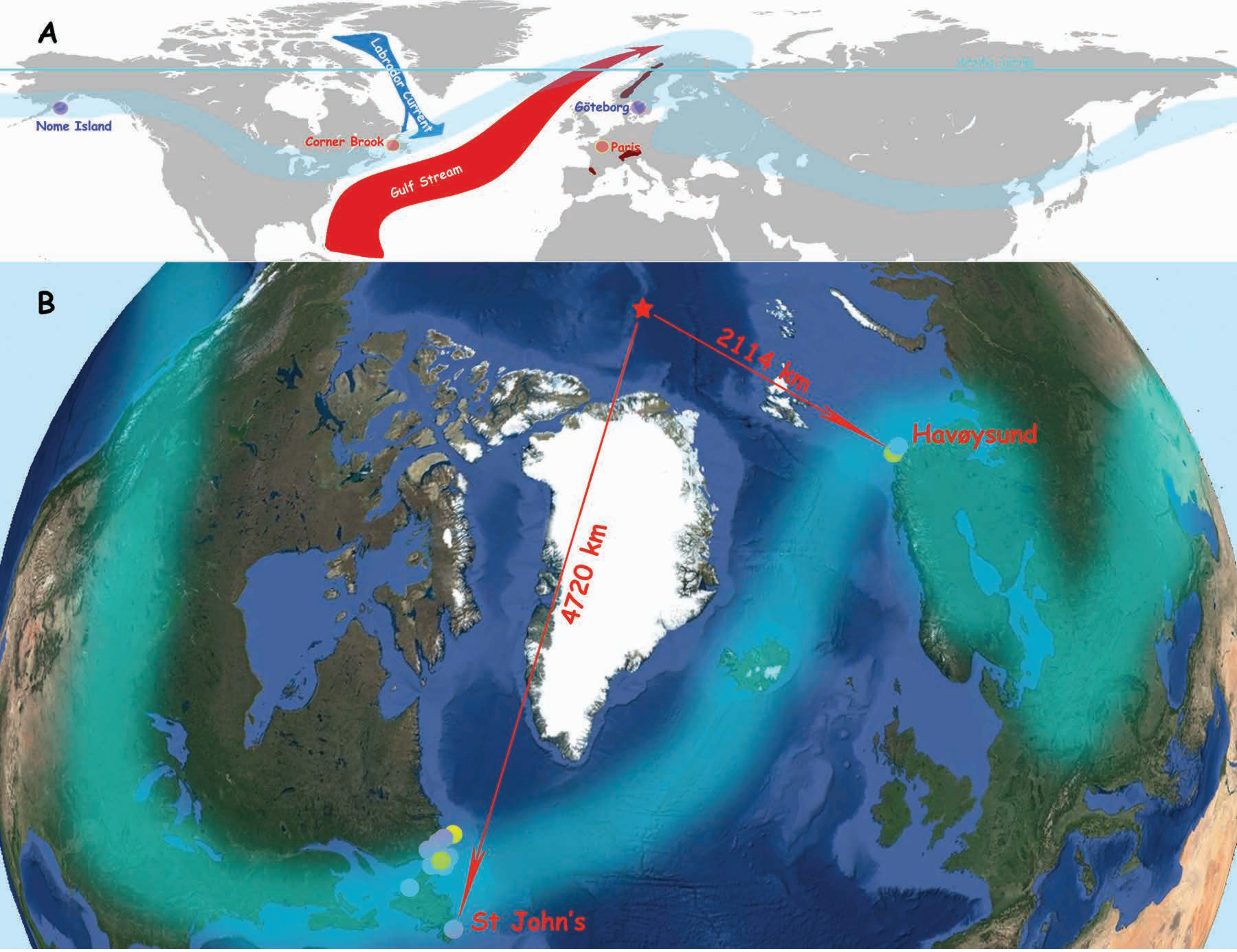


Figure 3: January isotherm for Newfoundland. Discussed in detail in the text. Note the similarity of this band to the one on the Berghaus map (title banner). Modified from previous publication.[4]

gives a clear demonstration of the effect of the ocean currents on temperature, explaining the disparate temperatures between Corner Brook and Paris. The result can be seen on the ground. Used to seeing pine struggle to thrive in Newfoundland, where its northern limit is about mid-Island (i.e. about the latitude of Paris), I was amazed when I saw lush pine forests north of the Arctic Circle in Norway. A look at the January isotherm suggests this observation should be expected. Finding the "northern" *Chromosera lilacina* in Havøysund is no surprise, but our January isotherm also explains why it should not be a totally unexpected find in St. John's, over 2,500 km further south from the North Pole (Fig. 3B). I show only three alpine regions, all in Europe (dark brown areas). The Alps of central Europe and the Pyrénées between France and Spain fall outside our isotherm, but the mountain range separating Norway and Sweden is inside. Also note that our isotherm parallels the timberline across North America, which should explain the distribution of certain fungal tree associates across the continent.

Two other things bear noting on this map. An impression I have had for a while is that if Peck described it, likely we have it. This did not come from any knowledge of the similarity of Peck's foraging regions to our province, but rather from seeing over and over again that whenever we were able to sequence a Peck collection, it matched a similar one of ours. Hitherto I thought Peck collected sufficiently south of us to explore a different mycota, but we can see that New England and New York State fall within our January isotherm. The second thing to note is that this isotherm widens out significantly over Fennoscandia and the Baltic states, covers most of western central Europe, before looping southwards as it crosses Asia to Alaska. Göteborg, Sweden, is within the same isotherm. Femsjö, the home of Elias Magnus Fries, is very near Göteborg, and falls well within the same isotherm. If our observations about the effect of temperature on species diversity and similarity are correct, then odds are that we are dealing with a mycota very similar to that seen and studied by Fries. Species may differ due to difference in our flora or mycota from the ravages of repeated glaciation, or divergent evolution in regions that have not permitted continued genetic mixing, but at least the broad strokes should be similar.

A word of caution: several factors other than mean temperature also influence the ability of a species to thrive in a region. For example, the extremes of temperature: if a species cannot survive the extremes, it does not matter how ideal the average is. Other climatic conditions involve presence and severity of sun radiation, available daylight, wind, humidity, mean precipitation, and so forth. Edaphic conditions include soil characteristics like acidity, availability of water, minerals and nutrients. We already made a reference to physical or other barriers for exchange of genetic material. Biotic conditions include availability of other organisms not only as fodder or mutualistic partners, but also as providers of shade and shelter, vectors for spore dispersal, or as predators or otherwise hostile organisms. In other words, there are many more factors than average temperature that influence an organism's ability to thrive in any location, and therefore, help to explain similarity or difference in regional mycota. That said, the coldest monthly mean isotherm may be a reasonably accurate rough single index, more reliable than altitude, latitude or a relationship between them.

In closing, I hasten to add that I have no expertise in climate or geography, and the serious reader needs to consult more expert sources for a full understanding of the concepts involved or a more accurate explanation of the few observations. The first two works in the References[1,2] might be an excellent place to start. For the collector of characters, any biography of Humboldt would be a feast. Also, to prevent giving the wrong impression, I must emphasize that nothing written here is an original discovery, or even very recent new knowledge. The Gulf Stream was described by Juan Ponce de Leon in 1513, and charted by Benjamin Franklin in 1786. The isotherm concept, as it relates to vegetation, can be considered common knowledge for over a century, even in Newfoundland. For example, in his memoirs of working as a doctor in Twillingate in 1937, the Brooklyn-born Robert Ecke explains that although Twillingate is not arctic by Peary's standards, it is a cold region unable to support major communities north of it due to the Labrador Current, relating this to the January isotherm.[5] I am not reporting anything new, just reporting that I have finally caught up with at least this small segment of common knowledge.

Acknowledgments

I thank Don Pfister for discussion that resulted in this article and for reviewing the result. I am also grateful to Scott Grant and Wikimedia for the somewhat irreverent use of their respective photos, The Library of Congress for the Berghaus map used for the title banner, as well as the various sources from which material was extracted to make Fig. 3. Profound thanks go to Gro Gulden, who gave me the book by her husband, Eilif Dahl,[2] when Maria and I were her guests. Very moved, I thanked her at the time, but there can be no better thanks than to acknowledge the contribution of that work to my understanding of these concepts.

References

1. Klein M. 2018. The first isothermic world maps. Worlds revealed: Geography & maps, blog. https://blogs.loc.gov/maps/2018/04/the-first-isothermic-world-maps/. Accessed Aug 18, 2020.
2. Dahl E. 1998. The phytogeography of northern Europe (British Isles, Fennoscandia and adjacent areas). Cambridge University Press, Cambridge.
3. Voitk A, Voitk T. 2020. The *Chromosera* of Newfoundland and Labrador. Omphalina 11: 28–35.
4. Voitk A, Burzynski M. 2018. Great Caribou Island *Arrhenia* quest 2018. Omphalina 10(8): 14–18.
5. Ecke RS. 2000. Snowshoe & lancet. Memoirs of a frontier Newfoundland doctor 1937–1948. PE Randall, Portsmouth, NH.

Peziza nivalis—constant species or species complex?

by Andrus Voitk, Renée Lebeuf, Donald Pfister

Our story begins in the senior author's yard (Fig. 1). The house is in a clearing about 20 m asl, beside a river in a mixed forest on sandy soil in a valley overlying limestone bedrock; the clearing, a mixture of moss, grass and weeds—termed wildflowers by the owners—is mown once or occasionally twice a year, and is not subjected to care, fertilizer, or weed killer. There is a fire pit at the forest edge and a second burn site in the middle of the clearing, placed to avoid igniting tree branches when burning brush. Every year these sites have been surveyed for carbonicolous fungi. Ten years, nothing.

Winter 2019–2020 tarried, but brought record snowfalls at the end of spring, followed by a drawn-out period of intermittent snow through spring thaw. During one of these periods of thaw, small cup fungi, brown like last year's birch leaves, were found on the burn site in the clearing: eight thin brown discs, 7–26 mm in diameter, a few cup-shaped, but most flat (Fig. 2), followed after some intervening snowfalls by a second crop of 5 cups a week later. Pitting of the hymenium seemed characteristic, prompting a review of other collections, which revealed two hitherto unidentified earlier collections, 2002 and 2009, 25 and 60 m asl, 3 and 70 km away from the current site. Both collections had pitted hymenia, were from burnt ground and occurred at snowmelt (Fig. 3). The collection from 2002 was destroyed by mould in 2010 with only a photo remaining, but a robust collection remained from 2009. Because these were the first fungi to arise from the burn site in ten years, because the species had been collected twice before without identification, but mostly because the choice at snowmelt time is limited, a concerted effort was made to identify the species.

How can somebody as blessedly ignorant about cup fungi as the senior author begin to identify these from what seems like tons of other brown cups?

Glossary of Terms

Anthracophilic Coal-liker, or a species that prefers to grow with coal, but the relationship is facultative, not obligate, so that the species may also be found in coal-free sites. From the Greek anthrax (coal) and philia (friendship).

Carbonicolous Coal-dwelling (living/growing in/on/with coal). Suggests an obligate relationship, and inaccurate for a facultative coal-dweller that may also grow on a substrate not containing coal.

Complex Denotes a group of similar, frequently cryptic, related species. Frequently these have been known by a single name until molecular studies have shown an unsuspected evolutionary diversity, often related to geologic dispersal to regions with intervening impediments to continued mixing of genetic material.

Constant English meaning of unwavering or steadfast, not the current favourite, "annoyingly repetitive". Think of le Carré's *The constant gardener*.

Fortoulism Coined by Donadini,[1] a French student of Ascomycetes, to describe the phenomenon of cylindric paraphyses becoming inflated (moniliform) or deformed. He remarked that specimens close to snowbanks (presumably younger) were lighter in colour and had cylindrical paraphyses, but those further from the melting snow (presumably older) were darker and showed strongly inflated and deformed paraphyses. In our QC collection of light specimens close to snow, most paraphyses were cylindrical, whereas in the darker NL specimens fortoulism was flagrant. Hymenial pitting is also presumably due to old age: in the younger QC population it was observed only on one old ascocarp, but all were pitted in the older NL population.

Donadini first observed the phenomenon of inflated, deformed paraphyses, now known to be characteristic of many species of *Peziza*, in *Peziza fortoulii*, a taxon named in honour of French mycophile Gabriel Fortoul, and thus coined the term "fortoulism" to indicate structural inflation. *Peziza fortoulii* was recognized by Pfister[2] as a later synonym of *P. nivalis*.

Gabriel Fortoul studied mycology with the noted French mycologist Pouchet, and later became a pharmacist in Toulon, La Valette du Var. He persisted with his mycophilic avocation, and became a valued guide for many mycologists who came to collect and study the mycota of the region. He was known for painting extraordinary aquarelles, and his wife was renowned for finding rare and unusual fungi, reminding the second author of this tract of the wife of the first author.

Nivaloid Similar to *P. nivalis*, i.e. member of the *P. nivalis* complex. A slightly contracted construction for easier pronunciation.

Nivicolous Snow-dwelling, usually in the sense that the organism thrives when snow is still on the ground, i.e. snowmelt time, or for fungi, the group often known as snowbank fungi.

Well, surround yourself with knowledgeable people. And use books. A great time to test the pictorial key in *Ascomycete fungi of North America* by Beug et al.,[3] reviewed to deserved praise by Dave Malloch in Omphalina.[4] As suspected, the key led to pages of photos of brown cups and discs, most resembling ours, but none with the same pockmarked hymenium (Fig. 2, 3). What if it is not a consistent feature? Two other characters may help to narrow down the field a bit: a preference for an old burn site, and fruiting while snow is still on the ground. This helped a lot. None of the described burn site cups quite fit, but the book also gave a brief review of carbonicolous pezizas not treated there. Among these, *Peziza nivalis* stood out as a species that fruits when snow is still on the ground. Spore size was provided, and the length matched our specimen. What was expected to take at least a full day of hunting, with no big hopes of success, was solved after no more than 10–15 minutes of reading—it was that easy! Thanks, Michael.

Now that we have a putative name for our find, let us see what is known about the species. *Peziza nivalis* has not been known for long and is definitely not common.... unless you read the ASCOfrance Forum, a wonderful website for anybody interested

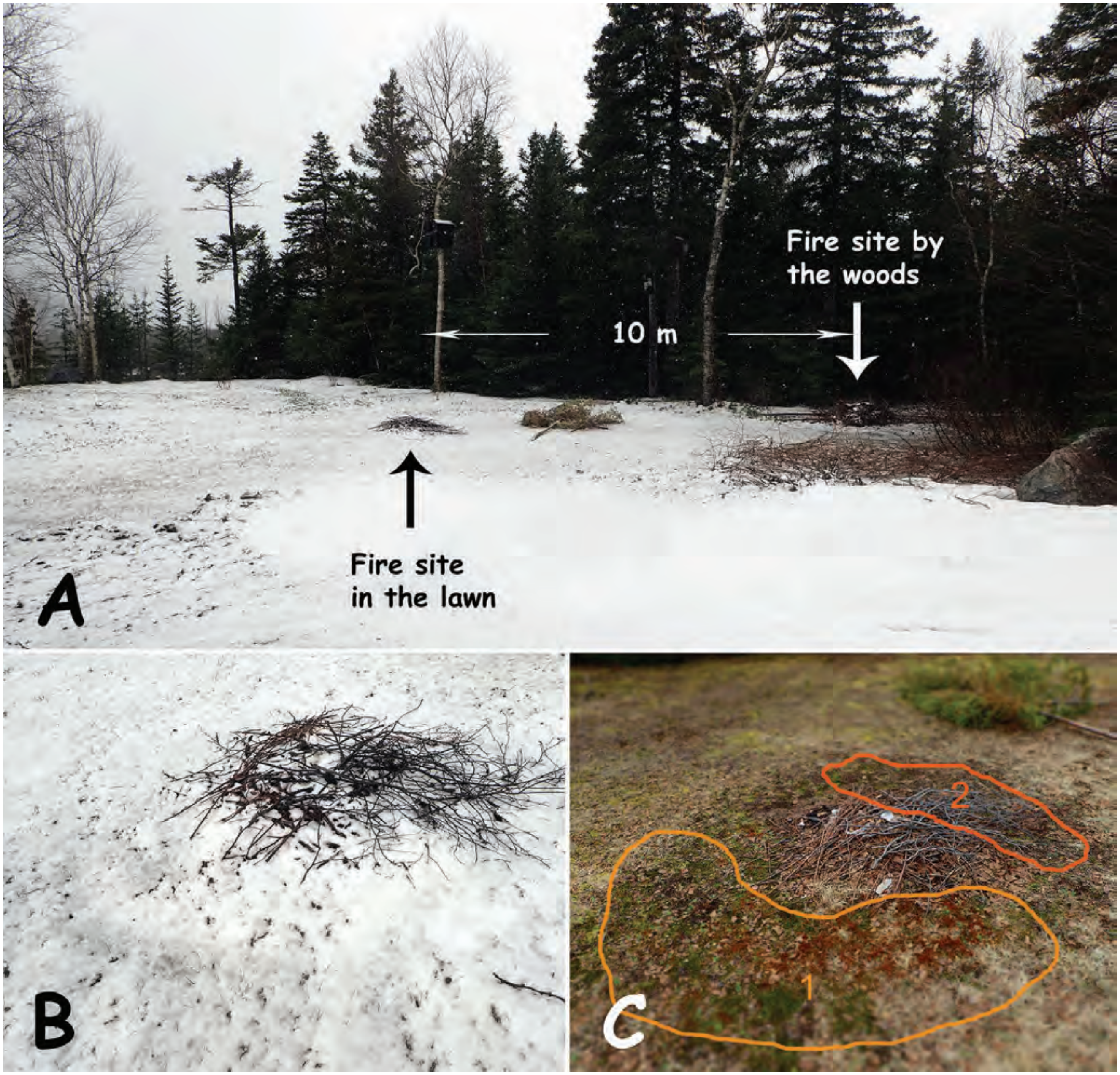


Figure 1: Habitat of current NL collection of alpine snowbank fungi. (A)Senior author's lawn, on the sandy bank of the Humber River, 20 m asl. Two fire sites marked, 10 m apart from each other. (B–C) Close-up view of the fire site in the lawn, two days apart. Orange line 1 in (C) shows location of first crop of the *Peziza sp.* "nivenena", and 2 shows the location of the second crop a week later.

in ascomycetes, where it is described as "a rather common species in the French Alps when the snow melts."[5] In other words, like many niche organisms, it is generally very uncommon, but quite common in its specialized habitat. First described by Heim and Rémy in 1932 from the French Alps between 2100 to 2400 m asl,[6] it has since been described as an alpine snowbank species from other mountainous areas around the globe: Australia, Austria, Bulgaria, Canada (BC), Israel, Italy, Montenegro, New Zealand, Norway, Switzerland, and the USA (CA & OR). There is no formal report of the species from eastern North America, but Renée Lebeuf, one of the authors, posted photos on the Mycoquébec website of a 2017 collection from her flowerbed in Saint-Casimir, Québec, about 30 m asl (title banner).[7]

You may wonder why we consider this lawn and flowerbed denizen from 20–60 m asl as a fit for a species recognized as alpine the world over. One explanation could be the latitude = altitude theory from the previous article, the theory justifying the term arctoalpine: species that like the cold temperatures found at high altitudes also enjoy cold in arctic latitudes without the need for high elevation. By itself, that theory is not solid here, because being

Figure 2: *Peziza sp.* "nivenena". (A) Exposed ascocarp of 2020 NL collection after snow has gone. Note several small pits irregularly distributed in hymenium. (B) Same ascocarp immediately after new snowfall has melted, but water not evaporated. The small pits seem swollen shut. (C) 2017 QC collection, in close proximity to melting snowbank. Ascocarps lighter, without pits, presumed to be younger. (D) Abhymenial (lower, outer, sterile) surface. (E) Close-up of cut surface, showing weak layering. Arrow indicates cut through one of the pits: hymenium is missing, but other layers intact.

Figure 3: Other two NL collections. (A) Collection from May 17, 2002. Identification based on macromorphology only, as the specimen was destroyed by mould in 2010. (B) Collection from Apr 11, 2009, near Rocky Harbour, NL (70 km away, 57 m asl). Note again characteristic pockmarking of hymenium.

further north than the un-Alaskan USA is not the same as being northern, let alone arctic; we are at the same latitude as Paris. Another explanation we have invoked in some instances adds the effect of sea currents: the cold Labrador Current bathing our shores, makes our climate much more northern than the latitude might suggest, compared to Europe, warmed by the Gulf Stream.[8] This explanation is weakened slightly by Renée's collection, because the climate in her home is not exposed to the Labrador Current, being considerably more continental than ours. As I write these words on the morning of May 8, 2020, there is 4" of fresh snow on the ground outside my window.

It is possible that the important things to this species are first the temperature-moisture conditions found at snowmelt, and secondly the nutrition release created by past fires. If these needs are satisfied, alpine habitat may be an irrelevant red herring imposed by human nature. After all, no sane person walks around looking for little nondescript brown discs on burn sites on oh, so boring soppy muddy lawns in the cold, cloudy, unpleasant weather of April–May, when snow alternates with rain. It is much more exciting to organize a trek to the high mountains in the nice, sunny and warm days of July, there to dally around a pannier of Champagne and caviar while cooling off beside a snowbank, casually exploring the moist drainage areas for unusual fungi. Any find, no matter how pedestrian, is unusual, encouraging future similar surveys, thereby guaranteeing the fungus immediate mountaineering fame. The same phenomenon has been recorded for species like nivicolous slime moulds,[9] an observation we have been able to confirm. The alpine habitat may have nothing to do with the fungus or its needs, but be a fiction pinned on it by us.

An anthracophilic lifestyle was not mentioned when the species was described, or by all observers, but has been noted since.[3,10,11] All three NL collections came from burnt ground, with charcoal evident in the photos. Renée's collection came from a flowerbed in her yard, where there has been no fire. Other species known for their affinity for burnt ground, like fire morels, have been collected on occasion from sites with no evidence of past fire. This could be one such species.

This might be a good time to discuss the pockmarks in the hymenium. Are they a good identification character for the species? In the case of the NL finds, all three collections had pockmarks, and the specimen from the Rockies collected by Pfister also had pockmarks in the hymenium.[2] However, many descriptions do not mention them and produce photos with contiguous hymenia (e.g. the QC collection, Fig. 2C). The small holes go through the hymenium down to the hypothecium (Fig. 2E), and may be obscured by tissue swelling (Fig. 2A, B), but this cannot explain all the descriptions and photos of smooth hymenia. When found, they can have identification value, but they cannot be considered a sine qua non identification characteristic. Both Renée Lebeuf and Don Pfister believe they are related to age, as both have observed them in older specimens.

As is often the case, several similar species have been described. In 1992 Don Pfister, the third of our authors and a recognized student of Ascomycetes, reported on a find of *P. nivalis* in the California mountains, and used that report to review the nomenclature of these snowbank pezizas, synonymizing several names, and creating a new name, *P. heimii*, for a similar species that differed by having relatively huge spores (27–33 x 15–16 µm).[2] This work, from the tail end of the morphological era, gave the species a very solid taxonomic footing to enter the era of molecular studies. To date the *Peziza nivalis* populations have not been studied with current molecular techniques, although the two sequences from USA (CA & OR), available at the time, were used to place *P. nivalis* within the core species of *Peziza*;[11] to those two, four sequences from New Zealand have been added in GenBank. A superficial look (Fig. 4) suggests that the western North American and the New Zealand collections might form a single species clade. If all nivaloids were to fall into one clade, it would be a species of very unusual genetic stability, without much evolutionary change in response to wide geographic dispersal across both hemispheres. In that case, *P. nivalis* would surely be one of the most constant as well as cosmopolitan of fungal species. Because recent techniques have uncovered so many species complexes, a molecular study of the various reported collections across the globe would be very interesting. The odds probably favour a complex, giving an opportunity to resuscitate some synonymized names.

While we await the post-Covid-19 opening of laboratories to investigate this, we can seek available evidence favouring either nivaloid constancy or complexity. All four eastern Canadian collections may be considered coastal, although one may debate whether the inland portion of the St Lawrence River should be considered coastal. Ergo, it is possible that instead of being lowland versions of the same species, they represent a different species in the complex, one preferring littoral habitats at low altitude. We turned to spore measurements (Fig. 5), to see if they can give a hint, and learned the following:

1. Measurements of the three preserved eastern Canadian specimens are nicely superimposed, supporting conspecificity. They differ from spores from other geographic locations, suggesting ours may indeed be a separate low altitude coastal species.

2. Spores of the type specimen from the French Alps are significantly shorter than any others plotted. If the difference is not due to observer or technique variation, it seems sufficiently diverse to suggest *P. nivalis* s. str. differs from the others shown.

3. Spores of specimens reported from Switzerland are narrower than those from eastern North America. Although the length matches, barring observer or technique variation, average spore size seems sufficiently far apart to suggest species difference, making this at least the third species of the complex from the European Alps (counting *P. heimii*).

4. Spores of all specimens from western North America are significantly broader than those from the east:

    a. Pfister's collection from the California Rockies[2].

    b. Four of five collections with spore measurements from western North America (CO, ID and BC) located on MyCoPortal[12] (the fifth collection was excluded for technical reasons).

    c. *Peziza phaeotheca*, a species described from Utah[13] and synonymized with *P. nivalis* by Pfister.[2]

These speculations are attempts to formulate a big picture from small data. But it is fun, and that is how the science of mycology works: a hypothesis is developed to explain observations in the field and then tested in the lab. The answer is taken back to the field to see if it fits. We shall await the definitive results from molecular studies (see Table 1: DAOM accession numbers for follow-up) to return to the field. Meanwhile, preliminary or not, you heard it here first.

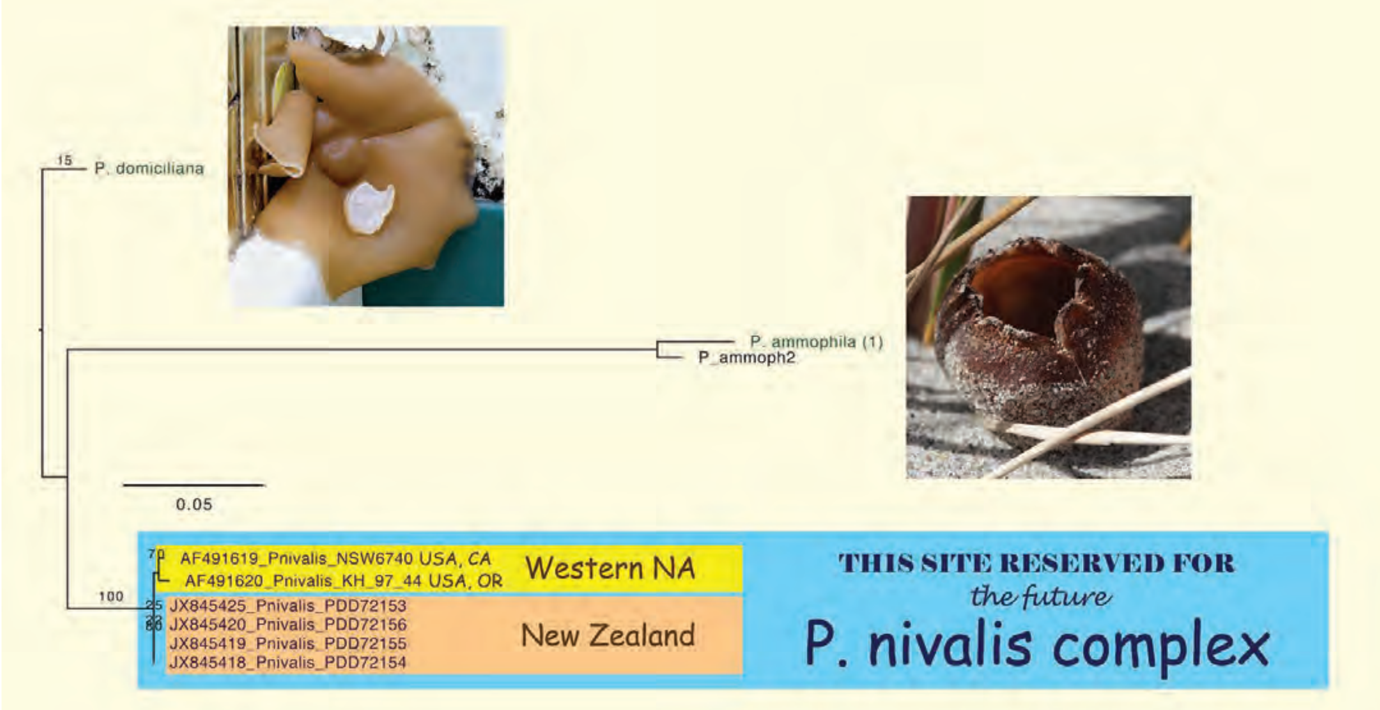


Figure 4: A Maximum Likelihood tree from ITS data of core *Peziza* species, to which some Southern Hemisphere nivaloids have been grafted, and the tree then judiciously pruned, leaving two interesting species we have recorded here, as well as our nivaloid group of interest. The *Peziza domiciliana* shown fruited on a shower stall at our 2009 foray,[17] and *P. ammophila* was collected from the Shallow Bay sand dunes near Gros Morne National Park at our 2014 foray.[18] Both probably represent species complexes. Nivaloid data are limited to collections from mountainous regions in New Zealand and western North America. Both populations cluster in common clade, highly suggestive that they are the same species. The small separation is compatible with geographic variation. Additional collections, representation of other potential species in the complex, and multilocus analysis would be needed to make a definitive statement about conspecificity; sequencing the type (with new typification, if needed) will fix the name and determine the relationship of other populations to *P. nivalis* s. str.

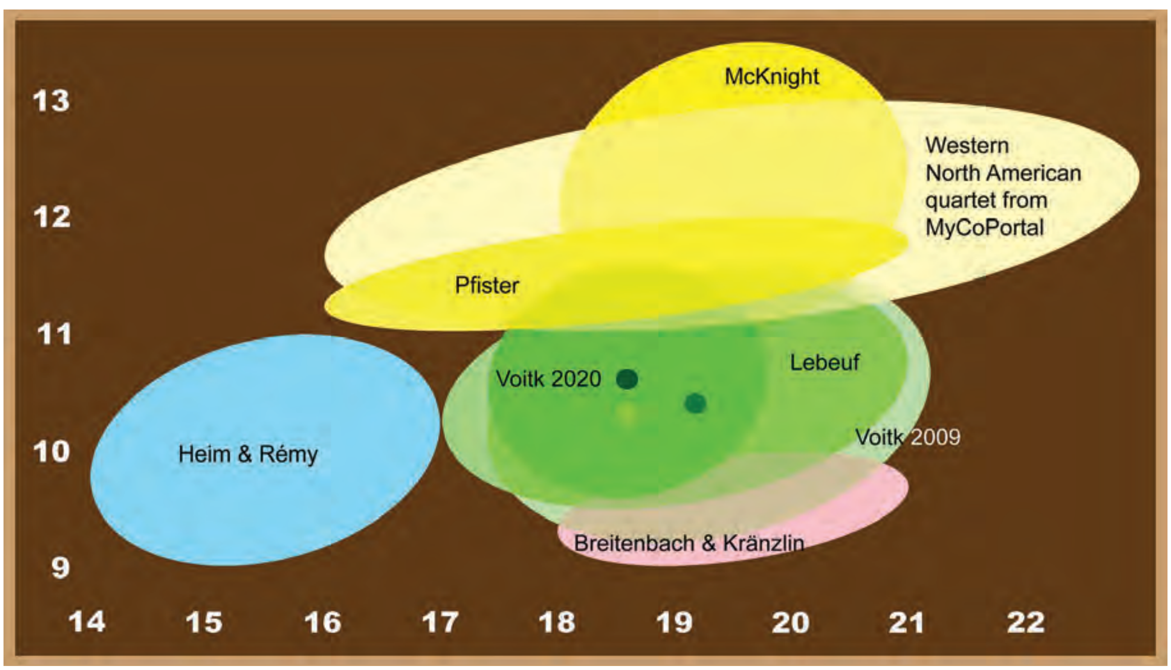


Figure 5: Available spore size data for nivaloid species. Length in µm in x-axis and width on y-axis. Size range in big ovals; where available, average size marked by small circles. Green: *Peziza sp.* "nivenena": all superimposed, suggesting conspecificity. Blue: spore size from protologue of *P. nivalis*. If measurements comparable, this size range is incompatible with conspecificity with *Peziza sp.* "nivenena". Pink: spore size for Swiss specimens as reported in Fungi of Switzerland.[10] Although length fits with *Peziza sp.* "nivenena", the average size (not shown) would be a bit too far from the average size of *Peziza sp.* "nivenena" to be considered conspecific. Yellow: western North American species. Although length may be compatible with *Peziza sp.* "nivenena", the average size (not shown) would be further from the average size of *Peziza sp.* "nivenena" to be considered conspecific.

Figure 6: *Gyromitra leucoxantha* collected May 7, 2020 from other burn site near forest edge, 10 m away from collections of nivaloid discs.

After these speculations, our story is over, and we can go straight to a description of our species. But like all better stories, actually, it is not over. You will recall that Figure 1 showed two burn sites. One yielded the putative *P. nivalis*. The other was the source of four ascocarps of *Gyromitra leucoxantha* (Fig. 6). How cool is that? Both are cool because they fruit at snowmelt time, known as snowbank mushrooms, and nivalis means "from the snow". But this is far cooler than a play on words. *Peziza nivalis* was described from the French Alps, not that far from the Italian border, and *G. leucoxantha* was described from the Italian Alps around Torino, not really that far from the French border.[14] Here, on an uncared-for lawn on the west coast of Newfoundland, in a river valley about 20 m asl are two snowbank species from the European Alps, one from the French side and one from the Italian side, within 10 m of each other. Cool, eh? For a description of *G. leucoxantha* you have to go to a previous issue of Omphalina.[15] There you will learn that the authors sequenced a similar specimen from its alpine type locality (this time on the Austrian side of the Austro-Italian border), which fell in the same clade as the NL specimens, making ours the real *Gyromitra leucoxantha*, and not some similar species in a complex.

Now, go to the description of *Peziza* sp. "nivenena". Because this preliminary review suggests that this may be a different species from *P. nivalis* s. str., for the time being we adopted the code name "nivenena" (**NIV**-alis of – N-[=**EN**]-orth-**E**-astern **N**-orth **A**-merica). The name is a temporary placeholder and not a valid species name; more investigation is required to determine whether this is a different species from the western North American species, and how it is related to other described taxa.

Acknowledgments

We are grateful to collectors and others, who examine collected specimens, record the results and deposit them along with the specimens in public herbaria; we are very grateful that a resource like MyCoPortal exists, whereby information about herbarium specimens is readily available to the public; we are also grateful to have a resource like ASCOfrance available for consultation. We thank Katherine F. LoBuglio for help with the sequence analysis.

Table 1: DAOM accession information for *Peziza nivalis*.

NUMBER	DAOM	NAME	DATE (YYYY.MM.DD)	LOCATION	HABITAT	LATITUDE WGS84, deg.	LONGITUDE WGS84, deg.	ELEVATION (m asl)
09.04.11.av01	DAOM 984760	*Peziza nivalis* complex	2009.04.11	Humber Village, Barry's Lookout	field	48.988302	57.784462	31
20.05.04.av01	DAOM 984761	*Peziza nivalis* complex	2020.05.04	HV 13 Maple	burn site	48.984473	57.768225	11
20.05.09.av01	DAOM 984762	*Peziza nivalis* complex	2020.05.09	HV 13 Maple	burn site	48.984473	57.768225	11

Description

Peziza sp. "nivenena"

Synopsis: Up to 54 mm diameter thin stemless brown disc, somewhat lobular at maturity, with an upper (fertile) surface yellowish brown when young, becoming dark brown to purplish brown and pock-marked with age, appearing on soil, often on burnt ground, in wet areas at snowmelt.

Cup: Diameter up to 54 mm; round with some lobulation at maturity, begins deeply cup-shaped but quickly opens to flat with minimally upturned margins that become somewhat ragged; smooth, in maturity may be pitted with irregularly placed round holes (Fig. 2A) that seem to close when wet (Fig. 2B), and reach the subhymenium (Fig. 2E); occasionally developing minimal radial wrinkling and central puckering with age; hymenial layer first yellowish brown, becoming dark brown with dark purplish tones with age, lighter yellowish brown toward the margin; sterile undersurface finely granular to almost smooth, concolorous with the hymenium or somewhat paler (Fig. 2D). Dries tan-brown to dark grayish brown with minimal purplish overtones. Sporeprint yellowish white (Fig. 7A).

Stipe: absent.

Context: Friable, less than 3 mm thick, weakly layered, darker brown hymenium, light brownish subhymenium; smell unremarkable, taste mild.

Microscopy: [NL specimens: 2020 collection: 10 spores from fresh hymenium of 1 ascocarp; 20 spores from sporeprints from 5 fresh ascocarps (Fig. 7C). No difference noted between the two sources. 2009 specimen: 20 spores from rehydrated dried hymenium of 1 ascocarp. QC specimen: 30 spores from rehydrated ascocarp. All measurements at 1000 × in H_2O mount.] Ascospores 15.4–19.8 × 9.6–13.5 µm, average 18.5 × 10.5; Q = 1.4–2.0, average 1.8. Immature spores have thick, wrinkled walls and granular content, maturing to thin, smooth, walls and hyaline content; asci 280–330 × 15–19 µm, 8-spored, forked croziers at base; paraphyses slender, filiform, apex subclavate to subcapitate, 6–9 µm wide, septate, often forked at distal septa, 3–5 µm wide, but showing variable fortoulism (Fig. 7B); rehydrated NL specimen showed filiform subclavate paraphyses, most of which failed to inflate.

Habitat (Fig. 1): Open clearings in coastal lowlands.

Substrate: Moist soil with charcoal and woody and herbaceous debris.

Season: Snowmelt in April–May.

Comments: It is interesting to note that spore morphology and size was comparable whether spores were from fresh or dried specimens, and whether they were shed or in the hymenium. In a H_2O mount, the walls of mature spores appeared smooth. Cotton blue has been reported to show microscaly spore wall ornamentation.[16] Electron microscopy of mature cells from the western North American population shows low wrinkling of the cell wall.[11, 13]

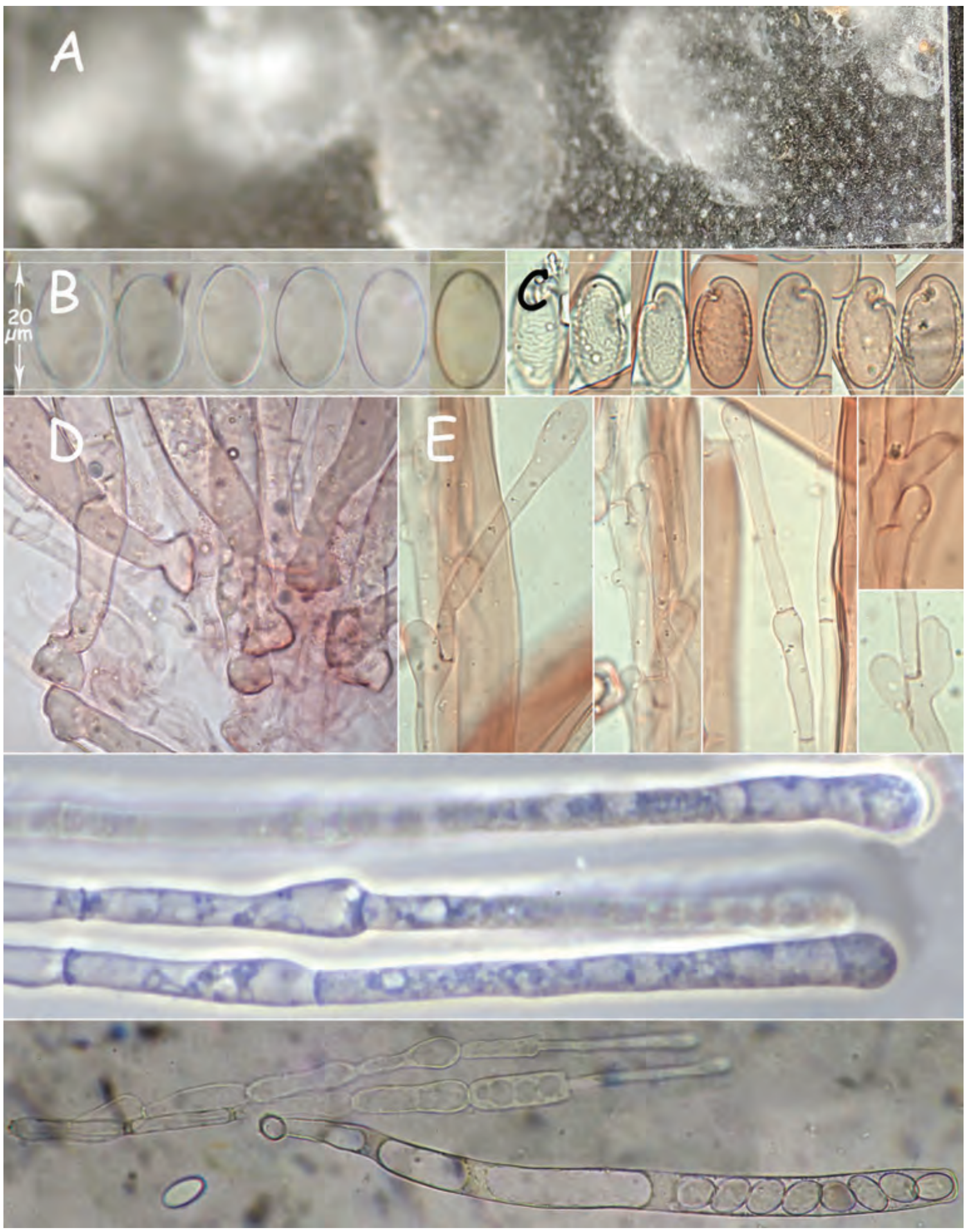


Figure 7: Sporeprint and microscopic findings of *Peziza sp.* "nivenena".

(A) Sporeprint of 2020 NL collection. Difficult to appreciate with certainty here, but colour is subtly to the yellowish side of pure white. Take our word.

(B) Mature spores in water mount under 1000 × (oil) magnification. 20 µm between white lines. Note thin, smooth wall and hyaline content.

(C) Immature spores. Note smaller size, double wall, granular, darker content. Note wrinkling of the outer wall or perisporium.

(D) Bases of the asci, showing croziers that are forked (technical term: pleurorhyncous), quite broadened in this case. Croziers are the ascomycete equivalent of clamp connections in basidiomycetes, have the same function, and have similar value for identification.

(E) Encompasses all remaining images to show variable degree of fortoulism of paraphyses, from minimal swelling to uniform or varied widening, and variable degrees of branching. Variable magnification. An ascus with two fortoulistic paraphyses. Terminal cells remain filiform with a subclavate head.

Peziza nivalis—afterword

Figure 8

A year has passed since the above observations. This was the mildest winter, with the earliest snowmelt in the 22 winters I have spent in NL. The first robins have arrived and a new crop of pezizas presented itself for examination in the same place on our lawn. This time I was waiting for them, so saw them from the first appearance onwards. My collaborators Renée Lebeuf and Don Pfister were right about the development of the species with time. The mushrooms presented as 4–5 mm globes with a tiny upper opening. They opened up as they enlarged, until they became flat with an upturned edge. The young specimens were light and began darkening after flattening. Pockmarks in the hymenium, as suggested by Lebeuf and Pfister, only appeared in the late stages. Microscopically, Donadini's observations were also corroborated: fortoulism was not observed until the mushrooms had aged, darkened and flattened.

As Donadini, Lebeuf and Pfister suggested, the youngest specimens were closest to the receding snow, the oldest the furthest away. This enables one to reconstruct this developmental picture at one sitting. The specimens on Figure 8 were photographed on the same day, arranged sequentially from closest to furthest from the receding snow edge. You can readily see the development of size, shape, and colour, and appreciate the lack of hymenial pockmarks at this stage. Only the largest showed mild fortoulism. As I said, it is easy to write these articles and descriptions if you work with knowledgeable collaborators.

-av

References

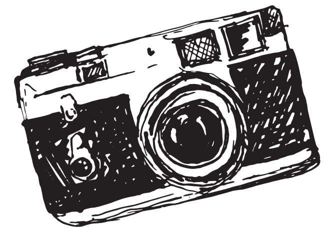
1. Donadini JC. 1980. Le genre *Peziza* (suite) Fortoulisme. Critères taxonomiques chez les Discomycètes operculés. Documents mycologiques 11:27–30.
2. Pfister DH. 1992. A collection of *Peziza nivalis* from California with comments on the nomenclature of the snowbank pezizas. Mycotaxon 43:171–175.
3. Beug MW, Bessette AE, Bessette AR. 2014. *Ascomycete fungi of North America*. University of Texas Press, Austin, TX.
4. Malloch D. 2014. Book review: Beug MW, Bessette AE, Bessette AR: *Ascomycetes of North America*. Omphalina 5(4):25–27.
5. Van Vooren N. 2012. Comment. http://www.ascofrance.fr/forum/18621/early-peziza. Last accessed May, 2020.
6. Heim R, Rémy L. 1932. *Galactinia nivalis*. Bulletin trimestriel de la Société Mycologique de France 48:63.
7. Lebeuf R. *Peziza nivalis*. Mycoquébec. https://www.mycoquebec.org/bas.php?trie=P&l=f&nom=Peziza%20nivalis%20/%20P%C3%A9zize%20des%20neiges&tag=Peziza%20nivalis&gro=86 Last accessed May, 2020.
8. Voitk A, Voitk T. 2020. The *Chromosera* of Newfoundland and Labrador. Omphalina 11:28–35.
9. Ronikier A, Ronikier M. 2009. How "alpine" are nivicolous myxomycetes? A worldwide assessment of altitudinal distribution. Mycologia 101:1–16.
10. Breitenbach J, Kränzlin . 1984. *Fungi of Switzerland*, Vol 1. Mykologia Lucerne. 1984
11. Hansen K, Lassøe T, Pfister DH. 2002. Phylogenetic diversity in the core group of *Peziza* inferred from ITS sequences and morphology. Mycological Research 106:879–902.
12. MyCoPortal. http://mycoportal.org/portal/index.php. Last accessed May, 2020.
13. McKnight KH, Dublin V. 1977. A new *Peziza* from the snowbank flora of Western America. Sydowia Biehefte 8 :224–227.
14. Bresadola G. 1881. *Discina leucoxantha*. Revue mycologique: Toulouse 4:212.
15. Miller AN, Matlak A, Raudabauch D, Pärtel K, Tamm H, Methven AS, Voitk A. 2015. The genus *Gyromitra* in NL. Omphalina 6(3):4–15.
16. Matocec N. 2012. Comment. http://www.ascofrance.fr/forum/18621/early-peziza Last accessed May, 2020.
17. Voitk A. 2012. Fungal homewreckers & vandals. Omphalina 3(8):10–12.
18. Voitk A. 2014. *Peziza ammophila*. Omphalina 5(9):12.

The Bishop's Sketchbook

Art by Glynn Bishop

The Photographer's Corner

the weird & the wonderful from the wild



Chlorociboria aeruginascens, or green stain fungus, is an ascomycete fungi that produces a vibrant turquoise stain on wood. The stained wood has been used since at least the 16th century in European intarsia work (fine inlay woodwork), as seen in these examples from German bureaus in the collection of the Museo Nacional de Artes Decorativas, Spain (images: public domain, via Wikimedia Commons).

Chlorociboria aeruginascens and visually similar *Chlorociboria aeruginosa* are both documented in NL. This Editor cannot tell you which were photographed here, but their fruiting bodies sure are stunning, regardless! Photos by Scott Fowlow. Text by Sara Jenkins.

THE MAIL BAG

Photo by Radek Grzybowski on Unsplash

Congratulations on the article about **Irene Mounce** in the latest OMPHALINA. I never met her, but her reputation was right up there with **Mildred Nobles**, **Luella Weresub**, **Mary Elliott** and the other taxonomists doing work at the Biosystematics Research Institute "back in the day".

— Regards, Ken Harrison, March 9, 2021

Andrus Voitk's piece, "Species and Speciation" (OMPHALINA vol 12(2), p. 84-86) is an excellent example of the importance of an interdisciplinary approach when explaining the distribution of fungi. Without mentioning the discipline of Biogeography, Voitk's discussion of the factors influencing Fomitopsis clearly demonstrates that the rigorous study of processes shaping the speciation and geographic distributions of fungi involves not only mycology but the disciplines of biology, ecology, geology, climatology, geomorphology, and geography. This multifaceted and interdisciplinary view of life is relatively new to mycology, whose focus over the years has centered more on the collection and classification of fungi than on the how and why fungi are distributed and how that distribution has influenced speciation.

— **Jim Cornish,** March 13, 2021

Thank you for your observation, Jim. As you know, commenting on an author's words is the highest form of flattery.

New is relative: from a perspective of several centuries, biogeography is new to mycology, but from the perspective of our own lifetimes, the concept has not been all that new. Ron Petersen had mulled about the effects on speciation by north-south movements of higher plants and their fungal associates in response to alternating periods of warming and glaciation so often that he jokingly referred to it as Petersen's Highway. Similarly, Nils Hallenberg had contemplated for a long while about the effect of barriers to interbreeding on speciation in a setting where "spores are everywhere". But you are right that it has not caught the imagination of the mainstream until relatively recently.

It took a major technological advance for that to happen: a rapid, cheap and reliable way to analyze DNA. This has brought about a veritable revolution in Mycology, from which none of us have been immune—witness the almost daily name changes we need to take into account. The mushrooms remain the same, but what we call them, how we rank them, our ways of approaching them in our mind, these things are shifting. Names are not changed to be annoying, but changes are the result of totally new vistas, specifically on evolution and speciation, that this new technology opens up. All of a sudden we discover that several species, mushrooms that we thought to be the same, are actually "complexes", groups of similar species, which have evolved genetically, but not always morphologically. We discover that in many cases regions, biomes, habitats substrates, isotherms, host species, these and many other variables are often outward indicators of speciation, where looks are (relatively) similar. Ability to estimate the time of changes enables us not only to plot the course of evolution of a complex, but also trace its path across the globe. Imagine the power of a simple soil sample. No need to collect mushrooms for decades to learn what grows in any region—analyse a spoonful of earth for fungal DNA and recover hundreds of species!

Overnight, biogeography becomes an unavoidable concept, and an exciting new tool to explain new discoveries. The well-known Chinese curse, "May you live in interesting times" is probably not Chinese and definitely not a curse. If you are interested in a subject, curious to unravel how it works, nothing can be more satisfying than to live in a time of major technological advance that opens up brand new doors through which to explore it. It has been my great fortune to live through two great technological advances in disciplines that had ensnared me, each one opening up areas I could not have imagined. That thrill is no curse.

— **Andrus Voitk**, March 16, 2021

Soil sampling around the globe for a report of global distribution of fungi by Tedersoo et al., *see* OMPHALINA 6(1):3–6, 2015. Photos, top to bottom: Malaysia (photo: Terry Henkel), Patagonia (photo: Alina Greslebin), Newfoundland (photo: Maria Voitk), Panama (photo: Mieke Piepenbring), Guyana, Benin (photo: Nourou Yorou), New Zealand (photo: Gwen Grelet).

Fomitopsis mounceae
photo: Maria Voitk

Our Partner Organizations

People of Newfoundland and Labrador, through

Department of Tourism, Culture, Industry & Innovation
Provincial Parks Division

Department of Fisheries & Land Resources
Wildlife Division
Center for Forest Science and Innovation

People of Canada, through

Parks Canada
Gros Morne National Park

The Gros Morne Co-operating Association

Memorial University of Newfoundland

St. John's Campus

Grenfell Campus

Tuckamore Lodge

FORAY
NEWFOUNDLAND
AND LABRADOR

The second decade
2021

Information on Foray NL's 2021 fall activities coming soon!

Updates will be sent to Foray NL Members by email, or check our website:

www.nlmushrooms.ca