Plant Lover's Almanac

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As you read this on this chilly Saturday morn, or Friday night on ohio.com, I will be in Cincinnati at a woodland and wildlife conference, holding forth on fungi. So, instead of recent Almanac musings on plant parts, from roots to stems, and in future weeks and months on leaves, flowers and fruits, let us digress to the land of decomposition and other functions, to the wild world of the Kingdom Fungi. Instead of continuing with plant stems and their wonderful bark features and the magic of maple sap flow, down this year with all that means for maple syrup production, for today "let rot proclaim its revolution", let's surround ourselves with "*Chaos fungorum*".

Fungi are many things, from saprophytes living on dead organic matter to parasites feeding enzymatically on living plant and animal cells. Usually, I tend to focus on plant parasitic fungi, plant pathogens, since fungi are the most common pathogens we deal with in horticulture, from the rose black spot fungus, *Diplocarpon rosae*,to the Dutch elm disease fungus, *Ophiostoma ulmi.* These fungal pathogens include *Phytophthora infestans*, the pathogen of potatoes that causes late blight of potato, de-fueling large areas of Ireland and Europe and a key factor in the Irish potato famine and mass death and emigration. Oh, but wait, *Phytophthora infestans,* this water mold organism, is no longer considered a fungus by scientists. Whazzup with that? Is this another example of scientists changing their paradigm. Scandalous? Not. Science is all about describing nature better and better over time. But more on that later.

Many fungi are soloists, but many others are symbionts, making their living in intimate connection with other living things, many in a win-win sort of way as mutualistic symbionts where both partners benefit. A common example is a lichen, when certain fungal species partner with cyanobacteria or algae, with the fungus absorbing minerals and water for the partnership and adhering to the substrate, be it tree bark or cemetery stones. The algae in turn photosynthesizes, doing what plants do, taking energy from the sun to combine with carbon dioxide and water and converting into carbohydrate food, the energy that drives the food chain for us all – and its partner fungi of the lichen. Another example of a mutualistic symbiosis is mycorrhizae (literally "fungus-root"), in which certain soil-borne mycorrhizal fungi link up with the roots of most plants, enhancing mineral uptake for the plants with the plant of course benefitting the fungus by providing it food produced by photosynthesis.

Fungi, of course, are also often good food for us humans. Fungi are useful for processing foods because they are heterotrophs (organisms that get their nutrition from other organisms) that feed by absorption- that is, they secrete powerful enzymes into their environment that break down complex organic molecules into smaller molecules, which they then absorb. Thusly, we can alter the chemical makeup (and therefore the nutrition, taste, and texture) of foods by allowing fungi to grow into them. Fungi also produce chemicals - which are waste products as far as the fungi are concerned - that can impart desirable flavors and aromas.

For example, consider that most heavenly of foods, those derived from *Theobroma cacao* (which literally means "food of the gods"), the cocoa plant. Cacoa beans are naturally extremely bitter, but, with the help of the fungi *Candida krusei* and species of the *Geotrichum* fungus, cacoa seeds decompose, produce acetic acid, kill the seed embryo, destroy the bitter compounds and help create – heavenly aromas and flavors. Gods-like, indeed. And,

as an extra benefit, *Theobroma cacao,* in tropical soils, often relies heavily on mycorrhizal fungi to survive and thrive.

And that is only the beginning of our mycological meal (*mycos*= fungus). With our chocolate, how about some cheese? Say some Roquefort or gorgonzola or stilton or North American blues? Fungal spores and threadlike mycelium in Roquefort cheese comes from the fungus, *Penicillium roquefortii.* Instead of a blue, how about camembert, you say? Well then, that comes from *Penicillium camembertii*, I kid you not. Of course we also need milk from cows and sheep and goats. One of the reasons Roquefort cheese costs so much is that it is made from sheep's milk, and sheep produce relatively less milk.

Returning to our picnic, how about a crusty French baguette and some beer or wine – well yeasts are fungi! Maybe add some truffles – fungi! Eastern picnic rather than Western picnic? Fill your bento box with textured tempeh which ferments soy due to the fungus *Rhizopus oligosporus* or with miso paste, made possible, along with rice, due to the fungus *Aspergillus oryzae.* We are the fungus we eat!

Of course, not all is so lovely for us in our interactions with the fungal world. Aflatoxins, produced by the fungus *Aspergillus flavus,* if at too high a level in agricultural products from corn to peanuts are carcinogens and can cause liver damage, and levels are carefully monitored with the principle that "the dose is the poison". There are of course poisonous mushrooms. There are alkaloids produced by the ergot fungus (*Claviceps purpurea*) which, when the fungus growing along with rye seedlings produced ergoted grains that were then harvested with healthy grains in too high a percentage, resulted in gangrenous (from ergotamine) and hallucinogenic (from lysergic acid) ergotism (St. Anthony's Fire). This was mostly a medieval phenomenon, but when grain quality controls were lax in Europe during the hunger years after World War I, ergotism was still a gangrene-maker and killer. And that hallucinogen-inducing alkaloid and its role in the 20th and 21st century? It was the biological precursor of none other than LSD.

Add to that aspergillosis, candidosis, cryptococcosis, and histoplasmosis, all of these human diseases induced by fungi, and we realize, that as with all of "nature red with tooth and claw", fungi take us down many paths. Which reminds me of my own personal favorite – the Athlete's foot fungi (*Tinea* species). And one last unusual but potentially serious problem: Rose Gardener's Disease, caused by the fungus *Sporothrix schenckii,* so called because this soil fungus, if inoculated into your hand or arm on a rose thorn can cause serious long-term problems, even death. *Sporothrix* is not a plant pathogen (you do not have to worry about getting black spot or powdery mildew from your roses) but it can be a serious human pathogen, so with persistent problems with rose thorn injuries, consider contacting your physician.

Enough for now. Obviously, there is more: from fungi as medicines, either from the original *Penicillium chrysogenum* to more modern penicillin derivatives, to fungi as bioremediators, such as white rot fungi used for digestion of coal tars and other pollutants. Fungi fascinate, and as we learn more about them we continue to revise our understanding. The great categorizer of life on earth, the Swedish botanist Linnaeus, back in the mid-1700s, was utterly frustrated by fungi, the life cycles of which were hard to determine, especially with their microscopic stages. He threw up his hands and lumped them all together in one species: *Chaos fungorum!*

For ages we then classified the many fungal species as being in the Plant Kingdom due to the fact that they had cell walls and did not move around like animals, but in the 20th century scientists ditched that concept, bringing in the context that all self-respecting plants produce their own food, unlike fungi that feed on already dead organic matter or living organic matter, but not producing their own food. So, the Kingdom Fungi was proposed and accepted as a good construct for describing nature. And most recently, some organisms that what were once

considered fungi, like that *Phytophthora infextans* with its water mold relatives, wwere kicked out of the Fungi, due to differing cell wall constituents, and differing metabolic and reproductive features, and given its own kingdom, Oomycota. A revolution in rot!

Which brings us to the great poet, John Updike, and his "Ode to Rot"

Let rot
proclaim its revolution:
the microscopic hyphae sink
their fangs of enzyme into the rosy peach
and turn its blush a yielding brown,
a mud of melting glucose:
once-staunch committees of chemicals now vote
to join the invading union,
the former monarch and constitution routed
by the riot of rhizoids,
the thalloid consensus.