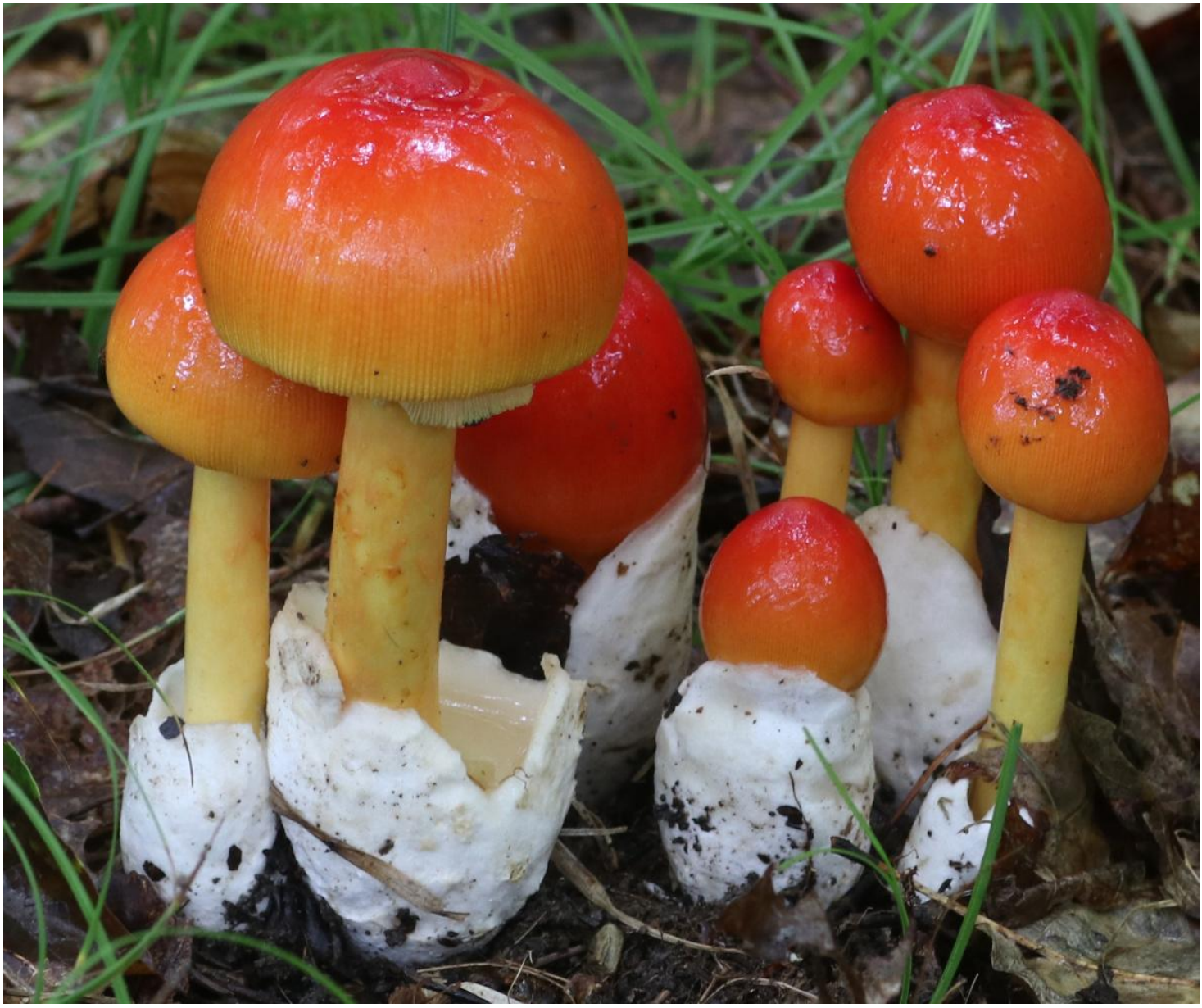
Summer 2022

Fungi Kingdom News

The newsletter of the Pioneer Valley Mycological Association



This beautiful collection of *Amanita caesarea* by Peter Russell is not from this year, as our collecting season has been somewhat of a bust so far, due to the ongoing drought. But to keep himself busy while waiting for the rains, Peter has gone back and studied a pile of *Amanita* collections he made in the past at Laurel Park in Northampton, and worked through their identifications. He shares his findings and beautiful photographs with us, beginning on page 3. Patient searching and strategies like rolling dead logs can still uncover wonderful finds, like the lovely ascomycete *Amicodisca virella* Jess Evans and Mike Ostrowski found during a club walk at Lily Pond in Goshen recently. See the photo of this little beauty on page 2. So don't give up the hunt, and let's keep hoping for rain!

In this issue ...

Pioneer Valley Mycological Association

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OUR MISSION STATEMENT
The Pioneer Valley Mycological Association is dedicated to enhancing the public's knowledge and appreciation of the fungal kingdom by providing ongoing educational programming in the form of guided mushroom walks, lectures, newsletters, information on multi-day regional and national forays, and citizen science projects. Because fungi are integral components of complex ecosystems, we are committed to advocating for responsible and sustainable study and collection methods. We focus on, but are not limited to, the three counties of the Pioneer Valley in western Massachusetts (Franklin, Hampshire and Hampden).

PVMA is a member of the Northeast Mycological Federation (www.nemf.org) and the North American Mycological Association (www.namyco.org).

www.PVMAmyco.org

Also visit Dianna Smith's educational site fungikingdom.net for articles, fungi photos, and more.

We Welcome Your Submissions!
This is your newsletter; we'd love to have you contribute to it!
Prose, verse, photos, drawings, recipes, scientific observations – send them all to:
jessicabensonevans@gmail.com
sue.lancelle@gmail.com

From the President…

Raise your hand if this mushroom season so far has been a bit of a disappointment! Yep, me too. Almost all of Massachusetts is in a drought, and it looks like those conditions will continue through the end of July and beyond. After last year's incredible fungi year, I think we can't help but be disappointed.

It's been wonderful to see so many of you still coming to walks with optimism and a sense of humor; I don't think I've ever seen a trail as barren as Mt. Toby was a few weeks ago! (One red *Russula* was the only fresh specimen found in almost two hours.) We're not alone, though; clubs throughout the Northeast and beyond are all reporting similar conditions.

Despite the drought, there are certainly still fungi out there. They are just much harder to find! I remain hopeful that even if this season is lackluster, there will still be bright spots. For example, Mike O. and I spotted a new-to-us ascomycete at Lily Pond this past weekend, *Amicodisca virella*. Keep rolling logs over, keep hiking the woods, and I think you'll still find a few treasures!

– Jessica

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The ascomycete *Amicodisca virella*, found at Lily Pond in Goshen recently.

Dabbling in Amanitas at Laurel Park, Northampton

By Peter Russell

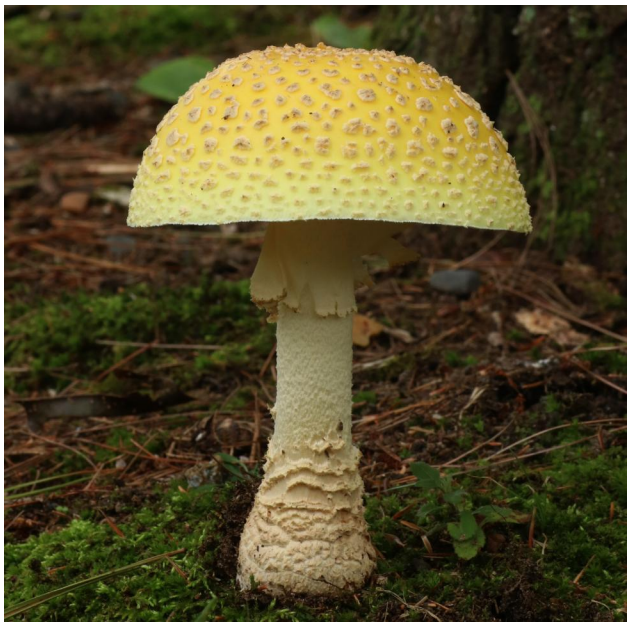
Laurel Park is on old Methodist summer camp on the outskirts of Northampton that celebrates its 150th anniversary this year (2022). It's a wooded parkland where cottages share the space with large trees mainly of oak, hickory, hemlock, white pine, red maple, sweet birch and European beech. All these mature trees mean it's a great place to look for fungi!

I've been recording the fungi in the park for the last 12 months, and in some cases I've even been able to identify them! To date there are 130 identified species which can be perused on iNaturalist under a project called "Fungi Of Laurel Park." The recent drought has slowed collections to a trickle, so in frustration I've started looking back at some of the many unidentified dried specimens I collected last year. One genera with the most collections is the genus *Amanita*. To date I've identified 17 species and I wanted to share some of these finds in this note.

The *Amanita* genus is one of the best groups of fungi to study as an enthusiast. It contains hundreds of described species and many common ones can reliably be found during the season, even in the current drought (as I write this in late July there is a small fruiting of *A. volvata* and *A. virginiana* basking under the sun). The genus contains many beautiful photogenic fungi, perhaps the best known fungus (the fly agaric) as well as some of the deadliest (e.g., destroying angel) and even one of the most edible (Caesar's mushroom). Most importantly there are several good resources to help with identification (not least, the excellent Amanitaceae website at http://www.amanitaceae.org/).

First some notes on the taxonomy and field characteristics of the genus *Amanita*. Most of us could recognize a mushroom as an *Amanita*, but just to recap, for the vast majority of amanitas:

- They have pale gills that are free, i.e., they don't quite reach the stipe so you can see a narrow open ring where the stipe meets the cap
- They have a white spore print
- Many have a bulbous base to the stipe, although



Amanita muscaria var. *guessowii*, the common fly agaric

there are some sections that don't (e.g., those in *Caesarae* or *Vaginatae*)

• The developing mushroom is enclosed in auniversal veil that looks like an egg when young. As the mushroom expands it breaks out of the universal veil, leaving the remains, depending on the section, as a volva at the base of the stipe or warts or patches on the cap

• They have relatively dry caps unlike the slimy caps of the closely related *Limacella* genus

• Many have the remains of a partial veil as a stipe ring or fragments attached to the stipe or cap edge. The partial veil extends from the stipe to the cap and protects the gills

• One unique feature of *Amanita* which we don't often observe is they have a schizohymenial (gill splitting) mode of development. If we were to look at a young *Amanita* button we would see a solid mass without any cavities. All parts of the mushroom develop in place within this solid mass and then split apart in the final stages of development

• Most amanitas are ectomycorrhizal but a few are saprobic (there have been attempts to split the saprobic members into a separate genus). The genus is monophyletic and descended from a common saprobic ancestor (it's fascinating that the mycorrhizal habit has evolved independently in groups other than *Amanita*!).

The *Amanita* genus has been divided into several sections that can be recognized by a combination of different physical characteristics, such as:

• Overall coloration and stature

• Presence and distribution of universal and partial veil tissues

• Sulcations (grooves) around the cap margin

• Shape of the base of the stipe

There are seven sections grouped under the sub-genus *Amanita* (spores are inamyloid) or the sub-genus *Amidella* (spores are amyloid). Amyloid is where the spores stain dark in iodine. All seven sections of *Amanita* are represented in Laurel Park and are described as follows.

***Amanita* subgenus *Amanita* (spores inamyloid):**

Amanita* sect. *Amanita: In the *Amanita* button, the mushroom develops off centre towards the top so when it bursts out of the universal veil it usually forms a swollen base below. The volva is usually concentrically ringed and scaly (as in the fly agaric) or collar like (as in the panther caps) or powdery (as in the eastern dust cap) or in a few cases sack like.

Amanita* sect. *Caesareae: The mushroom develops towards the centre of the button, so when it bursts out of the universal veil there is no swollen base. There is a partial veil (annulus or ring), the universal veil remains form a sack-like volva and the cap has a striate or narrowly grooved margin. Many like Caesar's mushroom are brightly colored and photogenic. Note there are some truffle-like amanitas that are placed in this section.

Amanita* sect. *Vaginatae: The mushroom develops as in section *Caesareae* but one big difference is they have no partial veil. The volva is usually saccate, but may break up and be difficult to find, whilst the edge of the cap margin is narrowly lined.

***Amanita* subgenus *Lepidella* (spores amyloid):**

Amanita* sect. *Lepidella: Are usually large and white (though may yellow in age). The universal and partial veils are poorly developed and margin of the cap is decorated with powdery& hanging material when young and the base of the stipe is not enclosed in a sack-like volva.

Amanita* sect. *Amidella: Have a cap with an appendiculate margin as in section *Lepidella*; however, the appendiculate material is less developed and disappears quickly. In many the stipe is not swollen and is enclosed in a very thick, multilayer, sack-like volva. Only one described

species has a partial veil that is only found in the early stages of expansion.

Amanita* sect. *Phalloideae: Have a cap that is usually bald with margin that is not appendiculate even in very young specimens, a stipe that always has a bulbous base and always has a persistent partial veil, a universal veil that is always membranous and is present on the stipe's bulb as either a limbate (flap-like) or saccate volva.

Amanita* sect. *Validae: Have a cap whose margin is never appendiculate, a persistent partial veil on the stipe, a swollen base to the stipe, and a volva that is always friable (fragile, breakable).

Amanita species found in Laurel Park

Section *Amanita: Amanita muscaria* var. *guessowii* – Eastern fly agaric

This is the iconic fly agaric, the bright red, white flecked toadstool of children's books. Although the red-capped version exists in North America, in our region it is the yellow-capped variety that predominates (var. *guessowii*). Note how the volva is concentrically ringed at the bottom of the stipe. This is primarily associated with conifers and is found under white pine in Laurel Park. A fungi that is sometimes found near the fly agaric is the small bolete *Chalciporus piperatus*, suspected to be a mycoparasite feeding on the mycelium of the *Amanita*. I have yet to find this species in the park.

Section *Amanita: Amanita frostiana* – Frost's amanita

This colorful *Amanita* is widely distributed but often confused with other species, including *A. flavorubens* and *A. flavoconia*. However, it has a striate margin to the cap, a persistent collar around the swollen base, and the ring is often in the middle or lower part of the stem (note that it isn't in the example shown!).

Section *Amanita: Amanita multisquamosa* – white panther

This is a fairly common *Amanita* in Laurel Park (though not yet in this year's drought!). It is one of the "panther caps" that are characterized by a single ring of tissue at the top of the basal bulb, sometimes described as a rolled sock or collar like. I have difficult distinguishing this from other species such as *A. velatipes* or *A. gemmata*, although this is meant to have long striations on the cap margin.

Section *Amanita: Amanita crenulata* – champagne amanita

This is another common fairly distinctive *Amanita* in Laurel Park: rather small (up to 4 inches in diameter), a pretty champagne cap colour with creamy tan or beige warts, and a swollen bulb at the base of the stipe typical of the *Amanita* section. It was first described from a collection near Boston and is common under pines and oaks.

Section *Amanita: Amanita farinosa* – Eastern dust cap

When I first found this little mushroom I did not recognize it as an *Amanita*! It had no ring on the stem and no great swollen base to the stem. The cap and stipe was covered in pulverent material (i.e. fine dust or powder) that are the remains of the universal veil, which is characteristic along with the small size for the species. I am fond of this find as it was fruiting on one of the hottest days of the year when there was nothing else to find!

Section *Caesareae: Amanita virginiana* – little gray Caesar

I restrict my collections to the wooded parkland though there is also a 9-acre wood owned by Laurel Park. In that wood there is the occasional orange edible Caesar's mushroom, but in the parkland there is a tiny member of the section known as the little gray Caesar. It could be confused with another diminutive species, A. pachysperma, but has a more persistent ring on the stem, less crowded gills, and smaller spores. This is another species I have found in the heat of the summer.

Section *Vaginatae: Amanita vaginata* group – grisette

This is a frequently fruiting species in the park growing under hickory and hemlock in the Park. This is the type species for the *Vaginatae* section and has the typical characteristics described for this section. However, there has been some disagreement on the concept of this species and most experts now feel there are several different species that go by this name.

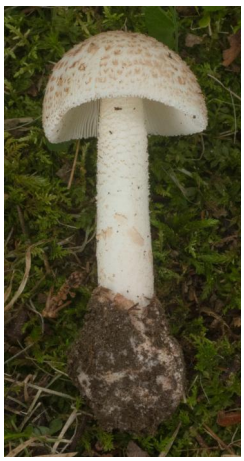
Section *Vaginatae: Amanita fulva* – tawny grisette
This is a common *Amanita* in our local woodlands, often being found in boggy areas or the rotting wood of old stumps, but is uncommon in Laurel Park. This is a fairly distinctive *Amanita* with the tawny color and *Vaginatae* characteristics but there is one look-alike, the curry yellow grisette or *A. sinicoflava*, that has yellow-olivaceous rather than tawny colors and a sack-like volva that turns a gray color.

Section *Vaginatae: Amanita rhacopus* – snakeskin grisette
This grisette has several common names including the strangulated amanita and is a frequent find in our area. In the past this was erroneously identified as the European species *A. ceciliae*. And older books may name it *A. inaurata* or *A. strangulata.* It gets its name from the surface of the stalk that breaks up into fibrils and become very dark on handling, resembling a grey snakeskin. The cap is gray or olivaceous brown.

Section *Lepidella: Amanita subcokeri* – false Coker's lepidella
Amanita subcokeri is a beautiful white *Amanita* with a big, long rooting, chiseled basal bulb with recurved scales and a pleasant odor when young. This is difficult to distinguish macroscopically from the rarer *A. cokeri* which is a larger mushroom whose basal bulb does not stain red and does not have an odor of burnt sugar.

Section *Lepidella: Amanita canescens* – gray lepidella
At first glance this looks like it belongs in the *Amanita* section with the smooth cap and large scales and muscaroid stature. Its most noticeable characteristic is meant to be fibrils on the stem that bruise orange and the graying cap color; however, I have not observed the former! This is fairly common in Laurel Park but few grow to maturity as most get attacked by a blue-green colored parasite suspected to be a *Hypomyces*.

Section *Amidella: Amanita volvata* –
American amidella
This little *Amanita* has been fruiting under a white oak tree throughout the very dry summer, not in any quantity, just the odd occasional specimen! It has a robust sack-like volva and stains pink. There is a look-alike species, *A. pseudovolvata,* but that is usually smaller and has short striations on the cap.

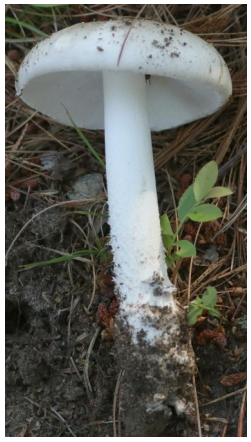


Section *Phalloideae: Amanita bisporigera* –
Eastern destroying angel
This deadly poisonous mushroom has been recorded from one garden in Laurel Park, where it is growing under a shagbark hickory. The current concept of *A. bisporigera* is actually a complex of 5 or 6 separate species; the true species can be separated microscopically by having only 2 spores per basidium and is a smaller, less robust, spindly version of the others.

Section *Validae: Amanita amerirubescens* –
Eastern blusher
The blushers are probably the most familiar of the ***Validae*** section as they are very common and recognized by bruising or aging a pinkish to reddish color. Most of the collections from Laurel Park I have identified as *A. amerirubescens* though they are quite variable in color, with some paler forms (e.g., the collection on the right). Variety *alba*, the eastern white blusher, is a much less common, stockier, paler form of the blusher.

Section *Validae: Amanita flavorubens* – yellow blusher
This is another commonly found blusher in Laurel Park recognized by its yellow cap with yellow warts (which may wash off in the rain!, a pale stalk, and the habit of bruising red. In its typical state it is easily recognizable but it can sometimes mimic other species such as *A. elongata* or *A. frostiana.*

Section *Validae: Amanita flavoconia* – yellow patches
Yellow patches is one of the most common amanitas in the Northeast, one of the first to appear, and has been fruiting this year in Laurel Park this year despite the drought. It is reasonably distinctive, though the yellow patches are often washed off by the rain and the stature can vary from quite stocky to quite slender.



Section *Validae: Amanita submaculata* – ballgown amanita
This collection illustrates how easy it is to get confused with the field characters. The common name of this species comes from the fact that it has a ring on the stem that is very striking and hard to miss, resembling a 19th century ball gown. Though the partial veil was still covering the gills in this specimen and was overlooked, DNA sequencing matched it to A. submaculata!

A Few Notes on Using Field Guides

By Jonathan Kranz
As a recovering vinyl records collector and sometime audiophile, I appreciate how inexpensive mycology is, demanding more an investment of time than of money – with the exception of the mushroom field guides I have difficulty resisting.

Our PVMA website offers an excellent guide to field guides. To get a deeper understanding of how to get the most from these (and other) mushroom books, I recently met with PVMA club cofounder and resident mycologist, Dianna Smith, who herself has co-written, with Alan E. and Arleen R. Bessette, the 2021 guide, *Polypores and Similar Fungi of Eastern and Central North America.* The following notes come from our conversation.

Jiggling the keys
"Keys" are the taxonomic gateways to identification through macroscopic (apparent to our unaided senses) observation of various mushroom qualities: spore color, overall fruiting body form, habitat, season, etc.

The most familiar format is the dichotomous key in which the user is marched down an identification pathway by means of mutually exclusive pairs (sometimes more) of qualities; at each juncture, the choice of one quality leads to another pair and so on until the identification is confirmed. David Arora's *Mushrooms Demystified*, for example, is particularly acclaimed for the clarity of its keys.

But dichotomous is not the only way to go. Gary Lincoff's *Field Guide to Mushrooms* applies the National Audubon Society's visual key format. Users follow icon tabs to find visual "sets" (e.g., conical caps, convex caps, convex caps with pores, etc.), then scroll through the images to find likely matches that lead to descriptions in the body of the book. Thomas Laessoe's and Jens H. Petersen's *Fungi of Temperate Europe* takes the visual approach to another level, creating a series of graphic "pies" in which related form groups occupy different "slices" of the pie; each slice, in turn, leads to another pie for deeper exploration.

Which is best? The one that works for you. Personally, I like to use Arora to get to genus, then apply a regional field guide – or a guide dedicated to exclusive taxons, such as boletes or milk mushrooms (*Lactarius*) – to get to species.

Reading the entries

Regardless of guide, the species entries tend to follow common formats that explore observable features: caps, fertile surfaces (gills, pores, teeth, etc.), stem, base, odor, taste, etc., reinforced with discussions of season, habit (do they appear solo or in groups?), habitat (where found), and substrate (what they're growing on). They'll often include statements of edibility or toxicity, plus other remarks or comments that may help narrow identification.

Nomenclature

On page 117 of *Polypores* you'll find the entry for the beefsteak polypore represented as:

Fistulina hepatica (Schaeff.) With.
= *Ceriomyces hepaticus* Sacc.
= *Fistulina hepatica* var. *monstrosa* Peck

Let's unpack the nomenclature. The name in bold gives us the current Latin binomial (determined by contemporary scientific consensus that can be frustratingly fleeting given evolving DNA research) with the capitalized genus followed by the lower-case species. The abbreviated name in parentheses refers to the first mycologist to identify this species by this name (Jacob Schaeffer) while the subsequent name refers to the mycologist who has composed the most current understanding of the species, William Withering. The subsequent names, prefaced with equal signs, offer alternative names (with their representative mycologists) that have been subsumed under the lead name.

Does any of this help with identification? Probably not, but it reminds us of two important points: 1) even the best mycologists struggle with identification and taxonomy, and 2) names are a moving target that shifts as new evidence emerges.

Color and vocabulary

As you dive more deeply into the physical descriptions, you'll notice two things. First, field guide authors are not nearly as fixated on color as many enthusiasts can be. No, science has not anaesthetized these writers against beauty; rather, they, being the experienced fungi hunters they are, recognize that color is fugitive, fleeting, and only partially reliable as means of distinguishing species. Why? Colors can change in the presence of moisture (hygrophanous), exposure to sunlight, and in the course of its aging and decay, among other things.

Beyond color, one must explore other physical qualities that challenge our vocabularies. In addition to "hygrophanous," you'll come across unfamiliar words such as "reticulation" (relief netting on the stem), "squamous" (scaly), and "appendiculate" (referring to tissue fragments dangling from cap margins), plus common words with unfamiliar meanings such as "even" (of a stem, consistent width top to bottom) or "free" (of gills not attached to the stem).

Point is, we all have to stretch our vocabularies to get the most from our guides and to share information with fellow mycologists. Many guides include glossaries within their back matter; our club offers two online: one by Roy Halling and one by Dianna Smith.

Dianna encourages us to learn, or at least form a nodding acquaintance with, the Latin roots behind the scientific nomenclature. Recognizing "semi-sanguineus" as meaning "somewhat blood-like" helps us remember the deeply red-gilled *Cortinarius semisanguineus*. (And translating "lycoperdon" helps us entertain children during long forays.) But … keep in mind that Latin references can be as idiosyncratic as English spelling; *Laetiporus sulphureus* (chicken of the woods) does indeed have a sulfur-yellow coloring, yet the name of its kissing cousin, *L. cincinnatus*, doesn't look anything like the home to three-way chili, but is just a shout-out to the location where it was first identified.

Non-body characteristics

As an eager beginner, I was too quick to pluck mushrooms without first recording, by photography and notes, where and how I found my specimens.

This is a big mistake – please learn from me. Most guides include information in three crucial areas that can save a lot of time and frustration – if you've taken the pains to collect the right data:

- **Habit:** What's the "social status" of your specimen? Does it appear alone (solitary), among a loose grouping (gregarious), in troops, are even clustered at the base (caespitose)? The distinctions matter: both the poisonous jack o'lantern (*Omphalotus illudens*) and the chanterelle (for sanity's sake, we'll call it *Cantharellus cibarius*, though the name is debated) are yellow-orange, but the former is typically densely clustered while the latter is usually scattered.

• **Habitat:** Where are they growing? Woods, fields, or waste areas? Among deciduous trees or conifers? In darker, wet areas or in drier uplands? You'll usually find *Agaricus* species in open grassy areas, while *Suillus* mushrooms favor pine forests. The jack o'lantern referenced above grows on wood (sometimes buried) while the chanterelles will be found on soil.

• **Substrate:** What are they growing on? Open soil, ground under/near trees, dead timber, wood chips, moss, leafy duff, or even dung? Sometimes the easiest way to eliminate look-alikes is to consider their substrates; *Pseudoboletus parasiticus* (remember the Latin we just talked about?) may look like many other yellow-pored boletes, but this is the ONE that grows on (parasitizes) the common earthball, *Scleroderma citrinum*.

Betcha' can't eat just one

People often ask for mushroom book recommendations. Please keep this in mind: if you're interested in mushroom identification, you're going to need more than one book. For our area alone, I have four books with "northeast" or "northeastern" in their titles. No one book can include all the specimens you may find; no one author's perspective may be definitive when you have ambiguous specimens on hand.

Guides tend to fall into three categories: broad introductions to mycology in general, region-specific guides, and taxon-specific guides. The aforementioned PVMA page is a great place to start; here are some of my personal recommendations.

General guides:

• *The Complete Mushroom Hunter* by the late Gary Lincoff is a thin, but comprehensive introduction to mushrooms and mushrooming, including thoughts on edibles and toxics.

• *Mushrooms Demystified* by David Arora is a thick, doorstopper of a book that, despite its age (1979/1986) and emphasis on West Coast fungi, remains an extremely useful "bible" for all matters fungal, including an excellent glossary reinforced with Latin terms!

Regional New England guides:

• *Mushrooms of the Northeast* by Teresa Marrone and Walt Sturgeon is one of the few field guides that, as a consequence of its small, compact format, can realistically be carried into the field. I love the visual icons for season and substrate, and the editors have highlighted the most important identification "tells" in **bold green print.**

• *Mushrooms of the Northeastern United States and Eastern Canada* by Timothy J. Baroni is current (2017), deep, and beautifully photographed. (This is the book that seems to be most used by our ID leaders on PVMA walks.)

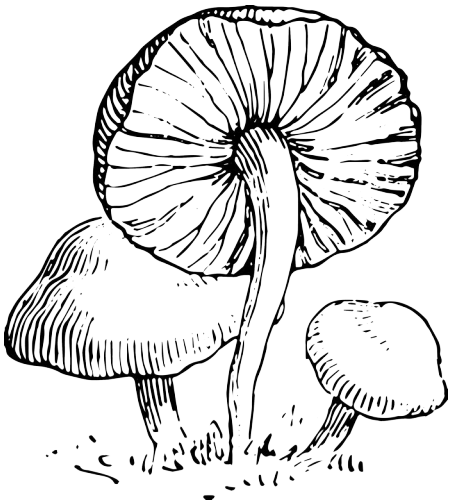
• Dianna notes that field guides devoted to regions east of the Rockies sometimes refer to mushrooms we might find in our area, but are often neglected by "northeastern" guides. These include *Appalachian Mushrooms: A Field Guide* by Walt Sturgeon, and *Mushrooms of West Virginia and the Central Appalachians* by William C. Roody.

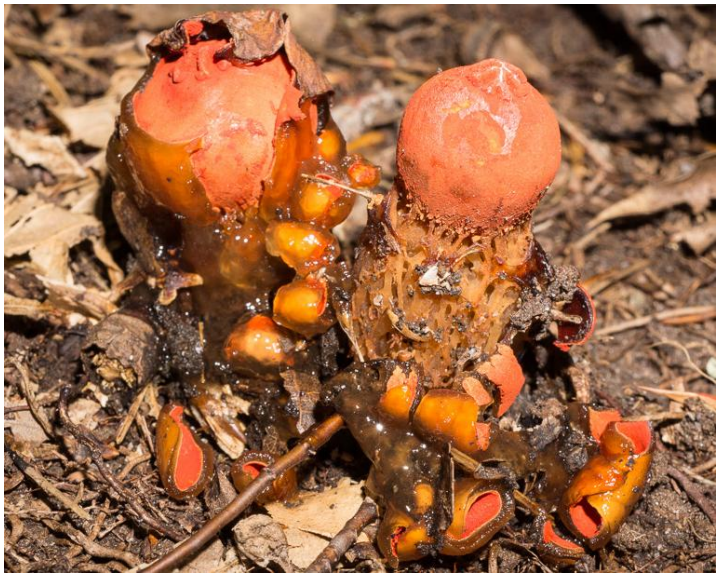
Taxon-specific Guides

These are entirely a matter of your tastes and interests. I suspect that, given the visual splendor and high proportion of edibles among the boletes, many club members would appreciate *Boletes of Eastern North America* by Alan E. Bessette, William C. Roody, and Arleen R. Bessette. *Polypores and Similar Fungi* by Alan E. Bessette, Dianna Smith, and Arleen R. Bessette (mentioned earlier) is not only the most current book (2021) on the topic, but a true companion for the long New England winters when polypores may be the only fungal game available to us.

A final thought on acquiring books

Many of our best, most forward thinking mycologists are scientific nomads who make a living through a complex mix of teaching, research, consulting, public speaking … and writing. If you've learned from one of these people and/or have appreciated their walks and talks – buy their books. By doing so, you enrich your life with greater knowledge while supporting the very people who expand that knowledge.





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In all its gelatinous glory ...

Calostoma cinnabarinum

By Sue Lancelle

Long before I knew much of anything about fungal identification, I would sometimes stumble upon strange looking little organisms in the woods. They consisted of orange or red spheres atop stringy stalks, and were often covered in a clear gooey gel that had red or orange bits embedded in it. I knew they had to be fungal, but they looked so different from any fungi I had ever seen that I found myself thinking, "What the heck is this thing?"

It turns out that I was seeing *Calostoma cinnabarinum*, a fungus that goes by many colorful common names, including "stalked puffball in aspic," "gelatinous stalked puffball," "stalked globose puffball," "pretty mouth," and "hot lips." The name *Calostoma* arises from the Greek *kallos*, meaning "beauty," and *stoma,* meaning "mouth." The "beautiful mouth" refers to the opening at the top of the globe and its surrounding red "peristome," ridges that line the opening and give it a very distinctive appearance. Incidentally, you might also see this fungus referred to as "*C. cinnabarina*," but this is wrong because of the Greek, rather than Latin, origin of the genus name. *Stoma* is neutral in Greek, so the species name (in Latin) must also be neutral, thus the Latin name "*cinnabarinum*."

Castro-Mendoza *et al.* (1983) described the morphology and development of *C. cinnabarinum* as follows. Most of the development of the globose head takes place underground. It starts to emerge as a red sphere covered in gelatinous goo (Fig. 1). Eventually, a stringy stalk elongates, pushing the globose head up out of the soil (Fig. 2). The globose head has an outer layer (peridium) consisting of three layers. The outermost layer is the exoperidium, which is shed as the fungus emerges from the soil and ends up embedded in the surrounding gel (Figs. 3, 4). The middle layer (mesoperidium) is harder and is colored bright red or orange. Most of it also falls off when the fungus reaches full maturity. The inner endoperidium is less colorful, slightly gelatinous, and has the opening at the top, surrounded by the red star-shaped peristome (Figs. 2, 5). Inside the endoperidium is the spore sac. At maturity, the spores, which are distinctively reticulated, escape through the opening, like a puffball (Fig. 6).

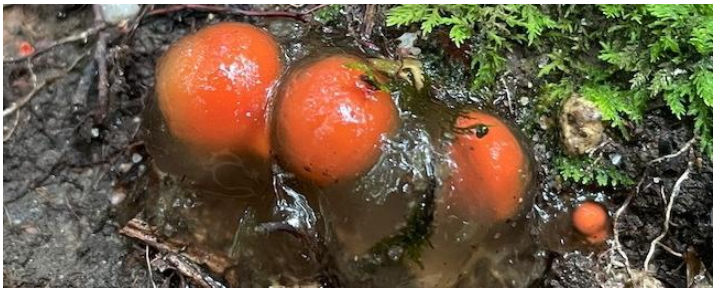

Figure 1. After developing underground, the globose head emerges, covered with gelatinous goo.
Image ©Rob Gourmand. Used under CC BY-SA, cropped. Accessed at Mushroom Observer.

Figure 2. Elongation of the stringy stalk pushes the head up out of the soil. The head has shed its outer layers and the colorful peristome remains at the top.
Image ©Geoff Balme. Used under CC BY-SA, cropped. Accessed at Mushroom Observer.

To get back to the question of "what the heck is this thing?", this fungus has a long history of being

categorized into many different groups. As described in Hughey et al. (2000), *Calostoma* is one of many fungi that previously had been categorized in the catch-all (but artificial) group called "Gasteromycetes" because their spores develop internally rather than on external structures like gills or tubes. It was variously placed with stalked puffballs, true puffballs, earthstars, or stinkhorns. Traditional morphological and developmental studies could not convincingly answer the question of its evolutionary lineage. Hughey *et al*. (2000) employed DNA sequencing to solve the mystery, and perhaps surprisingly, it turns out that *Calostoma* belongs in the Boletales. After further extensive DNA analysis, Binder and Bresinsky (2002) first proposed placing *Calostoma* in a suborder of the Boletales, the Sclerodermatineae, along with an array of morphologically diverse families that include such genera as *Pisolithus* (another "Gasteromycete"), *Astraeus* (the hygroscopic earth star), *Scleroderma* (pigskin puffball), *Gyroporus*, and *Boletinellus*. This is a mind boggling example of the power of DNA analysis!

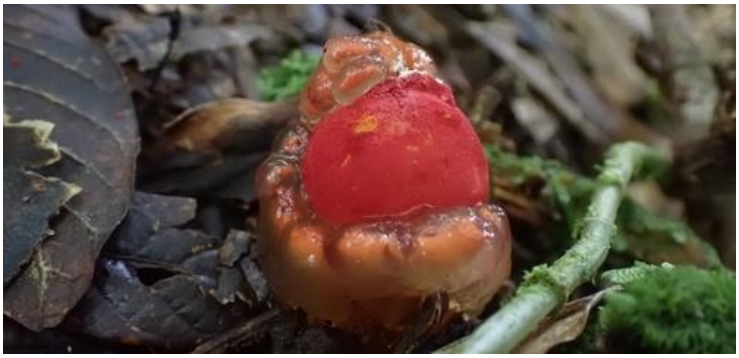

Figure 3. The exoperidium is shed and ends up embedded in the surrounding gel. Image ©Paolo Acevedo. Used under CC BY-4.0, cropped. Accessed at iNaturalist.

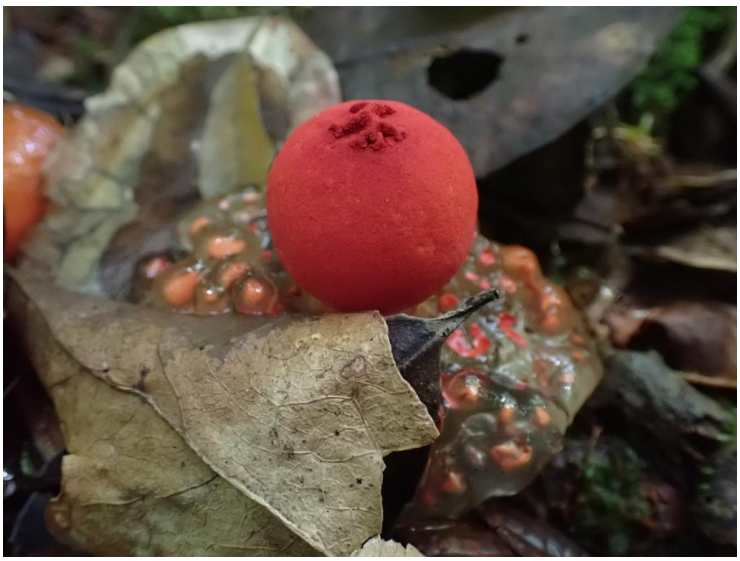

Figure 4. The brightly colored mesoperidium remains after the exoperidium is shed. Image ©Paolo Acevedo. Used under CC BY-4.0, cropped. Accessed at iNaturalist.

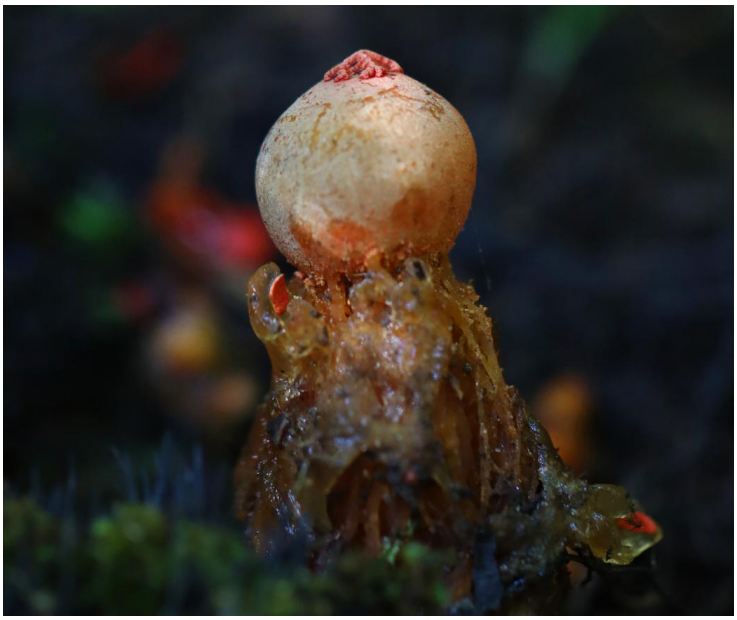

Figure 5. After the mesoperidium is shed, the brightly colored peristome and less colorful endoperidium remain. Image ©Christine Young. Used under CC v. 3.0, cropped. Accessed at Mushroom Observer.

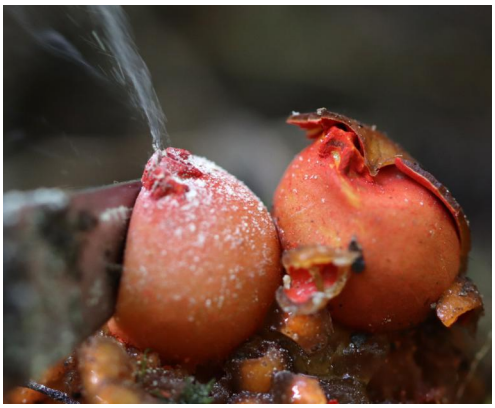

Figure 6. Mature spores escaping from the globose head. Image ©Christine Young. Used under CC v. 3.0, cropped. Accessed at Mushroom Observer.

There are three species of *Calostoma* found in the eastern U.S., but *C. cinnabarinum* is the one you will most likely see in our area. *C. lutescens* is only rarely found here, and it is yellow rather than red or deep orange (but old specimens of *C. cinnabarinum* can look yellowish as well). *C. ravenelii* is found in the southeastern U.S.

Calostoma was long assumed to be saprophytic, but Wilson *et al.* (2007) investigated the nutritional mode of *C. cinnabarinum* to determine if it is ectomycorrhizal like the other members of the Sclerodermatineae. Using various methods, they concluded that *Calostoma* is indeed ectomycorrhizal rather than saprophytic, most likely with species of oak (*Quercus*).

Look for *C. cinnabarinum* growing singly or gregariously, from late summer until well into the winter. It is often found in disturbed soil along wooded trails or roadsides.

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