

May 2015

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Identifying Galls

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Plant Galls: Myths and Misconceptions

An unusual plant growth can be disconcerting, especially if you're not sure what it is—or what kind of damage it can cause. In Part I of a series, Ohio State University entomologists and plant pathologists help to identify galls.

By Joe Boggs and Jim Chatfield

Plant galls have a rich history—and a dedicated branch of science—so it could be assumed that plant galls are well understood. In fact, despite plant galls being one of the most obvious and unusual of plant structures, there remains much that we do not know. Scientists continue to debate exactly how galls are formed; so far, no scientist has ever grown a plant gall without help from a natural gall-maker. The identification of the gall-makers behind many of our most noteworthy plant galls remains a mystery. This dearth of gall-knowledge does little to remedy many longstanding myths and misconceptions about plant galls.

So in this first part of our exploration into galls, we'll introduce you to the basics: namely, how to tell whether an unusual plant structure is a gall or some other oddity.

Is it a gall?

Occasionally, abnormal gall-like growths that are caused by something other than a living gall-maker can occur on trees. These are not true plant galls. The growths may be stimulated by exposure to chemicals such as herbicides or even misdirected plant hormones circulating within the tree. If no organism is found to be directly associated with the formation of the abnormal gall-like structure, we have eliminated the path to a "gall diagnosis" and opened other paths that may lead to a correct diagnosis, such as a physiological problem or exposure to an herbicide.

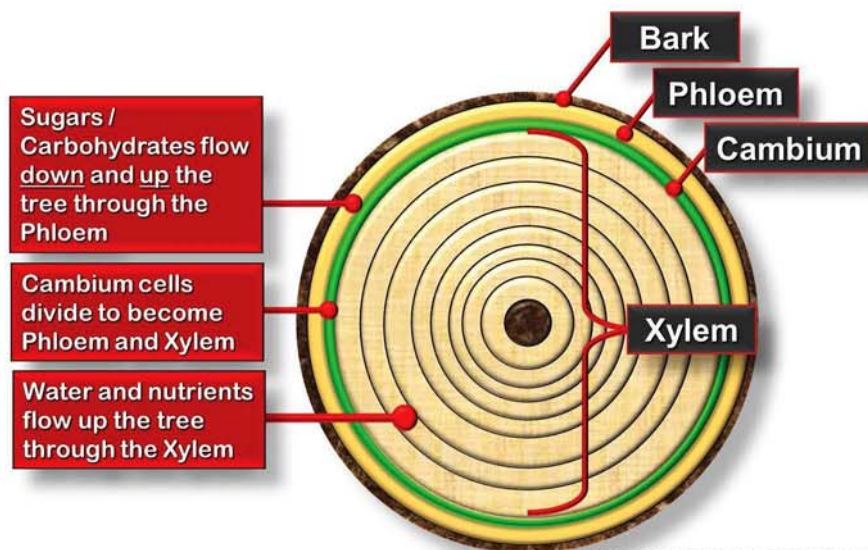
The name "gall" may conjure a range

of images; some accurate, some inaccurate. Various fungal fruiting structures are occasionally mistaken for galls, particularly the shelflike growths sprouting out of trees that are produced by bracket fungi. These structures are the macroscopic form of the microscopic wood decay fungi that are digesting the tree from within. Their activity may be dramatically disclosed when trees fall; galls do not cause such damage. The brackets are solely composed of fungal tissue with the purpose of producing fungal spores, thus the name "fruiting structures."

Fungal cankers on trees are sometimes mistaken for galls, and vice versa. The big difference is that cankers involve

the death of plant tissue. A brief review of tree anatomy will be helpful in understanding the cankering process as well as stem gall formation that will be described later. Tree stems are composed of a series of rings within rings, with the outermost ring being the protective bark. Beneath the bark is a thin ring of phloem, and beneath the phloem is an even thinner ring of cambium; it's only about three cell layers thick.

Beneath the cambium are multiple rings of xylem, which is the "wood" of the tree and the target of the aforementioned wood decay fungi. Cambial cells are "undifferentiated" (= meristematic) meaning they can become something else. The



Tree trunk basics

All photos: Courtesy of Joe Boggs

Graphic by Joe Boggs, OSU Extension



Although this growth may appear to be a gall, it's actually a reaction to exposure to a herbicide.



These shelflike structures are not galls, but dryad saddle bracket fungi (*Polyporus squamosus*).



Although galls are sometimes incorrectly called "plant tumors," bacterial crown galls—such as this found on euonymus—resemble tumors because of their lack of organized structure.

cells may become phloem to the outside or xylem to the inside, which is how trees increase girth. However, if exposed to oxygen, the cambial cells form an entirely different type of tissue called callus tissue. This tissue overgrows wounds through the bark. It is the tree's method for closing a wound; trees do not heal, they seal.

Fungal tree cankers develop in a two-step process. First, the cankering fungus infects and consumes the phloem, which produces a void beneath the bark. The loss of the supporting phloem tissue may cause the bark to become sunken and crack, exposing the surrounding cambial tissue to oxygen. The second step occurs when cambial cells produce callus tissue in response to exposure to oxygen. If the fungus does not immediately infect and destroy the callus tissue (e.g., diffuse cankers), a raised boundary of liplike callus tissue develops around the void beneath the bark and may eventually expand to push the

broken bark aside. This two-step process sometimes generates confusing descriptions of cankers: They are sunken areas of the bark; they are raised areas of the bark. Of course, they may be both!

While cankers form in response to an injury, the term "galled" has also been used to mean "injured" for hundreds of years. When the Earl of Salisbury unsheathed his sword in Shakespeare's play, *King John* (Act IV, Scene III), he bellowed, "*Stand by, or I shall gall you, Faulconbridge.*" Salisbury wasn't threatening to cause Faulconbridge to sprout galls; he was warning him that he may injure him with his sword! When Shakespeare used "canker," he was often referring to an injury caused by a cankerworm, a type of moth caterpillar. "*The canker galls the infants of the spring too oft before their buttons be disclosed.*" (*Hamlet*, Act II, Scene III). Translation: Cankerworms often injure the flower buds of spring before the buds open in bloom.

Is it a canker? Is it a gall? Reading Shakespeare doesn't help.

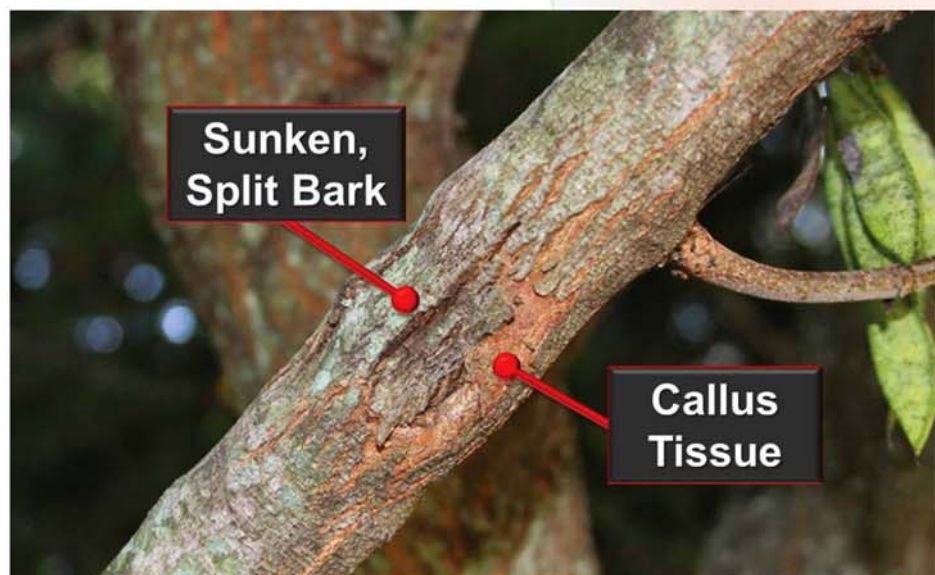
Galls involve the *growth* of plant tissue. However, one size does not fit all. There are many organisms that can induce gall formation including microorganisms such as viruses, bacteria, fungi, nematodes and eriophyid mites; as well as macroorganisms such as insects. Exactly how the galls grow depends on the gall-maker.

Bacterial crown gall

Crown galls produced under the direction of the bacterium *Agrobacterium tumefaciens* represent a number of unique features compared to other gall-makers. Plant galls are sometimes incorrectly referred to as "plant tumors"—this is inaccurate, because they are often highly organized structures. However, crown galls are much like tumors in that they lack an organized structure and are composed of a chaotic agglomeration of cells. The bacterium transfers genetic material in the form of T-DNA into plant cells, which is then integrated into the cell's chromosomes. The new DNA induces a frenzied proliferation of infected plant cells with each cell becoming "bacterial factories" cranking out more bacterial bodies.

The second unique feature is the way the bacterium spreads. Because each cell includes infectious material, a very tiny piece of the gall can induce new gall formation. Most other plant galls arise as the result of the movement of the gall-maker to new sites as with insect gall-makers, or by the movement of spores as with fungal galls, not by movement of a piece of the gall.

Finally, crown galls may be found on an impressive number of hosts, including members of 93 plant families. Most gall-makers have a very narrow host range, often confined to a single plant



Liplike callus tissue—the result of *Botryosphaeria* canker—is evident on redbud.

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Elm sackgalls



Translucent oak gall



Hawthorn pod galls

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species. Thankfully, while the bacterium is capable of infecting a wide range of plants, in reality galls tend to occur on only a few landscape plant species, most notably on rose (*Rosa* spp.), euonymus (*Euonymus* spp.), forsythia (*Forsythia* spp.), and wisteria (*Wisteria* spp.).

Fungal galls

Various fungal galls represent another type of gall-growth. The cedar-apple rust fungus, *Gymnosporangium juniperi-virginianae*, is so named because one of its hosts is eastern red cedar (*Juniperus virginiana*), which is a type of juniper; the fungus does not infect cedar. It also infects apple (*Malus* spp.). In fact, the fungus cannot complete its development on either juniper or apple; it must alternate between the two hosts to complete its life cycle. Galls are only produced on juniper; rusty-orange lesions are produced on the leaves and fruit of apple.

The brainlike galls produced on juniper are more organized compared to crown gall and are composed of a combination of plant tissue, mainly parenchyma, and fungal hyphae. The fungal partnership is dramatically revealed in the spring during wet weather when bright orange, gelatinous, tentacle-like “telial horns” are extruded from the galls. The horns are composed of fungal teliospores, which give rise to basidiospores that are ejected into the air to drift onto apple where they germinate, marking the beginning of the other half of the fungal life cycle. Although the infectious spores can be blown a considerable distance, infections on both hosts are certainly enhanced by in plantings where the two hosts are in close proximity to one another.

Black knot of *Prunus* is caused by the fungus, *Apiosporina morbosa*, and is characterized by thick, rough, elongated growths on the twigs and branches.

Although black knot is primarily associated with cherry and plums, fungal galls have been recorded on 24 species of *Prunus*. Young galls are olive-green or reddish-green and have a velvety texture; older galls are coal-black and corky. The galls may develop a white or pink discoloration caused by the fungal parasite, *Trichothecium roseum*.



Figure 6. This cedar-apple rust fungal gall exhibits telltale bright orange, gelatinous, tentacle-like telial horns.

Like the cedar-apple rust galls on junipers, the knot-like galls are composed of fungal tissue mingled with plant tissue. The galls disrupt vascular flow, and heavy galling causes stem dieback. The fungus infects newly developing twigs in the spring, and production of infectious spores occurs about two years after the initial infection. Thus, pruning and destroying newly developing galls is an important step in preventing development of more fungal galls.

Insect and mite galls

Insect and mite (arthropod) galls exhibit a wide range of forms; some are

simple structures, while others are complex. The galls can be separated into different groups, which helps with identification. First, where is the gall located? Is it on the leaf or petiole? Is it growing from flower or fruit parts? Has the gall-maker hijacked a leaf bud, or did it commandeer meristematic stem tissue? Second, how many chambers are found in the gall and how many immature gall-makers live in the chambers? Unilocular galls have only one chamber; plurilocular galls have multiple chambers. Unilarval galls only have one gall-maker per chamber; multilarval galls have more than one gall-maker per chamber. Thankfully for identification purposes, most arthropod gall-makers strongly adhere to these rules of segregation. *Stay tuned: The next article in this series will cover insect and mite galls in depth.*

Leaf/petiole galls

These galls are further separated by where they occur on the leaf. Are the galls only found on the petiole, on leaf veins, or between the leaf veins? Or are they found on two or three of these locations? Are they found on the lower leaf surface, upper leaf surface, or both? This is not Gall-Trivial Pursuit: Many gall-making arthropods confine their activity to a well-defined area of the leaf.

The unilocular, multilarval elm sackgalls that are produced by the aphid, *Colopha ulmisacculi*, only arise on the upper leaf surface between the leaf veins. The colorful, fleshy, unilocular, unilarval translucent oak galls produced by the gall wasp, *Amphibolips nubilipennis*, are firmly attached to veins on the underside of leaves. Among the most dramatic leaf-vein galls are the so-called hawthorn pod galls produced by the gall midge, *Blaesodiplosis* (syn. *Lobopteromyia*) *venae*. The half-inch-long galls are at first light green, but turn deep red as they mature.



Erineum galls on beech



Maple spindle galls



Acorn plum gall

They arise from veins on the underside of leaves, and their size and weight cause affected leaves to droop making the galling more noticeable.

The felt-like “erineum galls” produced by the eriophyid mite, *Acalitus fagerinea*, creep across the upper leaf surface of American beech (*Fagus grandifolia*). It is believed these simple galls are produced by constant but subtle feeding irritation, perhaps coupled with the release of chemical inducers by the gall-maker. However, some eriophyid mites induce truly unique plant growths

that must involve some chemical direction. Two examples are maple bladder galls produced under the direction of the eriophyid mite, *Vasates quadripedes*, on the upper leaf surfaces of some red and silver maples, and the finger-like spindle galls produced by *V. aceriscrumena* on the upper leaf surface of sugar maple.

Flower/fruit galls

While the vast majority of arthropod gall-makers cause little to no injury to the overall health of their plant hosts, those that only affect flowers or fruit are truly

innocuous. However, they can have a serious impact on reproduction. One of the most spectacular galls in this group is the acorn plum gall (a.k.a. acorn gall); these sprout from acorn caps under the direction of the gall wasp, *Amphibolips quercusjuglans*. The ball-like galls are around 1 inch in diameter, and their unique coloration of yellowish-brown shot through with purplish-brown “veins” makes the galls look like blood-shot eyeballs; a disconcerting sight once the galls detach and drop to the ground in late summer! The

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Ash flower gall



A yellowjacket is attracted to nectar produced by a bud gall.



Scales that envelop this gall resemble a pinecone—thus the name willow pinecone gall.

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deep reddish-purple color of the mature galls is responsible for the “plum” in their common name.

The attention drawn to North American ash trees due to emerald ash borer (*Agrilus planipennis*) has also focused a spotlight on the handiwork of the eriophyid mite, *Eriophyes fraxinivorus*. The mite targets male flowers in the spring, inducing the flowers to become distorted, brushlike, witches’-brooms. The affected flowers are green while the mites are in residence and become brownish-black once the mites vacate the galls. Spent galls may cling to trees for several years. Insecticide treatments for emerald ash borer will have no effect on the eriophyid mites; treated trees may still become festooned with spent galls.

Bud galls

Unlike the leaf/petiole gall-makers that commandeer a limited number of meristematic cells in the leaf buds, gall-makers that produce bud galls hijack all of the meristematic cells. In some cases, the effect is obvious. The descriptively named oak bud gall produced by the gall wasp, *Neuroterus vesicula*, is formed when a single bud is directed to become a reddish-brown, ball-like gall that is only slightly larger than a normal bud. The small size should not be allowed to contravene the complexity of this gall. A close examination of the gall’s surface may reveal tiny droplets of nectar produced by nectaries located within the gall; this is one of the galls with functional plant organs. The nectar attracts ants and stinging insects, which provide protection for the developing gall-maker.

In other cases, the gall-growth is so dramatic; the gall structure must be broken apart to reveal the source of the “parent” tissue. There are several types of “oak lobed galls.” They are composed of tight

clusters of wedge-shaped “kernels,” which gives them a multilobed appearance, thus their common name. The kernels of the oak lobed gall produced by the gall wasp, *Andricus quercusstrobilanus*, range in color from light to dark-brown tinged with red. The galls vaguely resemble pine cones and are sometimes called “pine cone oak gall.” The entire gall structure may measure 3 to 4 inches long and involve several buds. However, the origins of the kernels can only be revealed by peeling them away to show they arose from oak buds.

One of the most dramatic looking bud galls are willow pinecone galls formed by the gall midge, *Rhabdophaga strobiloides*, on its namesake host. The common name is very descriptive with the inclusion on pinecone-like scales on the surface of these fuzzy, greenish-white galls. The galls are formed from terminal buds of black willow (*Salix nigra*) presenting the bizarre display of “pinecones” growing from the tips of the willow branches.

Stem galls

The ring of stem cambium located between the xylem and phloem is meristematic tissue; the cells are undifferentiated. However, unlike bud cells, the cambium remains meristematic tissue throughout the growing season; undifferentiated cells are continually available. Since cambial cells remain free agents throughout the growing season, galls can be formed from these cells anytime during the growing season, although most stem galls start growing early on to provide ample time for the gall-maker to complete its development.

Oak bullet galls produced by the gall wasp, *Disholcaspis quercusglobulus*, is a good example of a stem gall arising from cambial cells. They are also another example of a gall that develops functional plant organs. Like the aforementioned oak bud galls, bullet galls have nectaries. The

sugary treat exuded from the nectaries serves as a “bribe” to entice ants and stinging insects that offer protection to the immature gall-maker. A predator or parasitoid intent upon targeting the helpless wasp larva within the gall would need to run a gauntlet of stinging and biting insects fueled by sugar! The downside is that heavily galled trees may literally buzz with stinging insects presenting a serious challenge if the tree is located near a home.

Most stem galls arise from the surface and cause no harm because they do not disrupt vascular flow within the stem. The exception is the horned oak gall produced by the wasp (*Callirhytis cornigera*). Of the more than 800 types of galls that may be found on oak, this is one of the few that can potentially cause significant damage to its oak host. That’s because the galls may completely surround and girdle the stem, and gall tissue may invade the xylem to choke off the flow of water and nutrients. As the result, the stem beyond the gall often dies. Although horned oak galls do not typically kill trees, the stem dieback can significantly disfigure tree canopies and the stress associated with loss of leaves can make heavily infested trees more susceptible to other problems.

Stay tuned ... we’ll cover horned oak gall in the next installment.

Next up: Insect and mite galls, followed by gall management. 🌱

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