Purdue University
Department of Entomology
Undergraduate Capstone
Project Summary

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Project Title:

Seasonal flight activity of scolytine beetles associated with black walnut

Introduction:

Black walnut (*Juglans nigra*) is an important hardwood species in the Eastern United States because of its role in the environment and the contributions it makes to the economy. Black walnut trees help to reduce soil erosion and they provide a rich food source for a variety of wildlife including birds and squirrels. They are also known to produce juglone, an allelochemical, which suppresses growth of plants around the tree and alters fauna (Virginia Cooperative Extension). Black walnut is an important economical resource because of its desirable wood qualities and nut production. It is used in a wide variety of wood products including furniture, veneer, plywood panels, and gunstocks. These products bring in $21.4 million into Indiana's economy annually and $325 million through annual U.S. exports. It is projected that the estimated value of black walnut in its native range is $569 billion (USFS 2002).

Black Walnut trees are currently being challenged by thousand cankers disease. This disease is caused by a fungus, *(Geosmithia morbida)*, that is associated with the walnut twig beetle *(Pityophthorus juglandis)*. The main symptoms of thousand cankers disease are small cankers underneath the bark, on branches and the trunk, entry holes from the walnut twig beetle, and branch death (USDA Forest Service, 2013). Infection occurs when an adult walnut twig beetle emerges from a symptomatic tree and flies to a new black walnut tree where it bores into the bark introducing the fungus. This results in the growth of small cankers around the galleries of the walnut twig beetle. These cankers cause disruption in the flow of the cambium and phloem. Trees with symptoms of thousand cankers disease die after 3 to 4 years (Kolařík et al, 2011). Thousand cankers disease was first discovered in the Western US in the 1990's and in the Eastern US by 2010 (Tisserat et al, 2011; Utley et al, 2013). This is alarming because the relatively new detection of *G. morbida* in the east overlaps with the native range of the black walnut tree.

It has been found that *P. juglandis* is not the only beetle that serves as a vector for *G. morbida*. The weevil *Stenomimus pallidus*, and two ambrosia beetles, *Xylosandrus crassiusculus* and *Xyleborinus saxeseni*, were also found to carry small amounts of *G. morbida* (Juzwik et al, 2015; Juzwik et al, 2016). It is concerning that ambrosia beetles were found to be vectors of *G. morbida* because of the relationship between ambrosia beetles and fungi. Ambrosia beetles have been known to cultivate fungi as a food source by inoculating the tree with spores from specialized fungus-carrying compartments called the mycangia. It is unknown whether the ambrosia beetles were cultivating *G. morbida* in their mycangia or if fungal spores attached to the cuticle as an adult left a symptomatic tree.

Purpose of Study:

The purpose of the study is to identify the species of ambrosia beetles collected on black walnut trees and to determine when they emerge.

Method:

Ambrosia beetles were collected with Lindgren funnel traps baited with ethanol lures on the property of Arbor America in Tippecanoe Co., Indiana. Arbor America is a business that maintains a black walnut plantation. A total of seventy-two traps were set at seven different sites owned by Arbor America. Each trap was checked and insects were collected on a weekly basis from roughly May through October. Data was collected from 2012 through 2015.

Results:

The results section is separated into two main sections: (1) number of beetles collected, and (2) times of the year that two known beetles that vector *G. morbida* and one species of concern, were collected.

Total Number of Beetles Collected

Beetles at the seventy-two Arbor America collection sites were collected in 2013, 2014 and 2015. During this time, 8,274 beetles were collected. The most commonly found ambrosia beetles were the *Xyleborinus saxeseni* (5,363 beetles, 64.8% of total), *Xylosandrus crassiusculus* (2,196 beetles, 26.5% of total), and *Xylosandrus germanus* (199 beetles, 2.4% of total). For a more complete analysis of the beetles collected, see table 1.

Table 1

Number of beetles collected by species and by year

Beetle (species)	Year			Total (N = 8,274)	
	2013	***2014***	***2015***	***Total (n)***	***Percent (%) of total***
Ambrosiodus tachygraphus	2			2	0.02
Ambrosiophilus atratus	41	6	17	64	0.77
Anisandrus sp.			3	3	0.04
Cnesinus strigicollis	0			0	0.00
Corthylus punctatissimus	1		3	4	0.05
Cyclorhipidion pelliculosum	110			110	1.33
Dryoxylon onoharaense			0	0	0.00
Euwallacea validus	5	8	2	15	0.18
Gnathotrichus materiarius			1	1	0.01
Hylastes sp.	8			8	0.10
Hylastes porculus		0	1	1	0.10
Hylocurus sp.		4	4	8	0.10
Hylesinus aculeatus	17	0	1	18	0.22
Hypothenemus eruditus	1	7		8	0.10
Hypothenemus interstitialis	13			13	0.16
Hypothenemus sp.			6	6	0.07
Monarthrum fasciatum	14	3	43	60	0.73
Monarthrum mali	15	4	2	21	0.25
Phloeotribus dentifrons	1	4	0	5	0.06
Phloeotribus liminaris	53	36	44	133	1.61
Pityophthorus sp.	2	26	2	30	0.37
Scolytus multistratus			3	3	0.04
Scolytus muticus		1	1	3	004
Xyleborinus saxeseni	2946	1097	1320	5363	64.82
Xylosandrus crassiusculus	1616	186	394	2196	26.54
Xylosandrus germanus	132	23	44	199	2.41

Times of the year that two known beetles that vector G. morbida and one species of concern were collected

The following results present data on two beetles collected that serve as vectors and one species of concern to the black walnut tree. For each of the three beetles *(Xylosandrus crassiusculus, Xylosandrus germanus,* and *Xyleborinus saxeseni)* the total number collected and the time of the year during which they were collected is provided.

Xylosandrus crassiusculus

Natural History

Xylosandrus crassiusculus is an ambrosia beetle that originated in Asia. It was first detected in Indiana in 1992 in Johnson county and is considered an invasive pest species (Cote, 2008). The host range of *X. crassiusculus* is vast, with most deciduous trees being susceptible. Conifer trees are not targeted. The adult beetle overwinters in galleries and emerges in later spring to early summer. There is sexual dimorphism with only females able to fly. The new females mate with their brothers in the maternal galleries, allowing them to be quicker and more effective at establishing new and active populations. Once a female has bored into a new tree and created a gallery, she will inoculate the tree with a symbiotic fungus that acts as the beetle's food source. Once the fungus is established, the female will lay eggs in the gallery. It takes about 55-60 days for a larva to turn into an adult (Cabi, n.d.a)

Data

The highest peaks for number of *Xylosandrus crassiusculus* beetles collected was in June for both 2013 and 2015. As noted in figure 2, the peak collection time in 2014 was at the end of July. The highest mean numbers of beetles captured was 95 in 2013. Data collected from 2015 had the highest mean number captured at 25 with six in 2014. Both 2013 and 2015 show a large drop in the numbers of beetles starting around the end of June/start of July. See figures 1 for additional details.

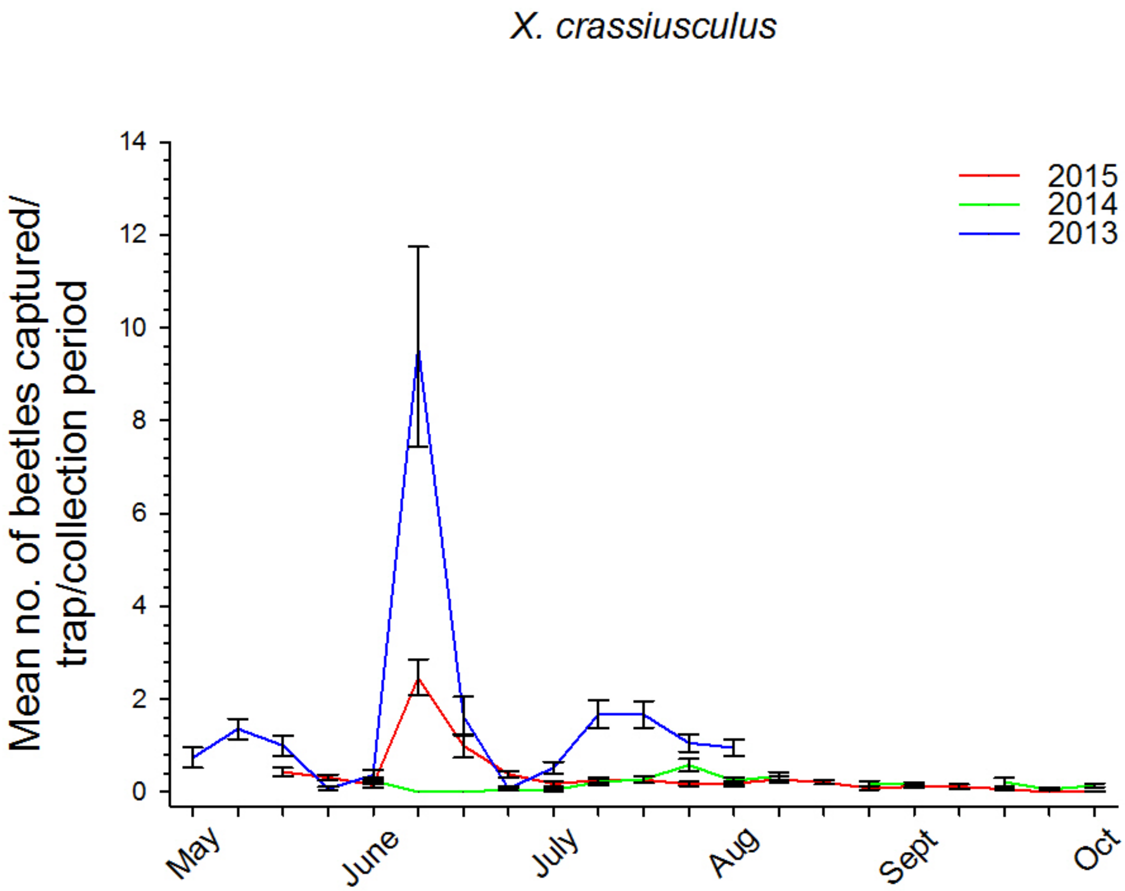

Figure 1. Mean number of *Xylosandrus crassiusculus* beetles collected by trap and collection period.

Xylosandrus germanus

Natural History

Xylosandrus germanus is an ambrosia beetle that originates from Asia. The beetle is most successful in temperate zones. It was first reported in Indiana in 1975 and is considered an invasive species. The host range of *X. germanus* is large, including both deciduous and coniferous tree species. They are not size-specific on breeding area and can be found in both small stems to logs. The adults overwinter in clusters in the galleries. This species exhibits extreme polygamy with females inbreeding with their brothers. There is sexual dimorphism with females being larger and the only active flyers. Colonies show a high female to male ratio. Mated females leave and are able to colonize new areas quickly. Females lay eggs after new galleries are inoculated with symbiotic fungus. There are two different generations per year for populations from North Carolina to Illinois (Waber and Mcpherson, 1983; Cabi, n.d.b).

Data

For *Xylosandrus germanus,* the peak times varied from one year to the next. In 2013, the peak time was in late June to early July (figure 2). For 2014, a minor peak was noted at the end of June to the start of July and another peak started at the beginning of October. In 2015, the peak occurred at the beginning of August. The largest mean number of beetles collected at one time was in 2013 when 16 were captured. In 2014 and 2015, the mean total captured at one time was considerably lower at approximately one. Data from 2014 and 2015 showed a low number of beetles collected, ranging from zero to under two beetles for each week.

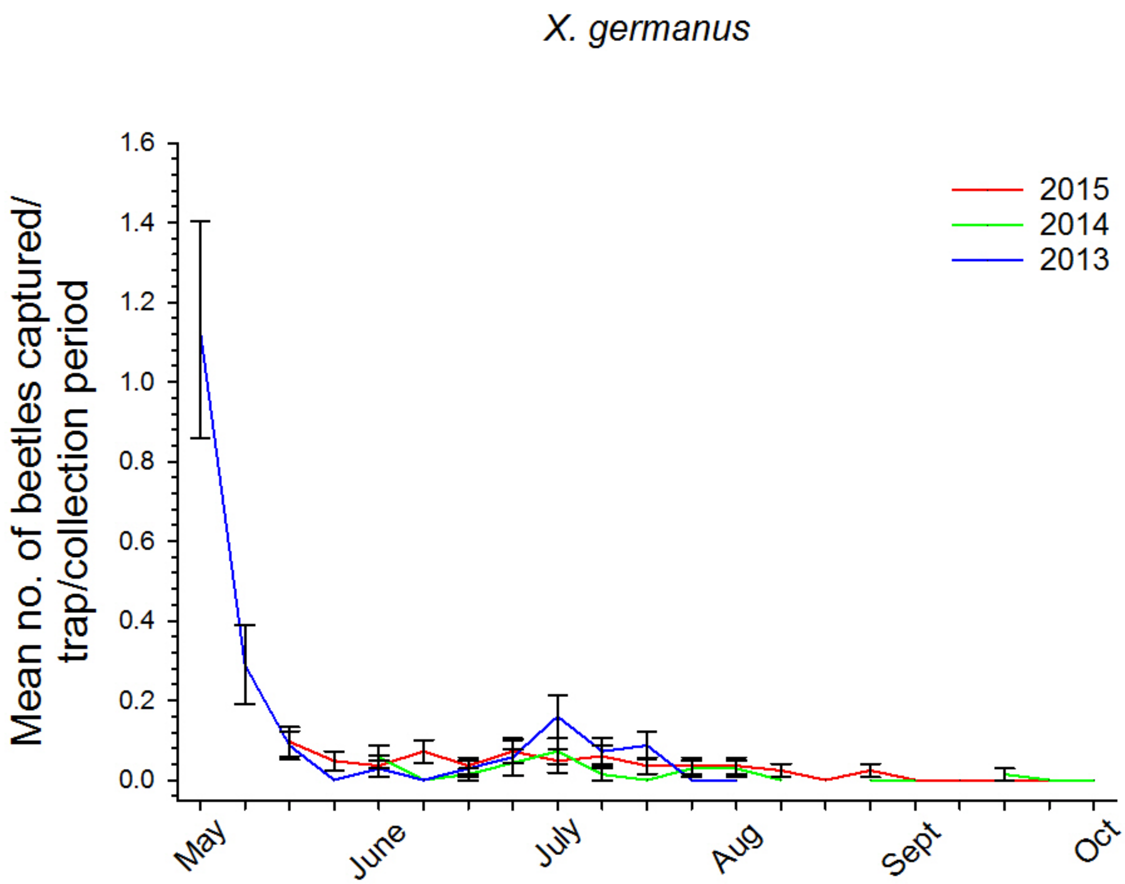

Figure 2. Number of *Xylosandrus germanus* beetles collected by trap and collection period.

Xyleborinus saxeseni

Natural History

Xyleborinus saxeseni is an ambrosia beetle that is native to Asia and parts of Africa. The beetle is primarily found in temperate zones but can be in tropical zones. It is an introduced invasive species to Indiana. The beetle has a wide range of hosts that include both deciduous and coniferous tree species. The beetle show strong sexual dimorphism with larger female beetles being the active colonizers. Adults overwinter in galleries and females breed with their brothers. Once they emerge in later spring to early summer, the females bore into new trees and create galleries. They inoculate the tree with symbiotic fungus that acts as a food source for the beetle. The females lay a cluster of 8-12 eggs that take between 7-15 weeks to grow from larva to an adult. It has been shown that some galleries can have over 100 beetles in them (Egger, 1973; Cabi, n.d.c;).

Data

The mean number of beetles collected in 2013 showed a decline following a peak at the start of May. Very little activity was noted for the remainder of the collection period (figure 3). Beetle activity was high in early June with substantial numbers captured. Numbers declined thereafter and stayed low for the remainder of the collection period. Data from 2015 showed a peak at the end of May to early June and a minor peak in the middle of July. The highest mean number of beetles collected was in 2013. For more information, see figures 3.

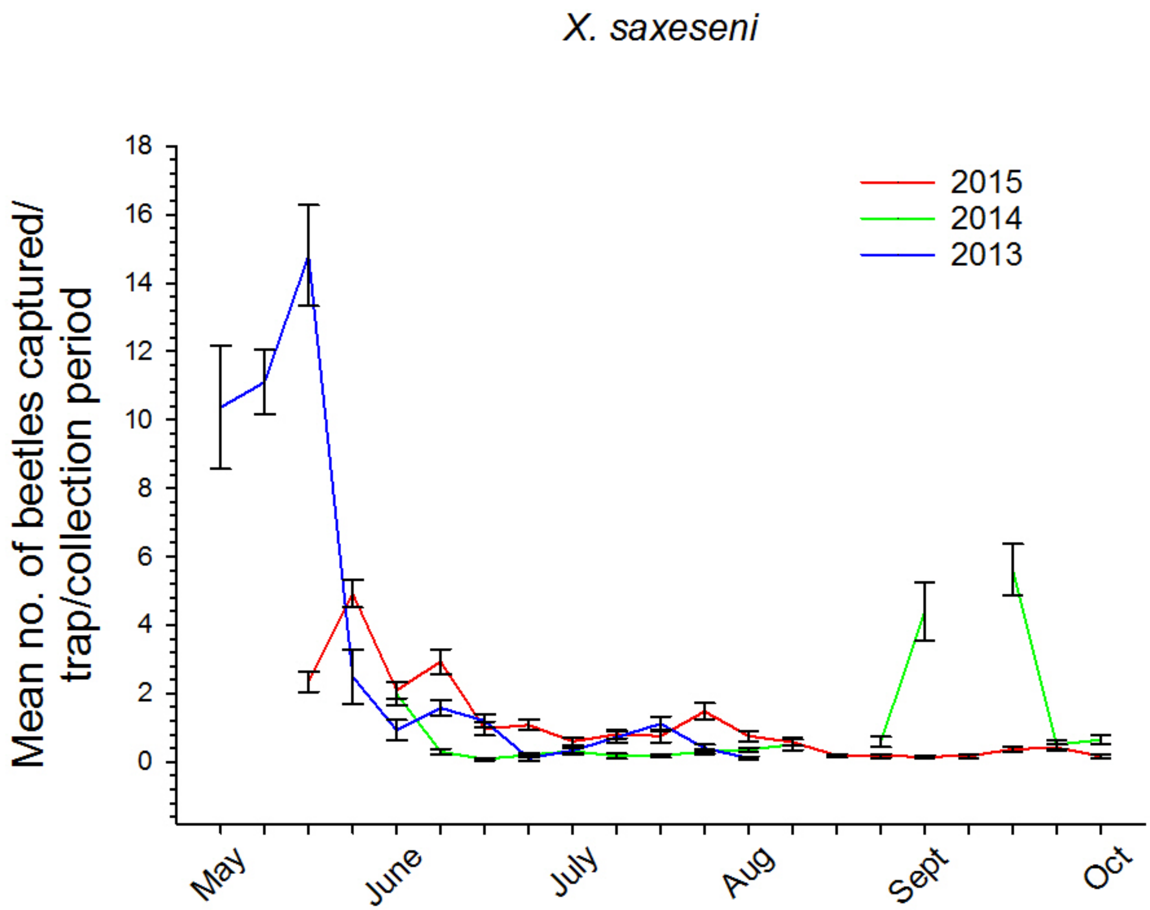

Figure 3. Number of *Xyleborinus saxeseni* beetles collected by trap and collection period.

Management Considerations:

The spread of *G. morbida* and new vectors shows the importance for strong management plans. It is recommended that land users implement a monitoring program for the two known vectors of *G. morbida*, *Xylosandrus crassiusculus* and *Xyleborinus saxeseni,* and the species of concern, *Xylosandrus germanus*. The monitoring program should include:

1. setting up traps, and
2. inspecting trees for potential signs of thousand cankers disease.

The most effective methods of inspecting the trees for damage are by looking at the crown rating and surveys for flagging. Suspected symptomatic trees can be reported to state natural resource agencies.

Recommendations for Future Research:

This project focused on identifying the species and number of ambrosia beetles collected at a black walnut plantation in northwestern Indiana. This research did not take into consideration the optimal time for setting traps, the impact of weather (i.e., temperature and precipitation), and site conditions. Thus, future research should be conducted to determine:

1. The impact of weather (i.e., temperature and precipitation) on the activity of known and suspected vectors of *G. morbida*.
2. The optimal time to set traps for the collection of known and suspected vectors of *G. morbida*.
3. If site conditions impact activity of known and suspected vectors of *G. morbida*.

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