

Delineating range expansion of Asian chestnut gall wasp (*Dryocosmus kuriphilus*) using iNaturalist

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with considerable recognition to the many iNaturalist observers
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Background

The Asian chestnut gall wasp (ACGW), also known as the oriental chestnut gall wasp is a species of gall-forming wasp (Hymenoptera: Cynipidae) that affects nearly all members of the genus *Castanea*. Native to China, this species has been reported from 26 non-native countries spanning Asia, Europe, and North America¹.

ACGW can be identified by its host association and distinct gall characteristics. Only found on *Castanea* species, newly developed galls are globular, thick-walled, green to red in color, and occur anywhere from the stalk to the midvein of the leaf (Fig. 1). These current-season galls can affect tree vigor, and reduce shoot elongation, photosynthetic leaf area, flowering, fruiting, and nut production². Following leaf abscission at the end of the growing season, galls often remain attached to their host becoming brown and lignified (Fig. 1). These may remain on the tree for multiple growing seasons, eliminating subsequent shoot production and leading to increased pathogen susceptibility.



Figure 1. Gall morphology
A) Green current season gall, Light brown previous season gall (left to right) B) Leaf gall C) Stalk gall D) Terminal petiole gall

Life Cycle

- Galls begin to form shortly after budbreak (~300-350 GDD_{50F})³
- Larvae feed within the gall, completing final 2 instars
- Adults emerge following peak pollen production and oviposit their eggs into chestnut buds
 - Emergence causes premature leaf death known as “flagging” (Fig.2)
 - 4-6 week period (~1050-2100 GDD_{50F})³ although individuals only survive for 2-10 days
 - All are asexually reproducing females capable of ovipositing up to 100 eggs⁴
- First instar larvae hatch near the end of the growing season and feed for a brief period before overwinter in the dormant buds
- Larvae resume feeding just before bud-burst inducing gall formation (Fig. 2)

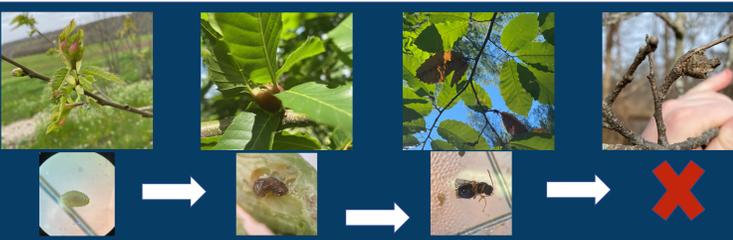


Figure 2. Annual cycle of the ACGW during the chestnut growing season

References

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Range and Dispersal

First U.S. detection: Peach County, Georgia (1974)⁵

- Range expansion characterized through active flight and wind-aided dispersal (~25 km/year) and additionally through the anthropogenic movement of infested plant material²
- Multiple North American satellite populations reported in the past 20 years
 - Ohio (2002), Maryland/Pennsylvania (2006), Connecticut (2011), Ontario (2012), Massachusetts (2013), Michigan (2015)
- As of 2021, the ACGW has been documented in 104 North American counties located in 19 states, districts, or provinces (Fig. 4)^{6,7,8}

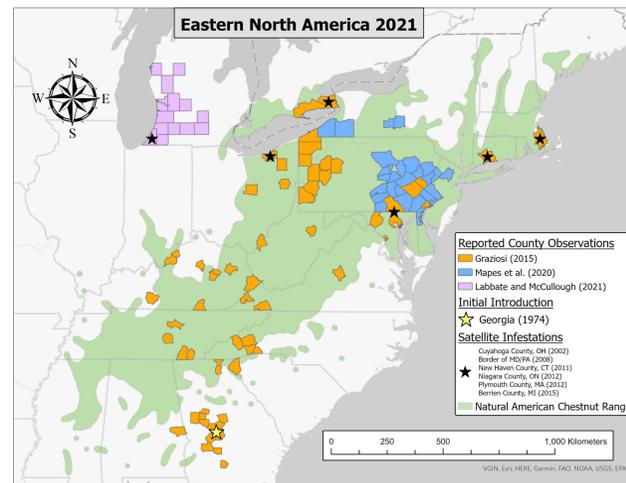


Figure 4. All previous North American Reports of Asian chestnut gall wasp presence

Objectives

- Validate the utility of citizen science as a cost-effective method of monitoring ACGW
- Report previously undocumented state and county observations
- Reevaluate the known limits of ACGW population throughout the historic range of the American chestnut

Methods

- The iNaturalist database was searched for all North American observations of *Dryocosmus kuriphilus* and all species of *Castanea*.
- Reported observations of *Dryocosmus kuriphilus* were verified through the identification of a *Castanea* host and presence of characteristic gall morphology.
- Castanea* observations were examined for the presence of ACGW galls.
- Additionally, weekly examination of observations from 5/27/22 to 9/22/22 was conducted to evaluate the prevalence of ACGW detections during the growing season.
- Location of observations were recorded at the state and county levels.
 - New state observations were ground-truthed and confirmed in person. Galls were collected for further validation.
 - Observations with accuracies of 400 meters (~0.25 miles) or less were crosschecked using context clues from photos and Google Earth imagery.
 - Observations with accuracies of > 400 meters were reported in our total observations but not as new county reports unless location was confirmed via the original user.

Results

- From iNaturalist, 326 ACGW observations were found throughout the United States and Canada.
 - 251 were detected from images of *Castanea* while 75 were direct reports of *Dryocosmus kuriphilus*.
- ACGW presence in Missouri and Rhode Island was detected from *Castanea* observations and subsequently confirmed as new state observations through gall collection.
- Additionally, 83 new county observations were documented with 69 detections from *Castanea* observations and 14 reported *Dryocosmus kuriphilus* records.
- During the 2022 growing season, a total of 63 ACGW observations were documented in which 53 were detected from *Castanea* observations and 10 were reported as *Dryocosmus kuriphilus*.

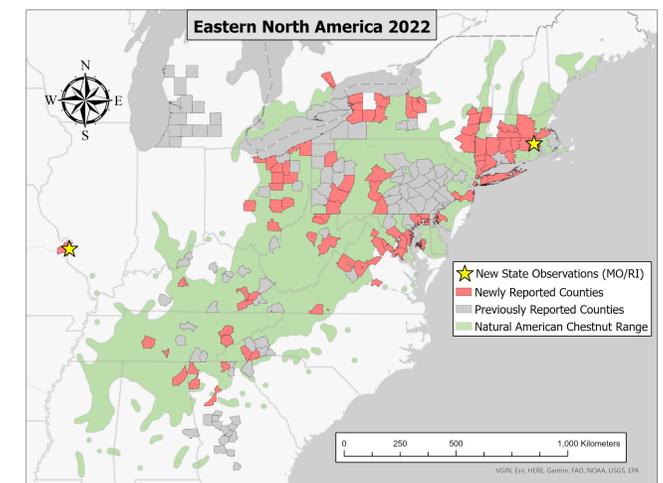


Figure 5. All North American reports of Asian chestnut gall wasp presence with the aid of iNaturalist

Discussion

- Using iNaturalist, we were able to identify 2 new state records while nearly doubling the previously reported number of infested counties. As Missouri occurs well outside of the historic American chestnut range, this method could be used as part of an early detection strategy in high-risk region such as the western US.
- We report a steep increase in the range expansion along the northeastern edge of the invasion front.
- The distribution in southern states has poor resolution due to a lack of recorded observations.
- Public awareness of this invasive species is low, given the disparity between detected vs. reported observations.
- Our newly documented range expansion builds on prior studies and shows that the distribution of *D. kuriphilus* now encompasses most of the historic natural range of American chestnut.
- With ongoing efforts to repopulate forests with American chestnut, research efforts should focus on managing this insect (biological control, host resistance, etc.) as it may inhibit the success or restoration efforts.

Acknowledgements

We would like to acknowledge SUNY-ESF and the Edna Bailey Sussman Foundation for funding this project. We also thank the Powell lab for their valued support. This poster was made possible by the thousands of citizen scientists who contributed their knowledge of chestnut and chestnut pests to the iNaturalist database.