The Potomac Sporophore

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Fungus in Focus: Bird's Nest

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Common Name: Bird's Nest Fungus, Splash Cups, Fluted Bird's Nest – Each of the individual fruiting bodies of the fungus looks like a miniature bird's nest, complete with what appear to be eggs. Splash cups is a minimalist description of the method of spore dispersal.

Scientific Name: *Cyathus striatus* – The generic name is derived from the Greek *kyathoi*, a long-handled cup used in Ancient Greece, used here to describe the cup shape of the fungus. *Stria* is the Latin word for furrow, as the cups are radially grooved.

Potpourri: Bird's nest fungi are diminutive with dimensions in the millimeter range. This is the only reason they mostly go unnoted, as their singular appearance would otherwise incite inspection and explanation. Other than a flock of impossibly small and very gregarious birds, what else could explain expansive arrays of miniature nests each having a number of eggs cascading in all directions? One might equally attribute the individual yet colonial nests to some sort of insect with a peculiar idea of pupation or a communal group of small reptiles seeking safety in numbers. The reality is verisimilitude, as the nest is not a nest and the eggs are not eggs. The nest is really a fungal cup but not one associated with the Phylum Ascomycota, which are commonly called cup fungi as many species have concave shapes. The bird's nest with cup has another purpose altogether. And while the eggs are not eggs, one might make a reasonable case that they could be, since they are the reproductive agents of the fungus. Like the duck-billed platypuses, bird's nest fungi seemed to have been designed by committee without a chairman in becoming a collection of inconsistent parts.

Bird's Nest Fungi in wood mulch. Photo: William Needham

Like all macroscopic fungi except those associated with lichens, the bird's nest is not really the fungus, but a reproductive structure called a fruiting body…

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Book Review: "Mushrooms of the Northeastern United States and Eastern Canada" by Tim Baroni

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There are certain mushroom books that appeal to novices, and others that are geared towards experts. "Mushrooms of the Northeastern United States and Eastern Canada" by Timothy J. Baroni will appeal to both. The author, until his recent retirement, was a Distinguished Professor of Biology at the State University of New York. The author of two other books and over 70 articles, he also served as past president of the Mycological Society of America.

It is evident that Baroni is knowledgeable about his topic. His descriptions of various fungi in this book are clear and vivid, and those who want a more technical analysis will find his description of microscopic features to be very helpful. He also points out that many of the species found in North America are different from those found in Europe; he includes the new names assigned to these mushrooms, which are based on DNA sequencing. Thanks to the contribution of Renee Lebeuf, Howard Bigelow and other photographers, the book is beautifully illustrated, displaying the stunning diversity of Northeastern mushrooms.

The book is divided in two general sections. The first part covers phylum Basidiomycetes (which includes gilled mushrooms, boletes, polypores…

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Mushrooms

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that bears its progeny. The "real" fungus is an interwoven mat called a mycelium consisting of individual strands called hyphae that each emanate from a spore. Bird's nest fungi mycelia are saprophytic, subsisting on dead wood, mulchy wood chips, vegetable debris, and even rags and dung which requires breaking down cellulose, lignin, and other compounds with enzymes. When environmental factors favor reproduction, the bird's nest mycelium produces the immature cups called peridia that start out covered with a protective lid or epiphragm. As the peridium grows, the epiphragm membrane parts to reveal a number of small ellipsoid-shaped bodies called peridioles at the bottom of the cup. Voila - a nest of eggs!

The structure, shape and components of bird's nest fungi are determined according to the physics of the natural world and the ecological demands of survival. Bird's nests can make more bird's nests only if they are able get their spores to a location where they will germinate, grow into hyphae and flourish with a mycelial mate. The manner in which they have come to carry out this function is testimony to the bizarre outcomes of mutant trial and error. The peridiole "eggs" are like seed cases, containing spores aggregated in a mass called a gleba. The purpose of the cup is to launch the peridiole out of the peridium as high and as far away as it can using only the forces of nature — raindrops. The efficacy of the "splash cup" can only be measured by the degree to which the ejected peridioles are able to reproduce to start a new mycelium to pass on the DNA for that particular shape. Over the millennial stretches that govern the laws of evolution, the most effective shape and launch angle eventually emerge as the winning combination. The cup is held firm by a thick mat of shaggy hairs on the underside and the concave cup interior surface is striated with radial lines as guiderails for projectile launch.

The hydrodynamic force of splashing rain imparts enough momentum to launch the peridioles some distance from the nest-like cup. High speed photography has been used to measure the physics with precision for bird's nest fungi of the *Cyathus* genus. Raindrops that strike the rim of the cup are the most effective … 2 percent of the drop's kinetic energy is enough to eject peridioles at 5 meters per second at a launch angle ranging from 67 to 73 degrees to deposit them 1 meter away. At first blush, this would seem to be wholly adequate to enhance the probability of successful germination to ensure future generations. Apparently not. Competition in the form of billions of microscopic and nearly weightless fungal spores that are widely dispersed on air currents by other fungi is impetus for improvement. In many bird's nest fungi species, *Cyathus striatus* included, enhancement takes the form of an elastic cord called a funiculus that is attached to the peridiole or "egg" at one end and to the peridium or "nest" at the other, something like a tether ball. The funiculus consists of interwoven strands of hyphae, the filamentous growths that emanate from spores that are characteristic of fungi in general. About ten centimeters of the hyphal cord of the funiculus is coiled up inside the peridiole in a sac called a purse with a sticky appendage called a hapteron at one end, waiting for a rainy day. When the peridiole is ejected, the purse is torn by the abrupt force and the funiculus extends in flight, one end attached to the peridiole and the other attached to the sticky hapteron. Flying through the air like a gaucho's bola, the hapteron adheres to the first thing it runs into,

Bird's Nest Fungi just before the "nest" opens.
Photo: William Needham

Upcoming Events

The events listed below may change, so read MAW emails and check our website at **http://mawdc.org** for up-to-date information on events.

Upcoming Scheduled Programs

April 6 **Monthly Meeting** featuring Eugenia Bone, a nature and food journalist, who was featured in the documentary *Fantastic Fungi* and is working on a mushroom-focused cookbook.

May 4 **Monthly Meeting** featuring WVU professors Brian Lovett and Matt Kasson, who will present their lecture "The Zombie Ant Apocalypse" about fungi that are pathogenic to insects.

June 1 **Monthly Meeting** featuring Dr. Anne Pringle who will fill us in on the physics of spore dispersal, complete with detailed photography of spore release.

For the time being, monthly meetings will be held on the first Tuesday of the month at 7:00 PM online via Zoom (www.zoom.us). Links will be emailed to members before each meeting, posted on the club's Facebook page, and can also be found on the MAWDC website. Members of the public are welcome to attend. To participate in the virtual mushroom ID session, email pictures of mushrooms ahead of time to forays@mawdc.org.

jerking the peridiole backward to spiral around the attachment point, affixing it with loops of hyphae like fungal duct tape. The peridiole is now ideally positioned for its mission, to germinate. Those bird's nest fungi that do not have a lasso have peridioles lathered with adhesive to do more or less the same thing, if not as coherently.

One cannot help but be amazed by the strange forms that biological innovation may take to find favor and therefore retention. Some plants produce fruit or nuts to attract mobile animals to transport their seeds from their source to propagate when deposited elsewhere. Other plants and most fungi use the convective currents of wind to waft away fogbanks of pollen (the allergic bane of spring) or uncountable spores. Shooting seeds or spores is a third mechanism that is a favored option where animals are not attractable and where the wind won't do. Fungi are masters of ballistics. Some fungi use what is called a "momentum catapult" to fire the spores away from the gills or pores to launch spores into the air so that the wind can take it from there. The reason that basidiomycete mushrooms are shaped like, well, mushrooms and appear shortly after rain is that water vapor that builds up under the cap condenses into micro-droplets at the base of the spores mounted on basidia. The water evaporation provides enough power to shoot the nearly weightless spores a few microns at a speed of ten centimeters per second, just far enough to clear datum. Some fungi of the phylum Ascomycota and the former phylum Zygomycota use the osmotic pressure of a "squirt gun" to shoot spores up, up, and away. Launch speeds of up to 25 meters per second with an acceleration of 180,000 *g*'s have been measured. [6] Fungi are described as fantastic with good reason.

Bird's nest fungi produce only a few egg-peridiole bundles and glue them to whatever they run into after the rain splash launch, usually the stems of adjacent plants that thrive on the same decayed material or dung that nurture both. This defies the adage to not put all of your eggs into one basket, more literal in this case than most … but they do. It is not well established how the peridioles manage to disperse the spores of the gleba but to some extent, it is species specific. For those bird's nest fungi that grow on dung, deposition on grass adjacent to the cow pie from which they arose would surely be subject to bovine browse. As spores are packaged for endurance, passing through the digestive system of a cud-chewing cow is hardly insurmountable with the reward of fresh dung to start a new mycelial family. Other species rely on insects to chew away the peridiole enclosure, presumably drawn there for some nutritive reason, releasing the spores to the wind and the mating mission. For most fungi, spore pairing is not a matter of boy meets girl, as they have what are known as mating factors that must be satisfied for sexual union to proceed. One of the reasons that most fungi produce so many spores is that this is not easy. Bird's nest fungi account for their relative paucity of spores by producing "matched sets" that are released together, ready for action. There is a cost for doing this, of course; genetic diversity is the handmaiden of endurance. Inbreeding enhances survival in the short term but it is ultimately a poor choice. Populations of bird's nest fungi were compared for genetic similarity in a study showing those with high DNA correlation experienced a 15 percent reduction in growth. Historically, intermarriage of the closely related royal families of Europe has frequently resulted in poor health outcomes; kissing cousins is not a particularly good idea.

It literally took centuries to figure out how bird's nest fungi worked, not too surprising since fungi were thought to be members of Kingdom Plantae in the Phylum Thallophyta until about forty years ago. The pioneering botanist Carolus Clusius wrote in 1601 that: "… this fungus which I will call anonymous, is very different from the preceding ones. and I consider it to be the smallest of all, for it is barely a half inch height. In the fall a great many grow, without petiole, on wooden boards away from the dust and sand … when ripe, they throw off the top part and appear full of a viscous juice, and of seeds which are

about the size of seeds of cyclamen." After about a century, it was determined that the seeds could not be seeds since they contained spores, but that the seed-egg-peridioles might contain embryonic plants. The mode of peridiole dispersal was equally perplexing. Theories ranged from some sort of mechanical ejection spring, though none was ever found, to insects dragging the peridioles back to their nests and getting their feet tangled in the viscous root-like strands. Water was proposed as dispersant, flooding the cup nests so that the seeds would float away. This seemed plausible until it was pointed out that bird's nest seeds from a wooden bridge did not result in any growth on a second bridge just 100 meters downstream even though the stream frequently flooded. It was not until 1928 that a research scientist demonstrated that the peridioles could be readily dispersed by dripping water from a pipette suspended several feet above them in a laboratory. Science takes time and is never fully settled. Toward the end of the last century, bird's nest fungi were grouped together with other outliers in the Class Gasteromycetes, meaning "stomach fungi" in Greek. The "stomach" they have in common is the gleba, an internal spore repository that must provide for some form of dispersal to allow for species reproduction. Among the internal spore/gleba variants are puffballs that puff spores through a hole when struck by raindrops, stinkhorns that stink to attract insects to carry spores away, and bird's nests that have splash cups. DNA sequencing has upended fungal taxonomy to the extent that the Class Gasteromycetes is no more and the fungi that have a gleba are generally referred to as gasteroids. By the turn of the century, the true and very complex reality of the tree of life became evident … gilled mushrooms evolved at least six times and the gasteroids at least four times, one of which was the family Nidulariaceae, the bird's nest fungi. They probably started out as gilled mushrooms of the clade sometimes called euagarics and will inevitably become associated with one of the extant families in due order. [14] Birds and nests had nothing to do with it, but nest eggs might.

References available upon request

A swath of Bird's Nest fungi in wood mulch. These mushrooms are often found in large numbers like this.
Photo: William Needham

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coral fungi). The second part covers the phylum Ascomycetes (morels, cup fungi, Earth tongues etc.). The pages of the book are organized according to common characteristics, and are color-coded based on spore prints, making it easy to use. Towards the end of the book is a useful glossary where mycological terms are defined. Although not a book on mycophagy, it gives some helpful hints in preparing wild mushrooms, such as the beefsteak mushroom (*Fistulina hepatica*), which he suggests soaking first in milk to eliminate the strong acid. The geographical area covered by this book spans from New Brunswick and Newfoundland in Eastern Canada to Pennsylvania, Maryland and other Northeastern states. It describes over 500 species in the region, including many mushrooms not described in other publications.

One of the shortcomings of writing a book that covers a wide geographical area is its inability to point out which variety of mushrooms will be dominant or rare in certain regions, and when they would normally fruit. For example, in many northern states such as Wisconsin and Minnesota, *Cantharellus americanus* is the most common chanterelle which fruits sometime in September. But when one moves southwards to Pennsylvania, Virginia or Maryland, the most dominant chanterelle found is the smooth chanterelle or *Cantharellus lateritus* which fruits abundantly in late July and early August. Despite my minor quibble, this book will be my go-to book for mushrooms in Northeastern United States and Eastern Canada.

Fungi in the News

Annie Greene
Newsletter Editor

Editor's Note: This article contains summaries of notable fungus-related news from December 2020 through March 2021. Visit the URL following each topic below for a closer look.

Psychedelic fungi officially decriminalized in DC

DC voters approved Initiative 81 during last November's election, and the initiative has now gone into effect, thereby decriminalizing the possession of psychedelic plants and fungi within the District. These entheogenic plants and fungi are not technically "legal," but law enforcement officers inside DC will now treat possession of psychedelic plants and fungi as their lowest priority. This Initiative was spearheaded by DC resident Melissa Lavasani, who spoke at the October 2020 MAWDC monthly meeting about how consuming psilocybin-containing mushrooms helped her heal from postpartum depression. If you missed it, the recording of Lavasani's presentation is available on the MAWDC Youtube page. Read more at: **https://www.nbcwashington.com/news/dc-loosens-enforcement-psychedelic-plants-magic-mushrooms/2608734/**

Researchers to test soil fungi as a replacement for fertilizer in vineyards

Scientists at Washington State University have initiated a research project to understand more about the effect of certain mycorrhizal fungi on the growth of grapevines. Arbuscular mycorrhizal fungi associate with the plant roots of most agricultural crops, forming a mutually beneficial union where the soil fungi send water and nutrients to the plant, and the plant sends sugars from photosynthesis to the fungi. The researchers plan to examine whether adding arbuscular mycorrhizal fungi to vineyard soil can help reduce the need for fertilizer applications. Populations of soil fungi are self-renewing, unlike fertilizers, which need to be applied yearly. This research project may help guide farmers who want to implement environmentally friendly practices while maintaining plant health. Read more at: **https://news.wsu.edu/2020/11/30/wine-fungi-perfect-pairing/**

Adidas to develop mycelium-based leather

As part of a new initiative for environmental sustainability, Adidas has announced they are developing a mycelium-based alternative to leather that will be used in the shoes they produce. Adidas has already released several plant-based shoe styles, which were very popular among consumers. The demand for vegan alternatives has increased in recent years, as consumers seek to purchase more environmentally friendly products. Perhaps this project from Adidas will inspire other large shoe brands to take similar steps to increase environmental sustainability and avoid animal products. Adidas' other efforts toward sustainability include using more than 60% recycled polyester during 2021, and achieving global climate neutrality by 2050. Read more at: **https://plantbasednews.org/lifestyle/fashion/adidas-developing-plant-based-leather-from-fungus/**

The International Space Station is home to many bacteria and fungi

NASA recently conducted a study to examine the characteristics of microscopic bacteria and fungi living on surfaces inside the International Space Station. They wanted to investigate whether the extreme conditions on the ISS (microgravity and elevated radiation for example) would promote the growth of only the most aggressive microbes, which might pose harm to astronauts' health. Ultimately, they found that the bacteria and fungi residing on the ISS show similar characteristics as microbes found in similar clean rooms on Earth, so they likely don't pose any extra risk to astronauts. Interestingly, they found some fungi called "technophiles," which gather on metal surfaces and wiring. These technophiles can corrode metals over time, so this study reinforced the need to keep all metal surfaces on the ISS sanitized and free of moisture. Read more at: **https://www.nasa.gov/mission_pages/station/research/news/space-station-microbes-no-more-harmful-than-those-on-earth-extremophiles**

Best wishes for a fruitful morel season!

Versatile Mushroom Risotto

This risotto recipe was presented by Albert Casciero at the March 2021 MAWDC meeting. Risotto can be customized with a variety of flavors, including all sorts of mushrooms. Any morels you find in the coming season would make a great addition to this risotto!

Ingredients for Basic Risotto:

1 cup	White rice (best varieties: *Vialone Nano*, *Carnaroli*, *Arborio*)
¼ to ½ cup	White wine
2 to 3 cups	Hot water
1/3 cup	Chopped onion or shallots
Olive oil, salt, and pepper to taste	
Grated Parmesan to taste	

Directions

1. Heat olive oil in a heavy pot.
2. Add chopped onions or shallots and sauté gently for a few minutes.
3. Add rice and stir gently until coated in oil.
4. Add wine and simmer, gently stirring, until the rice absorbs the wine.
5. Add water and let it simmer gently for 16-18 minutes, stirring occasionally to prevent the rice from sticking to the pot. Taste the rice and finish cooking when *al dente*, a little chewy and not overcooked or soupy.
6. Serve hot, topping generously with grated Parmesan Reggiano or similar hard cheese.

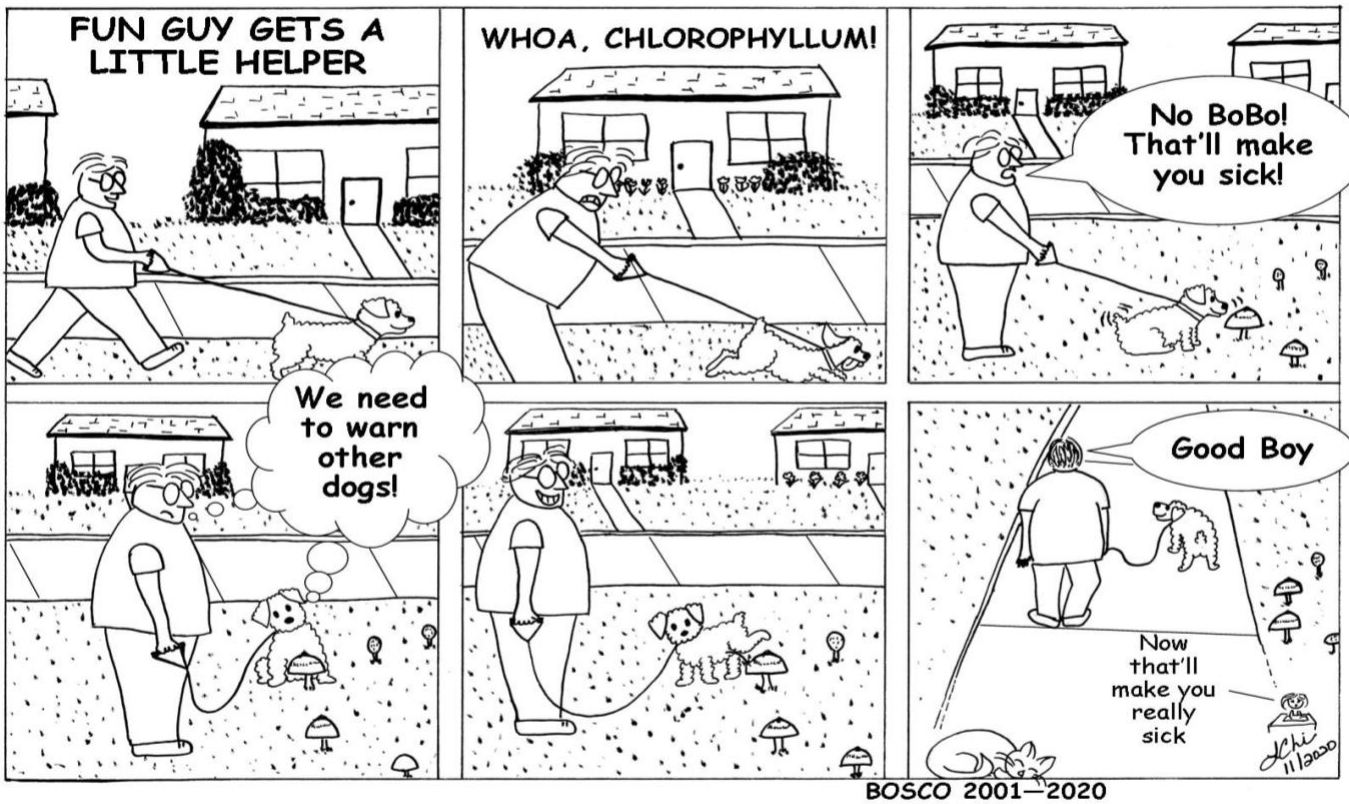
Albert's Recommended Add-ins

Here are some ideas of what to add to the risotto while it simmers:

- Fresh, lightly sauteed black morels (or rehydrated dried morels), with chopped fried bacon bits (optional)
- Lightly sauteed Golden Chanterelles with green peas
- Sauteed fresh Porcini (*Boletus edulis*) and fresh oregano
- Sauteed Black Chanterelles with finely chopped leek (white parts)

TALES OF THE FUN GUY

by Loretta E. Chi



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