Photo 1: One of the first photos of "ash decline" taken by the author in June 2001. In the spring of 2002, the author would discover the cause of ash decline in SE Michigan: the Emerald Ash Borer.

Photo 2: The earliest known photo of an adult EAB emerging from ash wood, taken by the author in the spring of 2002.

The Plant Doctor's LANDSCAPE TIPS

By David L. Roberts, Ph.D., *Senior Academic Specialist, College of Agriculture and Natural Resources, Michigan State University*

THE EMERALD ASH BORER AT 12: WHAT HAVE WE LEARNED?

INTRODUCTION:

The spring of 2014 marks 12 years since author's research on ash decline uncovered the existence of the Emerald Ash Borer (EAB=*Agrilus planipennis Fairmaire*, 1888) in Southeast Michigan in 2002 (Photos 1 & 2) and in Windsor Ontario in early July, 2002. The EAB was believed to have existed in SE Michigan at least ten years prior to 2002. Much has transpired during the ensuing 12 years. Scientists from all over North America as well as from Asia have advanced our knowledge on various aspects of EAB. Undoubtedly, the advancement of knowledge on the EAB in the recent twelve years has probably eclipsed that of the previous 100 years, due largely to the fact that the EAB was considered a background/nuisance pest in Asia, its location of origin.

Much more has been learned about EAB's biology, habit, distribution, DNA, and management . . . among a plethora of other attributes. Although the task of summarizing our current knowledge about EAB would be daunting in an article of this length, I have elected to summarize a few topics that may be of interest for many in the green industry.

EAB Distribution: The EAB has spread from its initial point source of introduction in SE Michigan, probably the Canton area, to many states and Canadian provinces in the past 12 years. In the U.S., at the time of this writing, the EAB is now found in Michigan, Colorado, Connecticut, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Massachusetts, Minnesota, Mississippi, New Hampshire, New York, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin (Figure 1). With re-

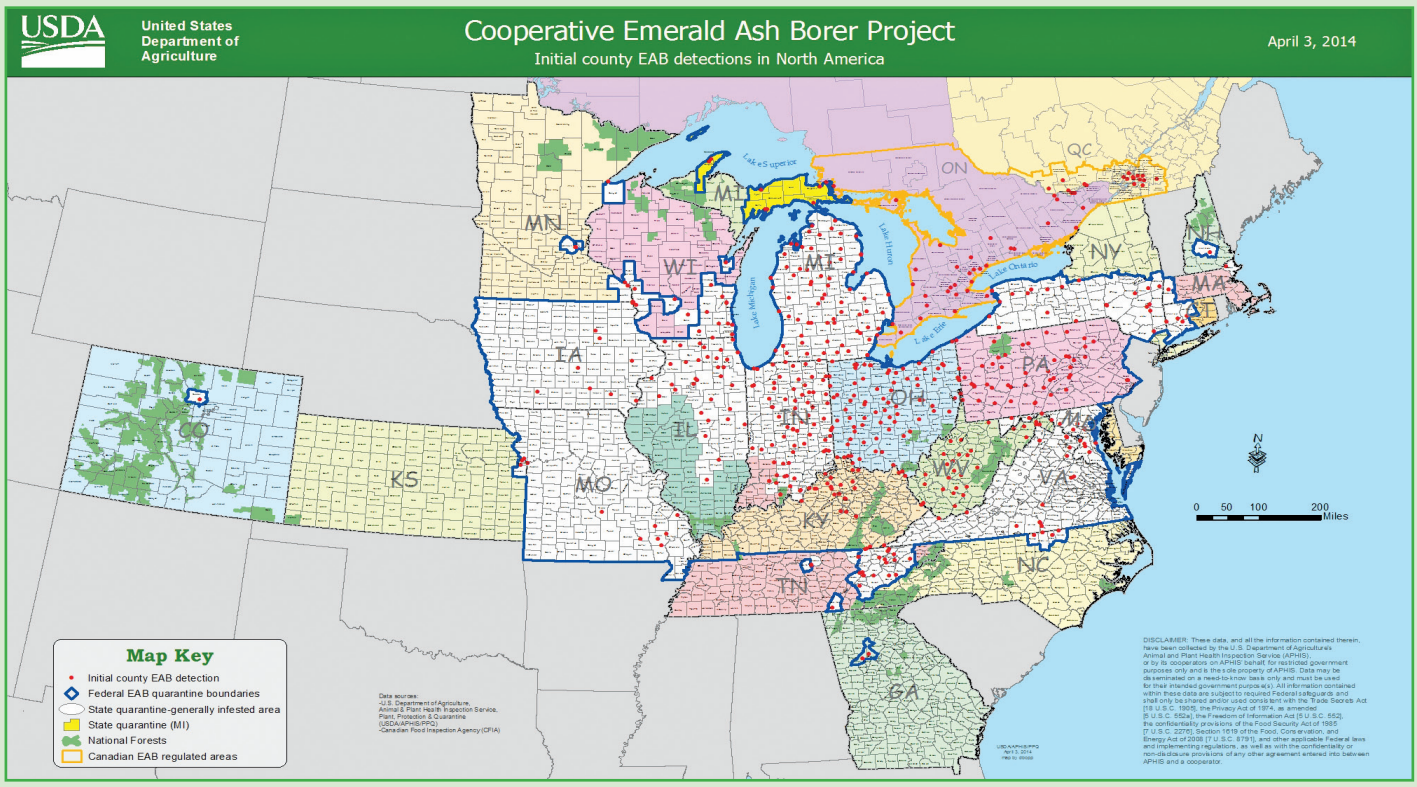

Figure 1: The current EAB distribution in the United States and Canada (April 2014).

call, it was initially suggested (by scientists) that the EAB might spread only about one-half mile per year on its own accord. If that were true, it would take more than 200 years to spread across Michigan. Obviously, the EAB's main manner of long distance distribution is in ash wood material, especially firewood. Even so, the adult EAB has been observed to attach itself to vehicles and be transported for miles. In 2007, the EAB was found in the vicinity of Moscow (Russia) and is expected to march into Western Europe and the UK; in the Moscow area, it was observed to move approximately 25 miles per year.

Science and the EAB: In the early deliberations on EAB, the primary goal was to eradicate the invasive pest from North America. As such, it sometimes appeared that politics drove the research. At the time, many of us recall government officials claiming that their decisions would be "science-based." As it turned out, that proclamation actually meant that they would adopt the science that supported their agenda. For example, some research "designed" to support this agenda showed that the EAB could be destroyed if ash trees were cut down and chipped to one inch or less. Subsequently, this "cut and chip" program was heralded as the only proven control method for EAB, thwarting other attempts to manage the EAB by other means. This expensive "cut and chip" program, also heralded as the procedure for eradication of EAB from North America, proved to be a failure after my research demonstrated the EAB could survive the chipping process. Furthermore, I discovered that that the EAB was actually being disseminated in the chips! The early "science" also suggested that the EAB would only move about one-half mile, while we now know that it can actually move much farther by its own means. There are many other examples, but in the case of EAB, science has not been the hallmark that we would normally expect.

Play it Again Sam: In the mid-2000s and later, it was very interesting to witness reactions by state officials and scientists in other states as the EAB began to show up there. In essence, the same procedures, "cut and chip is the only proven control" and "insecticides don't work," became the mantra. Some of this exclusion of rational science represented attempts to continue receiving federal funding. In fact, some of us in Michigan were told (!) not to tell residents in other states that the cut and chip program was a failure and that ash trees could actually be saved by insecticidal treatments. Even after federal funding dried up, other states proposed state-sponsored cut and chip programs until the futility of the exercise was finally realized.

Photo 3: A clique of scientists have been proclaiming for years that Arborsystems Wedgle and Pointer insecticide cannot save ash trees from EAB attack. This is the oldest EAB management test site in the world, located near Plymouth Michigan. The Pointer treatments were initiated by Mark Baldwin of Mark Baldwin and Associates and thereafter assumed by the author and cooperators. Photo was taken in 2012.

Photo 4: The EAB seems to initially prefer certain ash trees over other ash trees. While the tree on the right appears unaffected, it eventually succumbed.

Management of EAB: Because of the failure of the "cut and chip" program to eradicate EAB from North America, we were left to save individual trees and slow EAB progress by whatever means. There have been great strides in the area of EAB management, particularly with insecticides. Several delivery methods have proven to be effective: foliar and trunk sprays, trunk injections and soil treatments. For a summary of these methods, please review the article "The Emerald Ash Borer, The Plant Doctor's Landscape Tips," January 2009, *The Landsculptor*, which I believe is still relevant. Along with various traditional techniques, scientists at the USDA and various Universities have pursued the possibility of EAB management by predators, parasites and diseases of EAB. Interestingly, one of the most early noticed predators of EAB were wood peckers (Hairy, Downy, Red-Bellied), first noticed by the author during the winter of 2001-2002, on trees infested by borers, which in the spring of 2002 was subsequently identified as EAB. Various parasitoids, predators, and parasites have been found attacking the EAB in both the U.S. (native) and in China. It has been suggested by some individuals that the reason that the EAB is so destructive in the U.S is due to the lack of natural enemies of EAB here compared to China. Hence, a significant research effort is underway to collect potential enemies of EAB in China and bring them to the U.S. for release. Regardless of natural enemies here, we know that much of the difference in susceptibility between North American Ash and Asian ash is genetics (see below). It is perhaps somewhat disconcerting to me that we are releasing foreign "bugs" into the North American ecosystem. I hope I am wrong, but I can't foresee that natural enemies will ever reduce the populations of EAB to levels that preclude the need for insecticidal treatment (or other technology) to save native ash trees.

Still Controversy (after all these years): For whatever reason, and perhaps in relation to questionable science, there is one very controversial area still permeating throughout the EAB community. This controversy surrounds the use of trunk injections for EAB management. As the EAB advanced into new communities and states, I continue to receive queries about the efficacy of certain injection procedures. I was told many times that I was at the center of the controversy. Regrettably, a clique of scientists in the Midwest has become fairly adamant about their recommendations while scientific results I obtained and the field results of some arborist have been dismissed. This clique of scientists apparently feel the need to be "on the same page (agree)" whether the scientific results support their conclusions or not. Some false information was published on the emeraldashborer.info web site and in publications for years before finally being retracted by the clique. This is very confusing to many in the public domain who expect scientific integrity. As a University scientist, I remain committed to the value not to endorse any particular product or technique. As routinely stated, I believe many of the treatment methods can be effective if applied correctly (Photo 3). Still, one of the greatest challenges is treating ash trees before the EAB does extensive damage to the conductive tissues of the tree. There is a significant lag time between infestation and decline symptoms in ash trees. Various arborists and I have found that a variety of injection techniques can be effective. Whether treatments work or do not work is simply a matter of science.

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Photo 5: The EAB swept through this area over 10 years ago, killing virtually all ash trees not treated with insecticides. This lone ash tree appears immune to attack as of 2013 and may represent some potential for EAB-resistant *Fraxinus* in North America.

Photo 6: The typical overwintering pose of EAB larvae presumably helps it survive very cold winters.

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MICHIGAN GREEN INDUSTRY ASSOCIATION

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Treatment after EAB? Many have suggested that after the EAB has killed "all" ash trees and has moved through a region, we will be able to cease treatments for EAB on those trees that have been left behind. Hence, those remaining ash trees can live on into old age without threat from EAB. FALSE. At least from my own research and observations, there are significant EAB populations being maintained on ash sprouts from old trunks and on newly germinated trees (from seed) to maintain populations of EAB into the foreseeable future in many of these natural areas that had been previously devastated by EAB. We can even find populations of EAB on declining scrub ash seedlings and sprouts in the Canton area, which was believed by many to be near the epicenter of EAB release into North America and where my research disclosed the present of this invasive pest 12 years ago. Once treatments on surviving ash trees in these locales are discontinued, the EAB will pounce on any remaining untreated ash trees with a vengeance for food and survival.

Ash Resistance to EAB: It appears that all North American Fraxinus species are susceptible to the EAB. We know however from early studies that many Asian ash species are tolerant if not resistant to EAB. The susceptibility or resistance of ash species to EAB can be ascribed to something we might term "evolutionary coexistence." Those trees that have been exposed over millennia to the EAB have developed some measure of resistance while those species that have not been exposed are extremely susceptible. However, as the EAB advances through communities, ash trees are differentially affected (Photo 4). Some trees are apparently unaffected and initially presumed to be resistance. Invariably however, these "resistant" trees eventually succumb likely demonstrating a differentia preference by the EAB . One tree which I have been following resides in an overgrown pasture (Photo 5). The EAB was detected in the vicinity more than 10 years ago and has killed all surrounding trees that have not been treated. Thus far, this tree exhibits neither EAB attack nor any sort of decline.

EAB Survival: The Polar Vortex-induced record low temperatures have caused much discussion about survival of EAB this past winter. Apparently, there has been some evidence that these low temperatures may cause some demise in the population of EAB. Apparently, to prepare for cold temperatures, the EAB larvae (the overwintering stage) purge their guts of contents that may freeze and cause them harm. The larvae subsequently adopt a" V" pose, as is often witnessed when overwintering larvae are observed in bark in the spring (Photo 6). Even though cold temperatures may kill many larvae, the EAB is known to survive in Siberia. While many EAB larvae were undoubtedly killed this past winter, the survival of many along with their exponential reproductive rate will ensure we will have to contend with EAB for at least another twelve years.

Note: The author hopes to update his website this year. This website will include all of the historical perspective on the EAB, including the discovery, as well as many other topics and The Plant Doctor's Landscape Tips. (treedoctor.anr.msu.edu)

For more information, please feel free to email David Roberts at robertsd@msu.edu or contact a professional plant health care provider. The author, MSU and MGIA do not endorse any particular products. If using pesticides, be sure to read and follow label directions.