Can the Emerald Ash Borer occupy other tree species?

Presented by Anna Seuberling

Background

➽The Emerald Ash Borer (EAB), A.planipennis, was discovered in Michigan in 2002. Since then, it has populated 17 U.S. states, 2 Canadian Provinces and killed millions of Ash Trees (Rajarapu, 2013). A. planipennis is native to Asia (Anulewicz, McCullough,Cappaert, Poland, 2008) and has since found its way to North America where its larvae develop/ feed on Ash trees, primarily Green Ash trees.

➽As Ash tree populations are decimated, Borer populations will need other suitable host species, but how will A. Planipennis adapt? A recent study showed that there is a difference in genes associated with Chitin Metabolism (carboxylesterase and sulfotransferase) between EAB's that feed on Green Ash Tree and those that feed on a resistant Asain species, Manchurian Ash (Rigsby, Showalter, Herms, Koch, BOnello, Cipollini, 2015).

➽The Chitin polymer found in EAB's from Asia is integral in peritrophic matrices which *enhance* digestion (Tellam, 1996). The Chitin related genes allow for A. Planipennis to feed on more resistant species like Asain Manchurian Ash.

Motivation

➽As Ash Tree populations dwindle across the North America, forest management must adapt with it. Currently, some methods include chopping down the remainder of an area's ash trees or treating Ash trees with emamectin benzoate through a tree IV (Shenandoah National Park, 2019) These methods can be costly and time consuming.

➽Will an EAB population native to Asia that has Chitin related genes be able to feed on other species of trees? Do forests across North America need to be concerned about a second wave or coevolution of the Emerald Ash Borer?

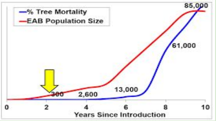

Figure 3: The percentage of Ash tree mortality and EAB population size over time. You can see EAB populations level off as tree mortality percentage reaches 85%.

*Image from Sioux Falls city council

Hypothesis

We hypothesize that there is a relationship between A.Planipennis with carboxylesterase and sulfotransferase (Chitin metabolic genes) and the ability to feed off of trees other than ash.

Prediction

We predict that A.Planipennis with carboxylesterase and sulfotransferase will be able to feed on other species of trees that are not Ash.

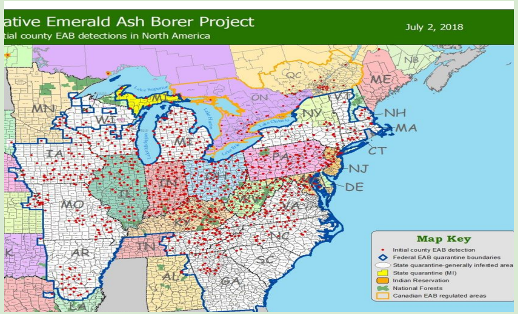

FIgure 1: Map of EAB detection in North America. U. (2018, July 2). Initial County EAB Detections in North America [Digital image]. Retrieved November 24, 2020, from http://www.acapsj.org/staff-blog/2018/7/3/emerald-ash-borer-coming-to-an-ash-tree-near-you#

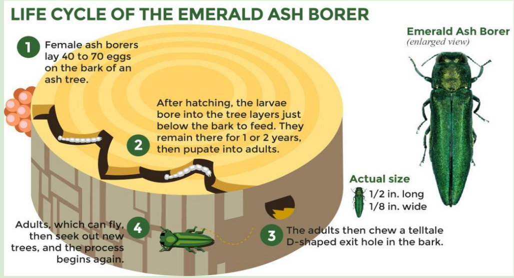

FIgure 2: The life cycle of the Emerald Ash Borer. Natural Resource Canada (2016). "Emerald ash borer (factsheet)". Retrieved November 24, 2020, from:https://www.nrcan.gc.ca/forests/fire-insects-disturbances/top-insects/13395

Study Design

➽We will conduct a **manipulative experiment** similar to Rajarapu and Anulewicz. We will conduct this experiment within a lab to control any unforeseen, confounding variables. To investigate the effect of the Chitin polymer on the host range of EAB, we will have a control group of offspring from a Green Ash feeding borer. The other sample group will be offspring from a Manchurian feeding EAB that has the Chitin metabolism genes.

➽We will collect 320 offspring from Manchurian feeding EAB and 320 green ash offspring. To collect these samples we will find larvae from Manchurian and Green ash trees, follow them into adulthood and track their larvae. This will ensure that our samples will/ won't have the Chitlin genes. The eggs will be removed from their original trees and moved to different tree species in our lab setting immediately after they are laid.

➽The experiment will use 8 different species of tree: sugar maple, red maple, beech, red alder, red oak, white oak, balsam poplar and black cherry. 40 of each larvae will be placed on each type of log samples. Like Anulewicz set up, we will construct 16 T shaped posts, 2 m gall and place them in the ground 10 m apart. A log of each species will sit at the top of each post where the larvae will live.

➽Like figure 2 shows, the EAB larvae will be expected to bore into the log samples after they hatch. Close watch will be kept following the hatch to see if, in fact, the borers with Chitin genes are able to bore into non ash species.

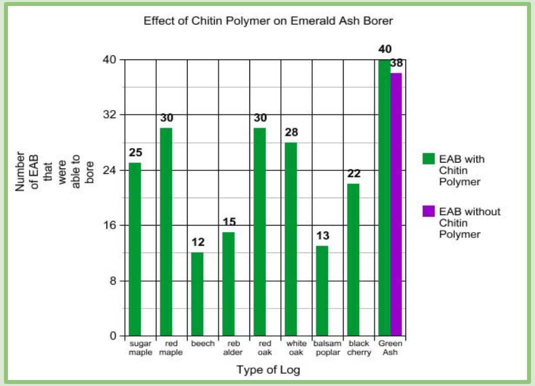

Figure 4: The predicted outcome of the experiment.

We predict that larvae collected from Manchurian Ash that have genes related to Chitin will be able to successfully bore into other types of trees. The control group will not be able to bore into any type of tree other than the Green Ash.

Intended Analysis

➽Our *response variable is categorical* (whether not the larvae will be able to bore) a*s well as our independent variable* (type of log) which means we would use a **Chi-Squared Test.**

➽A Chi-Square test will help determine if there is a significant difference between A.Planipennis that could bore into other species of trees and those that could not.

➽ If there is a significant difference that tells us that EAB with Chitlin genes are able to bore into other tree species besides Ash, North America needs to be on the lookout. This study will be able to push for further protection against this invasive species. This includes practices like enforcing a "no transportation of firewood policy" and thorough inspection of log related imports from Asia.

Literature Cited:Andrea C. Anulewicz, Deborah G. McCullough, David L. Cappaert, Therese M. Poland, Host Range of the Emerald Ash Borer (*Agrilus planipennis* Fairmaire) (Coleoptera: Buprestidae) in North America: Results of Multiple-Choice Field Experiments, *Environmental Entomology*, Volume 37, Issue 1, 1 February 2008, Pages 230–241, https://doi.org/10.1603/0046-225X(2008)37[230:HROTEA]2.0.CO;2;Rajarapu, S. (2013). *Integrated omics on the physiology of emerald ash borer (Agrilus planipennis Fairmaire)* . (Electronic Thesis or Dissertation). Retrieved from https://etd.ohiolink.edu/ ;Rigsby, C., Showalter, D., Herms, D., Koch, J., Bonello, P., & Cipollini, D. (2015). Physiological responses of emerald ash borer larvae to feeding on different ash species reveal putative resistance mechanisms and insect counter-adaptations. *Journal of Insect Physiology, 78*, 47-54. doi:10.1016/j.jinsphys.2015.05.001;Shenandoah National Park Fights Emerald Ash Borer (U.S. National Park Service). (2019, November 8). Retrieved November 25, 2020, from https://www.nps.gov/articles/eab-is-bad.htm;Tellam, R. L. (1996). The peritrophic matrix. In *Biology of the Insect Midgut* (ed. M. J. Lehane and P. F. Billingsley), pp. 86-114. Cambridge: Chapman and Hall.