OMPHALINA

Newsletter of FORAY NEWFOUNDLAND AND LABRADOR

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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.

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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

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CONTENT*

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Cover: *Cuphophyllus subviolaceus* Peck (Bon). In the past we have applied the name *C. lacmus* to this species, but our studies have shown that *C. lacmus* is not found in eastern North America. The article on p. 71 describes this species and tells you that for this report the type specimen was sequenced, to fix the name. You will also learn about several new species from our province, including one that has not been formally described yet—described here in the hopes you might recognize it and report your find to the editor. Photo: Andrus Voitk.

Message from the Editor

Hello again, friend of fungi!

Now that our mushroom season is starting to calm down, we can turn our efforts to preserving our harvest for the winter and resuming that never-ending process of trying to assign names to the thousands of photos we've taken out on the trails this summer and fall. To that end, we've introduced two new sections in this issue focusing on celebrating your best finds of the mushroom season here in Newfoundland and Labrador: The Photographer's Corner, and Notable Finds. Just because we cannot confidently identify mushrooms from photographs, doesn't mean we cannot appreciate their diversity in shape, form and color, so I encourage you to send in your favourite photograph to omphalina.ed@gmail.com so that we can all take a few moments in each issue to revive our sense of curiosity and wonder.

Also in this issue, Andrus Voitk issues a call for you to keep an eye out for any late-season *Cuphophyllus sp.* while you're out and about. We can't promise fame and fortune, but you might get your find written up in the next issue...

We hope you will also enjoy the fascinating contribution from Jim Cornish on mushroom odours, complete with a short printable scent reference table, and Marisa Rowsell's daring adventure into fairy circle folklore.

And as always, Happy Hunting everyone!

Sara

These stunning *Suillus paluster*, one of my favourite finds each year, were growing not in a bog, but rather, on a mossy hilltop in St. John's.

You'll understand why *Cortinarius semisanguineus* (sanguis = Latin for "blood") is called the Surprise Webcap when you flip over its dull olive brown cap to find this shock of brick red.

Foray Matters &

Message from the President

Hello Foray NL members and friends,

I hope you are enjoying the fungal season. The pandemic has given us an excuse to get outdoors even more than usual and I hope you've been able to use some of that time to enjoy finding mushrooms and lichens.

Back in April it was with heavy hearts that we cancelled the 2020 Foray, which was scheduled for the first week of October. The annual NL Foray has several goals: it's not only about compiling a species list for Newfoundland and Labrador, but also about sharing knowledge, skills, and a sense of community.

Happily, the Foray NL Board of Directors is a diverse crew and we set about exploring options for achieving some of our goals in 2020 despite Covid-19. Under the leadership of Verlé Harrop and with the diverse skillset within our Board and friends (who enthusiastically agreed to present), we pulled off our first Online Learning Series, which ran for 8 weeks from late August to early October. I hope you had a chance to tune in, and we extend our gratitude to those of you who have so happily shared your knowledge with our audience.

What an interesting journey it's been to get to the actual series! Hats off, please, to Verlé Harrop, Sara Jenkins, André Arsenault, Chris Deduke, Katherine Flores, Bill Bryden and Maude Parent, who met umpteen times by ZOOM and email over the past few months to gather ideas, find our presenters and then figure out how to make it happen. It's been a lot of work, but it's been a fun process, and I think we have achieved two of the Foray's goals of sharing knowledge/skills and of building community. In fact we are very excited to have 25 new Foray NL members, some of you far from N.L., and our weekly audience included folks from as far away as Italy, B.C., and the northeastern USA!

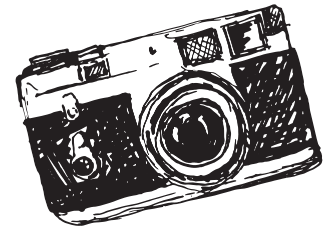
Wishing you the very best and hoping we might get together for real in 2021, but if we can't, then I'm sure we will come up with something...

Helen Spencer

Oct. 16, 2020

The Photographer's Corner

the weird & the wonderful from the wild



Just love the shape or colour of your find? This page is for you! Send us your best photographs to share with our readers, and let's all just take a moment to appreciate the beauty of the mushroom season.

Photographs submitted by Scott Fowlow, highlighting the fungal biodiversity we find in our fall forests.

Amanita sp.

Helvella cf. lacunosa

Smitten with Helvella? Andrus Voitk has indicated that this group of similar-looking mushrooms are worthy candidates for further study. Let the editor know if you're game for a challenge!

Gloeophyllum sp.

From Esteri's to Bond's mushroom—some new and old *Cuphophylli* in NL

Andrus Voitk, Irja Saar, Deborah J Lodge, David Boertmann, Ellen Larsson, Shannon Berch, Renée Lebeuf

One nice July day in 2010 one of us (AV) found what seemed like a new species of *Cuphophyllus* in a bog, which another of us (DB) examined and thought to be close to *C. cinerellus* microscopically (Fig. 1). Macroscopically it was not *C. cinerellus*: paler, more brownish than greyish, bigger and grew in boreal bogs, not arctic tundra habitat. Our interest was piqued, subsequent collections sought in other bogs, and a team put together to study this species. The fruit of that investigation was recently reported in Mycologia.[2] The bog mushroom turned out to be a new species, and, as seen on Figure 2, was closely related to both *C. cinerellus* and *C. esteriae*. We called it *C. lamarum*, or *Cuphophyllus* of the bogs (lama from Latin for "bog").

You have never heard of *C. esteriae*? Neither had we. It seems that the species, which we had taken to be *C. cinerellus*, a species introduced to us by Esteri Ohenoja in 2008, was actually a distinct new species, very similar and very closely related to *C. cinerellus* (Fig. 3), seemingly limited to eastern North America (so far documented from Labrador, Newfoundland, and Greenland). We decided to name it after Esteri: *Cuphophyllus esteriae*, or Esteri's *Cuphophyllus*. Veterans of our provincial mushroom club's (Foray Newfoundland & Labrador or FNL) forays will know Esteri, but others need a short introduction.

Our first foray took place in Gros Morne National Park in 2003, even before we had the FNL name. By 2005 FNL did its first survey of the coast of Labrador, and in 2008, FNL was invited by the Wildlife Division of the provincial government to field a small team to join provincial biologists in a multi-taxon survey of remote Labrador near Konrad Brook, located in the approximate geographic middle of Labrador. The campsite was selected at the bottom of the Konrad Brook valley, surrounded by subarctic tundra highlands. FNL accepted, on condition it could recruit a mycologist with expertise in arctic-alpine mushrooms to come along. We had no expertise with fungi in this habitat, and felt it would not justify the cost if we could not identify our finds. After asking around for good candidates, we were referred to Esteri Ohenoja from Oulu, Finland (Fig. 4).

Figure 1: Holotype for *Cuphophyllus lamarum*, illustrating the yellowish colour of the lower stem. Of our three collections, only this one had orange staining. Our experience is not sufficient to know whether this is an unusual finding, or a character for the species.

[Here we need to interrupt our story to clarify a detail. The above does not mean that the provincial government paid a stipend or even covered Esteri's (or our) travel expenses. This was all volunteer work at her own expense, although travel from Deer Lake to Konrad Brook and food plus some equipment were covered by the government. All of our faculty travel at their own expense and provide invaluable service free of charge to our understanding of our rich fungal heritage.]

Esteri accepted, and we spent a delightful two weeks—all of it detailed in the Konrad Brook Mushroom Census report.[2] You can download the Census from our website http://www.nlmushrooms.ca (click on Foray Reports and scroll to bottom of that page). Thus began a beautiful friendship from which we benefitted both personally and mycologically. Esteri returned to our foray on several occasions, the last time in 2013 in Fogo, where we celebrated her 75th birthday (one year late, not unusual for FNL). She introduced us to many tundra species, common there, but exotic to us, among them the arctic pioneer species *Cuphophyllus cinerellus* (Fig. 5). That is the species that now turned out not to be *C. cinerellus* but closely related to it, which we named *C. esteriae*, in fitting tribute to our friend and arctic-alpine mentor, Esteri. The two species are very alike macroscopically (Fig. 3). Their spores differ in size, but one completely overlaps the other, so that most of the time this measurement does not help (Fig. 6).

Now, back to the bog mushroom. One of the obvious characters of it is a yellow lower half of its stem. *Cuphophyllus cinerellus* and *C. esteriae* may also be found in *Sphagnum* at times, and occasionally a few of them also have a little bit of yellow on the bottom of the stem. There is another species described in Europe, *Cuphophyllus flavipes*, named after its yellow stem (flavi = yellow, pes = foot). The onus is on whoever describes a new species to make sure it has not been described before. There was no type specimen of *C. flavipes*, so we got some help from Peter Karasch, who collects in the region from where the species was described, to seek out a good collection of this European species. Once a good specimen had been located, we sequenced it and declared it the epitype for *C. flavipes* to fix the name. It looked different from our bog mushroom, did not grow in bogs, and had different genetic sequence data. Thus we could show that our yellow-stemmed species was not the same as the European yellowfoot. In North America, Hesler & Smith had also described a yellow-legged species, *Cuphophyllus pseudopallidus*, but its holotype fell into a different clade, again a different entity from ours (Fig. 2). Thus we could publish ours confidently as a new species.

This should be where our story ends, but no. After we had submitted our report one of us happened to spot an FNL photo of another collection that resembled our bog mushroom: yellow lower stem and light pinkish brown cap. When we looked it up in the database, we found that it differed from our bog mushroom because it was collected a full two months later than the early-fruiting *C. lamarum*, and not from a *Sphagnum* bog, but from grassland of the Sir Robert Bond Park, a site with several introduced trees like oak, Norway maple and pine. Because of its pale colour, we expected it to be the unknown (to us) North American *C. pseudopallidus* of Hesler & Smith, but sequencing revealed it to be a species of its own, separate from the other species clades among the yellowlegs (Fig. 7)—another new species.

Why did we not report this in the Mycologia article? Well, our report had already been submitted, reviewed, revised, accepted and was in the preprint process, when we became aware of this new species. We contacted the editor, but because we were not in a position to make a formal description on the basis of a single fruiting body, he agreed that the little we can really contribute is not worth the effort of

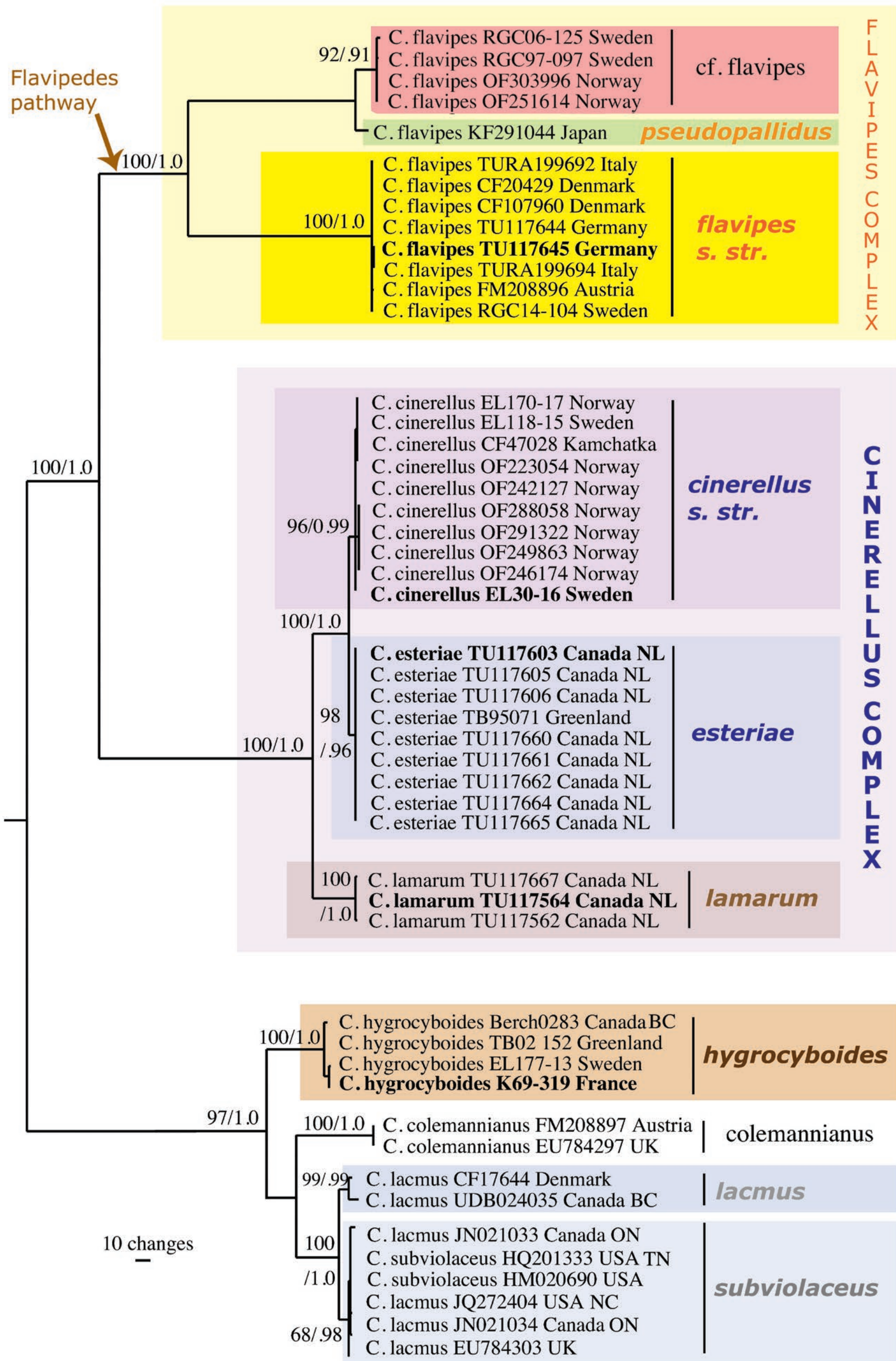


Figure 2. One of our phylogenetic trees for this group. The *cinerellus* complex is in the middle, with the European *C. cinerellus* a sister species to the North American *C. esteriae*, both arctic-alpine species. Our *C. lamarum*, found in boreal bogs, is sister to the pathway leading to those two. Note *C. hygrocyboides* toward the bottom, and the *lacmus* complex, showing a putative *C. lacmus* clade, and a separate eastern North American clade, which also contains the type species for *C. subviolaceus*. Finally, note the flavipedes pathway at the top. The big clade on the yellow panel contains the type specimen for *C. flavipes*, identifying the species. The pink panel has an unnamed, somewhat similar species from Scandinavia. And the green panel shows one member of *C. pseudopallidus*. The type specimen for the species also fell into this clade. We shall encounter this flavipedes pathway again, when we discuss Bond's mushroom.

altering the manuscript and illustrations at this time. Instead, he supported our plan to make a preliminary report in OMPHALINA—which is why you read it here first!

This sort of thing is not unique. Just as we were completing this report for OMPHALINA, Ellen Larsson found another European specimen of *Cuphophyllus* that looked different. On sequencing, it proved to be another new species, this time ancestral to the *lamarum/cinerellus/esteriae* clade, not in the flavipedes pathway. So the story is far from over.

The formal description of our Bond Park species must await further finds. Obviously it is uncommon, because in 16 years of forays in the province, this is the first discovery. It is more likely to recur at this site, and we intend to visit it again. Meanwhile, Renée Lebeuf, who collected it, offers a preliminary description with Roger Smith's foray photo (article title image), under the code name "Bond's mushroom".

THE PURPOSE OF THIS PRELIMINARY REPORT IS THAT READERS WILL BE AWARE OF IT AND HELP LOOK FOR MORE.

Please keep your eyes open for anything that looks like this and fits the description. Should you see one, please take a photo, collect it, and notify the editor of OMPHALINA, who will sound the alarm.

In addition to the species we have discussed so far, we shall describe two additional species here. First, *C. subviolaceus*, a species described by Peck, often erroneously identified (including at FNL forays) as *C. lacmus*. Peck's species matches *C. lamarum* in size and shape, and is closest to *C. esteriae* in colour. Its range extends close to the arctic-alpine range of the latter, so that we fixed the name by sequencing the type, to ensure it is distinct from both. Our analysis revealed that all NL collections (mis)identified as "*C. lacmus*" fell into a clade with Peck's type—along with a collection from UK—that is *C. subviolaceus* (Fig. 2). One Danish collection identified as *C. lacmus*, a species first described from Denmark, fell into a different clade in our tree, along with one from BC. Because the species has not been typified, we cannot say for certain that these are the "true" *C. lacmus*, but odds are high that they are. Thus, we have at least two species in that complex, both found in Europe and North America. Additional data are required to define the exact respective distribution of these species. Because we have fixed the name *subviolaceus* by sequencing the type, and identified it as the species found in NL, we shall describe it at this time. Fair notice to all to change whatever you have called "*lacmus*" to *subviolaceus*.

The other species we shall describe here is *C. hygrocyboides*. This species, hitherto known only from Europe, was also described in our article, and is now known from North America, phylogenetically confirmed from Greenland and BC. It has not been collected in NL, but the likelihood is very high that the species will also prove to be a resident of NL, possibly on the Great Northern Peninsula, but almost certainly in the highlands, tundra, and arctic-alpine barrens of Labrador.

There are other species of *Cuphophyllus* in NL, more complicated to sort out, where significant study needs to be done, before a definitive report on these can be brought to you. Meanwhile, continue to use the names *C. pratensis*, *C. borealis*, *C. colemannianus* and *C. ochraceopallidus* as we have so far. Enjoy those names, because of these only *C. borealis* is likely to survive (and likely it will be one of 2–3 similar species); it is probable that the other names will be replaced by one or more North American ones.

Figure 3. The macroscopic similarity of *C. cinerellus* (top) and *C. esteriae* (bottom). Apart from geographic distribution, the most obvious difference between them is in the size of the basidia. This need not worry us, so long as we know whether we are in North America or Europe.

Figure 4. Two views of Esteri Ohenoja in Konrad Brook, Labrador, in 2008, above water (right), and in water (left). Note that as opposed to her mushroom, she is not hygrophanous. Photos: Michael Burzynski.

Figure 5. The four sequenced and photographed collections of what now is known as *C. esteriae*, Esteri's mushroom, collected in Konrad Brook in 2008, with the aid of Esteri. The top right specimen is the holotype for the species. Note the various degrees of translucency and darkness, depending primarily on hydration.

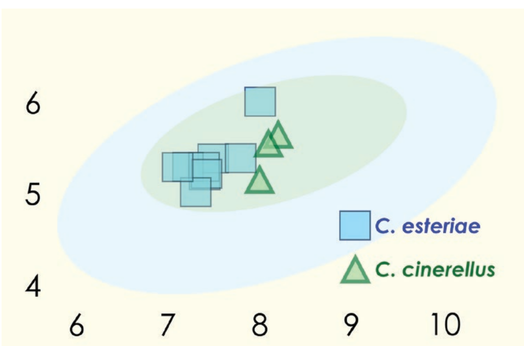


Figure 6. Spore size of *C. esteriae* (blue oval for size range and blue squares for average sizes of nine sequenced collections) and *C. cinerellus* (green oval for size range and green triangle for average spore sizes of three sequenced collections). Length on x-axis and width on y-axis, in µm. If you are advanced enough to measure spores and this graph makes sense to you, you should read the technical article![1]

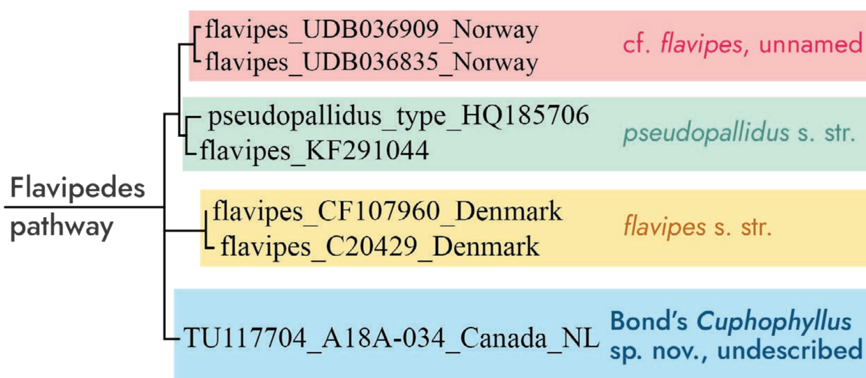


Figure 7. Compare to the top group ("Flavipedes pathway") on Figure 2, using same order and panel colours to identify the species. The pink group is an as yet undescribed species of *Cuphophyllus* with a yellow stem from Scandinavia. The green panel contains *C. pseudopallidus*, found both in North America and Japan. The yellow panel contains the European *C. flavipes*. And on the blue panel our new species, code named "Bond's mushroom" because it was found in the Sir Robert Bond Park. Renée Lebeuf collected it and supplies a preliminary description here. Formal description and naming awaits the finding of a few more collections. The photo and Renée's description are published here in the hopes to make our members aware of this species, and solicit help in the discovery of more collections. If you find anything that looks like this mushroom, please take a photo and collect it, and notify our editor, who can contact the appropriate people.

References

1. Voitk A, Saar I, Lodge DJ, Boertmann D, Berch SM, Larsson E, 2020. New species and reports of *Cuphophyllus* from northern North America compared to related Eurasian species. Mycologia 112(2): 438–452. doi: 10.1080/00275514.2019.1703476

2. Voitk A, Ohenoja E, Burzynski M, Marceau A, Hanel C, 2008. Mushroom census, Konrad Brook, Labrador, July 21–August 3, 2008. FNL publications.

Cuphophyllus esteriae

Macroscopic. Cap usually under 25 mm wide, domed, often developing a shallow central depression, edges curved down becoming plane, occasionally even shallowly funnel shaped, margin becoming somewhat wavy-wrinkled with age; surface lubricious when wet, at times becoming scurfy with age, opaque to translucently striate to the disc, hygrophanous; grey to dark greyish brown with violet tones, drying pale violaceous grey. Gills decurrent, increasing cross-veining in age; light to dark brownish violet grey. Stem 6–28 × 1.5–4.5 mm; light brownish grey, uncommonly somewhat yellowish near the base. Sporeprint white.

Microscopic. Spores 6–10.5 × 4–6.5 µm, average 7.6 × 5.3 µm, Q_{ave} 1.4; broadly elliptical to pip-shaped, hyaline. Basidia 4-spored, 22–40 µm long. Clamp connections in all tissues.

Habitat, Substrate, Season, Distribution. In heath or arctic-alpine pioneer soil, often with Sphagnum or other moss, in small groups of one to four. Jun–Sep, so far known from eastern North America (Greenland, Newfoundland and Labrador).

Differs from *C. lamarum* by its arctic-alpine habitat, smaller size, darker cap, more violet coloration, rarely yellow stem base. Although found at times in *Sphagnum*, the habitat is entirely different from that of *C. lamarum*. Smaller size and arctic habitat separates it from *C. subviolaceus*. Photo shows a typical setting for the species, in *Sphagnum*. There is often a concentric partial splitting of the cap covering. The spores are from the holotype.

Cuphophyllus lamarum

Macroscopic. Cap around 35–40 mm wide on average, round, domed, becoming almost plane with age, edge somewhat inrolled well into maturity; surface dry to minimally lubricious, opaque, but indistinctly translucently striate at edge, hygrophanous; light to moderately tan, with light greyish violet hues, more yellowish over disc and grey-violet over periphery. Gills decurrent, with increasing cross-veining in age, whitish grey. Stem 25–70 × 4–10 mm, often slightly curved; light straw coloured, with increasing yellowish tones towards base. Sporeprint white.

Microscopic. Spores 5.5–9 × 4.5–7 µm, Q_{ave} = 1.3 broadly elliptic to pip-shaped. Basidia 4-spored. Clamp connections in all tissues.

Habitat, Substrate, Season, Distribution. In small groups on raised *Sphagnum* bogs in western Newfoundland, July, at least a month before other species of the genus in this region. Our experience is limited to three collections, and we expect that as people become aware of this species, additional data may change or add to the description in the future. Photo shows the holotype above and two views of the raised Sphagnum bog habitat, including flowering *Drocera* (sundew) to indicate the early fruiting time of this species.

Bond's mushroom

Macroscopic. Cap 30 mm wide, depressed around a low umbo and with reflexed margin; surface smooth, lubricious, opaque, pinkish buff, somewhat paler at the margin. Gills subdecurrent, distant, with 1–2 tiers of lamellulae, very pale brown. Stem 50 × 6 mm, equal, concolorous with the gills in the upper half, with increasing yellow tones towards the base. Sporeprint not collected.

Microscopic. Spores 5.0–8.0 × 4.5–6 µm, average 6.8 × 5.3 µm, Qave = 1.29 (39 spores), broadly ellipsoid to subglobose, some ellipsoid, smooth. Basidia 45–55 × 6.5–9 µm, 2-, 3- and 4-spored, predominantly 3- and 4-spored in equal proportion, clavate; sterigmata 3-8 µm long. Hymenial cystidia absent. Lamellar trama interwoven, made up of inflated hyphae 25–85 × 4–12 µm. Suprapellis a thin ixocutis 10–50 µm wide, made of slightly gelatinized hyphae, some finely incrusted, 2–5 µm in diameter; subpellis compact, 20–50 µm wide, made of tightly interwoven hyphae 4–7 µm in diameter, this layer forming a strand easily separable from the context. Context hyphae subparallel, inflated, 4–10 µm wide. Clamps in all tissues. Microscopically, the basidia bearing 2, 3 and 4 spores are distinctive, but these characters will have to be confirmed with additional collections.

Habitat, Substrate, Season, Distribution. Found at a single location, under maple and oak in grassland at the Sir Robert Bond Park, in Whitbourne. This fungus is recognized by its pinkish buff cap and yellow stem base. Voucher photo: Roger Smith.

Cuphophyllus hygrocyboides

Macroscopic. Cap 10–30 mm wide, pulvinate when young, flattened to somewhat depressed with age, dry but slightly sticky when young; hygrophanous, edge variably translucently striate, bright to dark orange-brown. Gills decurrent, rather thick, pale orange-brown. Stem 20–40 × 2–5 mm, longitudinally fibrillose at least in age, pale orange-brown (paler than pileus). Sporeprint white.

Microscopic. Spores 6–10 × 4.5–5.5 μm, ellipsoid to ovoid. Basidia 4-spored. Clamps abundant in all tissues.

Habitat, Substrate, Season, Distribution. On ground in alpine zone with moss and dwarf willow, single or in groups. Likely circumboreal, including Northern NL; known from the Alps, the Pyrenees, northern Fennoscandia, Greenland and British Columbia. Photo of the BC collection, first report of the species in continental North America.

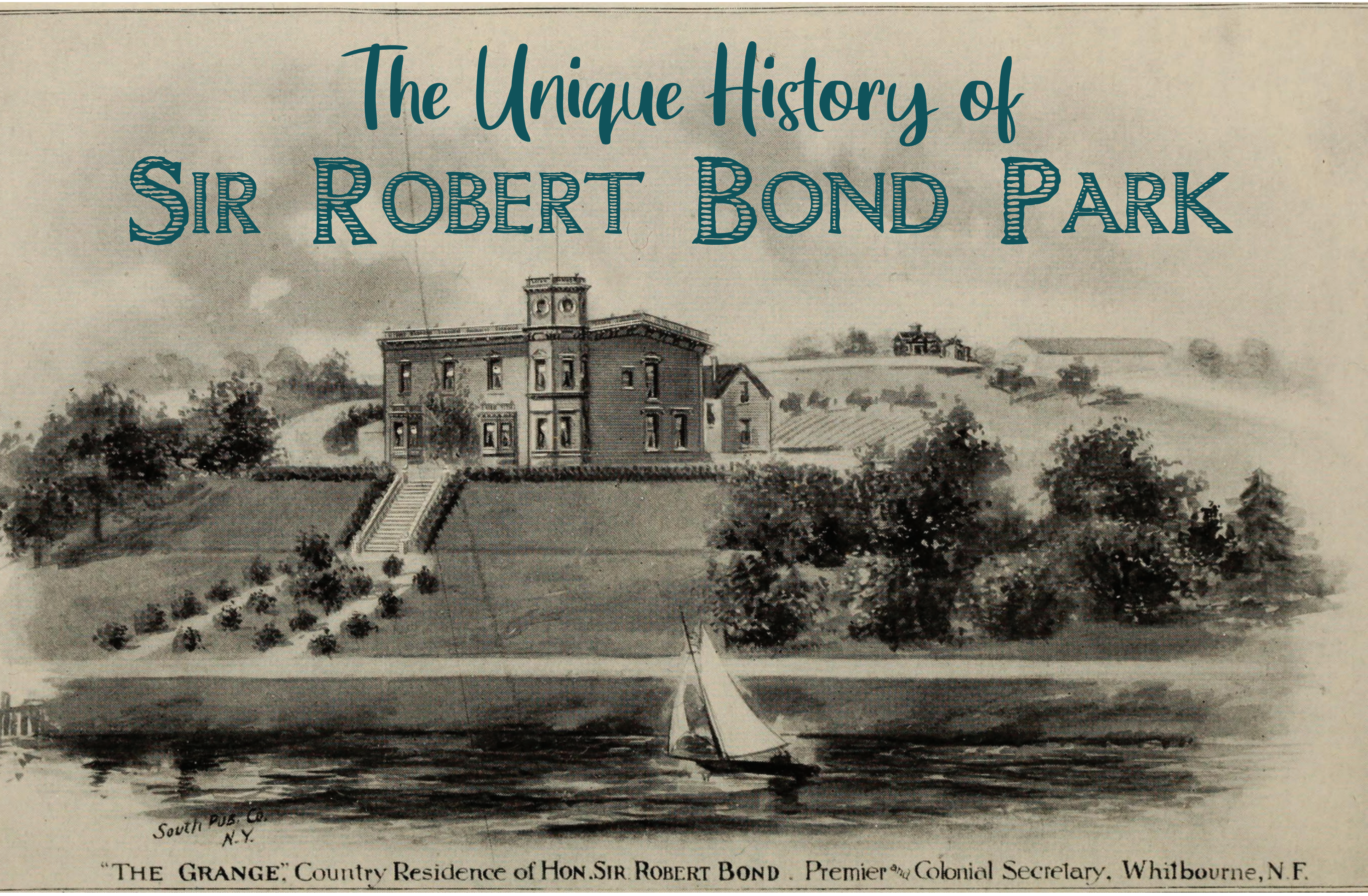
Cuphophyllus subviolaceus

Macroscopic. Cap around 35–40 mm wide on average, domed, becoming almost plane with age, edge somewhat inrolled well into maturity, becomes recurved past maturity; surface minimally lubricious, opaque, but translucently striate at edge, hygrophanous; dark to light cinereous (blue-violet) grey, often brownish tones over disc and grey-violet over periphery. Gills decurrent, with increasing cross-veining in age, whitish grey. Stem 30–60 × 3–10 mm; whitish to light grey. Sporeprint white.

Microscopic. Spores 5.5–8.5 × 4.5–6.5 µm, Qave = 1.3, broadly elliptic to pip-shaped. Basidia 4-spored. Clamp connections in all tissues.

Habitat, Substrate, Season, Distribution. In small groups on usually in or near coniferous woods, up to subarctic-alpine zone, late fall. Photo shows three collections to indicate variation in colour, cap shape and microhabitat for the species.

The Unique History of Sir Robert Bond Park



Johanna Bosch

What is now known as Sir Robert Bond Park, in the town of Whitbourne, was once the property of Sir Robert Bond (1857–1927) (Fig 1). Bond led Newfoundland through a historic transition, serving as both the last Premier of Newfoundland Colony from 1900–1907, and the first prime minister of the Dominion of Newfoundland, 1907–1909. If you were lucky enough to visit his property back then, you would have found yourself immersed in a world of exotics: bright ornamental shrubs, unusual evergreen plants, and birds not commonly found on the island.

Bond originally purchased a portion of land from the railway in an area formerly known as Harbour Grace Junction and later purchased the entire area to establish Whitbourne, Newfoundland's first inland railway and lumber town.[1,2] By the late 1880s, he had built The Grange, his Edwardian-style house and farm nestled in the hills overlooking Junction Pond (title image). The Grange was bequeathed to Newfoundland in his will, but the government declined to accept the gift, and the house was eventually demolished. The land where it once stood is now traversed by several well-graded walking paths to charming picnic areas, and maintained by the town of Whitbourne as Sir Robert Bond Park. When you visit the park today, you will find all that

Figure 1: Sir Robert Bond (1857—1927). Image: MUN Archives & Special Collections.

Figure 2: Stone marker at the former site of The Grange. Photo S. Jenkins

Figure 3: Scotch heather (*Calluna vulgaris*) growing on the grounds.

Figure 4: Blue felt lichen (*Pectenia plumbea*) surrounded by oak lungwort (*Lobaria quercizans*). Photo Roger Smith.

Figure 5: Cleared meadowland between and around the Swiss pine and English oak is home for species of lawn fungi, such as the new species of *Cuphophyllus* described in this issue, and the *Gliophorus* cf. *laetus* captured above. Photo: Michael Burzynski.

Figure 6: Female Rusty Blackbird (*Euphagus carolinus*) photographed in Bond Park by Bill MacKenzie in 2017.

remains of The Grange is the set of steps leading up from the lakefront to the former house location, a plateau marked by a stone monument (Fig 2), and expanses of the striking purple heather that he established on the property (Fig. 3).

As was fashionable at the time, Bond had a passion for importing non-native species from around the world for his landscaping. Now likely to get you in trouble with Border Control, Bond's horticultural habits have made a strong imprint on the landscape at The Grange. Some reports estimate he imported over 8000 individual plants to Whitbourne.[1] Those with a keen eye for mushrooms and lichens can tell you that Bond's lasting legacy is more than a set of steps; the trees—Norway and Japanese maples, English oak and Swiss pines[2]—and other perennials, that Sir Robert Bond imported for his gardens provide unique associations for unusual fungi, even today.

The less acidic bark of some of the imported trees, such as the seventy-foot-tall Norway Maple (*Acer platanoides*), Hawthorn, Trembling aspen, and European birch offer ideal conditions for the provincially-significant—and minor botanical celebrity—blue felt lichen (*Pectenia plumbea*,formerly *Degelia plumbea*[3]) to grow in relative abundance,[4,5] while English oak and Swiss pine provide unique partners for the root-associated fungi that grow in the large grass fields of the park (Fig 4, Fig 5). The potential for finding rare, and even new, species is what has drawn many nature enthusiasts from around the province to come visit the park. Take, for example, the recently discovered species of *Cuphophyllus*[6] found last year that is not only new to the province, but also new to the scientific community (reported in this issue). When walking in the park, visitors should keep an eye out for the fungi listed in the 2018 Foray NL report site list for Bond's Park[7], including the classic "toadstool", the vibrantly-coloured species of *Amanita muscaria*, and a biotrophic species of interest, *Pseudotricholoma umbrosum*.

Bond's eager attempts to create a unique land for his family sometimes got the best of him... In a short reflection in the Telegram, Elliot Gordon, who lived in Whitbourne during the development and maturity of The Grange's grounds, expressed the true lengths to which Bond went in developing his gardens.[9] Gordon recalls how Bond accidentally spread the invasive heather plants (as packing material around his imported saplings) that ended up covering the large grass lawns of his property, much to the frustration of his gardeners. He also tried to introduce a small population of Capercaillie (or wood grouse, *Tetrao urogallus*) from Scotland. They didn't fare well either; their population was quickly hunted to death by his dogs and neighbors.

Figure 7: Visiting the park today, you can still take a stroll amongst some of Bond's prized trees. Photo: Roger Smith.

Gordon also recalls how Bond once transferred four beavers into Junction Pond, and quickly regretted the decision when they felled some of his prized ornamental trees.

As Gordon's reflection suggests, introducing non-native species to the southern boreal forest could have been disastrous, but the park now flourishes with unique flora and fauna, enriched no doubt by Bond's green thumb. The wide diversity of flora in this park also provide unique habitat for other creatures, such as the common gastropod, the white lipped snail (*Cepaea hortensis*), and many species of songbird, such as the rusty blackbird (*Euphagus carolinus*)[8] (Fig 6). Today, the land is protected by the Newfoundland and Labrador Legacy Nature Trust, a non-profit agency working to finance conservation projects in the province. The Trust hopes that unique biological finds like those discussed herein, and the potential for additional new provincial records, will encourage people to visit the park more often. Sir Robert Bond Park is open year-round to visitors who would like to take advantage of its walking trails near Junction Pond in Whitbourne. (Fig. 7).

Acknowledgments The author would like to acknowledge Linda White of Memorial University's Archives & Special Collections for recommending photos from the Sir Robert Bond collection, and Roger Smith, Michael Burzynski, and Bill MacKenzie for sharing the images of Sir Robert Bond Provincial Park. Lastly, I should thank Andrus Voitk and Yolanda Wiersma for their generous contributions to this article.

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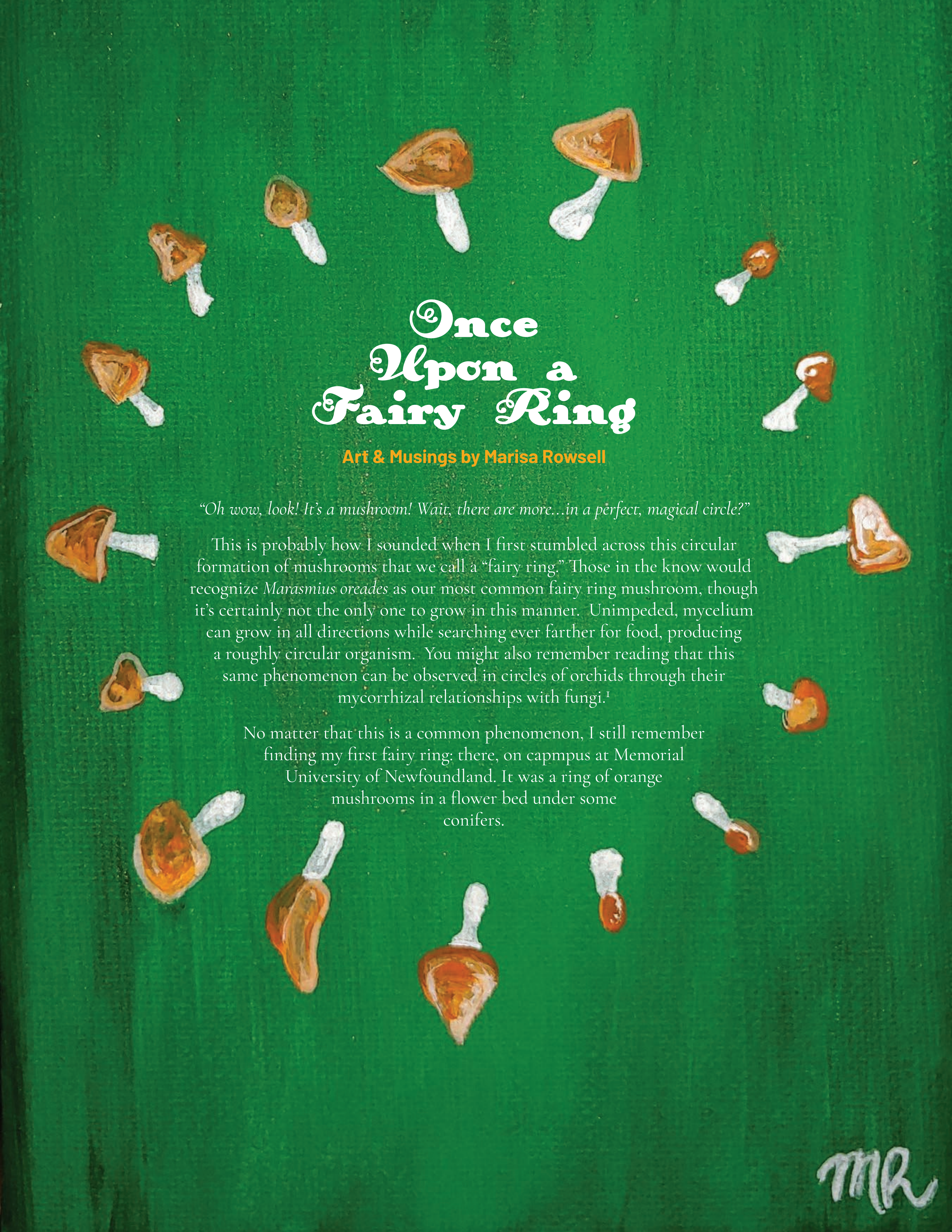

Once Upon a Fairy Ring

Art & Musings by Marisa Rowsell

"Oh wow, look! It's a mushroom! Wait, there are more…in a perfect, magical circle?"

This is probably how I sounded when I first stumbled across this circular formation of mushrooms that we call a "fairy ring." Those in the know would recognize *Marasmius oreades* as our most common fairy ring mushroom, though it's certainly not the only one to grow in this manner. Unimpeded, mycelium can grow in all directions while searching ever farther for food, producing a roughly circular organism. You might also remember reading that this same phenomenon can be observed in circles of orchids through their mycorrhizal relationships with fungi.[1]

No matter that this is a common phenomenon, I still remember finding my first fairy ring: there, on capmpus at Memorial University of Newfoundland. It was a ring of orange mushrooms in a flower bed under some conifers.

As an artist, I'm drawn to bright colours, and these vibrant saprophytic mushrooms drew me right in. I wanted to step into the ring, but having learned at the very same university that superstition dictates that I should not step into one of these for fun, I avoided it and moved on, for now.

Much like my English ancestors, I blamed this natural phenomenon something bad, something evil....the *fae*. Here in Newfoundland, this superstition may have been brought by settlers and fishermen who carried with them Celtic heritage and legend (we can also thank the Irish for bringing the Celtic tradition of Samhain to us, which we now celebrate as Halloween). The settlers believed that because the fungi appeared so quickly—seemingly spontaneously (although we now know all it takes is a good rain)—that surely there must be a supernatural explanation: a fairy fiesta, a pixie party, or maybe mischievous elf merriment.[2]

To learn more about our local fairy lore, I interviewed my grandmother from Bellevue, Newfoundland back in 2011. She told me fairies were mesmerizing creatures. As a child, she said had seen them while out berry picking, and told me they wore "beautiful clothing" and resembled little girls. Perhaps they took this form so she would trust them? We have always believed the fae have the power to use transformation to lure us to them. I was curious why my grandmother—a devout Catholic to this day—would hold on to such a supernatural, pagan concept, but she is certainly not alone in her beliefs. Folklore is just part of our identity here in Newfoundland.

Peter Narváez, renowned folklorist of Newfoundland and Labrador folklorist, explained that the berry grounds where my Nan took me picking are places of danger where fairies and humans often came face to face.[3] Narváez wrote that berry picking grounds were often considered liminal spaces between the heavens above and the underworld below. He compared the underworld to the unknown. The unknown is *known* to bring on dangerous situations in Newfoundland. When we enter a fairy ring, we might also cross a dangerous threshold to the unknown. This resonated with me; although I have not seen fairies myself, the concept of a fairy ring as an abduction platform is deeply rooted in the psychology of my ancestors.

But I wasn't satisfied with the unknown; I had to know. Years after I first saw it, that orange fairy ring popped up again on campus, so I said a prayer and I stepped inside the ring, and ..... nothing happened. Nothing at all. I was not transported to another dimension and my face did not age 40 years. I was still me, just inside a mushroom circle.

Even though I wasn't touched by the fairies that day, I can't deny the strength of belief held by my grandmother and generations before her. I understand the science of fairy rings, but I still feel a sense of magic when I see one. Science has explained what was formerly intangible, but fairy rings still feel like the physical symbol of a metaphysical portal to me. Is there enough room inside a fairy ring for science and the supernatural to co-exist?

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Left: A ring of *Marasmius oreades* in the Editor's front yard. Pay no attention to the poor lawn maintenance.

Mushroom Odours

Jim Cornish

Odours, and olfactors to detect them, have probably been around since life first appeared on our planet. After billions of years of evolution, species across all Kingdoms are fine-tuned to recognize and react to the various odours in their environments. We know that plants, animals, and insects use odours to defend themselves, to forage for food, and to find mates, but we are just beginning to learn that odours benefit fungi in similar ways.[1,2] This article brings together some of what has been published about mushroom odours and their use in the identification and ecology of some common mushrooms. Unfortunately, we cannot include "scratch and sniff" stickers to complement your reading experience. So instead, the next time you find a mushroom, take a whiff. You might be surprised by how familiar it smells!

What are Odours?

Odours are volatile organic compounds that evaporate easily at normal air temperatures and atmospheric pressures. Characteristically complex, odours are usually mixtures of dozens of different chemical compounds in varying proportions and concentrations, hence their variety in scent and potency.[3] Odours are ubiquitous in nature, usually resulting from metabolic activity and existing as secondary metabolites in plants, animals, bacteria, and fungi. Their potencies often depend on their functions, either as signals, cues, or weapons.[1]

In sufficient quantities, odours can be detected by olfactors such as vertebrate noses, invertebrate antennae, and plant and fungal receptor cells. But not all olfactors perceive odours equally. Animal noses and antennae can sense traces of volatiles undetectable by other creatures, including us humans. While our noses have some 400 scent receptors and can detect over a trillion odours, how we interpret scent and odour potency often depends on our age, gender, physiology, and individual sensitivities.[4] How plants and fungal cells sense odours has not yet been fully explained.

Mushroom Odours

To date, only some 300 distinct mushroom odours have been analyzed and their constituent chemicals profiled.[5] These profiles show that mushroom odours are typically mixtures of compounds from a variety of chemical classes such as esters, acids, aldehydes, amines, terpenes, sulfides and nitrogenic compounds and their derivatives.[1,6] Most fungal odours are biosynthesized as secondary metabolites; others arise from amino acids and the oxidation and cleavage of unsaturated fatty

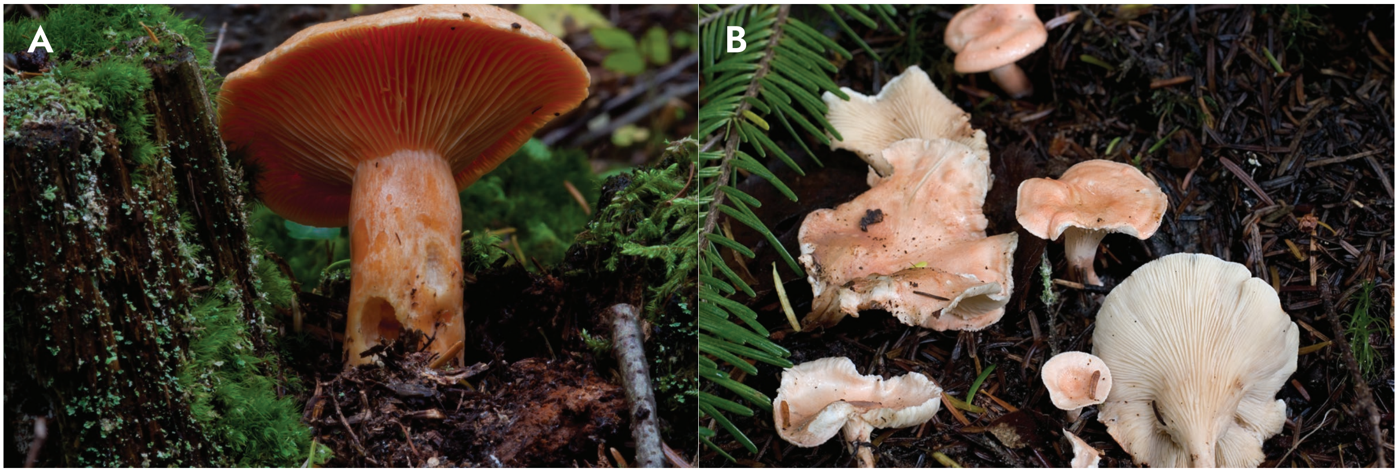

Figure 1: (A) *Lactarius thyinos* exudes a pleasant fruity aroma that reminds me of Wrigleys juicy-fruit gum. My first encounter with this mushroom brought back many memories of my childhood. Forager Shawn Dawson calls them "Froot Loop" milk caps on account of their pleasant resemblance to the sugary breakfast cereal. Photo Jim Cornish; **(B)** *Hygrophoropsis morganii* has both the pink colour and sweet odour of bubble gum. Photo Andrus Voitk.

Figure 2: The odour produced by fresh *Fomitopsis mounceae* (formerly *F. pinicola)* is associated with their brown rot decay. Insects use this odour to discriminate this polypore for nesting purposes.[8] Photo Jim Cornish.

Figure 3: A *Collybia* species decaying the remains of a *Lactarius* or *Russula* mushroom from the previous season. Photo Jim Cornish.

acids.[7] These sources create the myriad of odours we smell when sniffing mushroom caps and stems (Fig. 1). The remaining odours are considered incidental and are produced as fungi decay the organic matter they occupy (Fig. 2), including other mushrooms that have reached the end of their life cycles (Fig. 3).[4] These odours are released from the duff layer of the forest floor, and likely generate its characteristic "mushroomy" or "earthy" odour.

Some field guides include one or two-word descriptions of mushroom odours, especially when the odours are helpful in distinguishing species. The most common mushroom odour is described as "indistinctive"[9] or "not distinctive".[10] This means that while an odour exists, it is not strong or unique enough to be of interest or of value in species identification.

Distinctive odour descriptions are quite noticeable, but their names lack a universally accepted system of classification.[11] Instead, these descriptions are based on olfactory observations by the naturalists who first described the mushroom. Distinct odours are sometimes described in vague terms such as mildly aromatic, sickly sweet, unpleasant, or offensive. When given, specific descriptions are much more useful for species identification even though they, too, lack any kind of scientific codification. These specific names are often borrowed from familiar food odours, plants and animals, or aromatic man-made products.[12] For the entire fungal Kingdom, whether familiar or unfamiliar, or pleasant or unpleasant, mushrooms always smell like something else.

An illustration published in Fungi magazine lists mushroom odours in a well-organized wheel.[12] The

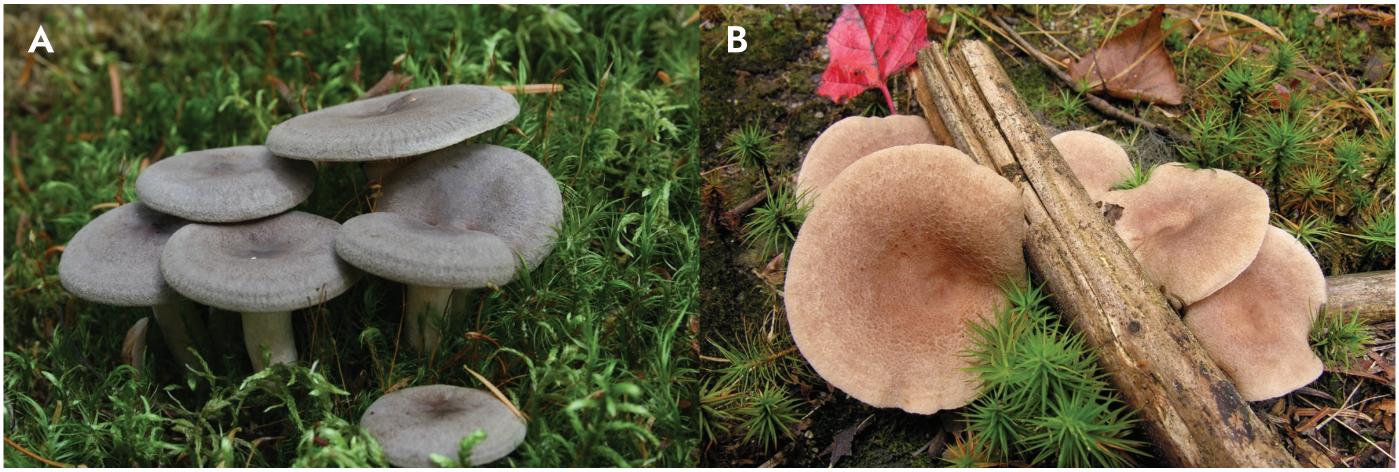

Figure 4: (A) *Lactarius hibbardae* is a pinkish grey mushroom that smells like coconut, especially as it dries. Photo Jim Cornish. **(B)** *Lactarius glyciosmus* has the same coconut odour but appears smaller and browner in our woods. Photo Andrus Voitk.

odours are grouped in two categories. The first category is broad using odour names such as fruity, sweet, floral, spicy, veggie, chemical, animatic, and nutty. The second category is more specific and lists odours as being like coconut (Fig.4), apricot (Fig. 5), peach, molasses, brown sugar, geraniums, wood, grass, cedar, fenugreek, anise, clove, curry, potato, radish (Fig. 6), garlic, iodine, chlorine, yeast, carrion, cheese, fish, walnut and almond odours, to name a few.[12] The article containing the odour wheel is available with the permission of Fungi magazine publisher Britt Bunyan on the Foray Newfoundland and Labrador website at www.nlmushrooms.ca/odour_wheel.pdf. A printout of this wheel will make a great addition to your favourite field guide. You will find it especially helpful when stuck trying to describe a specific mushroom smell.

Figure 5: *Cantherellus enelensis*, the Newfoundland chanterelle, exudes a fruity odour reminiscent of apricots, a key feature in the identification of this favourite edible. Photo Andrus Voitk.

Figure 6: *Mycena pura* is a saprobe that has a strong radish-like smell. This might be important in identification because of the colour variety within these species. Photo Renée Lebeuf.

Mushroom Nomenclature and Odours

Taxonomic classifications across all Kingdoms use Latin and Greek words and their derivatives to give scientific names to living organisms. Species names are sometimes based on obvious features such as size, shape, colour and other notable physical characteristics, including odour (Fig. 7-11). The epithets “odora”, “odoratum”, “odorifer”, and “ordorata”, for example, are vague references to a fragrant aroma. For mushrooms, other specific epithets are based on Latin/Greek words for familiar smells and are much more informative: “pryiodora” (smells like pears), “scorodonius” (like garlic), “saponacuem” (like soap), “traganus” (like goats), “prunulus” (like flour) and “glyciosmus” (like sugar), to name a few. Of course, like many things fungal, it is not always this simple. Some fungi with specific odour epithets do not smell as their names suggest. In *Cortinarius traganus*, for example, “traganus” suggests a “goat-like smell”, but the odour is often described as being more like pears (Fig. 12).

Figure 7: *Clitocybe odora*, the aniseed toadstool, is easily identified by its strong scent of anise (black licorice) in fresh specimens. Photo credit Andrus Voitk.

Figure 8: *Clitopilus prunulus*, the miller or the sweetbread mushroom, smells like flour. Photo credit Andrus Voitk.

Figure 9: *Inocybe pyriodora*, commonly called the pear fibrecap, smells like over-ripe pears. Photo credit Joseph Nuzzolese.

Figure 10: *Hygrophorus agathosmus*, commonly known as the gray almond waxy cap smells pleasant, hence its specific epithet *agathosmus*. Photo credit Andrus Voitk.

Figure 11 (far left): *Mycentina scorodonius* gets its specific name from scorodon, the ancient Greek and Roman word for garlic. Photo credit Andrus Voitk.

Figure 12 (left): *Cortinarius traganus*, common in our woods, has an odour resembling over ripened pears or apples, an important distinction when separating it from its look-a-like *C. camphoratus*. Photo credit Renée Lebeuf.

Odour as an Identification Tool

Except for species with telltale features, identifying mushrooms is not an easy task. Odours can help, especially when separating mushrooms that look alike but smell differently. However, our subjective perception of some odours and our lessened olfactory senses with age may make identification problematic. Different people may sense the same odour differently and name the same smell in different ways. (One person's maple syrup may be another's curry or another's fenugreek.) Some people use descriptions of specific odours that are not recorded anywhere. And still others may easily detect odours but may not be able to name it, especially if they have not experienced the odour before.[12] These comments should not discourage you from using odour as an aid to mushroom identification. Instead, they should help you understand that we do not all sense odours the same and allowances should be made for varying interpretations of a smell.

Further complicating mushroom identification using odour is intraspecific odour variability caused by environmental factors. The day-to-day strength of any mushroom odour may vary depending on air temperature and humidity as well as nutrient availability, soil temperature, oxygen availability, pH, soil moisture content of the substrate. Odour can also differ within a specimen, being weaker or stronger in either the cap, stem, or gills. Since odour biosynthesis is a resource-consuming process, some mushrooms synthesize or strengthen their odours on demand.[13] Odours can be released when mushrooms are crushed (Fig. 13A) or concentrated when they are dried or stored in a container.[6,14]

Figure 13: (A) The strength of the bleachy odour in *Inocybe geophylla*, and many other Inocybe species, is increased when the stem and cup are crushed. Photo credit Joseph Nuzzolese.;**(B)** *Mycena alcalina* complex is also easily recognized for their bleachy odour. Photo Andrus Voitk.

Figure 14: (A) On a calm day, experienced collectors may smell the maple sugar/fenugreek/curry odour of *Lactarius helvus* many metres away. Photo Jim Cornish; **(B):** *Hydnellum suaveolens* is another of our forest mushrooms whose anise/peppermint smell can be detected long before it is sighted. Photo Andrus Voitk.

Ecological Roles of Odours

Odours can be divided into two primary groups; those that signal and affect members of the same species, and those that signal and affect members of different species. Mushrooms give off many odours that are not detectable to our noses but are sensed by plants, animals, insects, bacteria, and other fungi sharing their habitat. These volatiles are thought to be a "universal language" in the complex intraspecific and interspecific interactions to help organisms survive.[5] Intraspecific communicative interactions may be cooperative, competitive, defensive, and pathogenic in nature, but how volatiles are sensed at the cellular level in organisms lacking olfactory organs is not yet fully understood.[1,15] Each of these types of interactions is discussed below with examples.

Volatiles and Interspecific Development

Volatiles are important in the early development of mycelia. When fungal spores germinate, their one or two germ tubes continuously branch to form simple independent mycelia that grow radially through the substrate in search of nutrients. Initially, mycelia emit volatiles to prevent their hyphae from fusing with each other, or with mycelia of other fungi, especially harmful ones. Following initial growth stages, genetically identical mycelia then secrete volatiles to help them locate one another and fuse. What were once individual mycelia becomes a colony capable of transporting nutrients, water and volatiles throughout a complex interconnected network that may grow to be several hectares in area (Fig. 15).[16, 17]

Figure 15: (A) Armillaria solidipes, the honey mushroom, is a parasitic fungus that consists mainly of fused masses of genetically identical mycelia connected by black bootlace-like rhizomorphs **(B)** that spread throughout the substrate in search of new hosts. Photo credit Jim Cornish.

Cooperative Interactions

Mushrooms and plants are known to form complex partnerships. Below ground, hyphae and plant roots exude volatiles that diffuse through air pockets in soils and the detritus layer.[18,19] This diffusion is an essential form of communication in the mycorrhization of plants that begins when a fungus and a plant use volatiles to locate one another.[20] Once found, the fungi release other volatiles that suspend the plants' immune responses, enabling hyphae to surround or penetrate root cells and begin the exchange of water and nutrients for the plant's carbohydrates. This mutualistic symbiosis lasts throughout the lifetime of both partners and comes with many other benefits (Fig. 16). Fungal volatiles are known to improve resistance to pathogens, to act like growth hormones in shaping root architecture and to promote apical root development and lateral root growth in the partnering plants. Because fungal volatile diffusion can be widespread, they can also affect growth similarly in non-partnering plants (see e.g., Fig. 17).[17, 21]

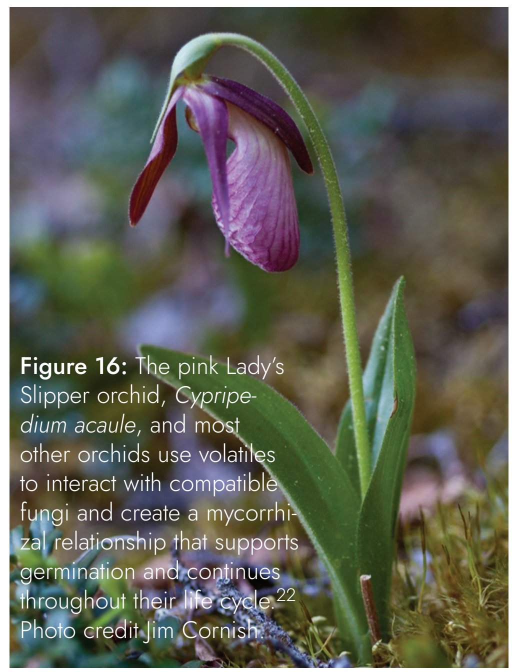

Figure 16: The pink Lady's Slipper orchid, *Cypripedium acaule*, and most other orchids use volatiles to interact with compatible fungi and create a mycorrhizal relationship that supports germination and continues throughout their life cycle.[22] Photo credit Jim Cornish.

Figure 17: In laboratory experiments, volatiles of Laccaria bicolor are known to induce radial root growth in poplar trees, one of its mycorrhizal partners, but also in plants like the mouse-ear cress with which it has no relationship.[21] Photo Andrus Voitk.

Competitive Interactions

Fungi often compete against each other for the same space and resources. To gain an advantage, some fungi produce and diffuse inhibitory volatiles to slow or halt competitor growth long before physical contact. When rivaling fungi meet (see e.g., Fig. 18), volatiles exuded by one or both competitors can cause changes in morphology, secondary metabolite production, pigment deposition, accumulation of oxidants, and enzyme activity in each other. These battles often tax resources and energy, forcing some fungi to sacrifice growth to synthesize the volatiles necessary to maintain their competitive advantages. These volatile-mediated competitions can end in a stalemate or one species can overtake some or all the territory and resources of its competitor.[19]

Pathogenic Interactions

Pathogenic fungi are parasitic and obtain their nutrients by feeding on living host cells. Pathogens usually "sniff" for specific plant odours to locate susceptible species and then inject them with volatiles to disarm or manipulate their defenses. Once the pathogen is established, volatiles are used to initiate physiological and developmental changes that appear as wilting leaves, lesions, cankers, and shriveled fruit in hosts (Fig. 19).[15,5]

Some fungi are invertebrate pathogens and use volatiles to seek out vulnerable insects. Fungal pathogenesis often results in fungal growths extending from the insect's exoskeleton and an invasion of their bodies by hyphae (Fig. 20).[5]

Defensive Interactions

Odours act as "swords and shields" in defending both fungi and their mycorrhizal partners against other organisms. Below ground, odours from mycorrhizal fungi are known to activate plant defenses against pathogens and to outcompete neighbouring plants by inhibiting their growth and the germination of their seeds.[18] Odours are also used by fungi to detoxify rival fungi and to attract or attack bacteria and mycophagic soil invertebrates such as beetles and nematodes. Above and below ground, odours exuded by endophytic fungi, ones that take nutrients from their host without causing harm, defend their hosts against pathogens and sometimes other endophytes.[23,1] In their

Figure 18: *Trametes versicolor* is a combative fungus that can easily take over the territory of competing fungi. Photo credit Henry Mann.

Figure 19: *Gymnosporagium clavariforme* creates pseudoflowers to attract insect vectors for its spores. Like some other rusts, does *G. clavariforme* also use odour as an attractant. Photo credit Andrus Voitk.

Figure 20: *Cordyceps militaris*, commonly known as the orange caterpillar fungus, is the best-known fungal parasite of moth and butterfly pupa and larvae. Do odours emitted by insects help these parasites find their hosts? Photo credit Renée Lebeuf.

own defense, some fungi also use odours to attract the predators of fungal pests (i.e., "the enemy of my enemy is my friend").[24]

Reproductive Interactions

Once fruiting bodies develop and ripen, odours can play a vital role in spore dispersal, especially for truffles and stinkhorns.[17] Truffles are the tuber-like fruiting bodies of symbiotic ascomycetes such as *Tuber melanosporum* (the black truffle; Fig. 21) and *Tuber magnatum* (the white truffle). Since truffles develop below ground, they are completely dependent on other organisms for spore dispersal. Ripened truffles release a mixture of pungent sulphur-based volatiles that diffuse up through the substratum and into the open air. Mammalian and invertebrate foragers attracted by the odours unearth and eat the truffles, and later spread the spores via their feces.[25] Stinkhorns are olfactory paradoxes. Growing above ground, their rancid sulfur-based volatiles are offensive to some creatures but readily attract flies, beetles and other insects who feed on their spore-filled slimy caps (Fig. 22). The spores are then dispersed into new habitats when they pass unharmed through the insects' digestive tracts.[20] Some fungi use volatiles to induce their hosts to form "pseudoflowers" that visually and olfactorily mimic nectar rewards and floral fragrances to attract spore vectors. (Fig. 23)

Are Mushroom Odours Aposematic?

That predators use odours to avoid unpalatable prey was first hypothesized decades ago,[27] but it was not until 1981 that two researchers coined the term "olfactory aposematism" to explain their theory.[28] Olfactory aposematism suggests that organisms secondarily defended by toxins, poisons, or bitter tastes, will also signal their unprofitability via an odour.[29] Odours, as warning signals, have several advantages over colour, the trait on which aposematic theory was founded. Odours can be more effective at warning nocturnal predators whose night vision is usually blind to colour. Odours can also signal unprofitability over longer distances and often circumvent line-of-sight barriers that could lead to inadvertent predator-prey contact.[30,31] Do these advantages also apply to mushroom odours and do poisonous mushrooms use odours to signal their unprofitability? As with colour, there is simply not enough research to give definitive answers yet.

Although field studies designed to test olfactory aposematism in mushrooms are scarce, a 2005 study using cross-species comparisons of hundreds of mushrooms in European and North American guide books found that poisonous mushrooms are more likely to smell "unpleasant" (as judged by humans and maybe other mammals) than edible ones.[29] It has been

Figure 21: The strong odour produced by the black truffle *Tuber melanosporum* produces a strong odour that attracts mammals who find, consume, and then spread the spores of this choice edible. Photo credit Mark Sewell.

Figure 22: *Mutinus ravenelli*, a variety of stinkhorn, produces a carrion odour that repels most animals but attracts insects to disperse its spores. Photo credit Andrus Voitk.

Figure 23: *Puccinia monoica* is a complex that uses volatiles to induce its host to create 'pseudoflower'.[26] Photo credit Doug Whyatt.

Figure 24: *Amanita bisporigera* (destroying angel) can be mistaken for a couple of common edibles. It is lethally toxic with an odour not distinctive in young specimens, but often becoming sickly sweet or reminiscent of rotting meat with age. Is this a warning to vertebrate mycophages and paradoxically an attractant to invertebrate mycophages? Photo credit Renée Lebeuf.

Figure 25 (above): *Amanita porphyria* (grey veiled amanita) is a nondescript poisonous mushroom with a radish smell. Although not unpleasant, does this distinct smell signal the mushroom's unprofitability? Photo credit Pieter van Heerdon.

Figure 26 (left): *Agaricus campestris* (meadow mushroom) is a white edible with a pleasant odour and nutty taste. Photo credit Renée Lebeuf.

Figure 27 (left, lower): *Agaricus arvensis* (horse mushroom) is a delicious white edible with a strong odour of aniseed (licorice). Photo credit Renée Lebeuf.

suggested that olfactory aposematism might be especially important in white mushrooms. While a connection between being poisonous and white is true for some mushrooms (Fig. 24, 25), it is not true for others (Fig. 26, 27)—a situation that contributes to many accidental mushroom poisonings each year.[32] Consequently, there is no reliable connection between odour and edibility other than pungency in odour might make the mushroom less appetizing, but not necessarily poisonous.

Research has also shown that odours do not have to be unpleasant to be effective signals of unprofitability. Since they are processed in the same area of mammalian brains where emotions and memories are stored, odours of any kind can trigger recollections of past encounters with secondarily defended prey that did not end well.[33,2] A study conducted in 1983 that tested opossums' reactions to *Agaricus bisporus* (the common button mushroom) treated with both an innocuous "mushroomy" volatile and the tasteless and odourless poison muscimo found that once the opossums associated illness with the treated mushrooms, they subsequently rejected, without tasting, all other untreated and muscimol laced *A. bisporus*. However, memories of the association did not last; after three months the opossums forgot about the odour as a warning signal and ate muscimol-treated and untreated mushroom alike.[27] Maybe, the short-term memory was enough given the short season and life spans of many mushrooms.

Variable pungency in odour emissions is common in mushrooms and might, for different reasons, be important during the various stages of mushroom development.[5] When spore-bearing structures (gills, pores, and spines) develop, it is in the mushroom's best interest to emit odours to discourage the premature consumption of unripened spores. During the adult stage when the spores are ripe, varying the odour might encourage mycophages to feed and aid spore dispersal. Some mushrooms are known to vary the pungency of their odours during various development stages, but whether this is an adaptation for spore dispersal, or a result of depleted resources remains an open question.[29]

Conclusion

The ability to detect and respond to odours is a primordial sensory ability common to most organisms across all Kingdoms; most organisms, including fungi, use their chemical senses to explore and make sense of their environment. Fungi also use their elaborate bouquets to communicate readiness to mate, to establish various kinds of relationships with plants, microbes, and other fungi, and to attract vectors to disperse their spores. Fungi may also use odours to trigger olfactory flashbacks in animals to avoid predation. Life, it seems, communicates and cooperates as much— if not more— than it competes; perhaps odour may be the universal language between organisms, one we are beginning to decipher only now.

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Some Common Mushrooms with Distinct Odours Found in Newfoundland

Voucher images of the following mushrooms can be found on the Foray Newfoundland and Labrador Flickr webpage at https://www.flickr.com/photos/foray_nl/albums

Odours from the Farmer's Market!

Species	Odour
Chanterelles	apricot
Cortinarius traganus	fetid, pear-like
Inocybe pyriodora	pears
Inocybe sororia	green corn
Lactarius deliciosus	fruity
Mycena pura	radish

Nut & Herb Odours

Species	Odour
Agaricus arvensis	almond
Agaricus bitorquis	faintly almond
Agaricus silvicola	almond
Clitocybe odora	licorice
Cortinarius flexipes	geranium
Hydnellum peckii	anise or peppermint
Lactarius glyciomus	coconut
Lactarius hibbardae	coconut
Lentinellus cochleatus	anise
Neolentinus lepideus	anise
Clitopilus nuciolens	nutty
Russula laurocerasi	almonds

Other Culinary Odours

Species	Odour
Clitopilus prunulus	flour
Hygrocybe helobia	garlic
Mycetinis scorodonius	garlic
Pholiota squarrosa	garlic
Russula adusta	wine
Sarcodon stereosarcinon	flour

Odours of Sweets & Treats

Species	Odour
Hygrophoropsis morganii	bubble gum
Hygrocybe reidii	honey
Hydnellum suaveolens	sweet
Lactarius camphoratus	maple syrup
Lactarius helvus	maple syrup
Lactarius rufus	strong maple syrup
Lactarius thyinos	fruity, like "Froot Loops" cereal

Scents of the Sea

Species	Odour
Lepiota cristata	fishy
Russula compacta	fishy
Russula xerampelina	shrimp

Rotten or Sour Odours

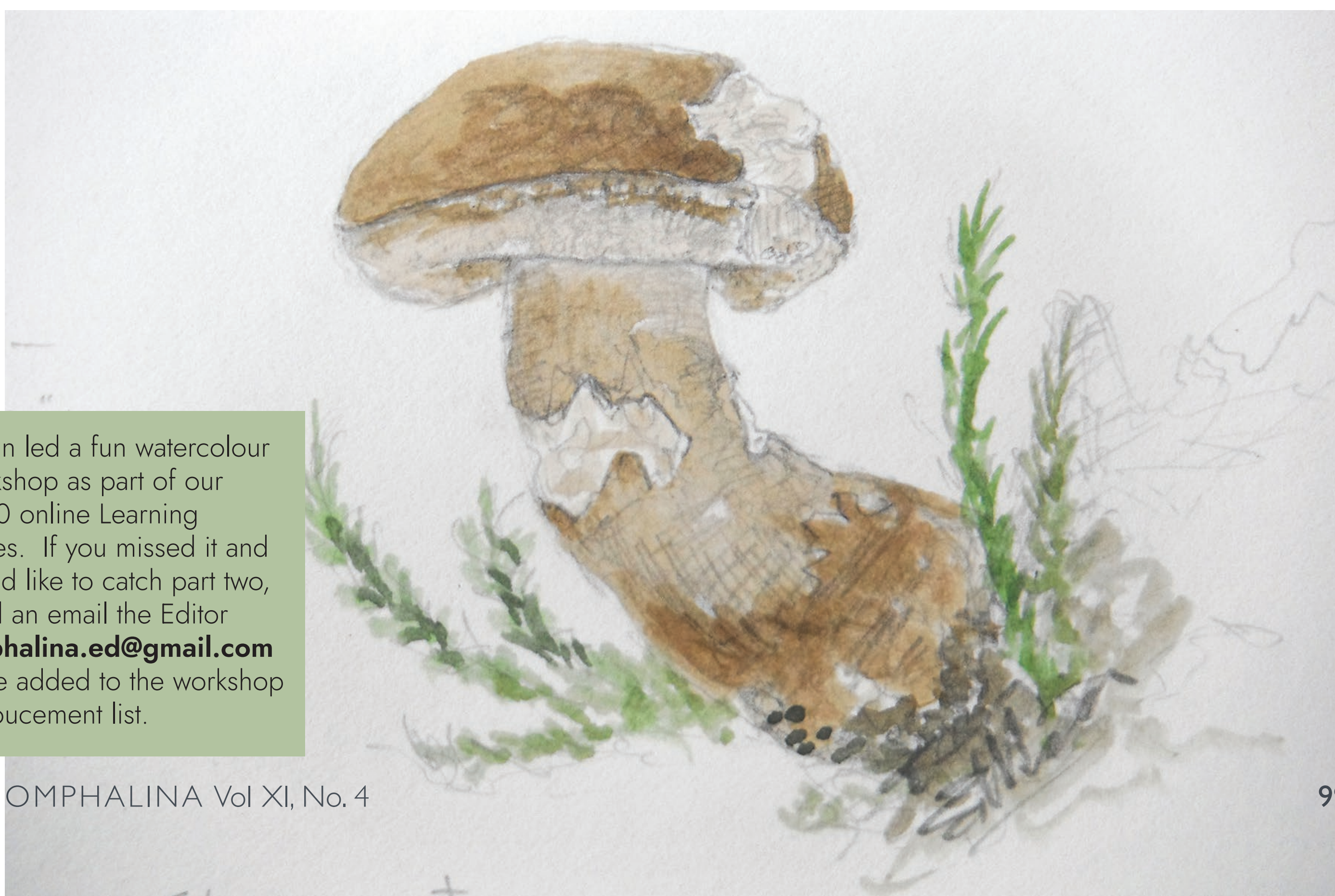
Species	Odour
Cortinarius camphoartus	rotting potatoes
Entoloma incanum	mice cage
Paragymnopus perforans	rotten cabbage
Russula deceptiva	sour; pungent with age

Cleaning Supply Odours

Species	Odour
Mycena alcalina	bleach
Tricholoma saponaceum	soapy

The Bishop's Sketchbook

Artwork by
Glynn Bishop



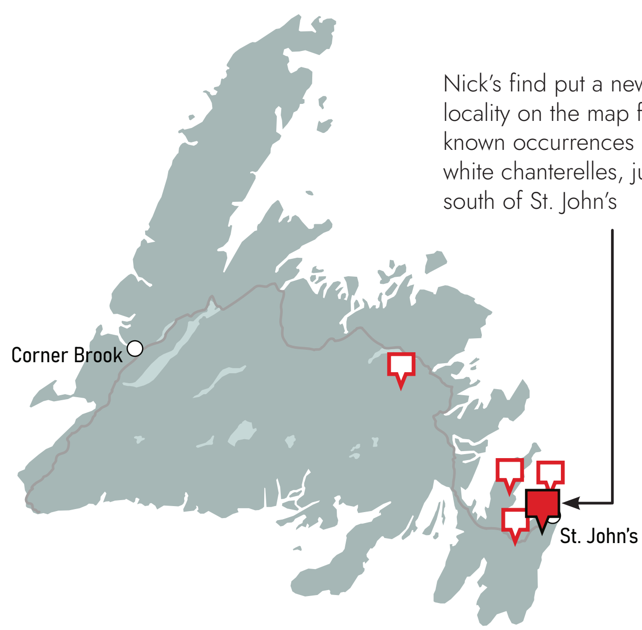
Glynn led a fun watercolour workshop as part of our 2020 online Learning Series. If you missed it and would like to catch part two, send an email the Editor **omphalina.ed@gmail.com** to be added to the workshop annoucement list.

NOTABLE FINDS

Nick Arsenault sent in this image of a handsome white chanterelle, a mushroom that seems to be getting a lot of attention these days in our mushroom circles. Nick indicated that this particular specimen, about 4–5 cm across, was growing alone in moss in a damp and boggy area. The characteristic chanterelle smell was not particularly noticeable in this mushroom.

Preliminary work by Greg Thorn, Bill Bryden, and Andrus Voitk indicates that our white chanterelle is a variety of *Cantharellus enelensis* that lacks the recognizeable orange pigments we all chase down in the woods during peak mushroom season (see OMPHALINA 9(7):7–11). They report their white chanterelle collections from the Avalon Peninsula and central Newfoundland. Since that initial collection effort, images have been trickling in on the Newfoundland Mushrooms Facebook group page, the Editor has stumbled across them in her local stomping grounds outside of St. John's, and they occasionally show up in the Barking Kettle baskets (image below) for sale at the Farmer's Markets. Perhaps they are less uncommon than they first seemed?

A delicious basket full of Newfoundland chanterelles, gold and white, with *Lactarius thyinos* Photo: Scott Fowlow.



Nick's find put a new locality on the map for known occurrences of white chanterelles, just south of St. John's

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