Invasive kudzu bug's (*Megacopta cribraria*) status in Maryland

Jessica Grant and Bill Lamp
University of Maryland

Background:

Kudzu bugs, *Megacopta cribraria* (Family Plataspididae), were first introduced to Georgia in 2009 and have since spread to Maryland in 2013. The bugs come from Asia, specifically Kyushu, an island in southern Japan. Adults have a wide diet but primarily feed on kudzu vines (*Pueraria sp.*) and soybeans (*Glycine sp.*). They have become a pest on soybean crops in both their native range and in the Southeastern United States.

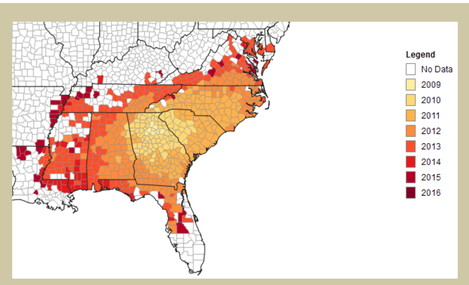


Figure 1: The kudzu bug invaded the United States from Japan in 2009. The map shown is the current distribution and progression of kudzu bugs from 2009 to 2016. (Megacopta working group: www.kudzubug.org)

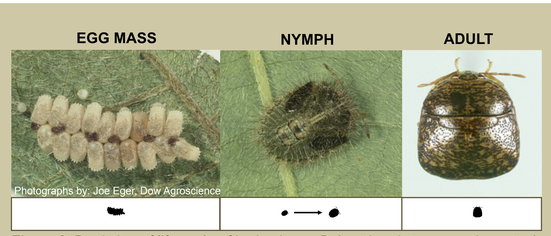


Figure 2: Depiction of life cycle of kudzu bugs. Below the pictures are the actual size of the bug.

Adults
Kudzu bug adults are small (3.5 to 6 mm long) and domed with a square shape outline. Their bodies are almost as wide as they are long with the wings hidden, which lends to their globular beetle-like appearance. Coloration of the body is a mottled greenish brown. The adults also give off a characteristic strong odor similar to native stinkbugs.

Nymphs
Nymphs of the kudzu bugs resemble adults but are fuzzy in appearance. Coloration can range from green to brownish green. Often the nymphs will blend in with the stem of the plant making them harder to spot than the adults.

Maryland Distribution
Since kudzu bugs were discovered in Maryland in 2013, they have not expanded their range in the state. Almost all kudzu bug sites have shown persistence from 2013 to 2016. Bugs are currently established in kudzu patches but have not been found to be a pest of soybeans in Maryland as they are in the Southeast.

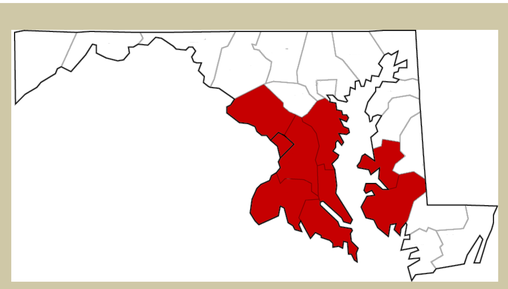


Figure 3: Red Maryland counties indicate present kudzu bugs in 2016. No expansion from 2013 has been found.

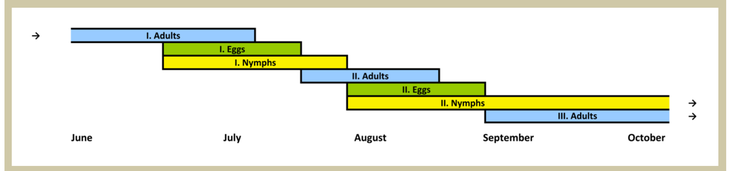


Figure 4: Expected phenology of the kudzu bug in Maryland based on 2013 and 2014 sampling.

Maryland Phenology
Bugs are expected to complete two full generations per year. Adults overwinter in the fall and emerge in the spring. Females can mate before winter and lay eggs as soon as temperature permits. The next generation adults are seen in late summer and then again in the fall. Eggs take 80 degree days to develop and nymphs require 545 degree days. The minimum temperature for development is 16°C (61°F). With such a strong relationship between temperature and development, timing of nymphs and adults may be predicted with daily temperatures.

Objectives:

1. Characterize cold tolerance of kudzu bugs
Lethal temperature to kill 50% of the population (LT_{50}) was determined along with the super cooling point (SCP), or the point at which the insect's body freezes.

2. Determine microhabitat temperatures
Kudzu bugs overwinter in leaf litter starting late November to December through the duration of the winter. Temperature differences between the leaf litter and kudzu vine from ambient temperatures were measured.

Methods:

Objective 1
LT_{50} and SCP were determined for three county sites (Suffolk, VA; Calvert, MD; Prince George's, MD) over the fall of 2015. Bugs were field caught and run through several chilling programs in a cooling fluid bath.

SCP:
Twenty bugs per site per month were used. Each bug was attached to a thermocouple wire in a vial. Vials were then placed into a fluid bath and cooled from 25°C to -25°C at a cooling rate of 0.27° C/min. SCP was determined as the temperature right before the release of heat from crystallization.

LT_{50}:
Forty bugs per site per month were used. Groups of 5 bugs were placed in vials and submerged in the cooling bath. Bugs were then cooled from 25°C to a minimum temperature of either -10, -6, -4, -2, +2 °C at a rate of 0.15° C/min and held at the minimum for 12 hours. Death was assessed 24 hours after warming the vials back to 25°C.

Objective 2
Temperature monitors were deployed in the vine and leaf litter of a kudzu patch in Calvert County, Maryland. The patch also contained an ambient monitor. All monitors were download once a month from December 2014 through 2016.

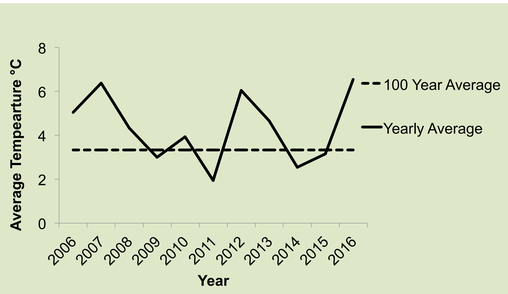


Figure 5: Average temperature from January to March from 2006 to 2016 in Maryland. The 100 year average from 1916 to 2016 is represented by the dashed line. Observed populations appear to fluctuate with temperature where since introduction, populations are lower following colder than average winters. Moreover, given that they have not expanded within Maryland, kudzu bugs seem to have reach a cold tolerance limit. (NOAA 2016)

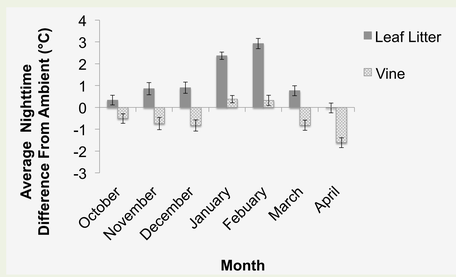


Figure 6: Nighttime differences from ambient temperature with standard error bars for leaf litter and vine monitors. Notice the insulating property of the leaf litter as compared to the vine. These differences may be used in correcting predictions of overwintering mortality based on measured ambient temperatures.

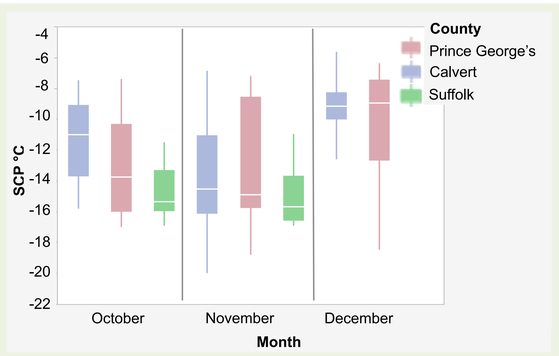
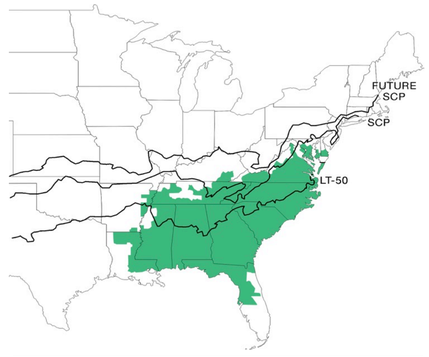


Figure 7: Super cooling points (SCP) between the three counties over the fall months. Suffolk in December was not analyzed due to a fungal infection of *Beauveria bassiana*. County and month were significant (ANOVA $F_{5,159}$=14.49 p=0.0019, p=<0.0001) with December and Suffolk being significantly warmer (Tukey p<0.05).

Month	County	LT_{50} (°C)	95% Confidence Interval Lower (°C)	95% Confidence Interval Upper (°C)
October	Prince George's	-5.1	-5.8	-4.4
	Calvert	-4.0	-4.9	-3.1
	Suffolk	-4.8	-5.3	-4.4
November	Prince George's	-6.6	-7.6	-5.8
	Calvert	-4.9	-5.9	-4.0

Figure 8: LT_{50} temperature values with the 95% confidence interval. Suffolk was dropped from November due to a fungal infection of *Beauveria bassiana* in the population. When experienced, LT_{50} temperatures hinder the bug's spring population size and ultimately the yearly pest pressure.



Implications of Results:

In the map above, the green represents the current kudzu bug range. Factoring microhabitat temperature differences, the current LT_{50} and SCP isolines are depicted. The future SCP is based on a 3°C increase in winter temperatures by the end of the century (IPCC RCP 4.5). Predictive capabilities for soybean producers include future range expansion as well as pest pressure per year.

Our Website:
www.mdkudzubug.org