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In This Issue:

This month we finish our series on the American chestnut. Charles Murphy entertains us with another "Ramblings." We look at foxtails and other grass seeds—deadly to our dogs.

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Master Gardener
Helping Gardeners Put Knowledge to Work

Picture courtesy of Rick Fisher

The Dangers of Grass Awns

Recently a dear friend of mine had a very sick Labrador Retriever. $5,000 later the surgeon, along with the canine radiologist and internist, had determined that Holly had an abscess in her neck the size of an egg—and that was the good news. The bad news was that none of these specialists knew what had caused the abscess. My friend, who knows more about dogs than anyone I know, suspects the root of the problem was a grass awn. Now, I have had dogs all my life but never have I ever heard of the term "grass awn"—perhaps you've heard them called "mean seeds." The situation has become so dangerous to dogs that the AKC has issued an advisory.[1]

Several years ago I planted in two planters bordering my walk leading to the front door *Pennisetum alopecuroides* 'Foxtrot', which bloomed relatively early in the summer. Every time I brushed by their inflorescences, tiny, pointed spikes would attach to my shirt and work their way through to my skin, causing discomfort. Consequently I cut off the inflorescences in a matter of weeks. What I was doing was riding myself of these pointed spikes, called grass awns.

I had never given the thought of grass and dogs much thought. I am fully aware that dog owners must avoid giving their canine family members chocolate, grapes—and this goes for raisins, onions, and garlic[2] but grass? All my dogs love to eat new tender grass, which they proceed to heave back up, preferably in the presence of company. Grass isn't the problem; rather the problem lies in the nature of some grass seeds.

Veterinarians assume that a problem with their patients and grass awns is intrinsically just a dilemma west of the Mississippi because one of the main producers of grass awns is foxtail brome. Now the *Bromus* species consists of over one hundred annual and perennial grasses, all of which produce inflorescences, which in turn produce grass awns, those sharp spikes that caused me such irritation. Named for their seeds that resemble foxtails, foxtails tend to be found west of the Mississippi but gradually are moving eastward. However, the *Bromus* species are not the only culprits; rye grass awns from Virginia and Wild Canadian rye grasses are also dangerous. Because these seeds are inexpensive, farmers whose lands fall under the guidelines of the Conservation Reserve Program (CRP), which the Farm Service Agency administers will frequently use them to obtain the necessary ground cover.

A grass awn is shaped like a torpedo with barbs that angle away from the tip, enabling the awn to move quickly in one direction, and one direction only. Once the awn has punctured the skin it can only move in one direction: deeper into the body. This is the reason they are so dangerous to dogs. When the grass awn burrows into the dog's skin, ears, eyes, nose, and feet, they then migrate throughout the body, creating infection in major organs. Those dogs such as spaniels and retrievers who spend much of time working in fields are especially prone to picking up grass awns in their travels, as are dogs with thick long coats as the awns frequently go undetected. What is important to remember is **that all dogs are at risk**.

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[1] See: http://www.akcchf.org/news-events/library/articles/going-on-offense-against.html.

[2] According to my friend Milly Welsh who knows everything about dogs the foods dogs need to avoid are: chocolate, coffee, caffeine, alcohol, avocado, macadamia nuts, grapes and raisins, yeast dough, raw eggs and meat, xylitol (sweetener), onions, garlic, chives—low dose as found in pet foods or treat is OK—milk, salt.

Compounding the problem is the size of the grass awns: they are very small. They easily detach from the mother plant, clinging to clothing or to any animal that brushes by them. The important thing to remember is that grass awns grow on many grasses—and are potentially dangerous to dogs. Basic measures to fight grass awns are preventative: cut any wild grasses that produce these awns; be vigilant with *Pennisetum* species as they produce grass awns; and check your dog thoroughly after a run or walk in wild areas. Because cats are such prolific groomers, grass awns are not as serious threat to cats as they are to dogs.

CM: RAMBLINGS

I've been thinking a lot about water lately. Water is, literally the stuff of life on earth. Together with energy from the sun, liquid water enables the proliferation of species, both extinct and alive on our planet and promises to continue doing so.

Thoughts of water were prompted by the heavy precipitation across the US in the last days of 2010. Southern California, roughly the area from Los Angeles to the Mexican border, got deluged. According to NOAA data, the average annual rainfall for that region is 6-9 inches. They measured almost that much during December 2010 alone. Heavy rain is to southern Californians what heavy snow is to us here. Driving becomes even more of a dangerous adventure than it normally is, stores exhaust their supplies of bread and milk in the first twenty-four hours, businesses close and people wander the streets wearing plastic garbage bag ponchos, shaking their fists at the heavens and cursing their fate.

Here in central North Carolina, nature punctuated the end of the year with the exclamation point of a 6-inch snow leading to an exponential rise in the incidence of cabin fever. The Northeast got really socked, much to its surprise. The Big Apple is a great place to visit, but the Christmas 2010 storm turned it into the Big Snowball, and even the NFL had to shut down in Philadelphia on December 26.

Earth is the only planet in our solar system that has confirmed significant amounts of water; it's the only planet that has water in its three natural forms: solid, liquid, and gas. California has the liquid form, we have the solid form and the vapor form is always present in the atmosphere (think NC summers). Water continually cycles through the three phases in the atmosphere. Liquid water, mostly from the oceans, evaporates. Vapor is transported around the planet by air movements and, when conditions are right, condenses and falls back to the surface. If vapor-laden air cools enough, the vapor molecules coalesce around dust grains into droplets. When droplets get too heavy to stay aloft, they fall as rain. If the water vapor is cooled quickly enough it goes directly to ice, bypassing the liquid state altogether. When this falls we call it snow. Eventually the liquid water either makes its way back to the sea or simply evaporates from the surface.

As water moves to the sea, it can do enormous work. Every river canyon on earth was carved through rock by the action of water. The Appalachian Mountains started out much higher and shaper-peaked than they are today. What happened?—water eroded them down.

About 70% of Earth's surface is covered by water, with roughly 97% of it being salt water. It's the water in the earth's oceans and seas that gives it the appearance from space that led to the nickname the Blue Planet. The cytoplasm of plant and animal cells (the clear, squishy stuff housed within the cell membrane) is water-based. An abundance of cell water is easy to notice in the garden—leaves look full, stems are

upright and strong—and its lack just as easy to spot. It's not so obvious with people and other animals but close observation can recognize even early signs of dehydration. People are so dependent on a continuous supply of potable water that three days is about the longest we can endure without water before we begin to experience vital organ shutdown.

We all know from basic chemistry that water is actually a combination of two gases, hydrogen and oxygen. Here nature performs one of its many miraculous transformations. Hydrogen, the lightest element, is an explosive gas (remember the Hindenburg). Oxygen supports combustion, and is a very active element, which enjoys combining with all sorts of materials. Oxidation (think rust) wears away strong metals, oxygen combines with most of the earth's minerals readily and is implicated in human aging and final breakdown. Two highly active and reactive elements combine to form a stable, life-giving compound. And, it can put out fires to boot. The middle school science demonstration using a beaker of water, a dry cell battery and two test tubes shows clearly how water can be dissociated into its constituent parts with a simple apparatus. Then after collection a tube of hydrogen, it's fun to put a burning splint to the mouth of the test tube and hear the POP!, or dip the splint into the oxygen tube and watch the flame grow brighter.

We all know too well the effects of our typical summer dry spell on garden plants, and we're accustomed to watching the local news with trepidation, waiting for the latest water restrictions announcement. Average annual rainfall for our region is 44-48 inches, and if it were evenly distributed throughout the year we would have few watering worries in the garden. But, due to the vagaries of nature, we often have to make do in dry times.

Are there measures we can take to better assure a stable water supply for our gardens throughout the uncertain month? Water Part 11, next month.

The American Chestnut—Part III

Editor: This is a long article and I do apologize but I simply fell in love with this tree. There are several good places to go on the Internet if you would like to learn more about helping this native American tree. The American Chestnut Foundation is at: www.acf.org. There is also the American Chestnut Restoration Project at http://www.fs.fed.us/r8/chestnut/ and the American Chestnut Cooperators' Foundation at http://www.ppws.vt.edu/griffin/accf.html. One of our own, Susan Looney, is very involved with the ACF. She wrote in an e-mail: "On December 21 we were pleased to host Bryan Burhans, the CEO of the American Chestnut Foundation, and members of his staff on our farm in Tennessee to plant three of the 'restoration chestnuts.' These are the latest line of potentially blight-resistant chestnuts. In attendance were folks from the Tennessee Forestry Association, the Tennessee Wildlife Association, as well as our local county extension agent, staff, and the local newspaper to celebrate the occasion. We are very hopeful that the trees will be resistant. The ACF chose to plant the trees on our farm because our farm is in a conservation easement and consequently will not be developed."

Born in 1904, the year the chestnut blight first appeared, the plant geneticist Charles Burnham retired from Cornell in 1972—but he was to have an impact on the future of the American chestnut. While a professor at the University of West Virginia, he had witnessed first hand the destruction of the chestnut but at the same time he had noticed that the dying giants still produced flowers, which indicated that American chestnut pollen was still available. When checking in with the USDA, the agency always assured him that the prospect for the native tree was promising, so it was a shock when he

learned that such was not the case. "Not only had the USDA abandoned ship, it has apparently missed the boat. The government breeders had pursued a strategy that was virtually guaranteed to fail."[3]

Burnham's idea was to employ a method called "backcross breeding": The basic idea is simple: "Say you have variety A which is prone to a disease and variety B which is impervious. You cross A and B, and then take the offspring of that union and cross it back to parent A for several generations. The result is a crop that is just like A in every way except that now it also has acquired B's resistance to disease" [1479-90]. Previously, this method had worked successfully both with grasses and cattle so Burnham had hopes that it could work with trees. This was the approach he had recommended to the USDA two decades earlier, advice the agency had left unheeded.

Burnham believed the pursuit of hypervirulence alone could not save the American chestnut; what was needed was a transformation of the tree's DNA. Burnham made contact with a Minnesotan farmer, Philip Rutter—and so began a collaboration that culminated in the "foremost effort to date to restore the beleaguered tree, the American Chestnut Foundation" [1490-1501]. Burnham brought the knowledge whereas Rutter had the organizational skills and passion. Rutter had tossed aside academia to settle in Minnesota to study the cultivation of tree crops, as he believed nut crops could feed the world as well as grains, but with far less damage to the environment. Consequently he began to grow hybrids.

The tragic factor in the history of the chestnut blight is that along with man's help it had managed to kill all the American chestnuts, something that is never in the interest of the pathogen. Epidemics by their very nature kill a lot—but they don't kill everyone or everything because this does not act in good service to the cause of the epidemic, whether it be bacterial, viral, or fungal in nature.[4] The American chestnut—pre blight—was so successful that surely there would have been some individual trees strong enough to withstand the onslaught of the blight. Keeping this in mind, Rutter began to think that other factors combined with *Cryphonectria parasitica* to achieve the devastation. Like Burnham, Rutter began to think in terms of backcross breeding as a means of bringing back the American chestnut.

In 1981 the two men combined forces. When coming across governmental regulations to chop down *all* the American chestnuts, Rutter finally began to understand why none had survived the blight: the government—state and federal—had combined with the blight to bring down all the American chestnuts. The federal government has lost interest in the tree when the first generation of hybrids had failed to fulfill their promise. The genes that protect the Chinese chestnut are only two or three but these genes are "incompletely dominant, meaning that they gather strength in numbers. The more of these genes a tree inherits, the better its ability to battle the blight" [1574-85]. Compounding the issue is the fact that the success of these genes varies. Consequently, when a Chinese chestnut is crossed with an American chestnut, the resulting hybrid will only have half of the genetic equipment needed to fight the blight. Where the government scientists, who were pathologists and not geneticists, erred was that they would take the first generation hybrid and breed it back to the Chinese chestnut rather than breeding it with another first generation hybrid.

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[3] Freinkel, Susan. *American Chestnut: The Life, Death, and Rebirth of a Perfect Tree* (University of California Press, Berkeley, 2007), 1462-1490. Please note that the location numbers refer to the Kindle. Future references will be in brackets [ ].

[4] Look back over some of the great epidemics, such as the Black Plague and the 1918 flu pandemic. They killed thousands and thousands of people but didn't kill everyone. Today we still have these infections with us, evidence that the pathogen has not been eradicated.

Together Burnham and Rutter composed a plan: (1) they would cross the American chestnut to the Chinese chestnut, which was the most blight resistant of all the *Castanea* species; (2) they would repeatedly breed the hybrids back to the American chestnuts to phase out all the undesirable Chinese characteristics (such as short height and less succulent nuts), concentrating on keeping the blight resistance. Burnham, the geneticist, estimated that it would take three generation of backcrosses to produce a tree that was 93.75% American; (3) the third step consisted of breeding these 93.75% American trees with one another, which would hopefully give the blight resistant genes from both parents to the offspring. The offspring would now have "a full arsenal of blight-fighting genes" while looking like the original American chestnuts [1595-1606]. This ambitious program to save the American chestnut would take a minimum of forty years—and Burnham was now age 75. The other problem was that now they had to find the trees in order to start their breeding program.

By the 1980s, the government had given up trying to save the tree while in the scientific community hypervirulence was the current rage. Gradually Burnham and Rutter collected the necessary pollen at the same time gradually learning how to handle it as the female chestnut flowers were finicky. By 1983 the pair had hybrids growing at Oberlin, in the Great Smokies, at Virginia Polytechnic Institute, West Virginia University and the University of Minnesota [1630-41]. Gradually the hugeness of the program overwhelmed them and they realized they needed an institution to carry on the work as this endeavor that would take more than a lifetime to complete. Feeling government agencies, such as the USDA, and universities were too fickle to trust with this enterprise, Rutter and Burnham understood they needed a foundation, whose sole purpose was to save the American chestnut. Burnham still had the stature to call in prominent scientists to a meeting in 1983, resulting in the founding of the American Chestnut Foundation.[5] Rutter provided the organization skills needed to get the foundation on its feet. He recruited members, encouraging them to open state chapters. However, his main problem was that this native American tree had slipped out of the public consciousness. By the mid-1980s most Americans had never even seen this native American tree.

Fortunately Rutter was a mesmerizing speaker. Not only was he a successful fundraiser, but he also was able to get land for the foundation's use: "It needed a lot of land because the calculus of breeding demanded that the foundation grow a lot of trees. To get just one fully resistant tree from a Chinese-American union required tossing the dice 190 times—in other words, producing and growing 190 nuts" [1663-79]. Soon, through the generosity of two sisters, Jennifer and Cheri Wagner, the foundation acquired twenty acres in Meadowview, VA in 1989. By this time Burnham was in a nursing home, unable to contribute to the future of the American chestnut, so the onus was on Rutter.

Today, backcrossing is not the only game in town.[6] Biotechnology is now rearing its head with scientists trying to "bioengineer a blight-resistant chestnut by taking genes from sources wholly unrelated to the *Castanea* family and inserting them into the DNA of American chestnuts," aka "new-fashioned breeding" [1706-17]. Old-fashioned breeding is time-consuming—and time is now of the essence in trying to save the American chestnut as its sprouts are growing weaker and weaker. "With a few snips and tucks of the molecular scissors and tweezers, you could potentially revise the genetic coding of a tree so that it grows faster or straighter, repels bugs or resists weed killers, weathers winter freezes or summer droughts….And you could rescue an endangered species" [1717-25].

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[5] http://www.acf.org/

[6] For a more detailed analysis on backcrossing and what it involves, go to: http://www.acf.org/r_r.php.

Some trees and plants take easily to genetic modification, such as the poplar, tobacco, and the soybean. In a perfect world, the American chestnut would also be amenable to genetic aid—but it isn't. It turns out that the American chestnut is a finicky tree. The most obvious genetic modification is to use those blight resistant genes of the Chinese chestnut—but scientists have not been able to isolate those genes.

Charles Maynard and William Powell who work at SUNY in Syracuse are hard at work trying to manufacture a blight-resistant American chestnut. However, questions remain about using a biotechnological approach. Will a chestnut with a "transgene" produce nuts that are safe for human consumption? Can a fungal-proof tree be part of the natural system? Trees, after all, need certain fungi, such as mycorrhizae, if they are to absorb minerals from the soil.

Different species can hybridize—oaks are willing to breed with other species—but often the offspring are sterile (think of mules). There are also gene variants, called alleles, which arise through natural selection. If an allele displays an advantage for survival, it has a good chance of being incorporated into the particular population over a long period of time. Bioengineering seeks to shorten the time period: "If multitudes of the transgenic organism are being produced in a lab, then a new population arises that has never been subjected to the tests of natural selection" [1842-52]. The rush to develop transgenic trees is on, with the American chestnut leading the way.

For the last fifty years there has been an effort to domesticate trees. We now breed loblollies that we can turn into paper pulp more easily; tree plantations now exist with trees growing in orderly rows to meet the demand for wood. Transgenic trees are here although the USDA has released only one commercially, a papaya that can resist the ring-spot virus [1872-81]. Some of this genetic engineering does take the environment into consideration: for example insect-resistant trees could help reduce the use of pesticides while low-lignin trees could be environmentally beneficial for the paper industry as removing lignin is a necessary but toxic and expensive process necessary to produce paper [1881-92]. Genetically altered poplars can take mercury from the soil and turn it into a less poisonous gas. Those aforementioned plantations of trees also protect the forests by supplying our demands for wood and paper.

The other side of the coin, of course, is that along with the aforementioned environmental benefits, there are environmental risks. Gene transfer is, at best, unpredictable. Adding a gene to the genome may unleash all kinds of unpredictable and undesirable traits: a potato bred to withstand the Colorado potato beetle succumbed to aphids while the Flavr-Savr tomato, bred to ripen more slowly, absorbed large amounts of heavy metals from the soil.

There are anywhere between 27,000-45,000 genes in the American chestnut genome so probably adding a few genes could conceivably be safer than backcross breeding, which introduces the Asian genes into the equation [1935-45]. The American chestnut is in such danger that many scientists have concluded that genetic engineering might be the only way to save the tree as time is of the essence. Bioengineering scientists are hoping for a transgenic American chestnut because the subject is sexy, one that would present a positive side to the American public, who tends to regard bioengineering as a form of voodoo: "The chestnut would be a perfect test case—a relative risk-free product that unlike, say, a more palpable pine, is genuinely wanted by the public" [1945-55].

The New York chapter of the American Chestnut Foundation[7] has taken the lead in bioengineering a new American chestnut while the other chapters have remained committed to the backcross breeding plan. So far several American chestnut "treelets" are in existence but it will be another five to six years before scientists will know whether they will survive.

The native habitat of the American chestnut stretched over two hundred million acres. This was an amazingly adaptive tree that could handle various climates, soils, and topography. Breeding wild trees—and the American chestnut was never domesticated—is no easy matter. Trees adapted to Meadowville, VA probably would have a tough time surviving a Maine winter. *C. parasitica* probably will change when it encounters disease-resistant chestnuts: "Over the course of a single tree's lifetime, thousands of generations of *Cryphonectria parasitica* will live, reproduce, and die, giving the fungus ample opportunity to evolve a way around the newly acquired fortifications" [2234-45]. Taking this into consideration, scientists now think they have to incorporate other species of *Castanea* along with Chinese cultivars "that draw on other, as yet untapped, genes to repel the blight. "In other words, the end result of the breeding program will not be a single perfect tree, but a panoply: a spectrum of perfection" [2245-56].

However, the blight is not the only threat to the American chestnut. *C. parasitica* kills only the tree's trunk and branches, leaving the roots alone, while *Phytophthora cinnamomi*, an Asian root rot destroys the roots. An outbreak of *P. cinnamomi* occurred in the Piedmont in the 19th century so scientists are also working on a hybrid that is resistant to this root rot. A heavy infestation of the Asian gull wasp is another danger as it can kill the tree. Other threats are the Ambrosia bark beetle, the gypsy moth, the two-lined chestnut borer and another species of *Phytophthora* that has devastated California oaks: "Every one but the chestnut borer was imported from abroad. If ever there was a poster child for the threat of invasive species, it is the American chestnut" [2256-64].

Charles Burnham had warned that it probably would take at least six generations of backcrosses before an American chestnut blight-resistant tree emerged [2264-73]. By 2004 the sixth generation appeared at Meadowville but once inoculated with the blight—the only way to quickly determine blight resistance—the results were disappointing. These trees are virtually indistinguishable from the original American chestnut but genetically they are 10% Chinese chestnut. Scientists are at odds whether this new chestnut is actually *C. dentate* because it is technically a "backcross American chestnut."

Conquering the blight is only half of the battle: "With the twenty-first century comes the even harder task of releasing the tree from human care and returning it to nature's hands" [2316-27]. Its natural habitat is gone, as over the past century the forests have changed, filling in the void left by the demise of the American chestnut. There are so many unknowns, such as: What kind of soil does the tree prefer? What fungi live in a symbiotic relationship with the tree? How does the tree deal with drought and fire? Will it tolerate shade if the tree is placed in a forest—whole forests have grown up without the chestnut. How will the young trees contend with the deer, which are so much more plentiful now? To reintroduce the American chestnut to the forest will demand some disturbance of the forest. "Will the chestnut's supporters be able to persuade local communities that chestnut restoration should trump competing natural landscapes?" [2348-56].

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[7] The American Chestnut Foundation has sixteen chapters located in sixteen states. The closest one to us is the Virginia Chapter. See: http://www.acf.org/Chapters.php.

In 2005 on Arbor Day President George W. Bush planted an American chestnut supplied by Meadowville on the north lawn of the White House. At the last report it wasn't doing well.

An EMGV in the News

Editor: Occasionally I like to profile EMGVs who are doing interesting things outside the program. If any of you would like to be profiled, please let me know. This is, I feel, a good way of maintaining connectedness in our EMGV community.

Rick Fisher, our current Vice Chair of the Advisory Committee, recently announced that he has formed Rick Fisher's Photography, LLC. Most of us know Rick as the EMGV who always shows up with his camera—some EMGVs have even accused him of doing this to avoid any "heavy lifting!"

Thinking about this move for a long time, Rick decided a few years ago to increase his photographic knowledge by improving his formal photographic knowledge through classes and workshops; he also arranged to have a professional photographer mentor. Since moving back to Durham, he has provided volunteer photographic services to the Durham Rescue Mission, Duke Gardens, the Museum of Life and Science, Downtown Durham, Inc., the Animal Protection Society of Durham as well as private weddings and sporting events, including a Duke baseball game and the NCAA National Championships in Eugene OR. Recently he worked on projects for two EMGVs, whose response to his work was quite positive. For those of you on Facebook, Rick posts a "picture of the day" every day, a project that has developed a large following, mainly by word of mouth. For those of you who would like to see his daily picture, simply click on "like" on his Rick Fisher's Photography Facebook page.

One major twist to his business is that *he plans to donate 100% of his business revenue to local charities*. Any revenue derived from work with the EMGVs will go to the Briggs Avenue Community Garden.

Rick will continue to do weddings, portraits, children, infants, pets, events, sports, and nature photography. He also plans to teach and to conduct photographic travel workshops throughout the country. Right now he is working on a "Waterfalls and Wildflowers" photography trip for the spring of 2012. For more information visit Rick Fisher's Photography page on Facebook or go to www.rickfishersphotography.com.

"Time will tell how well the business does. I'm very encouraged by the positive response I have received from people when they became aware of the new direction I'm taking," Rick said. I'm sure all EMGVs join me in wishing him good luck!

Editor: This picture is one of the daily pictures Rick posted on Facebook. It is one of my favorites.