False Truffles of Newfoundland and Labrador

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—Do we have truffles in Labrador?

It may not sound like much, but that is a $1,000 question. The caller was a senior manager at the Wildlife Division of our provincial Department of Environment and Conservation. He had read that according to the stomach content analysis of flying squirrels, most of their diet is made up of truffles. Although there are no flying squirrels on the Island, they do exist in Labrador, and the caller wondered what ours ate. The date was March 2006, a few months after we had completed the Report of our 2005 foray activity, including our first foray in Labrador. Therefore, I was able to answer.

—Yes. Not many words, but a $1,000 answer.

—I haven't heard that we have something as exotic as truffles in Labrador.

—There are various kinds of truffles, both the expensive edible ones and others, both real and false truffles. At our foray we collected a false truffle.

—How can you be sure?

—I'll send you a picture by e-mail. The specimen was identified by a mycologist, and rests in our herbarium. We keep a database to answer such queries. Our species list is published, available to all from our website. When we have a reasonable number, we'll investigate them further.

—So, this is quite a production, then? A validated and verifiable list?

—Yes. Collections are professionally identified by international experts invited for this purpose, then photographed by a professional biology photographer from the University of New Brunswick. Data is entered by a team of our own university students, who get to come to the foray without charge in return for their work. Voucher specimens to back up the list are dried in specially constructed driers and archived in our fungarium at Gros Morne National Park.

—This is very valuable for any organization interested in the biodiversity of our province.

—Yes, and unfortunately expensive. So, I was wondering…

—Yes?

Figure 1. Field pictures of *Alpova* sp., above, and *Rhizopogon pseudoroseolus*, below. Quite similar on the outside, the cut surface shows the difference between the genera: a solid marbled gleba for *Alpova*, and a palisade of air cells for *Rhizopogon*. There is also a change of color of the cut surface of *Alpova*, red first, turning a dusky brown with time.

—Well, seems this was of use to you just now. If you think the Foray generates useful data, would your Division be willing to become a partner in this effort?

—How much are we talking about?

—Well, how about figuring that this year we excuse five database team students from paying registration fees? Say, the fees were approximately $200 a head. That comes to $1,000. What do you think?

—Yes, I think that would be a reasonable expense for our Division.

—And a damn site cheaper than getting this information through a contract.

—Send me an invoice, partner.

Our partnership has grown. Thanks to continued help of our partners we have gathered enough information, experience and contacts to convert an amusing story to dine out on into this report: A brief overview of the truffles we have encountered in our province.

Most truffles are round mushrooms growing beneath the soil surface (hypogeous). The famous and prized edible truffles grow around the Mediterranean and on the west coast of continental North America. They are Ascomycetes, producing spores in elongated sacs like the cup fungi with whom they belong. False truffle is a term reserved for truffles that are not Ascomycetes. Most are Basidiomycetes (primarily mushrooms with cap and stem) that have lost their "normal" shape and gone underground (become hypogeous). Typically, the cap bears and protects the sporulating surface (gills or pores/tubes), and the

stem holds it above ground and moss, so that dropping spores can be borne afield by passing air currents. Going underground, this mechanism is no longer advantageous. Truffles become irregular round balls with the sporulating surface on the inside. However, the mycorrhizal habits of the "parent" species are maintained: truffles are mycorrhizal organisms, with tree or other plant partners.

Despite their macroscopic, microscopic and evolutionary differences, truffles make a logical grouping, because most are alike in behavior. They live underground. They have mycorrhizal relationships with green plants: they feed the plants minerals and water, and in return get some sugars that plants produce via photosynthesis, thanks to chlorophyll. Remaining underground, they do not have access to the wind for spore dispersal, like many mushrooms with a stem. Instead, they emit strong odors, attracting animals to eat them and spread the spores around in their feces. The odor explains why one way to find truffles is to look for swarms of truffle flies, attracted to the fragrance, and why pigs and dogs are used to hunt them. The same odor is why we like them as well.

"Truffleness" is an example of convergent evolution. Organisms from quite different evolutionary lines have independently discovered a similar way to make a living: go underground, partner up with a plant for food, produce spores inside your body, emit a smell to attract consumers to eat you and then disperse your spores to start the cycle anew.

As with many mushrooms, European names have been applied to many North American truffles, which may turn out to be sister species unique to this continent. To date, at Foray Newfoundland & Labrador we have recorded truffles from the genera *Alpova*, *Elaphomyces*, *Endogone, Hysterangium* and *Rhizopogon* in our province. These genera, at least, are reasonably easy to tell apart by their macroscopic morphology. Identification of truffles to species, however, is much more difficult. Truffler mercenaries come armed with microscope and chemicals, using both microscopic appearance and color reaction to chemicals to dissect out the species. Unfortunately, even this attack is repelled by some of our truly cryptic species, which can only be separated by their DNA. Analysis of genetic marker sequences by two of the authors (JH, TH) was used to identify our species of *Alpova* and *Rhizopogon*.

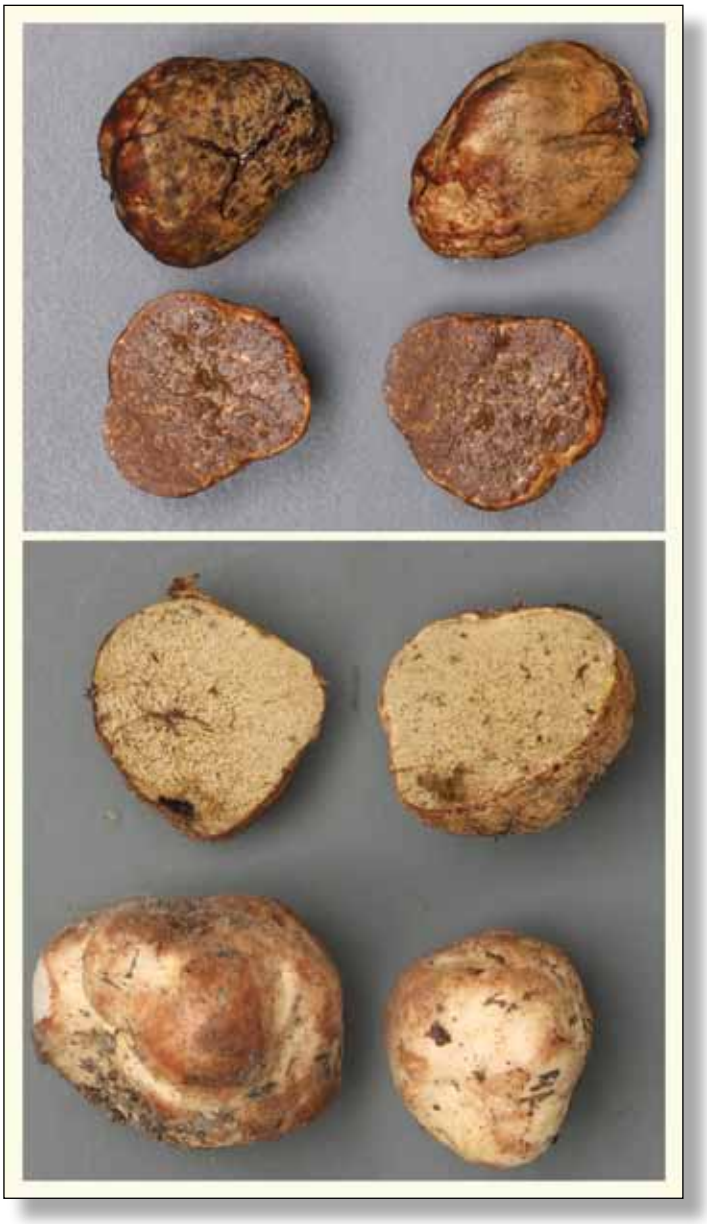

Figure 2. Voucher pictures of *Alpova* sp., above, and *Rhizopogon evadens*, below. Again note the obvious glebal difference between the two genera. These shots taken some hours after collection show that *Alpova* darkens with time more than *Rhizopogon*. Photo: Roger Smith.

Alpova

Alpova is a relative of the gilled bolete genus *Paxillus*, and is mycorrhizal with deciduous trees, mostly species of *Alnus*. In outward appearance, *Alpova* is indistinguishable from *Rhizopogon*, but the two genera are readily differentiated by cross section (Figures 1-2). The context of *Alpova* is solid, alternating between a darkening gelatinous material and a firmer ivory-colored stroma, giving it a marbled appearance.

Our *Alpova* collections range from Pasadena on the west coast of Newfoundland through coastal Labrador and up to its northern interior.* All were associated with *Alnus viridis* ssp. *crispa*, and all clustered together as a single species, close to *Alpova diplophloeus*, but sufficiently removed from it genetically to form a distinct genetic species. DNA (but not the truffle) has been recovered from a soil sample from Alaska, suggesting that it is likely a northern species of wide distribution on this continent. As stated in our preliminary report (Hayward, 2011), we are still working on the nature of this species.

Elaphomyces

Elaphomyces (Figure 3, page 14) is a mycorrhizal partner of conifers, and our only true truffle, although not the prized edible. Its outer shell, the peridium, is hard and thick; inside is a white spore mass that

* Note to puzzled Californians: Pasadena is a community on the shore of Deer Lake, near the west coast of Newfoundland, named by its founder after his wife's birthplace (Pasadena, California, naturally).

changes to a black powder with maturity. Only one specimen has been identified (as *E. muricatus*) others have not been identified to species. These have all been found as hosts to a parasitic ascomycete of the genus *Elaphocordyceps* (Figure 3). This is an interesting genus of small club-like mushrooms, related to the genus *Cordyceps*, so prized in Eastern medicine that pound for pound its cost outranks the most expensive truffle. Our commonest parasite has been *Elaphocordyceps ophioglossoides*; the others have not been identified to species. The easiest way to find an *Elaphomyces* is to dig carefully below an *Elaphocordyceps*. Often they form a ring around the base of a conifer, because the mycorrhizal *Elaphomyces* is distributed around the roots. Careful digging will lead you to the truffle.

Endogone

Endogone pisiformis is the only species of this genus that we have identified, found on the Avalon Peninsula, Central Newfoundland and quite commonly in the bogs along Main River. This miniscule truffle does not fruit underground, but atop *Sphagnum* (Figure 4). Apparently neither saprobe nor parasite, it is thought to form mycorrhizal relationships with plant roots. The plants involved are unclear—despite fruiting on top of *Sphagnum*, it seems that the mutualistic relationship is not with it. *Endogone* is neither ascomycete nor basidiomycete, but belongs to the phylum Zygomycota.

Hysterangium

We have found only one collection of *Hysterangium*, not yet identified to species (Figure 4). This is a basidiomycete genus related to *Phallus* and relatives, a group also quite uncommon in our province. The fruit bodies have a brittle, light-colored peridium, much like another false truffle genus, *Hymenogaster*. Fortunately, again the cross section allows us to identify the genus. *Hysterangium* has an olivaceous gleba (context), not seen with the otherwise dark *Hymenogaster*. *Hysterangium* also has a well-developed columella (an apparent central "trunk" from which branches of stroma split into smaller and smaller limbs to fill the inside). The interior is not solid as *Hymenogaster*, but has some air cells between the branches. Unfortunately the single small specimen found was cut on an angle, thus not showing the columella to advantage; however, careful inspection and a vivid imagination will suggest such a stem; the olivaceous color and air cells are readily seen. Ours was found in a stand of *Alnus viridis* subsp. *crispa*, but there were a few very small balsam fir and white spruce in the area, so that we cannot state the mycorrhizal host with certainty.

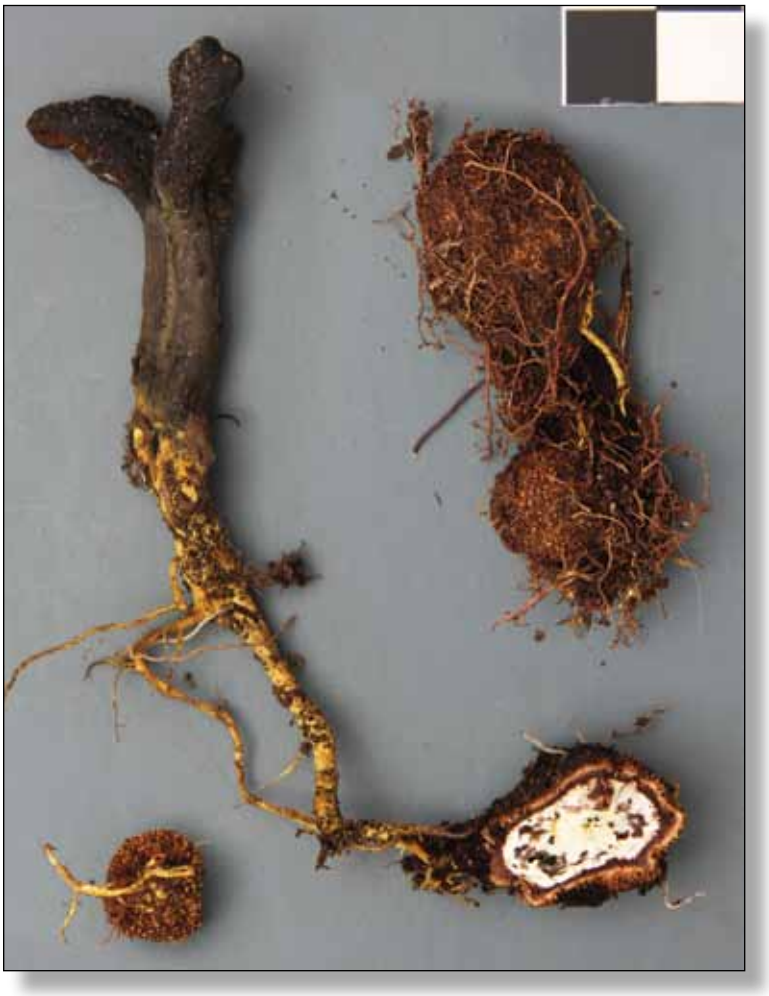

Figure 3. *Elaphomyces* sp. parasitized by *Elaphocordyceps ophioglossoides*. Photo: Roger Smith.

Rhizopogon

Rhizopogon is related to the genus *Suillus*, another subdivision of the boletes, forming mycorrhizal relationships with conifers. As mentioned, *Rhizopogon* and *Alpova* look very much alike on the outside, but are easy to differentiate on cross section. The context of *Rhizopogon* has well defined palisades of maze-like air chambers, the walls of which are white on cross section. The appearance is that of a sponge with very convoluted cells or spaces. Two *Rhizopogon* species have been identified, both from Central Newfoundland (Figure 2). *Rhizopogon evadens* was collected from Notre Dame Provincial Park, and *Rhizopogon pseudoroseolus* (Figure 1) from the red pine stand east of Gambo. A favorite food of squirrels, one specimen was found in the branches of a pine tree, where a squirrel had put it to dry for later use.

The difference between these species is more difficult to determine macroscopically. The skin (peridium) of both starts a light color and darkens with age. Both turn dark on rubbing, *R. evadens* a darker red and *R. pseudoroseolus* somewhat more pinkish. On cross section the skin of *R. evadens* is brown, while that of *R. pseudoroseolus* is a definite rose color. The content (gleba) is white until late, when it turns dark olive. It may stain pink, then brown (without an intermediary yellow stage) on injury. Again, pink staining of the context seems to be more common with *R. pseudoroseolus* than *R. evadens*. Finally, the context of *R. evadens* seems somewhat more compact, while *R. pseudoroseolus* looks to have more air cells. These differences are subtle, even if compared side by side, the pink skin on cross section perhaps being the easiest to discern. Microscopic examination

Figure 4. *Endogone pisiformis* fruiting in its characteristic location on top of *Sphagnum*. Greatest diameter 3.5 mm. Photo: Roger Smith.

Figure 5. *Hysterangium* sp. magnified by stereomicroscope. The suggestion of a columella is seen despite the tangential cut. Also, the olivaceous color and air cells characteristic of the genus are well demonstrated. Photo: Henry Mann.

is required to tell them apart with certainty.

The name *R. pseudoroseolus* suggests the existence of a species called *R. roseolus.* Indeed, this is true. Macroscopically the two have different size and shape of spores, and only *R. pseudoroseolus* shows a very strong reaction with $FeSO_4$.

Adaptation of a review (Voitk, 2011) and preliminary report (Hayward, 2011) in *Omphalina*, this article is not the end of the hypogeous fungi story in our province. Living and reproducing underground, this group of fungi is not often seen by most of us above ground dwellers, because by the time we make it underground, we usually do not report back on our observations there. As a result, the players and details will be slow to reveal themselves, and the story will unfold for a long time yet. No doubt, it is the same for any region, requiring only a small adjustment to the names of the players to reflect the local scene…

References

Hayward, J., T. Howard, and A. Voitk. 2011. Preliminary report from the boletes underground: the false truffles of Newfoundland and Labrador. Omphalina II(8):7-8. www.nlmushrooms.ca.

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