The Potomac Sporophore

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Fungus in Focus: Rock Greenshield Lichen

William Needham
MAW Vice President

Rock Greenshield Lichen on a rock, surrounded by snow
Photo: William Needham

Common Name: Rock Greenshield Lichen – The rosette shape is like a rounded shield and is greenish gray in color — a green shield found almost exclusively on rocks. Lichen has an obscure etymology but may derive from the Greek word *leichein* which means "to lick" just as it sounds. There is no extant clue for this association as very few lichens are eaten (and thus licked). Some, like this species, have small lobes that could be a metaphor of sorts for little (leichein) tongues. The Common Greenshield Lichen is found mostly on trees.

Scientific Name: *Flavoparmelia baltimorensis* – *Parmelia* is Latin for shield, the genus that was used broadly for all lichens that were shield shaped until 1974 when it was subdivided. *Flavo* as a prefix means yellow, distinguishing these lichens from the blue tint of other shield lichens. Yellow hues combine with blue so that the overall effect is green. This species was first classified from a Baltimore specimen giving rise to the familiar nomenclature.

Potpourri: The rock greenshield lichen and its virtually indistinguishable cousin the common greenshield lichen (*F. caperata*) are encountered clinging to a substrate of rock or wood while traipsing along almost any trail. In the winter months when deciduous trees are devoid of greenery and mostly annual undergrowth has died back, only the grays and browns of rocks, dirt, leaf litter, and boles remain. The exceptions are the greenshield lichens that spread their leaflike (and tongue-like) lobes outward and onward, oblivious to the reduced light and frigid temperatures by which the rest of the forest is constrained. Their persistence is testimony to the lichen lifestyle, one of the natural world's wonders. Comprised of a fungus that has partnered with one or more organisms from a different kingdom, 14,000 identified lichens have mastered the art of survival in the most inhospitable of habitats from hot, dry deserts to frozen tundra. They are even found on Mount Everest at elevations exceeding seven kilometers.

According to the International Association of Lichenology, a lichen is "an association of a fungus and a photosynthetic…

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In This Issue:

Where the Wapiti Are

Tom McCoy
Former MAW Programs Chair

For the nature lover, one of the best kept secrets in the Northeast can be found in North-Central Pennsylvania where there's a vast collection of parks, forests and game lands scattered across this thinly populated region. It's an area rich with beautiful landscapes, world-class fly-fishing, the oldest population of elk East of the Mississippi, and if your timing is right, you just might find a restaurant serving pizzas made from giant puffball mushrooms.

The word 'elk' in American English is a term that arrived on this continent along with British colonial settlers in Virginia, and after considering the etymology, I believe it's past time we abandon this name in lieu of something authentic. As colonists disembarked, they were met by all manner of unfamiliar flora and fauna and simply lacked the language to describe many of the organisms in their strange new surroundings. The natural thing to do was to employ a name from a similar Eurasian species, but given that elk, endemic to North America and East Asia, can be six…

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symbiont resulting in a stable vegetative body." The fungal partner is called the mycobiont and constitutes about 95% of the lichen body structure or thallus. Since fungi are heterotrophs and therefore cannot make their own food, they must rely on autotrophs that photosynthesize the sun's energy to produce nutrients. Some fungi consume dead plants as saprotrophs, some parasitize living organisms, and some connect to living plant roots in a mutually beneficial association called mycorrhizal (fungus root). Lichenized fungi evolved a relationship to photosynthesizing organisms that falls into the category of symbiosis, which is defined as an intimate relationship between two living things. The photosynthetic partner of the lichenized fungus is called the photobiont and can be either green, brown, golden algae or cyanobacteria, a type of bacteria that contains chlorophyll formerly called blue-green algae. Algae is now a broad non-technical name for several types of polyphyletic eukaryotes that photosynthesize, which is all that matters to the fungal partner. The photobiont for greenshield lichens is a green alga species in the genus *Trebouxia*, which is the most common photobiont for all lichens.

The relationship between the fungus and the algae in a lichen is complex. Traditionally the symbiosis of lichens has been characterized as mutualism in which both partners benefit equally. In reality, the relationship frequently ranges from commensalism, where the fungus benefits but the algae do not, to parasitism, where the algae are harmed for the benefit of the fungus. Some insight into the living arrangements is afforded by the observation that the lichen's fungi need the algae but not vice versa. That is to say that none of the lichen-forming fungi, comprising almost half of ascomycetes, the largest division of the Fungi Kingdom (mushroom are in the other large division – the basidiomycetes), exist in nature without algae, whereas the algae can and do lead independent lives on their own. However, having a place to live with enough water and air for photosynthesis to make carbohydrates and respiration to oxidize them for energy (both plants and fungi need to breathe) is certainly an algal advantage. At the cellular level, the controlling dominance of the fungus can become sinister. The root-like tendrils of the fungus called hyphae surround and penetrate the algal cells, releasing chemicals that weaken the surrounding membrane so that the carbohydrates leak out, feeding the fungus. Weaker algal cells thus violated die, and were it not for periodic reproduction, so too would the lichen. A lichen has been described as a fungus that discovered agriculture, an apt aphorism. The fungus uses the algae for subsistence like a farmer tending fields to extract their bounty — it would be nonsensical to assert that farmers and soybeans therefore benefit mutually in symbiosis.

Rock Greenshield Lichen on a branch.
Photo: William Needham

Lichen reproduction is also complicated, as it involves two different species that must reproduce independently and then come into close contact to form a union. While this union must have occurred at least once for any lichen to exist, a singular rare event in the millions of years of geologic time is not unusual. The mycobiont, in this case *F. baltimorensis*,

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

Sept 6 **Monthly Meeting** featuring Rick Silber, who will present a talk titled "Look down, not up: the first ever mushroom trek to Everest Base Camp". He will discuss the rich biological and cultural diversity of Nepal.

Sept 10 **Foray at Ridley Creek State Park** at 10:30am. This foray is being held in conjunction with the Eastern PA Mush Club. For more information, consult the Calendar on the MAWDC website.

Oct 4 **Monthly Meeting** featuring New Hampshire Mushroom Company, who have converted a garage into a multi-room gourmet mushroom cultivation powerhouse.

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.

produces reproductive spores in a fruiting body called an apothecia in a manner analogous to the gills of mushroom fruiting bodies. The photobiont, in this case *Trebouxia*, also reproduces using spores when independent of the fungus, but only reproduces asexually once lichenized. Apothecia are very rarely seen on greenshield lichens, direct evidence that, like most lichens, they have no pressing need for reproductive spores. Since they are abundantly distributed and can occasionally cover vast swaths of boulder fields (*F. baltimorensis*) and exposed wood surfaces (*F. caperata*), it is evident that there is a successful reproductive workaround. In general, this consists of a lichen forming a detachable unit that includes both the fungus and its algal partner for windborne distribution to new locations. These "lichen seed packets" take various forms including soredia, miniscule balls of fungal hyphae surrounding a few algal cells, and schizidia, which are flakes of the upper layer of the fungal thallus which also contains the algal layer. One of the ways to tell rock and common greenshield lichens apart is that *F. baltimorensis* has schizidia and *F. caperata* has soredia. However, identifying small irregular components on the gnarled surface of a lichen is a challenge even for a lichenologist with a lens.

Greenshield lichens often cover broad expanses of rock and tree surfaces to the extent that long-term effects come into question. Do lichen covered rocks disintegrate at an accelerated rate? Do trees weaken due to the amount of bark covered by lichens? For the most part, lichens are self-sustaining in that the heterotrophic fungus is supplied nutrients from autotrophic algae. While sunlight and water are the essential ingredients for photosynthesis, nitrogen, phosphorous and potassium are also required for plant growth. It is less well known that fungi need these same nutrients for the same metabolic reasons. In many cases, lichens are able to get all of the nutrients they need from minute amounts dissolved in water. The quality of precipitated rain water is why lichens are useful for environmental monitoring as their growth correlates to air quality. The two main substrate characteristics associated with lichen growth are moisture retention and exposure to sunlight. For lichens growing on exposed tree bark, the degree to which moisture is retained as it flows down the tree is the key factor. While it is true that the lichen will "rob" some of the nutrients that would otherwise go to the tree roots, the amount is negligible. Deciduous trees have more lichens than conifers because their leafless trunks are sunlit for six months of the year whereas evergreens are ever shaded. Rocks are not good at retaining moisture. Consequently, lichen hyphae penetrate rock surfaces to depths of several millimeters seeking water, and, depending on the type of rock, minerals as well. This contributes to the long-term weathering of rocks for soil formation, and more broadly to the million-year geologic cycle of mountain building and erosion. The answers to the two questions are yes, lichens do disintegrate rocks at a geologic rate, and no, lichens do not harm trees — they are sometimes called epiphytes for this reason.

Chemistry is another important aspect of lichen physiology. More than 600 unique compounds are concocted by lichens in surprisingly large quantities: up to five percent of total bodyweight. Notably, when lichenized fungi are artificially grown without algae in a laboratory, chemical output is negligible. This can only mean that specific chemicals promote the associative nature of the individual lichen species. There are several hypotheses that might explain this. Bitterness as deterrence to animal browse is certainly one possibility, as lichens grow quite slowly on exposed surfaces and are easy to spot. However, some lichens, notably reindeer moss (*Cladinia rangiferina*), are a major food source for animals and are quite likely propagated in their droppings. It is also believed that some chemicals act to coat sections of hyphae to provide air pockets necessary for photosynthesis by the algae. The chemical footprint of a lichen species is one of the main diagnostic tools used in field identification. Lye, bleach and several other reagents are dripped onto the

surface; a change in color indicates the presence of a specific chemical that is related to a specific lichen. There are many unknown aspects of lichen physiology. This was made manifest recently when it was discovered that many lichens contain a type of basidiomycete yeast (also a fungus), which is embedded in the body of the ascomycete fungus in varying concentrations that correlate to anatomical differences. Some, if not all, lichens may actually consist of two fungi and an alga or two, a far cry from simple symbiosis. The function of yeast fungi is not yet known.

The *Flavoparmelia* genus was separated from the other *Parmelia* (shield) lichens in 1986, partly due to their production of the chemical compound usnic acid. It is a large molecule with the formula $C_{18}H_{16}O_7$. Usnic acid is found primarily in the top layer of the fungus along with another chemical called altranorin just above the area where the algal bodies are concentrated. It is surmised that they contribute to shielding green algae from excessive sunlight exposure since bright sun is inimical to photosynthesis, the source of all lichen energy. Usnic acid is also a potent antibiotic, collected primarily from Usnea or beard lichens due to higher concentration for use as an additive in commercial creams and ointments. *F. caperata* is one of several lichens that have historically been used by indigenous peoples as a tonic taken internally or as a poultice applied to a wound. The medicinal uses of lichen fungi should come as no surprise, as many polypore type fungi growing as brackets on tree trunks have been used medicinally for millennia. The abundance of rock and common greenshield lichens is evidence of successful adaptation. In addition to thriving on bountiful rock and wood surfaces, the chemical shield screens sunlight to protect the green algal energy source and guard against assault by microbes and mammals. In other words, they are literally green shields.

Carl Linnaeus assigned lichens to the class Cryptogamia meaning "secret life" along with everything else that created spores and not seeds. One of the more enduring lichen secrets is how and when the coalition between fungi and algae began. It is widely accepted that simple replicating organisms started out in aqueous habitats, as water affords bodily support and nutrient transport. The transition from sea to shore would have been nearly impossible for an alga with no structure or a fungus with no food. There is good reason to suppose that some form of union like a lichen may have come about by chance and was then promoted by survival. Scientific research over the last several decades has cast some light into the dark shadows of this distant past. What look like lichen hyphae embedded in the soil around fossils from the pre-Cambrian or Ediacaran Period (635-541 million years ago) suggest that lichens may have been the first pioneers on dry land. This is supported by the finding that marine sediments from this same period contain not only the root-like hyphae of fungi but also the rounded shapes of blue green algae or cyanobacteria. This suggests that something lichen-like started out in the water was left high and dry in a tidal flat to make the critical transition. However, recent DNA analysis of primitive ferns and lichenized fungi revealed that the lichens evolved 100 million years after vascular plants. Lichenology, like all science, is a continuum that never ceases in its quest for knowledge. Future field tests and experiments are certain to clarify the origin story.

References available upon request

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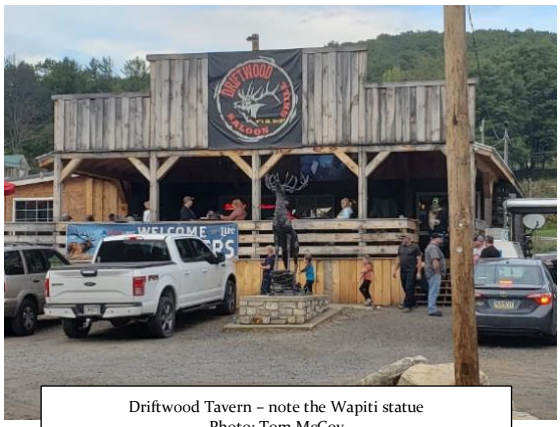
feet tall at the shoulder and weigh up to 1000 pounds, there was only one European ungulate of comparable size and features, the circumpolar *Alces alces*, an animal you know as the 'moose'. In British English, the common name for a moose was *elk*, a word which was misapplied by colonists some four centuries ago, and a word that continues to be misused into present day, so for the remainder of this article (and beyond), I plan to use the indigenous Shawnee word *wapiti* when referring to elk, and hope you'll do the same. Now a word about where these magnificent animals live, or 'where the wapiti are'.

Prior to European colonization, wapiti occupied most of North America from Canada to Mexico and from coast to coast. However, as virgin forests were cleared for farmland and timber, their habitat disappeared, as did the wapiti. Settlers didn't tolerate them foraging their crops and competing with livestock for pastureland, so hunting and poaching eventually led the eastern wapiti into extinction by 1877. In the United States, only the greatly reduced western population of wapiti remained, restricted to isolated valleys and high pastures in the Rocky Mountains along with herds in hunting prohibited Yellowstone National Park. Yellowstone was a refuge for one of America's last wapiti populations, and it's from here the seed animals were sourced

Elk sighting near Driftwood, PA
Photo: Tom McCoy



Driftwood Tavern – note the Wapiti statue
Photo: Tom McCoy

for their successful re-introduction into the eastern temperate forest when in 1913, fifty animals were transported by train and unceremoniously released directly from the rail cars into a rugged section of the keystone state known as the Pennsylvania Wilds.

Cameron County is the least populous county in Pennsylvania with a total headcount of 4,547, which equates to just 11.4 people per square mile. The county is 87% forest, and for comparison, Washington D.C. has 11,294 people per square mile, and more people than trees. If you like nature, and of course you do, you'd love Cameron County along with the lightly populated adjacent counties of Clinton, Elk, McKean and Potter. This is the epicenter of the Pennsylvania Wilds and it's where the wapiti are. Today there're ~1400 animals, all descendants of Yellowstone stock introduced more than a century ago, comprising the oldest wapiti community in the East, but Cameron County isn't just where the wapiti are, it's also home of the puffball pizza.

Driftwood is the second largest town in Cameron County with a population of just 67, and with so few people you might think there'd be little incentive to stop. But let me assure you the Driftwood Tavern is one neat place to grab a bite and a beer, and for the past ~20 years, it's been a good place to learn your mushrooms. Since the early 2000's, avid naturalist and local resident Jim Moser has been helping organize an annual event at the tavern to forage, ID and cook some of the local fungi. From humble beginnings and word of mouth advertising, this annual event has steadily gained in popularity, in part due to the prosperous natural scenery, and in part due to a culinary dish that for a time was synonymous with the event, the giant puffball pizza.

Puffballs are a group of saprotrophic basidiomycete fungi familiar to most of us, but unlike most basidiospores, they lack a fertile layer (hymenium) for spore development, a gill, a pore, or a tooth. Instead, they develop their spores in a globular mass of fertile tissue (gleba) enclosed within a sterile outer layer (peridium). As spores mature and darken, either the peridium disintegrates and cracks open, allowing spores to be swept away on the wind, or a small pore (ostiole) opens at the apex to release clouds of spores whenever struck by a raindrop, passing fauna, or the mushroom hunter's shoe.

In the DMV area, puffballs belong to genus *Calvatia* (tr. bald skull) and *Lycoperdon* (tr. wolf fart), and oh what fun they must have had coming up with those names. Of the two, *Lycoperdons* are smaller, more common, and include the most often seen puffball, the pear-shaped puffball (*Lycoperdon pyriforme,* renamed to *Apioperdon* in 2017) which grows on rotting deciduous wood, often gregariously, sometimes prolifically. The ghosts of these weathered fruiting bodies oftentimes persist for many months. The gem-studded puffball (*L. perlatum*) is nearly as common, except it likes mowed grassy areas, while the peeling puffball (*L. marginatum*) likes grassy areas too, especially when soil quality is poor.

In the genus *Calvatia* there are two largish, similar species, the brain puffball (*C. craniiformis*) and the purple-spored puffball (*C. cyathiformis*) and they're tough to distinguish until the spores mature. If yellow-brown, the former, if purple, the latter. And that leaves just one more common puffball for our area: the giant puffball (*C. gigantea*) which truly lives up to its name. While giant puffballs can be colossal (specimens up to 5 feet in diameter have been reported), it's typically about the size of a soccer ball, and produces a monumental ~7 trillion spores.

For the pot hunter though, the prodigious spore count of puffballs is of little concern, as they're all edible when the gleba is immature, and the interior is as pure as snow, but first a cautionary note about some other visually similar fungi. If the puffball is smaller than the size of an orange, ensure that there are no signs of mushroom structures within which would indicate it's a toxic Amanita button.

Earthballs are another group of species to be cautious of, they're mildly toxic, and about the size of the gem-studded, but dense and tough with a gleba that begins white but quickly turns purple-bla ck. *Scleroderma citrinum* is the most common earthball and has a pebbly exterior like a football, hence the common name: poison pigskin puffball. Once you're confident with your fieldcraft, simply toss your treasure in the collecting basket, you're dining on puffballs tonight. And if it's a giant puffball, which sometimes grow in a prolific fairy ring, you're gonna need a bigger basket. With little flavor and texture of their own, you won't find any cookbooks dedicated exclusively to puffballs, which isn't to say they can't be good, they just won't make you soon forget about other choice

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edibles. After you get your cache home, give them a quick rinse in cold water, not too long because they readily absorb moisture, and cut away those nasty bits. Some folks peel off the peridium, some leave it, it's your choice. I prefer to leave it. And, fun fact, should you nick your finger while doing prep work, you could try using a bit of puffball to staunch the blood flow. Puffballs have been a styptic wound bandage since ancient times and were often hung on a string near the hearth for that purpose.

The most common, and likely the best, way to cook puffballs is to coat them with egg wash and breadcrumbs then sauté in butter or olive oil. It's a fine dish to be sure, but a word of advice, puffballs readily absorb your lipid of choice, and unless you're careful, you'll ruin your diet as you add more and more butter to a seemingly dry skillet. Some more food for thought, potatoes and puffballs play well together so you could sauté them along with a bit of onion, bell pepper and whatever other odd bits you have in the 'fridge, add some cheese, and use it as filling in an omelet or the foundation for hash. Making omelets or hash is all about using leftovers, and now it's about the puffballs too. Try spritzing them with oil for a turn on the grill, or give my favorite application a spin, and use them in lieu of tofu in miso soup. I like eating puffballs as a substitute for tofu far more than I like tofu itself. Given puffballs are so culinarily versatile, it's no wonder they used to be part of the obsolete class Gasteromycetes (tr. stomach fungi). And should you be lucky enough to collect a giant puffball, try slicing it like a loaf of bread and use the rounds as a base for pizza, or better yet, take your giant puffball to the Driftwood Tavern on mushroom day, and they'll do it for you.

As the Driftwood Tavern event has grown in popularity, the organizers reached out to Bill Russell to help, a name that's synonymous with mushroom foraging in central Pennsylvania, and he's been a regular attendee and presenter for the past ~10 years. Many of us know Bill, and a few other familiar faces from the mushroom trail regularly attend too, like Chris Cicciarelli and John Traister, a couple of identifiers from the Central PA Mushroom Club. When you know your mushrooms you're part a fraternity, and whenever folks assemble to talk about the craft, you'll always find a familiar face in the crowd. Maybe we ought to have our own secret handshake?

When I went to Driftwood last year for the first time, I couldn't believe the crowd of ~140 attendees, and all the buzz about fungi. It was great, great fun, and to make it even better, on the drive home, I saw an enormous bull wapiti, so I pulled to the edge and watched it and his cows for half an hour, loving every second. If you'd like a chance for a similar experience, consider visiting the Driftwood Tavern this autumn, and I'll see you there. Until then, I'll get to work on that secret handshake. The Pennsylvania Wilds, it's where the wapiti (and mushrooms) are!

Giant puffball.

Photos: Tom McCoy and Wiki Commons

Jim Moser, Chris Cicciarelli, a few event day attendees, and a splendid table.
Photo: Tom McCoy

Fungi in the News

Marisa Bello
MAW Member and Contributor

Editor's Note: This article contains summaries of notable fungus-related news from January through July 2022. Visit the URL following each topic below for a closer look.

California study finds fungi and bacteria that survive forest fires

As megafires spread rapidly, devouring California's forests, scientists at UC Riverside research revealed fungi that not only thrived from fires, but even some that produced and enabled flame-resistant qualities. Mycologist Sydney Glassman identified Actinobacteria as a phylum in the Redwood Tanoak microbiome that demonstrated an increase after a megafire. Actinobacteria and bacteria Firmicutes act as plant decomposers and are vital parts of the redwood ecosystem. However, the surprising discovery came when Glassman's team discovered a large increase in the fungal category after the fire- specifically the heat resistant Basidioacsus yeast. Glassman's team emphasized the importance of their research, specifically their finding that even the microbes that did not experience an increase in growth are related to those that did, like the Basidioacsus. This means adaptive traits are shared and could potentially mean more resistance to forest fires.

Read more here: https://www.sciencedaily.com/releases/2022/04/220425085714.htm

Musician Tarun Nayar goes viral with his music made from fungi

Musicians around the world are quite literally making plants, cacti, and even fungi sing. By attaching modular synthesizers and electrodes to a fungi or plant, these savvy plant musicians can detect and measure said fungi or plants bioelectrical energy, and converting it into musical notes played on a synthesizer. However, for many of these musicians, their work goes beyond a singing mushroom. For Canadian musician Taurn Nayar, who has over half a million followers on Tik Tok, the mycomusic is a way for him to kindle human and environmental connection- even through a screen. British sonic artist Mileece was featured in an installation at Tate Modern in London for her work with plants. The installation examined how plants, flowers, and fungi reacted electronically to the presence of a human. For her, this connection could be used to emphasize environmental awareness and how what around us is alive, too. These botanical and mycological songs allow for a bridge to be built with humans and understanding our environment.

Read more here: https://www.theguardian.com/music/2022/may/13/artists-making-music-from-mushrooms

Professor Andrew Adamatzky discovers fungi communicate with something similar to a language

Do fungi talk to each other? Professor Andrew Adamatzky from the University of the West of England found that fungi could have a language of up to 50 words. These words, however, are most likely not used to communicate amongst different fungi, rather, they are used to interact with different parts of an entire organism or the entire mycelium network. Some fungi organisms can reach up to miles, such as the Honey Mushroom, or the Armillaria species. Adamatzky found "spikes" of activity when fungi "spoke"- very similar to neural activity in the human brain when we speak. These electrical spikes act as words for fungi. Adamatzky concluded that these mycelia likely "talk" to relay and process information such as chemical stimulation across the mycelium network.

Read more at: https://royalsocietypublishing.org/doi/10.1098/rsos.211926

MAWDC Photo Contest is back for 2022!

The Photo Contest will be held again this year, with a submission deadline of November 13, 2022.

Please visit https://mawdc.org/Photo-Contest for more details

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Did you know that MAW DC members can advertise fungal-related activities and products in the newsletter for free?

Email newsletter@mawdc.org for more information.

TALES OF THE FUN GUY

BY LORETTA E CHI