

Emerging and Evolving Threats  
to Chestnut Health:  
The Asian Chestnut Gall Wasp  
*Dryocosmus kuriphilus* Yasumatsu  
(Hymenoptera: Cynipidae) in  
North America

Carol C. Mapes, Ph.D.

Kutztown University of Pennsylvania

mapes@kutztown.edu





# Asian Chestnut Gall Wasp (ACGW) *Dryocosmus kuriphilus*



- An invasive cynipid wasp of global concern that forms galls on *Castanea* spp. including the American Chestnut



Image from Mapes et al., 2020

# Gall-forming Cynipid Wasps



- Tiny wasps in the family Cynipidae
- There are c. 1,300 species of cynipid wasps worldwide.
- Most form galls on oaks
- Most gall-forming cynipid wasps are not problematic.
- In North America, most gall-forming cynipid wasps are native wasps that form galls on native species. Predators and parasites help to control them.
- Most exhibit an alternation of generations between a sexually reproducing generation of males and females and an asexual generation of all females.
- The gall-forming Asian Chestnut Gall Wasp (ACGW) *Dryocosmus kuriphilus*, is not native to North America and is considered a global pest of *Castanea* spp.



# Characteristics of ACGW Galls

- Galls are green and/or red in color
- Unilocular to multilocular
  - 1 to 25 chambers
- Typically 5-20 mm in diameter, up to 30 mm



ACGW Gall on American Chestnut



Photo by Kevin Buss



Photo by Mark Giambrone

ACGW Gall showing 2 locules

# Life History of *Dryocosmus kuriphilus* (ACGW)

- Larvae spend the winter “hidden” in buds.
- After overwintering, the larvae form galls on developing petioles, leaves, and stems of *Castanea* spp. in the spring.



# Life History of *Dryocosmus kuriphilus* (ACGW)



Photo by Mark Giambrone

- Larvae pupate in the galls.
- Adult female wasps emerge from fully formed galls in late spring or early to mid-summer (site dependent).
- There are no male wasps!
- Wasps are tiny (2.5-3.0 mm long).



Photo by Kevin Buss



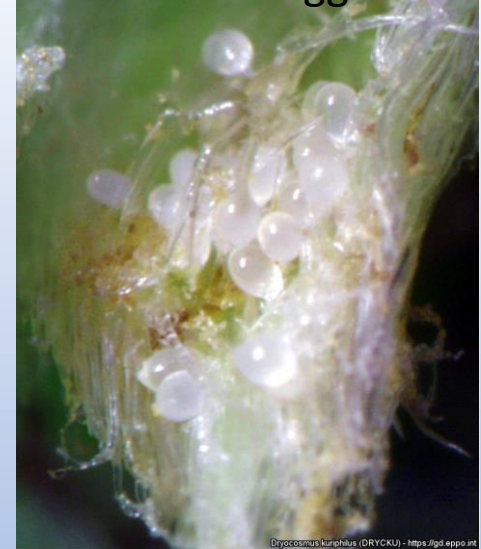
Photo by Kevin Buss

# Life History of *Dryocosmus kuriphilus* (ACGW)

- Adult females live from 2 to 10 days.
- Female wasps lay unfertilized eggs in *Castanea* spp. buds.
- Each female can lay up to 300 eggs.
  - It takes just one female to start an infestation!
- Buds can contain 10-30 eggs that are each 0.1-0.2 mm long.
- Larvae hatch from eggs in the buds in 30 to 40 days.
- Larvae spend the winter hidden in buds and form galls the next spring.
- Buds with larvae are visually undistinguishable.



ACGW eggs



<https://gd.eppo.int/taxon/DRYCKU/photos>

ACGW eggs in chestnut bud



Larvae in chestnut bud



# Damage to *Castanea* spp. Caused by ACGW Galls

- Inhibited shoot elongation
- Reduction in flowering and fruiting/nut production
- Early leaf death and abscission resulting in leaf area loss
- Twig dieback
- Reduction in winter bud development
- Reduction in shoot and tree vigor
- May make trees more vulnerable to diseases (e.g. blight)
- Death of small trees particularly when other stressors are present (e.g. drought, fungal infection)



©Wissenschaftszentrum RWG

*Dryocosmus kuriphilus* (DRYCKU) - <https://gd.eppo.int>

<https://gd.eppo.int/taxon/DRYCKU/photos>

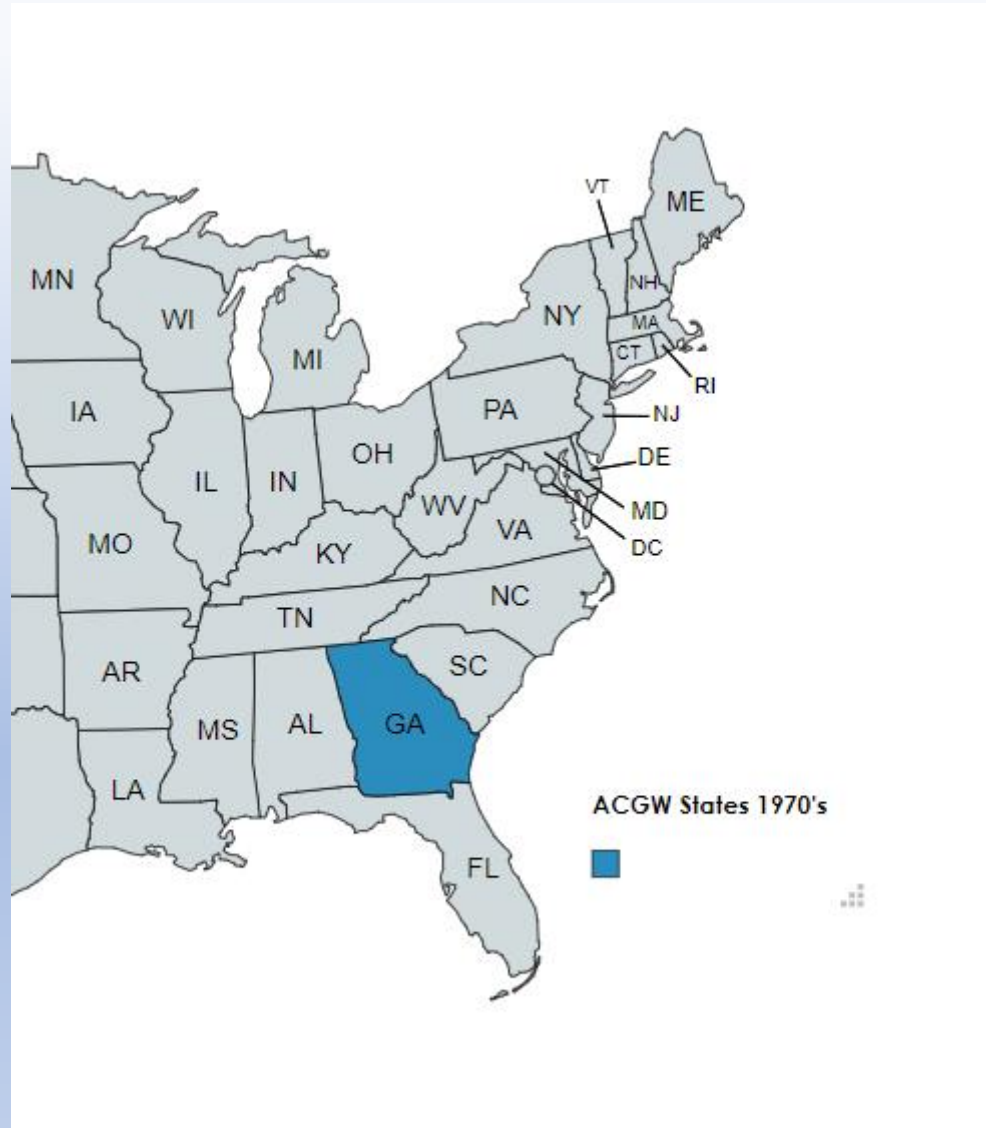


# Global spread of the Asian Chestnut Gall Wasp

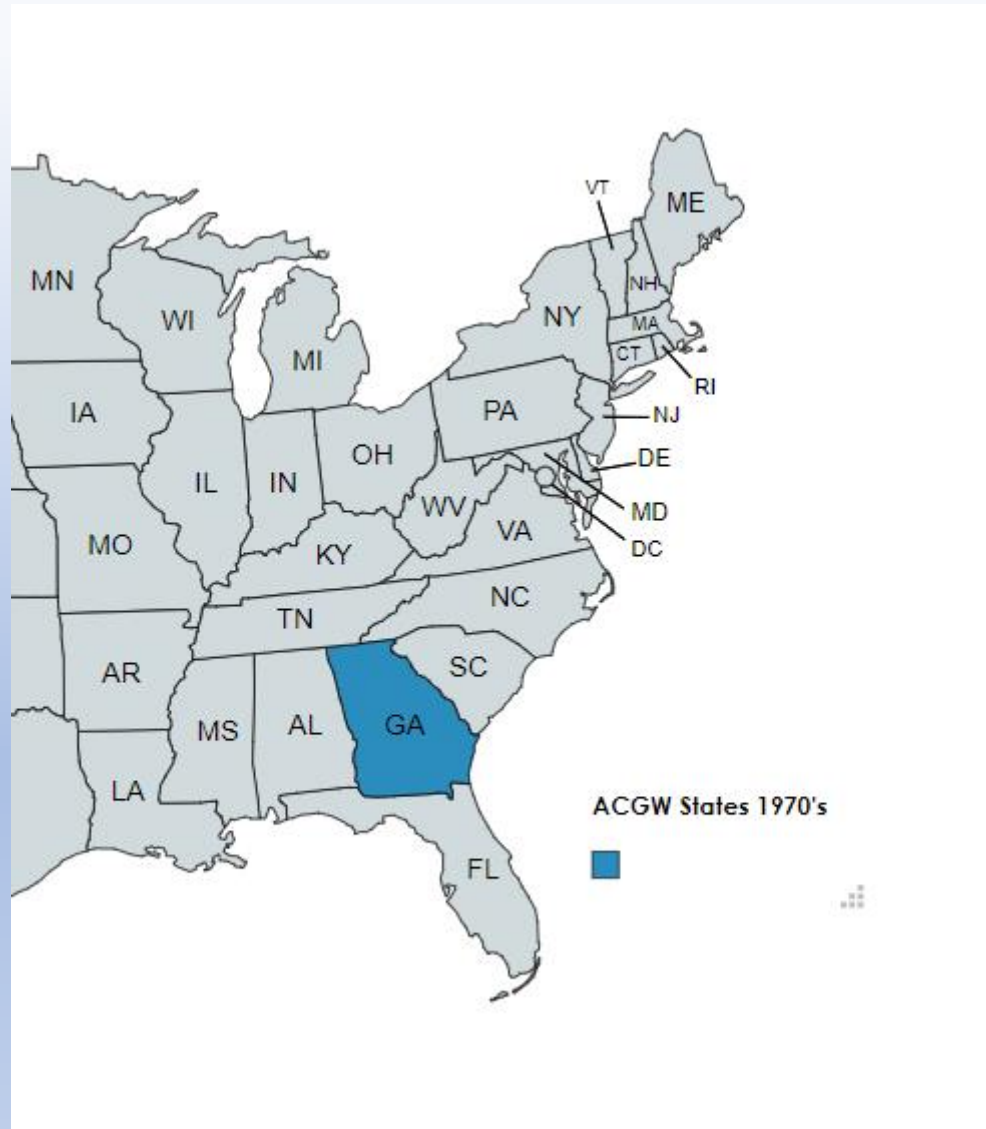
## *Dryocosmus kuriphilus*

- Native to China
- Has spread to:
  - Japan (1941)
  - Korea (1958)
  - USA (1974) Georgia → subsequent spread to other states
  - Nepal (1999)
  - Italy (2002) → subsequent spread to other European countries
  - Canada (2012)
  - Russia (2016)

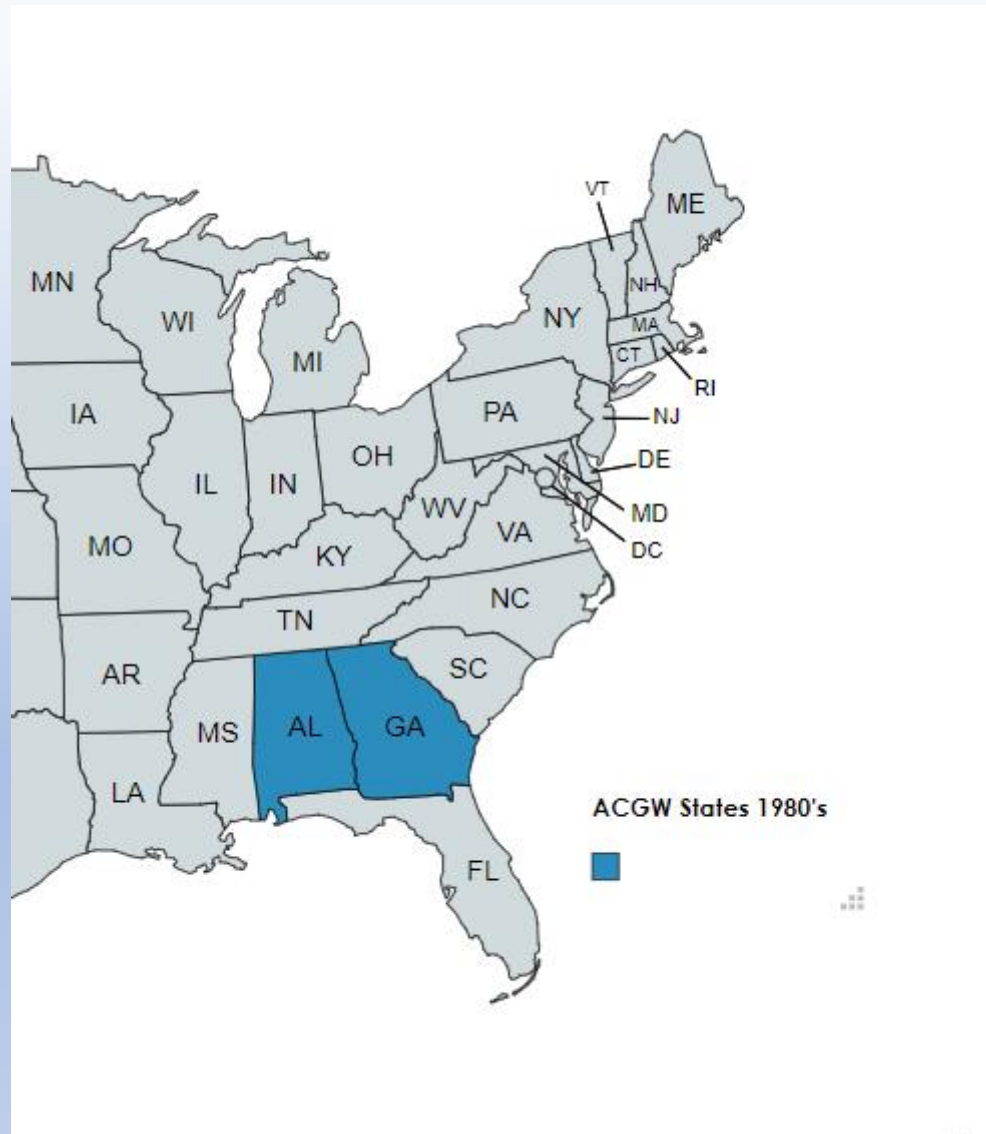
# ACGW Range Expansion in North America



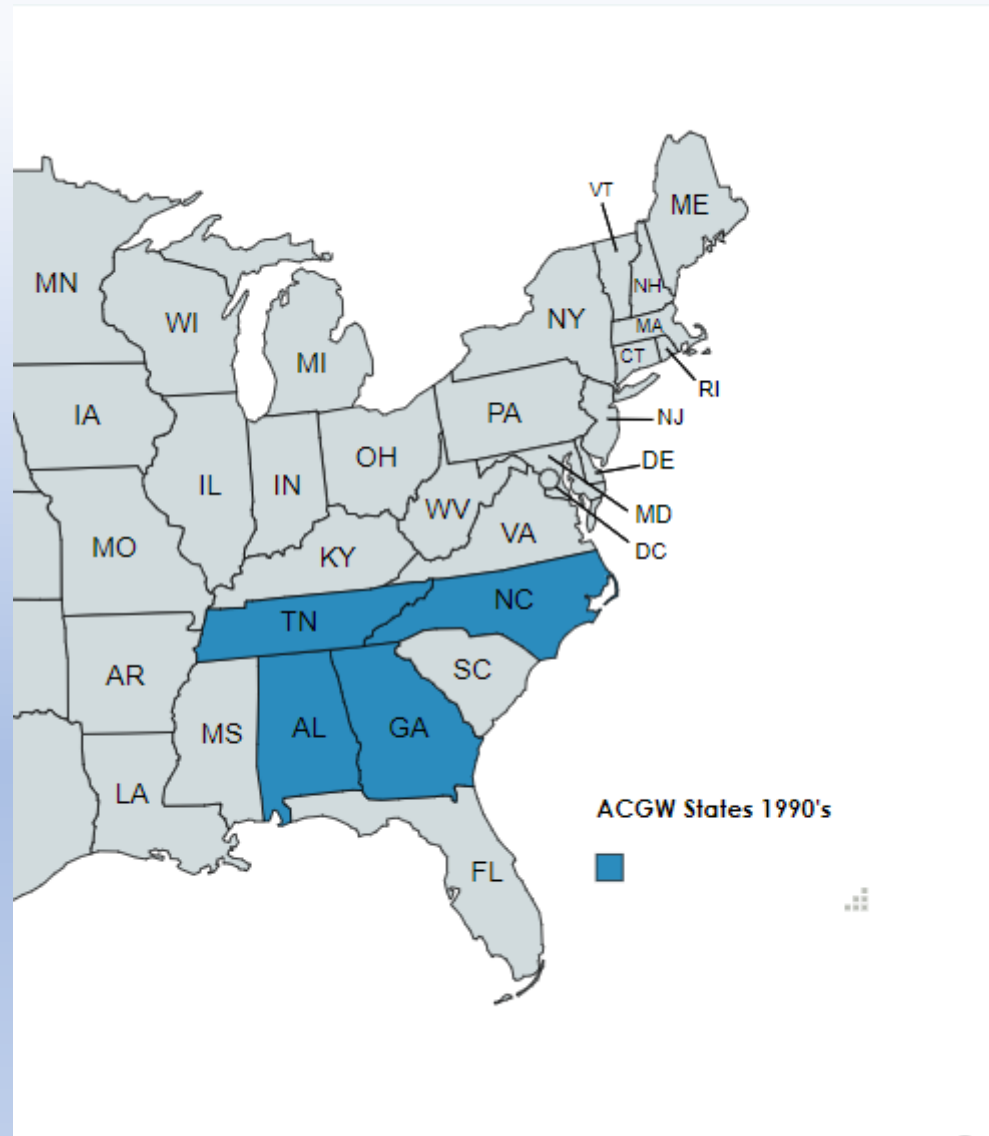
# ACGW Range Expansion Through the Decades



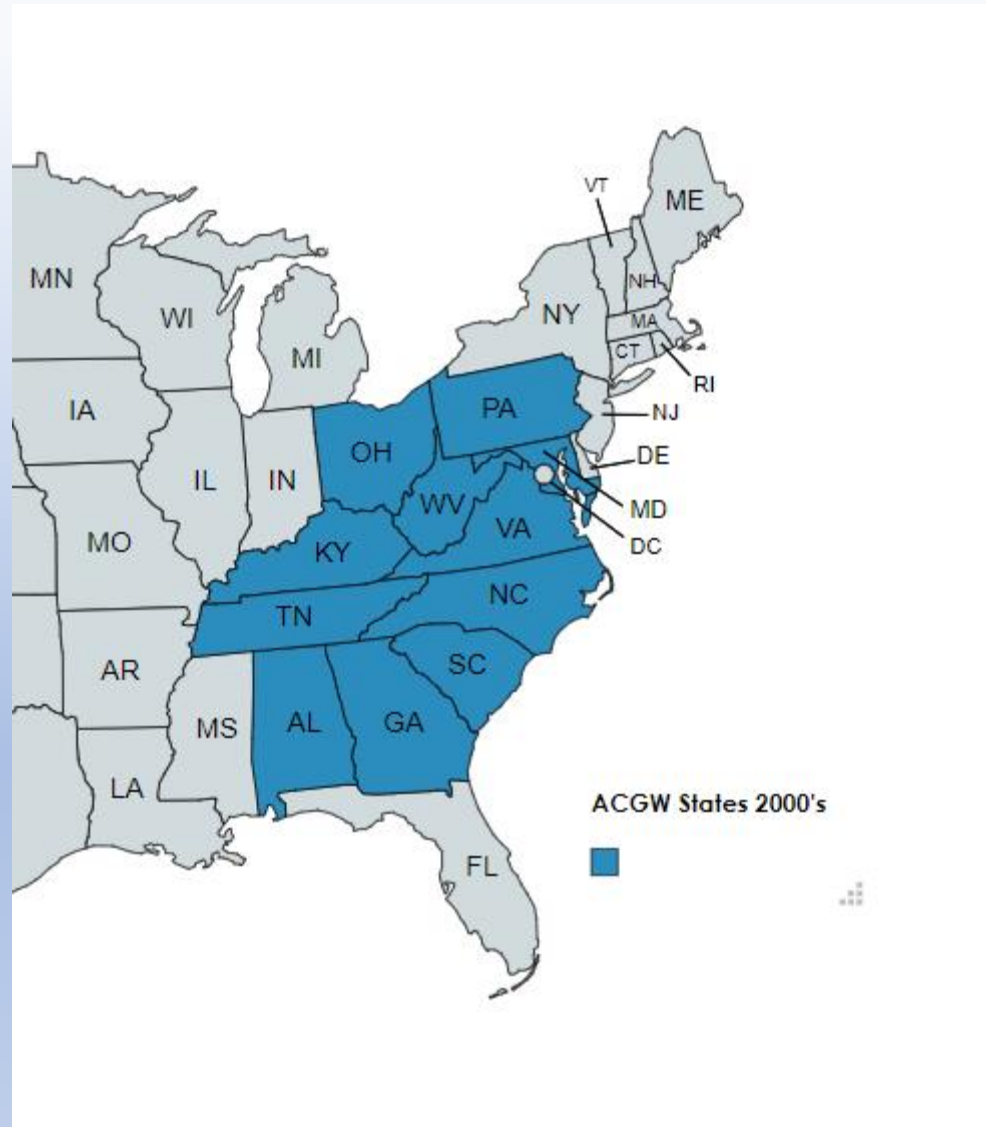
# ACGW Range Expansion Through the Decades



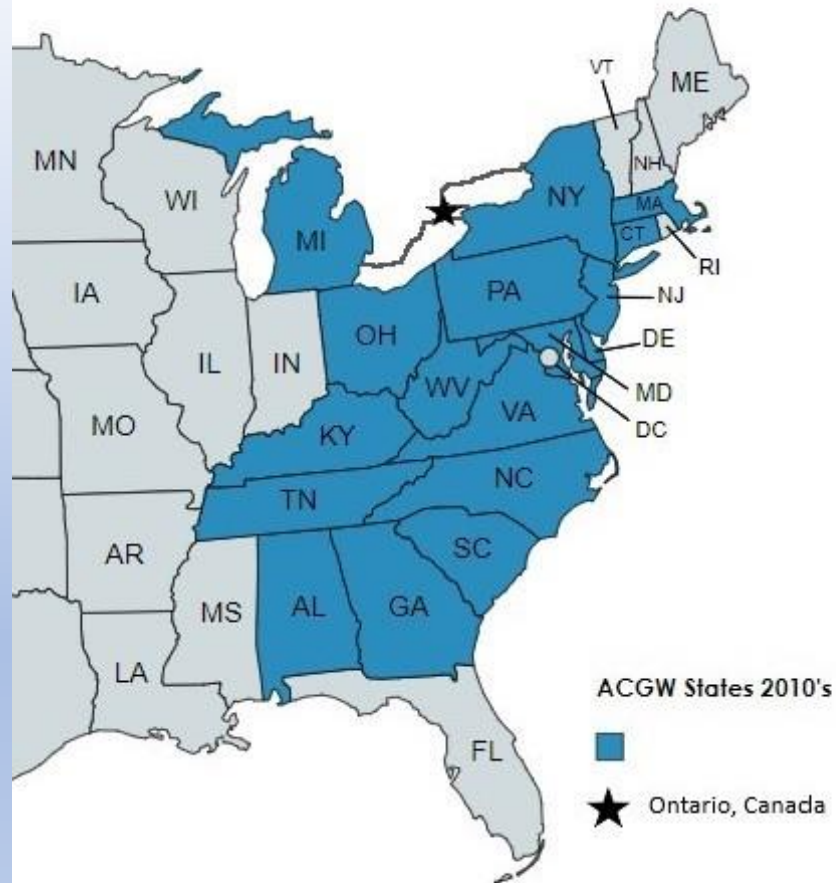
# ACGW Range Expansion Through the Decades



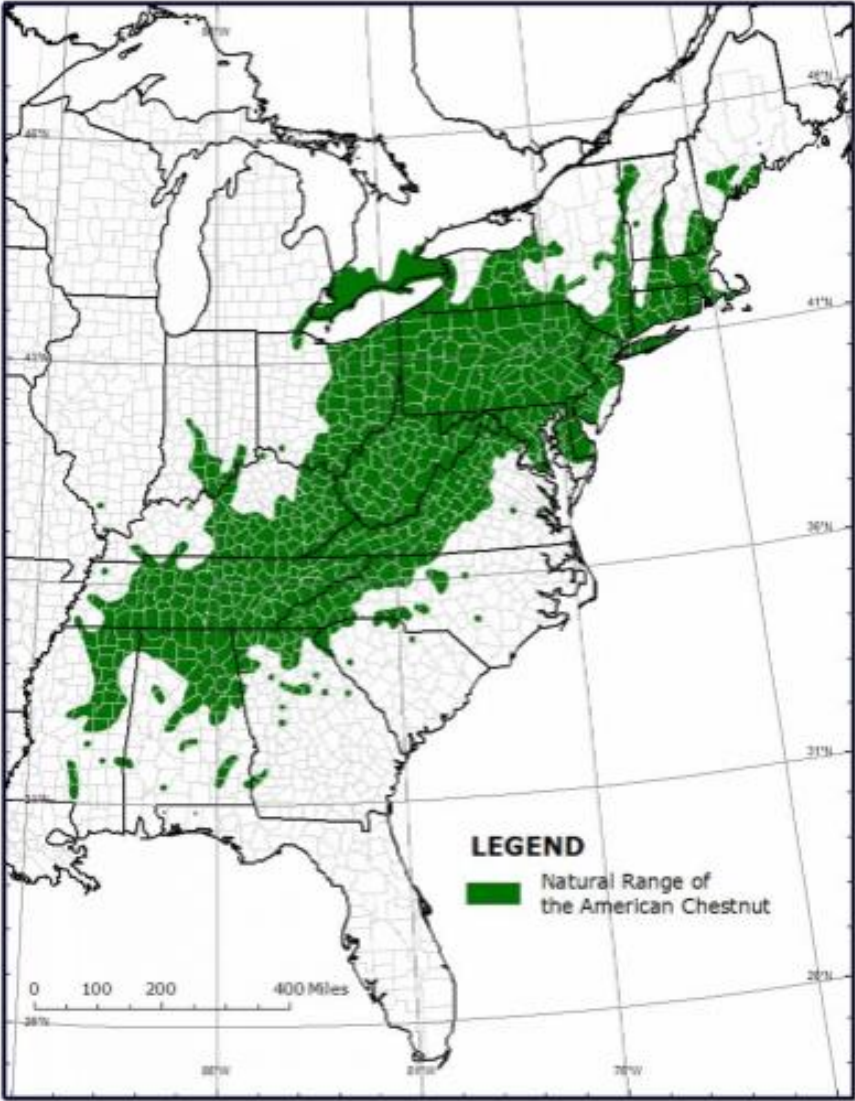
# ACGW Range Expansion Through the Decades



# ACGW Range Expansion Through the Decades



# Natural Range of the American Chestnut

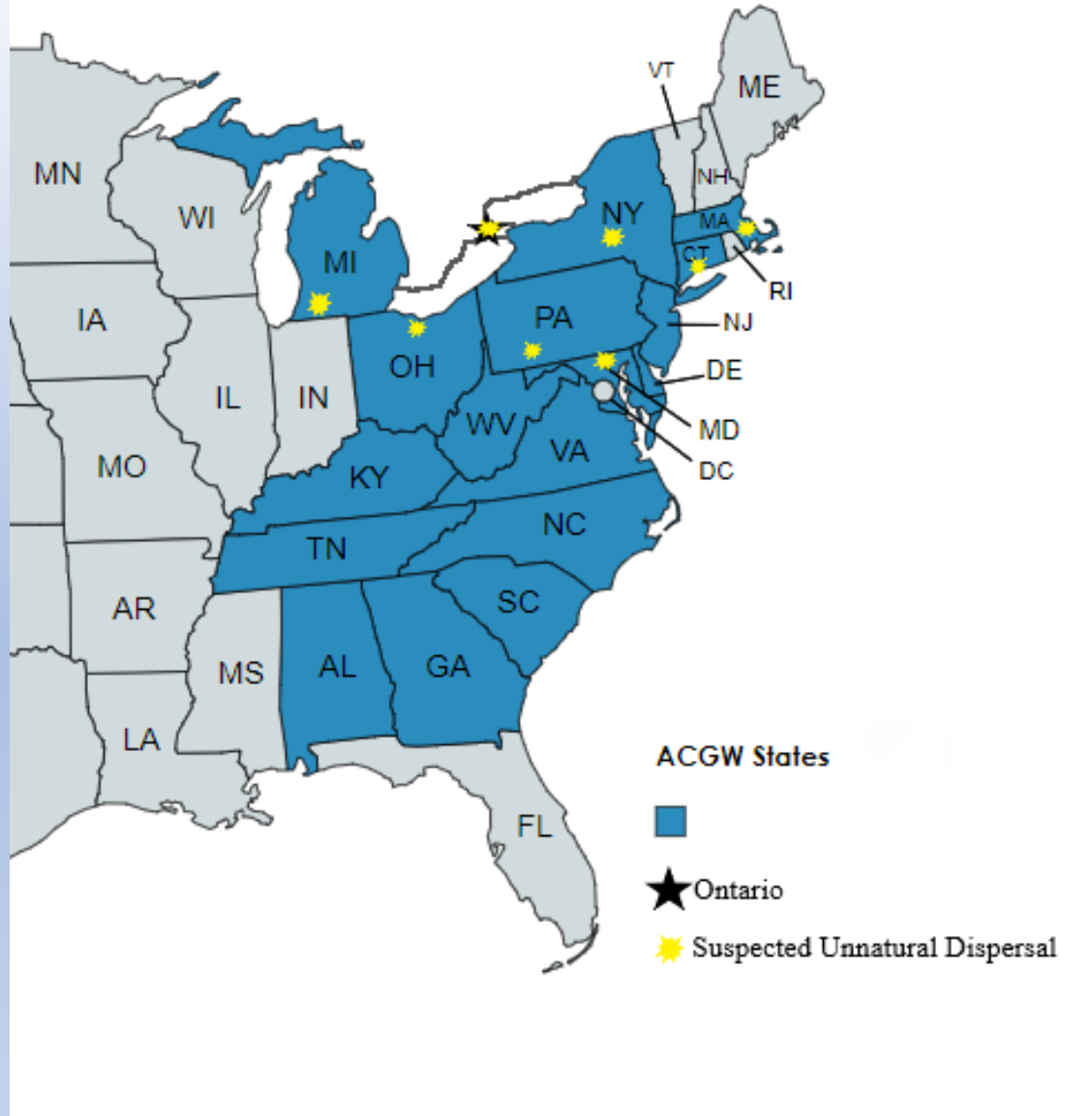




# Dispersal of the ACGW

- Natural means:
  - Active flight
    - ACGW is not a strong flyer.
    - Induced to fly at low wind speeds & then carried by the wind
  - Dispersal by the wind
    - Blown by the wind at high wind speeds
    - Direction of prevailing winds is important factor.
- Rates of dispersal:
  - Short distance dispersal c. 3 to 18 km/year (c. 2 to 11 miles/year)
  - Historical dispersal in the United States (Payne 1981; Rieske 2007)
    - A range of 15 to 25 km/year (c. 9 to 15.5 miles/year)
- Unnatural means:
  - Human transport of infested plant material
    - e.g. Seedlings, saplings, or scion wood

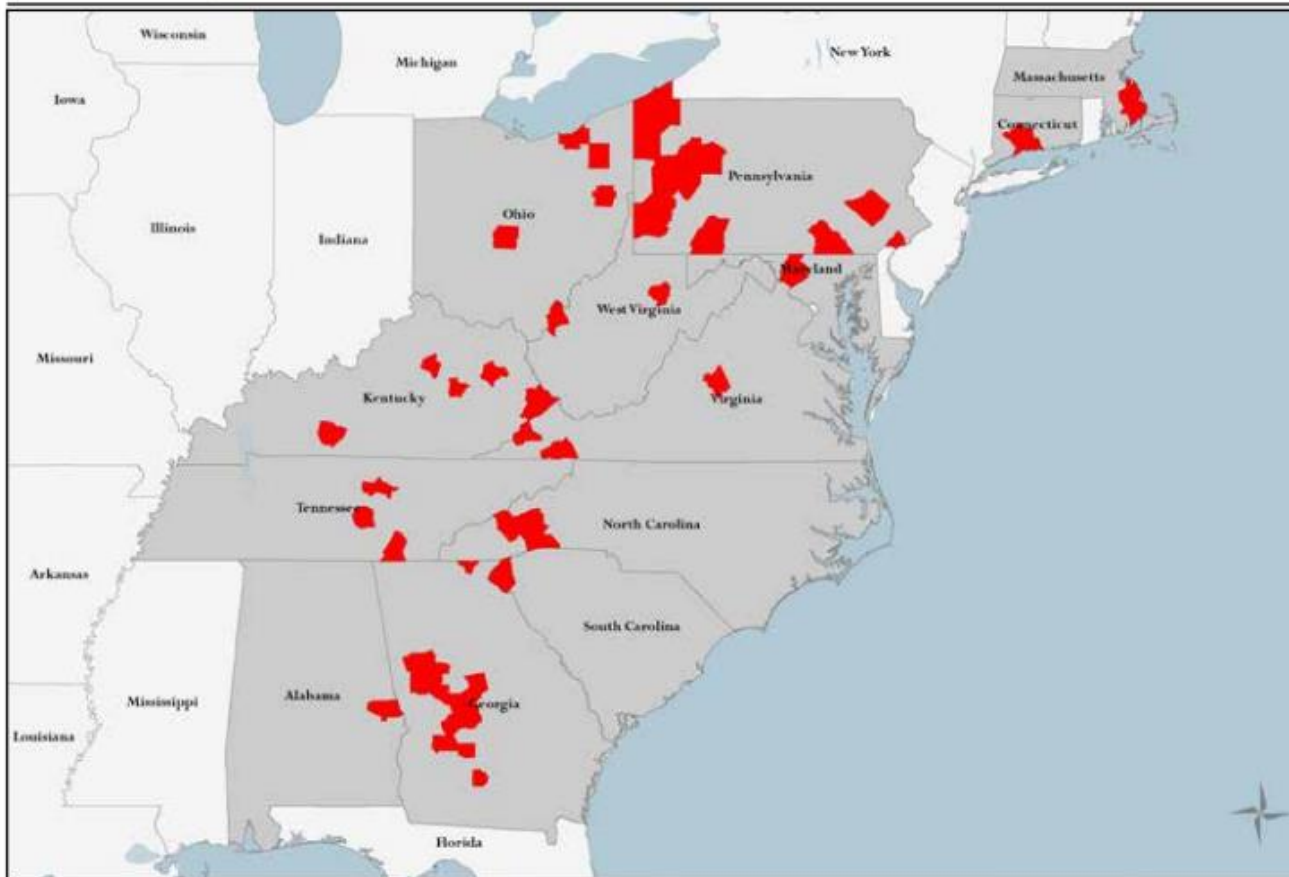
# ACGW Range Expansion in North America





# Asian Chestnut Gall Wasp

*Dryocosmus kuriphilus* (Yasumatsu)



State level report    County level observation



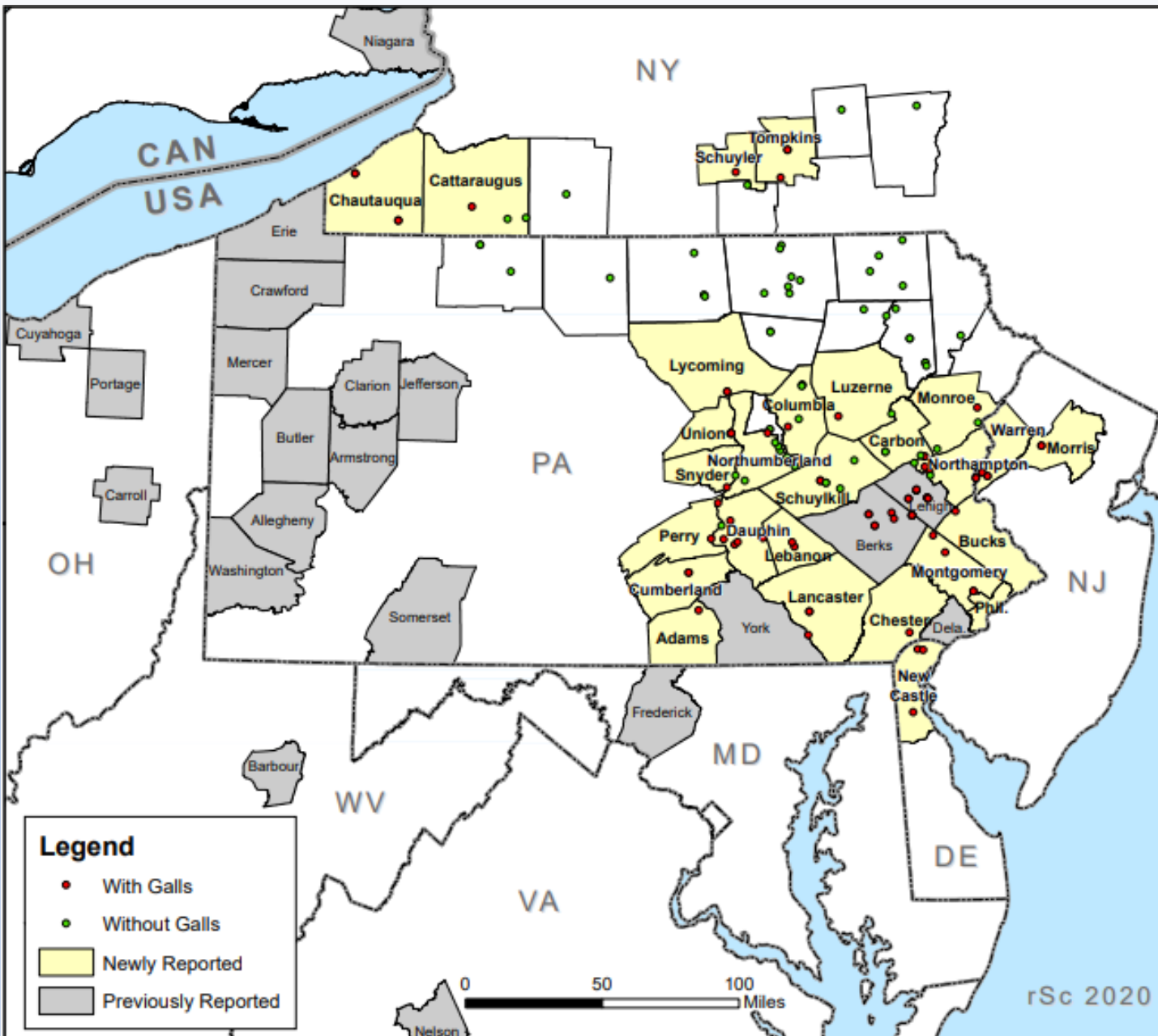
Photo Credit: Adult, Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org

Date created: 27 March 2019

USDA Forest Service, Northern Research Station and Forest Health Protection. "Alien Forest Pest Explorer - species map." Database last updated 25 March 2019.

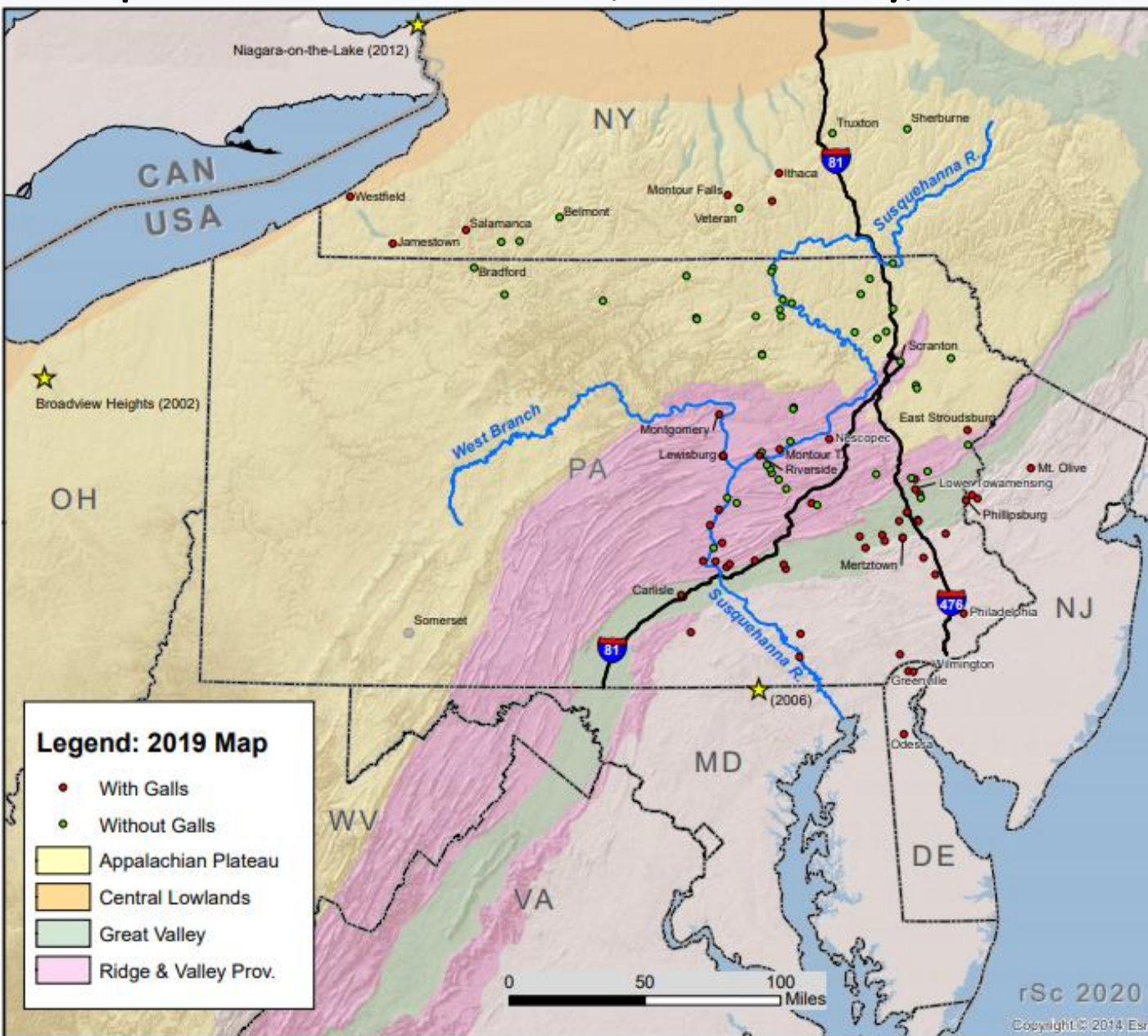
# Expansion of the Range of the ACGW

(Mapes et al. 2020)



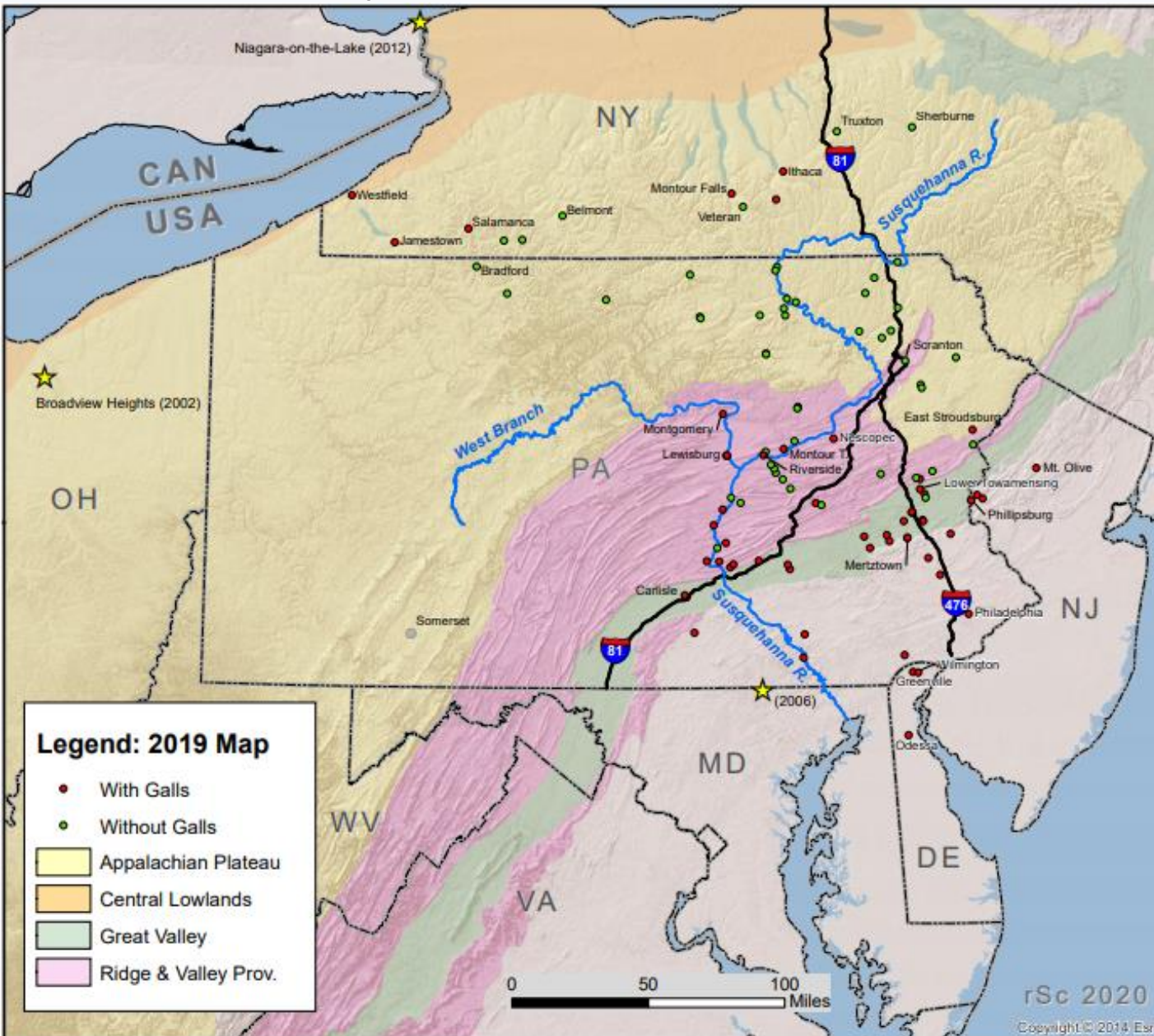
- Three additional states added to the range: New York, New Jersey, and Delaware
- 27 additional counties added to the range, 20 of which are in Eastern PA

# Distribution of the ACGW at selected sites as of 2019: Dispersal into Delaware, New Jersey, & New York (Mapes et al. 2020)



- ACGW in Delaware could have dispersed from PA or MD.
- ACGW in New Jersey could have dispersed from PA.
- ACGW present in Southwestern NY most probably was a result of dispersal from the Ohio site.
- ACGW in South Central NY was most probably due to a new introduction of contaminated plant material.

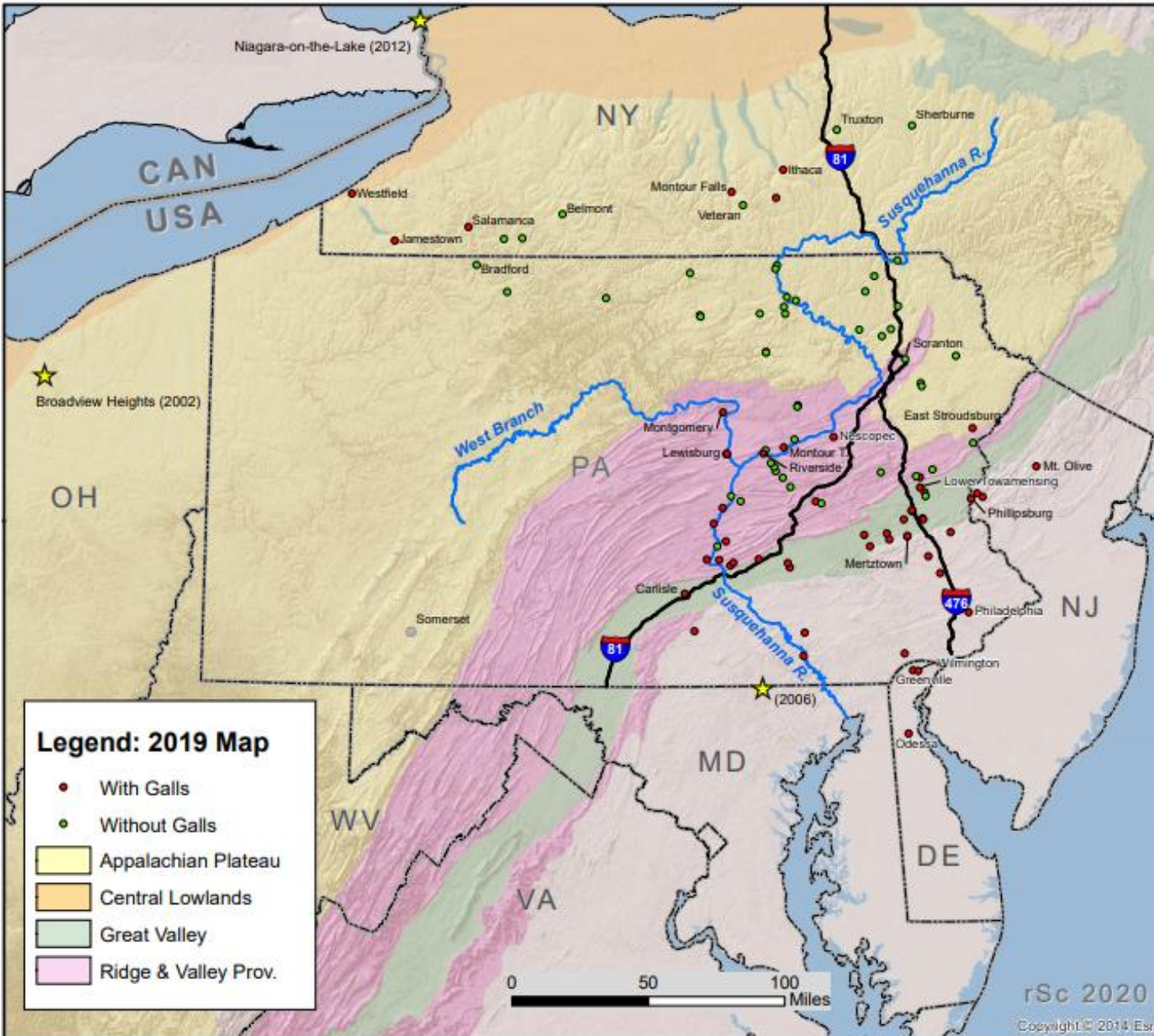
# Distribution of the ACGW at selected sites as of 2019: Dispersal in Southeastern PA (Mapes et al. 2020)



- Dispersal through and beyond the Ridge & Valley Province in Eastern PA was restricted except along the Susquehanna River Valley at 11-14 km/yr.
- Dispersal did not seem to be enhanced along major N/S highways beyond the Ridge & Valley Province.
- Dispersal seemed to be enhanced along the Great Valley; there also may have been one or more new introductions.

# Distribution of the ACGW at selected sites as of 2019

(Mapes et al. 2020)



- ACGW galls were primarily found on Chinese chestnuts on residential & business properties. Galls were also found on chestnuts in botanical gardens, orchards, educational campuses & on American chestnut saplings.
- Reservoirs for ACGW
- Need for more awareness!

# Control of the Asian Chestnut Gall Wasp Pesticides

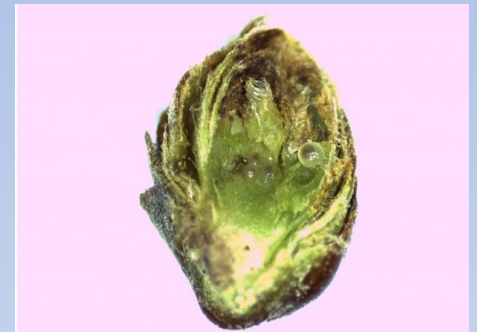
- Insecticides have not proven effective against the ACGW:
  - Larvae are well protected in the galls early in the season.
  - Bud scales provide protection of developing larvae within buds later in season.
  - Use against emerging adults would require precise timing and potentially large quantities of insecticides.
  - Toxicity concerns and environmental concerns such as negative effects on pollinators

ACGW gall showing 2 protected larval chambers



Photo by Mark Giambrone

First instar larvae  
in chestnut bud



© Kahraman Ipekdal

[@ipekdal](https://www.instagram.com/ipekdal) <https://www.facebook.com/ipekdal>

<https://gd.eppo.int/taxon/DRYCKU/photos>



# Control of the Asian Chestnut Gall Wasp

## Developing Resistant American Chestnut Hybrids

- Native chinquapins: Ozark chinquapins (*Castanea ozarkensis*) rarely galled, and Allegheny chinquapins (*C. pumila*) show resistance to galling by the ACGW. Chinese chinquapins, *C. henryi* also show some resistance.
- American chestnuts were crossed with Ozark chinquapin x Chinese chestnut hybrids. The offspring of the cross were planted, and after 14 years, some of the survivors had no ACGW galls despite being in an area where the ACGW wasp was present (Anagnostakis 2014).

# Asian Chestnut Gall Wasp: Biological Control

## *Torymus sinensis* Kamijo, 1982

### (Hymenoptera: Torymidae)



- Several parasitic wasp species were introduced into Georgia in 1977.
- Populations of *Torymus sinensis*, native to China, are now established in Japan, Europe, and North America.
- *T. sinensis* is a parasitoid because it ultimately kills the host (the ACGW).
- Biocontrol with *T. sinensis* seems to be the most effective method of ACGW control (Avtzis *et al.*, 2019).
- *T. sinensis* helps control levels of the ACGW.

Adult and larva of *T. sinensis* from ACGW galls on American Chestnut

# *Torymus sinensis* Life Cycle

- Adults emerge from overwintering ACGW galls in the spring.
- After mating, females lay eggs on *D. kuriphilus* larvae in developing ACGW galls.
- Each female can lay an average of 70 eggs.
- A larva of *T. sinensis* feeds on a *D. kuriphilus* larva, eventually killing it.
- Larvae of *T. sinensis* overwinter in ACGW galls and pupate.
- Adults emerge in the spring, and sometimes in the subsequent spring.



Image from Mapes et al., 2020

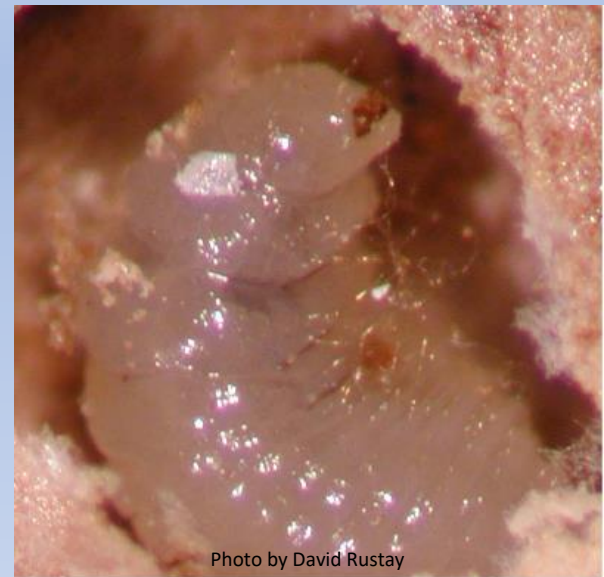


Photo by David Rustay

# Control of the Asian Chestnut Gall Wasp

## Hot Water Treatment (HWT) of Dormant Buds

- Immersion of Qing Chinese chestnut scions:
  - In water at 52°C for 10 minutes killed *D. kuriphilus* larvae in buds and resulted in successful grafts
  - Conditions need to be carefully controlled as slightly higher temperatures (53°C for 10 minutes) caused injury and much lower graft union success. (Warmund 2014).
- Immersion of European chestnut, *Castanea sativa* scions:
  - In water at 49°C for 10 minutes killed *D. kuriphilus* larvae in buds and resulted in a high percentage of successful grafts (Ciordia et al. 2020)
- More research is needed on HWT of other *Castanea* spp. such as *C. dentata* as well as HWT of seedlings

# Control of the Asian Chestnut Gall Wasp

## Surveillance & Pruning

- Pruning of branches with newly formed galls in the spring before adults emerge, and disposal of the galls in a manner that kills the wasps (e.g. burning) can provide control on a small scale.
- Removal of galls after ACGW departure will result in removal of parasitoids such as *Torymus sinensis* who overwinter in the galls and control *D. kuriphilus* levels. (Old galls however may harbor the blight fungus.)

Developing ACGW Gall



Overwintering ACGW Galls



# Emerging Concern: Interaction with Blight, Studies in Italy and Switzerland

- Heavy infestations of the ACGW may make European chestnut, *Castanea sativa* trees more susceptible to blight (Turchetti et al. 2010).
- The blight fungus *Cryphonectria parasitica* (Murill) Barr has been cultured from abandoned galls. The fungus may enter the wasp exit holes on abandoned galls (Prospero and Forster 2011).
- Abandoned ACGW galls on *C. sativa* were shown to preferentially harbor virulent (virus-free) strains of *C. parasitica* and were also shown to contain the chestnut brown rot fungus *Gnomoniopsis castanea* (Meyer et al. 2015).



# Emerging Concern: New Gall Former on *Castanea*: *Dryocosmus zhuili*

- New cynipid gall wasp described in 2015 from southeastern China in the same genus as the ACGW.
- Forms galls that look just like ACGW galls
- So far found only on *Castanea henryi*, Chinese chinquapin, but it has not been studied extensively.
- It exhibits sexual reproduction: there are male and female wasps!!
- Given that it reproduces sexually, the resultant genetic variation could lead to greater adaptability, making management more difficult.
- To date it has not been reported outside of China.



[https://www.researchgate.net/publication/283682668\\_New\\_Gall\\_Wasp\\_Species\\_Attacking\\_Chestnut\\_Trees\\_Dryocosmus\\_zhuili\\_n\\_sp\\_Hymenoptera\\_Cynipidae\\_on\\_Castanea\\_henryi\\_from\\_Southeastern\\_China](https://www.researchgate.net/publication/283682668_New_Gall_Wasp_Species_Attacking_Chestnut_Trees_Dryocosmus_zhuili_n_sp_Hymenoptera_Cynipidae_on_Castanea_henryi_from_Southeastern_China)

Zhu et al. 2015

More Awareness and More  
Research is Needed to Help Curb  
the Spread and Impact of the  
ACGW on the American  
Chestnut & other *Castanea* spp.  
in North America!



# Acknowledgments

- Many thanks to the following individuals:
- Kevin Buss
- Kelly Bothur
- Richard Courtney
- Mark Giambrone
- Roland Hilger
- Greg Setliff
- David Rustay
- All the property owners/managers who have allowed us to observe and monitor chestnut trees for the ACGW

# Selected References

- Anagnostakis SL (2014) The Connecticut Agricultural Experiment Station; Asian Chestnut Gall Wasps on Connecticut Chestnut Trees. Available from: [https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact\\_Sheets/Plant\\_Pathology\\_and\\_Ecology/](https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Fact_Sheets/Plant_Pathology_and_Ecology/)
- Avtzis DN, Melika G, Matošević, D, Coyle DR (2019) The Asian chestnut gall wasp *Dryocosmus kuriphilus* a global invader and a successful case of classical biological control. *Journal of Pest Science* 92: 107–115.
- Bosio G, Gerbaudo C, Piazza E (2010) *Dryocosmus kuriphilus* Yasumatsu: an outline seven years after the first report in Piedmont (Italy). *Acta Horticulturae* 866:341–348.
- Ciordia M, Garcia JC, Loureiro, MD (2020) Hot water treatment: An effective method for disinfecting *Castanea sativa* mill. dormant scions against *Dryocosmus kuriphilus* Yasumatsu. *Pest Management Science* 76: 1944-1948.
- Cooper WR, Rieske LK (2007) Community associates of an exotic gallmaker, *Dryocosmus kuriphilus* (Hymenoptera: Cynipidae), in Eastern North America. *Annals of the Entomological Society of America* 100 (2): 236–244.
- EPPO (2021) *Dryocosmus kuriphilus*. EPPO datasheets on pests recommended for regulation. Available online. <https://gd.eppo.int>
- Ferracini C, Gonella E, Ferrari E, Saladini MA, Picciau L, Tota F, Pontini M, Alma A (2015) Novel insight in the life cycle of *Torymus sinensis*, biocontrol agent of the chestnut gall wasp. *Biocontrol* 60:169–177.

# Selected References

- Huber JT, Read J (2012) First record of the oriental chestnut gall wasp, *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae), in Canada. *Journal of the Entomological Society of Canada* 143: 125–128.
- Mapes CC, Setliff GP, Courtney RS, Bothur K (2020) Range Expansion and Dispersal of the Asian Chestnut Gall Wasp *Dryocosmus kuriphilus* Yasumatsu (Hymenoptera: Cynipidae) in the Mid-Atlantic States. *Transactions of the American Entomological Society* 146: 503-519.
- Meyer JB, Gallien L, Prospero S (2015) Interaction between two invasive organisms on the European chestnut: does the chestnut blight fungus benefit from the presence of the gall wasp? *FEMS Microbiol Ecol* 91(11):fv122
- Oho N, Shimura I (1970) Research process on the chestnut gall wasp and some recent problems about its damage. *Shokubutsu Boeki (Plant Protection)* 24: 421–427.
- Payne JA (1978) Oriental chestnut gall wasp: new nut pest in North America. In *Proceedings, American chestnut symposium, 4–5 January 1978*. West Virginia University Press, Morgantown, pp 86–88 Payne JA, Johnson
- Payne, JA (1981) Gall wasp: status and future studies. P. 14. In: HC Smith (ed): *Proceedings, U.S. Forest Service American Chestnut Cooperators' Meeting*. United States Department of Agriculture Forest Service General Technical Report NE-64, 22 pp.

# Selected References

- Prospero S, Forster B, 2011. Chestnut gall wasp (*Dryocosmus kuriphilus*) infestations: new opportunities for the chestnut blight fungus *Cryphonectria parasitica*?. *New Disease Reports* 23, 35. [doi:10.5197/j.2044-0588.2011.023.035]
- Quacchia A, Moriya S, Bosio G, Scapin I, Alma A (2008) Rearing, release and settlement prospect in Italy of *Torymus sinensis*, the biological control agent of the chestnut gall wasp *Dryocosmus kuriphilus*. *Biological Control* 53:829–839.
- Rieske, LK (2007) Success of an exotic gallmaker, *Dryocosmus kuriphilus*, on chestnut in the USA: a historical account. *Bulletin OEPP/ EPPO Bulletin* 37: 172–174.
- Turchetti T, Addario E, Maresi G (2010) Interazioni tra cinipide galligeno e cancro della corteccia: Una nuova criticita per il castagno. *Forest* 7: 252–258
- Warmund, M.R. (2014). Disinfestation of *Dryocosmus kuriphilus* Yasumatsu in *Castanea* scion wood. *Acta Horticulturae* 1019,243-247
- Zhu D-H, Liu Z, Lu P-F, Yang X-H, Su C-Y, Liu P (2015) New gall wasp species attacking chestnut trees: *Dryocosmus zhuli* n. sp. (Hymenoptera: Cynipidae) on *Castanea henryi* from Southeastern China. *Journal of Insect Science* 15:1–7