Asian Chestnut Gall Wasp

An invasive pest of concern for Michigan chestnut growers

Authors:

Louise Labbate[2] and Deborah G. McCullough[2,3]
Michigan State University
[2]Department of Entomology and [3]Department of Forestry, Michigan State University

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Chestnuts (*Castanea* spp.) are grown and consumed by people around the world. While many people in the United States enjoy freshly roasted chestnuts in the winter, chestnuts are also used in a variety of products, from gluten-free flour to beer, liquors, and candy. The United States imports the vast majority of its chestnuts, but domestic production is steadily expanding. Michigan is the largest commercial producer of chestnuts in North America.

Unfortunately, the Asian chestnut gall wasp (ACGW) (*Dryokosmus kuriphilus* Yasumatsu) was discovered in Michigan in 2015. This tiny insect, a native of China, is a major invasive pest of chestnut trees in Japan, Korea, much of Europe, and the United States. At high densities, the spherical galls caused by the ACGW (Figure 1) can reduce tree growth and nut production. This invasive pest will continue to spread and could become a serious problem for commercial chestnut producers across the state. In this bulletin, we provide information on the ACGW, including its biology and impact. We also provide management options for dealing with the pest.

Figure 1. Chestnut shoot with leaf galls caused by the Asian chestnut gall wasp. Photo by Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org.

History and Distribution

The Asian chestnut gall wasp was accidentally introduced into the United States in 1974, when infested chestnut plant material from Japan was planted in Georgia. Since then, the ACGW has spread to at least 14 states, including much of the native range of the American chestnut (*Castanea dentata* [Marsh, Borkh]). Ongoing spread within the United States is due in part to the natural dispersal of adult wasps, which can fly and are probably also carried by the wind.

Movement of the ACGW across large distances, however, occurs when people transport infested plant material into previously uninfected areas. Nursery trees, scion wood, and chestnut cuttings can all harbor tiny, nearly invisible ACGW eggs or larvae, making unintentional movement of the wasp a major concern.

In an attempt to prevent the ACGW from becoming established in Michigan, the Michigan Department of Agriculture and Rural Development issued an external quarantine in 2010 that restricted importation of all live *Castanea* spp. material (except nuts for consumption), from states with known ACGW infestations. Despite this effort, the ACGW was detected in two chestnut orchards in southwest Michigan in July 2015, and additional infestations continue to be discovered. As of July 2021, the ACGW had been found in chestnut orchards in at least six southwest Michigan counties (Figure 2).

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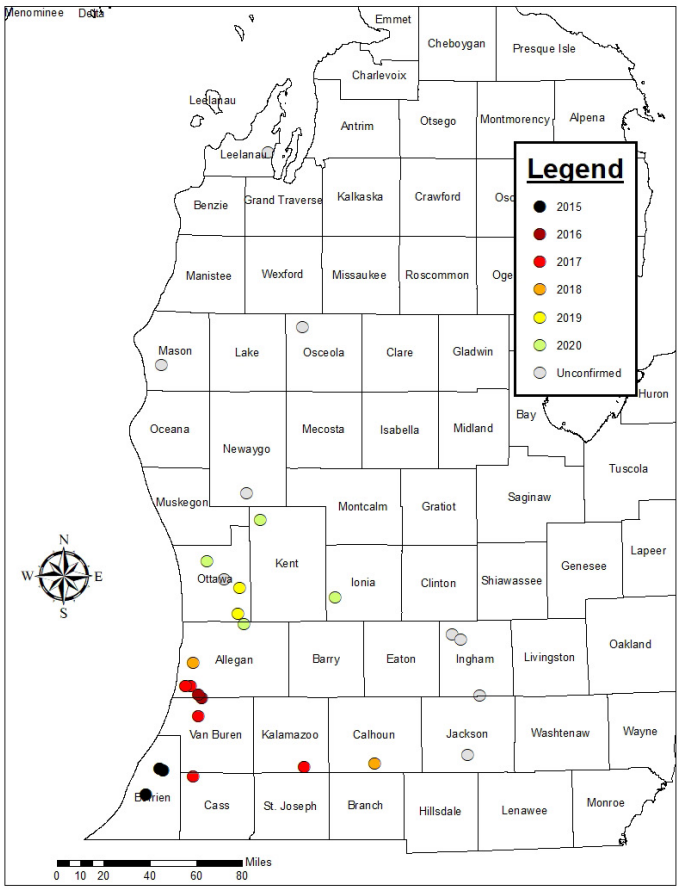

Figure 2. Locations and first year of Asian chestnut gall wasp detection in sites in southwest Michigan, as of July 2021. Map by M. Ferguson, L. Labbate, and D.G. McCullough, Michigan State University.

Life Cycle

The Asian chestnut gall wasp produces one generation per year and is a parthenogenetic species, meaning that all wasps are female and reproduction occurs asexually. Thus, even a single wasp can start a new infestation.

Figure 3. An adult Asian chestnut gall wasp. Photo by Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org.

Gall wasp adults are very small, about 1/8 inch (3 mm) long, and have black bodies with yellow legs (Figure 3). Adult wasps lay eggs inside chestnut buds over a four- to six-week period, typically from the last week of June to the second week in August in southwest Michigan. This period corresponds to approximately 1,050 to 2,100 cumulative growing degree days[1] (GDD), using a threshold temperature of 50º F (GDD_{50F}) and a starting date of January 1. Eggs hatch after about 40 days. The tiny larvae, which cannot be seen without magnification, remain dormant in the buds throughout the winter until the following spring.

As leaves begin expanding in spring around mid-May (300 to 350 GDD_{50F}), the ACGW larvae begin to feed. Their feeding causes the plant to form small galls, 1/4 to 3/4 inch (6 to 19 mm) in diameter, on current-year shoots and leaves (Figure 1).

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Larvae feed and develop in chambers inside the galls (Figure 4) throughout the summer. Each chamber contains a single larva. Most galls contain one or two chambers, but up to 20 chambers may be present in a large gall. Larvae feed for approximately four weeks and then pupate (Figure 5). The new generation of adult wasps begins to emerge in late June, just after trees drop their catkins. Adults continue to emerge and lay eggs for about six weeks.

Figure 4. Cross section of a gall with Asian chestnut gall wasp larvae. Photo by Jerry A. Payne, USDA Agricultural Research Service, Bugwood.org.

Figure 5. Cross section of a gall with two empty chambers and one chamber containing an Asian chestnut gall wasp pupa. Photo by Melanie Sprinkle, Bugwood.org.

Damage Caused by the ACGW

While leaf galls usually have little impact, galls that form on current-year shoots can affect chestnut tree vigor and nut production. Apical galls, which form at the tips of shoots, may be especially damaging. They reduce shoot elongation and can inhibit flower production, which reduces nut formation. Chestnut producers in Japan, Korea, several European countries, and some U.S. states have reported yield reductions following an ACGW invasion. Branch dieback has been observed in orchards in China, Japan, Korea, Italy, and the United States when ACGW densities are high.

Management

An array of methods to control the ACGW have been employed by commercial chestnut growers with varying success. Integrating strategies for managing the ACGW should prevent yield loss while minimizing unnecessary pest control expenses and impact on beneficial insects, such as pollinators and natural enemies of the ACGW.

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Scouting. Effective pest management starts with active scouting. Chestnut growers in counties west of Highway 127, especially areas south of I-96 in lower Michigan, should be scouting their trees for evidence of the ACGW during the growing season and again in fall or winter, after leaf drop.

In late spring and summer, green or reddish galls can be observed on branches or leaves (Figures 6 and 7). In fall and winter, look for dried, brown galls on the shoots (Figure 7). Many old galls remain on the tree through winter and are more visible after leaves drop in fall. These old galls can remain attached to the trees for at least one or two years after the wasps have emerged. If the ACGW is present, it is helpful to monitor gall densities and compare nut production between trees that are heavily infested and trees that are uninfested or have only a few galls.

Figure 6. A chestnut shoot with a high density of galls caused by the Asian chestnut gall wasp. Photo by Ignazio Graziosi, University of Kentucky, Bugwood.org.

Figure 7. New galls (orange color) caused by the Asian chestnut gall wasp along with old, dried galls from the previous year. Photo by Louise Labbate, Michigan State University.

Insecticide sprays. If galls are abundant and especially if nut production is low on heavily infested trees, you may need to control ACGW adults with a cover spray of a broad spectrum, conventional insecticide. If a cover spray is needed, correct timing and adequate coverage are essential. Correctly timing sprays is critical to ensure effective control of the pest and to minimize the effects on an important biocontrol agent (see below) and beneficial pollinators. Insecticide sprays will have no effect on immature stages of the ACGW, which are protected within galls.

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In southwest Michigan, the first adult wasps typically begin emerging in late June (about 1,050 DD_{50F}), while the last wasps may not emerge from galls until mid-August (about 2,100 DD_{50F}). It is not necessary to control the very first wasps or the very last wasps of the summer, but you will want the insecticide on the trees before adult wasp activity peaks, around mid-July. Consider applying a cover spray with a relatively persistent insecticide product at around 1,250 to 1,350 DD_{50F}, slightly before adult emergence and egg laying peaks.

Biological control. Classical biological control involves managing an invasive pest with a natural enemy from its native range. A tiny parasitoid wasp native to China, *Torymus sinensis* (Kamijo), is a biocontrol that has been successfully used to reduce ACGW damage in chestnut orchards in many countries, including Japan and Italy, and in U.S. states. *Torymus sinensis* was initially imported into Japan in 1975, where it successfully reduced ACGW densities. It has since been released in Korea, several countries in Europe, and the United States as a biocontrol for ACGW. There is no evidence that this highly specialized parasitoid has affected populations of native insects in areas where it has been introduced.

The *T. sinensis* parasitoid and the ACGW share a long co-evolutionary history in China, where the life cycle of the parasitoid is well synchronized with the ACGW. In early spring, as ACGW galls are forming, *T. sinensis* adult females lay an egg into individual gall chambers where an ACGW larva is feeding (Figure 8). Each parasitoid larva feeds on an ACGW larva within the gall chamber throughout the summer, eventually killing it. Parasitoid larvae then remain inside the galls throughout the winter. As chestnut buds break and new galls form in the spring, adult parasitoid wasps emerge from the dry, previous-year's galls to oviposit within the green, succulent, current-year galls.

Figure 8. An adult *Torymus sinensis* parasitoid wasp on a gall caused by the Asian chestnut gall wasp. Photo by Louise Labbate, Michigan State University.

Fortunately, the *T. sinensis* parasitoid seems to have arrived in southwest Michigan at about the same time as the ACGW, and this beneficial wasp appears to be spreading. We monitored parasitism of the ACGW by *T. sinensis* in four to seven Michigan orchards each year from 2017 to 2019. By 2019, the presence of *T. sinensis* was confirmed in at least seven Michigan orchards where the ACGW is established. In individual orchards, anywhere from one to 71 percent of ACGW larvae were killed by this parasitoid, and parasitism rates have generally increased over time. The important role of *T. sinensis* in reducing the ACGW's density highlights the need to correctly time insecticide cover sprays for the ACGW or other insect pests.

Note: Old galls do not need to be removed! Beneficial parasitoids may still be developing inside the old galls. Removing these galls will have no effect on the ACGW's density but could reduce the beneficial parasitoid population.

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Host resistance. Chestnut species and cultivars vary in their resistance to the ACGW. A few cultivars are highly resistant to the pest, including Bouche de Bétizac (*C. crenata x C. sativa*), an increasingly popular cultivar in Michigan orchards.

Colossal (*C. crenata x C. sativa*) chestnut trees, popular in Michigan due to their high yield and large nuts, are susceptible to the ACGW. Labor Day (*C. crenata*), a cultivar often used to pollinate Colossal, produces nuts early in the season and is highly susceptible to the ACGW.

Many cultivars of Chinese chestnuts (*C. mollissima*) have historically been planted in Michigan because of their resistance to chestnut blight. Chinese chestnut cultivars that share a long co-evolutionary history with the ACGW are generally less susceptible to the pest than Japanese or European cultivars, although susceptibility can vary even among Chinese cultivars.

Moreover, chestnut growers in Japan who converted orchards to resistant varieties of *C. crenata* chestnut after the ACGW invaded were initially successful. Over time, however, ACGW populations adapted and now colonize varieties that were previously resistant.

While the establishment of the invasive ACGW in Michigan is not good news, practical and cost-effective management practices can prevent severe damage to chestnut trees grown in Michigan. Scouting to assess the abundance of current and previous galls can help identify where the ACGW densities are relatively high. Monitoring yield is important to evaluating the effects of the ACGW on nut production. The *T. sinensis* parasitoid seems to be spreading with the ACGW and appears likely to play a major role in regulating ACGW populations over the long term. It will be important to apply insecticide cover sprays only when necessary and to time sprays correctly to avoid affecting the beneficial parasitoid population. When expanding an orchard and planting new trees, chestnut cultivars that offer some resistance to the ACGW should be considered (see above). Integrating these options should help minimize the impact of the ACGW and protect the Michigan chestnut industry well into the future.

[1]Cumulative growing degree days can be found on the MSU Enviroweather website at https://www.enviroweather.msu.edu. Select a station near your orchard to find current and projected GDDs. Be sure to use the Degree Days Base 50º F column. General information about using GDDs is available on the MSU website for Growing Degree Day Information - Integrated Pest Management at https://www.canr.msu.edu/ipm/agriculture/christmas_trees/growing_degree_day_information#landscapeinfo.

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