KANSAS DEPARTMENT OF AGRICULTURE—PLANT PROTECTION & WEED CONTROL

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INSECT HIGHLIGHT

Florida fern moth (*Callopistria floridensis*)

Figure 1. Florida fern moth intercepted in a KS greenhouse.

Scientific Name	Common Name
Adiantum pedatum	Northern maidenhair fern
Aglaomorpha sp.	Bear paw fern
* *Asparagus sprengeri*	Asparagus fern
Asplenium nidus	Bird's nest fern
Blechnum sp.	Hard fern
Cyrtomium falcatum	Japanese holly fern
Davallia sp.	Rabbit foot fern
Drynaria quercifolia	Oakleaf ern
Nephrolepis exaltata	Boston fern
Platycerium bifurcatum	Staghorn fern
Polypodium sp.	Rockcap fern
Pteris sp.	Brake
Rumohra adiantiformis	Leatherleaf fern
* *Smilax rotundifolia*	Roundleaf greenbrier
Thelypteris sp.	Maiden fern
Woodwardia radicans	European chain fern
Woodwardia virginica	Virginia chain fern

Table 1. Known host plants of FFM (adapted from Heppner 2007). * = non-fern hosts.

Kansas Department of Agriculture (KDA) has intercepted Florida fern moth (FFM) for the first time in Kansas (Fig. 1). Ferns are generally not a popular host plant for insects and reasons for this pattern is not entirely clear. While some KS growers were already aware of this pest, due to the general lack of fern pests, FFM has slipped under KDA radar until now.

Fern moths (*Callopistria* spp.) are native members of the owlet moth family which includes army worms and cut worms. Five species of fern moth are known from the United States: *cordata*, *floridensis*, *granitosa*, *jamaicensis*, and *molliussima*. While all fern moths are specialist herbivores of ferns, Florida fern moth (FFM) is the only routinely pestiferous species, feeding on a wide variety of native and cultivated ferns (Table 1). In addition, FFM also exhibits a relatively expansive distribution compared to other species of fern moth, occurring throughout the eastern half of North America (Fig. 5, Table 2), south into Central America, and across the ocean into the Caribbean.

While FFM clearly thrives in warmer environments it also extends quite far north and into Canada;

Figure 2–4. (2) Larval feeding damage; (3) pupal chamber in soil; (4) pupa.

whether this northerly distribution is an artifact of human transportation or represents their natural distribution is unclear. Therefore, while 22 species of fern are known from KS it is unknown whether they naturally occur in the state, feeding on native fern and overwintering outdoors.

Development

Typical of moths and butterflies, FFM develops through complete metamorphosis (egg → larva → pupa → adult). Developmental duration is roughly halved every 10°F (5.6°C) increase above 50°F (10°C). Development below 50°F may take months. However, at 70°F (21°C) FFM develops from egg to adult in approximately 60 days and at 85°F (30°C) in 30 days. In KS, FFM may experience several generations a year depending on growing conditions and grower's operation.

Egg

Adult females will lay between 200–600 eggs (average of 465.4 in one study). Eggs are typically laid singly on the underside of leaflets near the tips or on fiddleheads. Eggs are white to greenish early on and brown near hatching. Eggs typically take 5–7 days to hatch at 70°F.

Larva

Larvae experience 5–6 stages (instars). Males go through five with some females going through six stages. A full-grown or final instar larva is about 1.5 inches (3.8 cm) in length. At 70°F, larval development takes around 36–42 days. Larvae largely feed on leaflets (Fig. 2) throughout development and typically at night. During the day larvae hide near the base of plants or in the soil. Early instars are pale green, but at the fourth instar diverge into one of five color morphs that range from green, brown, or black, with variable whiteish markings.

Pupa

Pupation occurs in the soil just underneath the surface (Figs. 3–4). Pupae are brown and reside within a loosely woven silken cocoon covered in soil particles. Mature larvae will disperse over soil prior to pupating, frequently burrowing when they hit the side of the pot and forming their cocoon against the side. Due to this tendency in greenhouse settings, pulling ferns out of their pots and inspecting the soil along the sides is an effective means to survey for FFM pupae. Pupation takes about 18 days at 70°F.

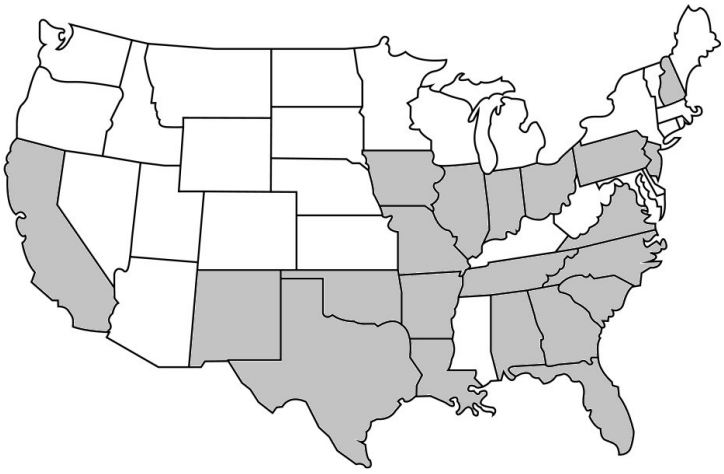

Figure 5. Previously known distribution of FFM (compiled from BugGuide.net & North American Moth Photographers Group).

Adult

Adults of FFM are attractive and distinctive. Moths are around an inch in length and can be separated from other local moths by their unique mid legs which sport a distinctively dense brush of fine hairs (setae) and a large protruding hair-covered spur near the middle of its length (apex of tibia). At rest the distinctive mid legs are stretched out to the sides and wings are held at a slight angle over the body. Fore wings display a characteristic pattern of brown shades with streaks of whiteish and pale purple markings. FFM can be separated from other fern moth species by the darker brown triangular marking on the outer edge of the fore wing near the middle.

Management

FFM has been associated with leatherleaf fern production as a pest since industry inception in Florida. A long history of FFM management practices reliant on a limited number of pesticides has likely contributed to reports of resistance within the last 20 years, particularly to pyrethroids. Florida growers are currently heavily dependent on diflubenzuron (e.g. Adept™, Dimilin™), but rotating classes and active compounds will prevent further encouraging development of resistance in FFM. *Bt*-based products are an alternative but have been observed to be slower acting and somewhat less effective in managing FFM. In KS, growers have found spinosad (Conserve™ SC) effective.

NOTE: As with the use of insecticides in any situation, rotating types/active compounds to avoid development of resistance and carefully reading/following the label is extremely important.

References

- Hendrix, S.D. 1980. An evolutionary and ecological perspective of the insect fauna of ferns. *The American Naturalist*, 115(2): 171–196.
- Heppner, J.B. 2007. Lepidoptera of Florida. Part 1: Introduction and Catalog. Arthropods of Florida and Neighboring Land Areas, Volume 17. Pp. 670. Florida Department of Agriculture & Consumer Services, Division of Plant Industry. Gainesville, Florida.
- Lawton, J. H. 1976. The structure of the arthropod community on bracken. *Botanical Journal of the Linnean Society*. 73: 187–216.
- Lawton, J. H. 1982. Vacant niches and unsaturated communities: a comparison of bracken herbivores at sites on two continents. *Journal of Animal Ecology*. 51: 573–595.

Additional Reading

- Michigan State University Extension (https://www.canr.msu.edu/news/florida_fern_caterpillar_larvae_found_on_boston_ferns_in_greenhouses)
- University of Florida Extension (https://mrec.ifas.ufl.edu/cutfol/cutpubs/cfg_99_1.pdf)

State/Province	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alabama					▪	▪	▪	▪	▪	▪	▪	
Arkansas									▪			
California						▪			▪	▪		
Florida	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
Georgia							▪	▪	▪	▪	▪	▪
Illinois								▪				
Indiana								▪				
Iowa								▪		▪		
Louisiana							▪	▪	▪	▪		▪
Maryland									▪			
Massachusetts								▪				
Michigan										▪		
Missouri						▪		▪	▪			
New Hampshire			▪									
New Jersey							▪	▪	▪	▪		
New Brunswick									▪			
New Mexico							▪					
North Carolina					▪	▪		▪	▪	▪		
Ohio								▪		▪		
Oklahoma								▪	▪	▪		
Ontario							▪					
Pennsylvania							▪	▪	▪			
South Carolina							▪	▪	▪		▪	
Tennessee							▪	▪	▪	▪		
Texas	▪		▪		▪	▪	▪	▪	▪	▪	▪	▪
Virginia							▪		▪			

Table 2. North American states/provinces and months when FFM has been recorded (compiled from BugGuide.net & North American Moth Photographers Group).

SURVEY & MANAGEMENT

Emerald ash borer (*Agrilus planipennis*)

Survey

As the USDA inches towards deregulating emerald ash borer (EAB) due to their prolific spread across the country, KDA will independently continue to monitor their westward spread and emphasize efforts towards management. As of 2018, EAB has been intercepted in eight counties (Atchison, Douglas, Jefferson, Johnson, Leavenworth, Shawnee, Wyandotte) centered around the northeastern border with Missouri (agriculture.ks.gov/eab). KDA will be monitoring for the spread of EAB along the western front of their established counties (Fig. 10).

Two monitoring methods are being employed: (1) purple prism traps (Fig. 6), and (2) trap trees (Fig. 7). Purple prism traps are plastic panels with Tanglefoot® layered on the outer side that is folded into an elongate triangular structure. Olfactory volatiles are hung on the inside of the prisms and suspended from ash trees. The volatiles mimic those released by stressed ash trees and the purple color is attractive to EAB, a group generally known for their excellent color vision. Trap trees, on the other hand, are trees treated to be more attractive to nearby EABs. Ash trees of suitable size are girdled (the bark removed) in the spring and Tanglefoot® is applied to a layer of plastic just above the girdle. Removing the bark prevents successful nutrient transport and stresses the tree to release more volatiles that EAB will hone into. The motivation here is to attract adults into laying eggs (ovipositing) on the trap trees or getting caught in the Tanglefoot® trying. Girdled trees are felled and bark removed in the fall (September–October) to check for EAB larvae. While prism traps are convenient, they are inefficient in EAB detection. On the other hand, trap trees are extremely labor intensive but far more

Figures 6–7. (6) Purple prism trap ; (7) girdled trap tree.

efficient. Therefore, KDA is applying both approaches for EAB monitoring.

The frontier counties of Brown, Miami, Jackson, Osage, and Wabaunsee are being monitored; southeastern KS is also being monitored due to the riparian corridors with plentiful ash that extends north from Oklahoma where EAB is established. Additionally, due to EAB's notorious spread through the transportation of firewood (currently not allowed due to quarantine), KDA is monitoring high traffic areas including Hays, Wilson Lake and Wichita.

Management

In conjunction with USDA-APHIS and -PPQ, KDA will emphasize EAB management over active quarantine starting this year. A major part of this effort will involve the release of biological control agents—natural enemies from EAB's native China to suppress further population growth and therefore regulate damage to native and planted ash. Three species of parasitic wasps developed by USDA-APHIS will be released for EAB management: two larval (*Spathius agrili* & *Tetrastichus planipennisi*) and an egg parasitoid (*Oobius agrili*).

Female parasitoid wasps lay their eggs into or on their hosts where larvae develop by feeding from either within or outside of the host, killing the beetles in the process (these wasps are termed parasitoids instead of parasites because they kill their hosts) (Gould *et al.* 2017). These wasps have multiple generations a year, and in Michigan, where they have been established for over a decade, studies have shown parasitism rates can get as high as 90%, controlling EAB populations and allowing ash to reestablish in the landscape (Duan *et al.* 2013, 2015).

Four sites were selected in eastern KS for release: Clinton Lake, Perry Lake, Shawnee Mission Park, and Wyandotte County Lake Park. Releases will occur weekly for a period of roughly 12 weeks beginning this June across at least two consecutive years. Since KS is at the western front of EAB's westward expansion, successfully establishing parasitic wasps in KS will be an important step towards management both at the state and national level.

Our efforts to tackle the EAB problem is

Figure 8. Severe damage to ash caused by EAB larval subcorticular burrowing at Clinton Lake.

ongoing, and we hope to work with members of the community to monitor, control, and prepare for EAB expansion to minimize damage to KS ash. Education is an important aspect of our mission concerning EAB in KS, and as a part of this effort, we will be conducting public bark peeling of trap trees this fall. If you are interested we encourage you to join us for these events in your area.

References

- Gould, J.S., L.S. Bauer & J. Duan. 2017. Emerald ash borer biological control release and recovery guidelines. USDA-APHIS-ARS-FS, Riverdale, Maryland, USA (https://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/downloads/EAB-FieldRelease-Guidelines.pdf).
- Duan, J.J., L.S. Bauer, K.J. Abell, J.P. Lelito, & R.V. Driesche. 2013. Establishment and abundance of *Tetrastichus planipennisi* (Hymenoptera: Eulophidae) in Michigan: potential for success in classical biocontrol of the invasive emerald ash borer (Coleoptera: Buprestidae). Biological and Microbial Control. 106(3): 1145–1154.
- Duan, J.J., L.S. Bauer, K.J. Abell, M.D. Ulyshen, & R.G. Van Driesche. 2015. Population dynamics of an invasive forest insect and associated natural enemies in the aftermath of invasion: implications for biological control. Journal of Applied Ecology. 52: 1246–1254.

Additional Reading

- Kansas Department of Agriculture (https://agriculture.ks.gov/divisions-programs/plant-protect-weed-control/emerald-ash-borer)

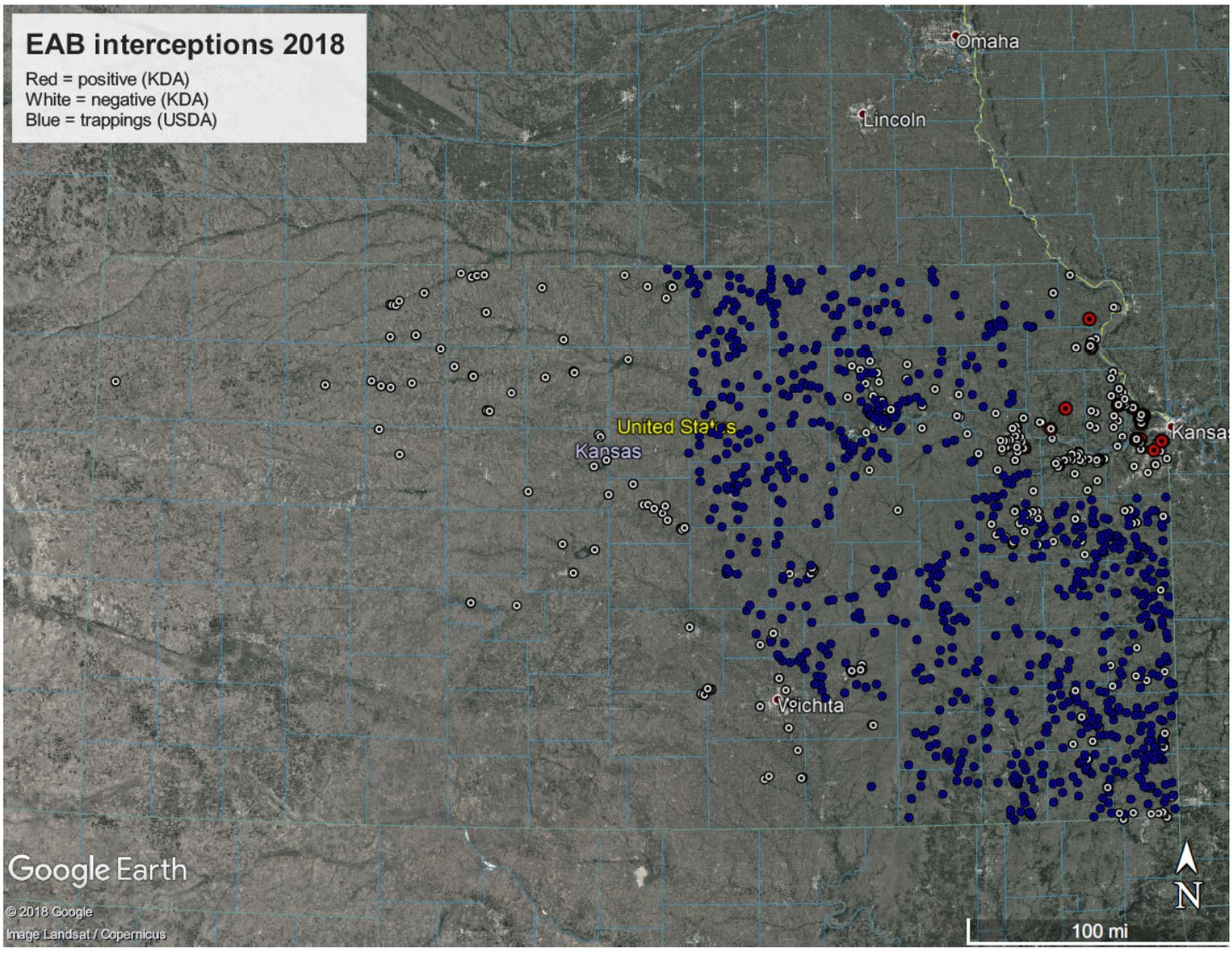

Figure 9. EAB interceptions and trapping in KS prior to 2019.

- Emerald Ash Borer Information Network (http://www.emeraldashborer.info/about-eab.php)
- USDA-APHIS (https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/emerald-ash-borer)

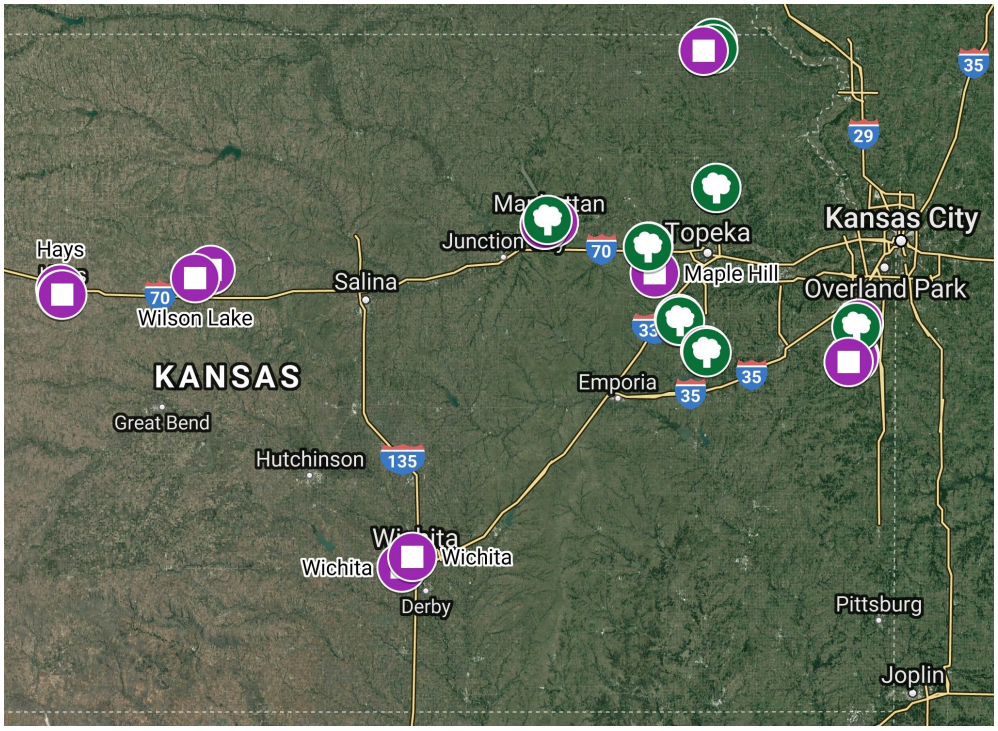

Figure 10. EAB monitoring efforts by KDA, 2019.

PPT = purple prism trap

TT = trap tree

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- Exclude or control harmful insects, plant diseases and weeds.
- Ensure Kansas plants and plant products entering commerce are free from quarantined pests.
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