Looking Forward by Glen Schwartz

Recently, I read an article describing how nature can restore our mental performance and significantly increase our creativity. To get the full effects, it said you need to immerse yourself in the outdoors for at least three days. After a few days outdoors, your blood pressure will be lower, an EEG will show a more calm brain wave activity, and your outlook on life will improve.

These effects have been known for a very long time. Some 2500 years ago, Cyrus the Great, ruler of Persia, had gardens built in his capital city Pasargadae for relaxation. Later in the article, other research shows similar effects starting in as little as 15 minutes of entering a natural environment. The effects could even be achieved in a virtual reality room with simulated images and recorded sound. Both indoor and outdoor air contain about the same concentration of particles, with indoor air having more pollution, so I was surprised that virtual reality works to restore brain activity. Apparently, the desired effect is triggered by sight and sound, and not so much by smell.

I am not 2500 years old, but I have known about the restorative effects of the great outdoors for a very long time. I know that I feel refreshed after a walk in the woods, or even when pulling weeds in my garden. I don’t get outside enough during the winter months, but I try to make up for that the rest of the year. I have not been outdoors for three full days in a row since I was a kid camping with my family, but just thinking about those days brings a smile to my face.

This got me thinking…I wonder how all of this fits in to our obsession with morel mushroom hunting. For most of us, our first trip into the woods every year is when we go out to hunt morels. If you are like me, the first morel hunting trip is a week or two early because I just can’t wait anymore. Maybe what I am seeking is not morels, but the restorative effects of being in the great outdoors.

Endophytes by Dave Layton

I’ve always known about fungi gaining nourishment 3 ways: saprophytic – digesting dead organic material, parasitic digesting living organic material and Mycorrhizal exchanging nutrients symbiotically through interactions with plant roots. Recently I was more than a little intrigued to learn about endophytic fungi (endophytes) from a brief description in an article on the internet. Endophytes live within live plants mainly between cells, but they don’t digest the live plant. Rather, they borrow moisture and nutrients that pass between cells. Usually endophytes are asymptomatic and in many cases they’re symbiotic, improving their host plants’ survival in a wide variety of ways including, in at least one case, making plants toxic to large animals that would eat them. In fact, cattle being strangely poisoned while eating a certain kind of grass in the 1970s really increased awareness of endophytes according to the book *Teaming with Microbes*. The grass was poisonous to herbivores but growing very well because they weren’t eating it. *Teaming with Microbes* is about understanding the complex microbial interactions in healthy garden soil – a must read for the organic gardener.

*Teaming With Microbes* also states that every plant tested so far has at least one type of endophyte living within it, and in some old growth forests individual trees can have hundreds. Beyond killing farm animals, the book lists other benefits from endophytes for plants. These benefits include producing toxins that kill aphids and other harmful insects and nematodes, improving seed germination, and providing disease resistance either chemically or by boosting the immune system. Plus endophytes often are the first step in the decay process when a plant dies, ensuring the release of nutrients in the soil for future plants.

Wikipedia lists even more potential benefits from endophytes, not just to plants but potentially to humans too. For instance some endophytes boost drought resistance in some grasses and one endophyte actually produces the anti-
cancer drug Taxol. Endophytes may also be used in making biofuels. Wikipedia states that there may be thousands of endophytes that could be beneficial to man. Then it follows with this sobering thought, “— since there are few scientists working in this field, and since environmental contamination, deforestation and biodiversity loss are widespread, many endophytes might be permanently lost before their utility is explored.” That’s an all too common story throughout nature.

Maybe what’s most astounding about endophytes (as with all microbes) is how little we know. There are thousands maybe millions of fungal endophytes that are unknown, just as there are billions of unknown endophytic bacteria and archaea (an entire kingdom of single cell organisms identified only four decades ago). Some of those types of endophytes actually live inside of fungal endophytes helping them to do their work. Of course many also live inside of humans helping us to do our work too - think good bacteria from yogurt.

Most of the known endophytic fungi are in the phylum Ascomycota (sac fungi) which includes some of the tastiest fungi, morels and truffles. However it’s also the largest phylum of fungi and includes all kinds of rusts and unseen fungi which don’t even fruit sexually or have any macrobiotic appearance at all. This is one reason why so many endophytes have been hidden from man for all this time.

I have a personal theory that some endophytes may actually be hiding in plain sight. I believe that one such species might be *Grifola frondosus*. It’s said that *Grifola* is both saprobic - consuming dead heartwood and parasitic on live oak trees. However, though I’ve seen live wood infected with *Grifola* I haven’t seen it killed by the fungus, certainly not like cases of Honey mushroom infestation or oak wilt.

Once I cut a small slice of live wood at the base of an ancient oak where *Grifola* was emerging. The rings directly surrounding the embedded fungus seemed swollen and a little discolored. They looked more active than nearby rings. More tellingly I checked the cut again a year later. Concerned that I may have allowed additional pathogens in. The cut was completely healed and barely visible. The tree has remained unchanged in the 8 years since. I’ve seen tree crowns that are amazingly alive despite being on top of ancient, hollow, gall encrusted, and *Grifola* infected trunks. I feel it’s possible that *Grifola* may actually boost the immune system of the trees it infests, possibly blocking other pathogens. It definitely consumes dead heartwood making oaks more hollow. This in turn gives flexibility and strength to the living wood on the perimeter of the trunk. This makes the tree more resistant to high wind. Either way it’s possible that *Grifola* actually extends the life of oaks it infests. If so then it would be an endophyte.

But I’ve only been informally studying the relationship between *Grifola* and oaks for a decade or so. That’s hardly enough time to see any change in the life of an oak. I’ll report on my informal study after another decade or so of research. I just hope that in that time *Grifola* doesn’t pick up its own endophyte making it toxic to medium sized bipedal Grifolavores.
You have found a pretty mushroom or an interesting composition and want to document it, or even better, make a little work of art. Or it may be a lovely flower or a striking landscape. While you are photographing, I suggest that you stop a moment and make several photos. Most photos of fungi and any other subject can be made in both horizontal (landscape) and vertical (portrait) compositions. Whatever the subject it may be more interesting in one or the other orientation. The photographer may not discover which is more interesting until he or she has processed the file.

One format may be more pleasing than the other but there are times when the space that needs to be filled requires a horizontal or vertical image. Magazine covers usually need a portrait image. A two page spread needs a landscape rendition. The spot you want to display the lovely subject may be too narrow for a landscape print so having a portrait file will fill that niche.

You may also want to make several more images from different vantage points. While you are at it remember to compose in portrait and landscape whenever possible. Of course, there are times when this may not be possible because of distractions in the frame. You may need to move to remove the distractions. It has been said that painters decide what to put in the frame while sculptors decide what to take out or let out of the block they are carving. Photographers are more like sculptors than painters.

We have not been able to determine the species in these two images with interesting elements and differing compositions. The fungus that lines the bark crevices and the shelf fungi as accents appealed so we made some images and now have to choose which one is the better image.

The same subject can look quite different when a vertical and a horizontal composition are compared. Sometimes the pattern is more interesting than the species, especially when one is not certain of the species.
Let’s Go Mushrooming!

A four-hour workshop, Saturday 1:00 – 5:00

- Get guided practice identifying mushrooms after collecting them on a foray (a mushroom hunt.) The instructor will bring top-rated field guides for Midwestern mushrooms to use. You will have an opportunity to purchase them at a discount at the end of the session.

- Learn how to be certain and how to be safe with mushrooms so that you don’t put yourself or your family at risk while enjoying nature’s bounty.

- Cook and taste positively identified edibles.

Mike Krebill, Instructor

You just read the top half of a sign-up sheet for a workshop conducted during the Midwest Wild Harvest Festival, September 12, 2015. This popular wild food gathering takes place the second weekend of September at the Wisconsin Badger Camp, about 10 miles south of Prairie du Chien in southwestern Wisconsin. 145 people is considered the carrying capacity of the MWHF, and 145 people signed up by the middle of August. 25 were allowed into the mushrooming workshop, and I was fortunate to have Damian Pieper’s assistance. I originally wanted the limit to be 16, but the event organizers twisted my arm due to the demand. Rachel Mifsud, a biology lecturer for the University of Michigan, Dearborn, helped out on the foray.

Returning from the foray, we spread our find out on picnic tables, as we normally do on our Prairie States Mushroom Club forays. I provided multiple copies of Kuo and Methven’s “Mushrooms of the Midwest” and spoke briefly about the process of identifying an unkown, given a good reference book. I split the group up, taking some to start cooking mushrooms for everyone to taste, while Damian worked with the rest on using the reference to identify mushrooms.

Prior to the MWHF, I placed posts on Facebook, requesting a favor from those planning to attend: would you kindly bring edible mushrooms for us to cook and taste in my workshop? The response was heart-warming. We were able to refrigerate and retrieve an adequate supply of ten species: sulfur shelf, oyster, elm oyster, yellow oyster, hen-of-the-woods, lion’s mane, common chanterelle, slippery jack, pear-shaped puffball, and giant puffball. No Scotch bonnets; last year there were thousands of them in the tenting site. (One woman, unknowingly, even pitched her tent inside a fairy ring!) No shaggymanes or inky caps or honey mushrooms or aborted entolomas or wood ears, either.

We fried up trayfuls of different species, and then invited Damian’s group to join our taste-testing party. Each mushroom had been prepared the same way: fried in grapeseed oil and drained on paper toweling. Salt was available for those wishing to use it. We kept on cooking after the taste-test, since we had mushrooms left. A friend who works at the Dragoncourt Restaurant in Minneapolis joined us, enhancing flavors as Dave Layton might, with butter, a homemade oyster sauce and a chiffonade of freshly-picked basil leaves. Awesome eating!
Soil Carbon and You: The Importance of Sequestering

By Larry Evans

Recently several scientific journals have addressed the issue of soil carbon sequestration. It seems that our methods of measuring the amount of carbon in soils have been inadequate, and the role of soil microorganisms in carbon sequestration and nutrient cycling have been underestimated. So, the dynamics of soils and the importance of fungi are even MORE than we supposed! It’s not just a geek thing! Gramps was right, organics are what makes a soil RICH! We know of the importance of mycorrhizae in acquiring nutrients for trees, but not so many of us realize the critical role of soil as a water reservoir, especially here in the arid west. Brown cuboidal rot (BCR) residues, common in rotting conifer logs, absorb at least five times their weight in water. These reservoirs provide an important means by which snow melt is captured and made available in the local ecosystem. The hyphae of saprotrophic fungi break down these materials, digesting bacteria, and create chitin, the main component of fungal cell walls. The new studies indicate that much more soil carbon is tied up as chitin than previously suspected. Chitin is very stable and durable, and can retain carbon in the soil for long times. Having now observed the immense capacity of these soil organisms to sequester carbon, are we doing something about it? Perhaps by outlawing the practice of slash pile burning after logging operations, instead mandate that prescribed amounts of coarse woody debris be buried, chipped, and/or inoculated with fungi. Fungi might be selected on the basis of their ability to produce an edible mushroom, their ability to produce water-retaining BCR residues, and value to wildlife. The USFS estimates that at a minimum 360 (upper estimates 700) million tons of carbon dioxide are put in the air annually from burning operations, and smoke from fire remains the most common complaint to USFS offices nationwide. The act of burning wood is inefficient to start with: flaring off the water molecules present in wood absorbs a large amount of the energy released by the combustion process. This vaporized water and carbon dioxide then enter the atmosphere, and leave western Montana for somewhere downwind. Contrast that with buried wood, which has a half-life in the soil of several years, during which it will retain and supply moisture, yielding a net gain of moisture to the local environment when it is gone. Virtually all the energy and nutrients released by metabolism will be used by the local ecosystem. Although the life processes of the fungi result in the release of carbon dioxide, a good percentage of the carbon will remain in the soil. I recently taught a section at a permaculture class, and they were all excited about Hugelkultur, a novel way to provide plants with moisture without irrigating, by burying a wood pile under your garden, or planting your garden atop your wood pile. In this case the rotting logs do what rotting logs do, absorb and retain moisture as they are broken down by fungi. Hugelkultur is another example of how natural processes can and should be employed in our management practices. A familiar example of this, for all you naturalists, foresters, and ecologists, is the notion of a “nurse log” that supports and sustains young seedlings of tree species like western hemlock. The ghost of a tree on the forest floor provides habitat to insects, fungi, and bacteria as well. Soil carbon could be the carbon sink that allows us to sequester enough carbon out of the atmosphere to balance our massive fossil fuel footprint. But we must review and revise the ways we manage soil, because now we are in the process of losing soil carbon, not sequestering it, on a landscape level. Why is soil carbon important, again? Soil organic matter, which is about 50% carbon, often occurs in the form of lignin-rich “brown rot” residues is the crumbly, cuboidal stuff left over when a rotten log goes soft. It absorbs about 5 times its weight in water. Mineral matter, another major component of our soils, little or absorbs none. Soil organic matter keeps water in the ecosystem. Soil and Coal tell the History of Fungi Many of you have already heard me tell the story of coal in lectures over the past couple years, and will share my delight in reading about recent research and publications that support this emerging viewpoint, notably David Hibbett of Clark University, and a recent Scientific American article by David Biello. The story of coal begins over 300 million years ago (mya) at the beginning of the appropriately named Carboniferous Period. You paleontologists will recall

(cont. on pg. 6)
that the Carboniferous is sometimes divided into the Mississippian and Pennsylvanian. At the beginning of the Carboniferous, the early vascular plants and fungi were locked in a balance of creation and destruction: the complex materials that plants created by photosynthesis, the fungi and bacteria could break down with their site-specific enzymes. Then in a geologic instant, an ancestor of modern conifers and cycads managed to synthesize the cell-wall component lignin, and nothing has been the same since. Unlike the thread like cellulose molecule, which is made up of thousands of sugar molecules chained together using the same bond, lignins are hodgepodges of interlinked rings. Whereas a single enzyme can unzip a whole chain of cellulose, the digestion of lignin required the production of several different enzymes. And so it went, for some 60 million years, more or less. Plants experienced a period of dominance, and as their lignin laden bodies crashed to the ground, the carbon remained sequestered, piling up many meters thick in swampy places where these forests existed. Tremendous amounts of oxygen were liberated as carbon dioxide was reduced to lignin, and the levels of O2 in the atmosphere reached the all time high of 35%. All this free oxygen had an effect. Insects, even with their poor gas exchange apparatus, achieved enormous proportions. Vertebrates got large, and carnivores got efficient. And this oxygen had an effect on the microbiota of the planet, especially among some lucky members of the Basidiomycota. These fungi, in their daily work of breaking down wood, somehow managed to produce an enzyme that makes hydrogen peroxide from water and then abundant oxygen. Three of these exoenzymes that attack lignin are: laccase, manganese dependent peroxidase, and lignin peroxidase. These enzymes manage to “burn apart” the complex bonds in lignin, recovering energy from a new source. This new ability allowed the White Rot Fungi to dominate the niche of wood decomposition and nutrient liberation, and effectively ended the Carboniferous Period about 245 mya. Today their descendants, spread across dozens of genera and 6 continents, continue to be the main drivers in decomposition and nutrient cycling in many forests. Let’s build on this to expand our understanding of the importance of carbon in soils. Terrestrial soil is the largest sink for carbon on our planet, vastly exceeding both the oceans and atmosphere in the carbon contained there. Recent studies from the Smithsonian Institute show that the carbon sequestered in ectomycorrhizal (EM)ecosystems (think conifers like pine trees and Douglas-fir with their Suillus fungal partners) is much greater than the carbon sequestered in ecosystems dominated by other major mycorrhizal type arbuscular (AM, which includes a range of plants, including most tropical trees and many temperate zone hardwoods) and should affect the way we manage these ecosystems. Because of their efficient system of harvesting nutrients from dead plants and other organic matter, EM fungi leave behind lots of carbon but little nitrogen, phosphorus, potassium, or other biologically interesting molecules. AM fungi on the other hand utilize different nutrient gathering techniques, resulting in more nutrients and bacteria in the soil, more glomalins, and less overall carbon sequestered in its reduced form. THE MYCOPHILE, MAY-JUNE 2015 Of course, many of you are now cringing, knowing that I am about to launch into another rant about the need to reform our current forestry practices to eliminate slash pile burning and address fuels reduction with metabolism rather than incineration. We need to place a much higher value on the presence of soil organic matter in our local Rocky Mountain neighborhood, or face an ecosystem collapse analogous to the Dust Bowl of the 1930’s because we have removed too much material from the soil side of the carbon cycle. The current administrative head set of “fuel reduction” by burning needs to be replaced with a mantra of “Don’t pyrolyze, Metabolize!” References Biello, David. 2012. White rot fungi slowed coal formation: The evolution of the ability to break down a plant’s protective lignin largely stopped the geologic burial of carbon that formed present-day coal deposits—and may provide secrets to making biofuels from inedible parts of plants. Scientific American online news article (reporting on the Floudas et al. paper), 28 June. Permanent address: http://www.scientificamerican.com/article/mushroom-evolutionbreaks-down-lignin-slows-coal-formation/ Floudas, D. and 70 others. 2012. The Paleozoic origin
Soil Carbon and You... (cont. from pg. 5)


Frost Flowers - It is as beautiful as it is rare. A frost flower is created on autumn or early winter mornings when ice in extremely thin layers is pushed out from the stems of plants or occasionally wood. This extrusion creates wonderful patterns which curl and fold into gorgeous frozen petioles giving this phenomenon both its name and its appearance........
If you have any articles, suggestions, or questions please email me, Karen Yakovich at snkyak@msn.com

A friendly reminder that dues for 2016 are due!