BEECH BARK DISEASE: 10+ YEARS AFTER TREATMENT

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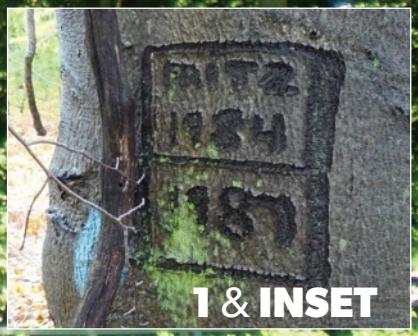
Dr. Roberts retired from Michigan State University in 2018 after committing four decades to advancing MSU's Land Grant Mission, originally signed into law by President Abraham Lincoln during the midst of the American Civil War. He has published hundreds of articles and has taught hundreds of lectures and workshops.

Dr. Roberts has researched many issues in Michigan's plant industry, including Oak Wilt, Dutch Elm Disease, Diplodia Tip Blight of Pines, along with a variety of cultural problems such as plant nutrition and herbicide toxicity. During his career, he has discovered a variety of new diseases and pests such as Phomopsis Canker of Spruce and the first bacterial wilt disease of turfgrasses in North America.

In the early 2000s, his research on Ash Decline in Southeast Michigan led to the discovery of the invasive Emerald Ash Borer in North America.

In his retirement, Dr. Roberts intends to remain active with the Arboriculture/Landscape/Nursery industries. Dr. Roberts is President, CEO and CBW (Chief Bottle Washer) of The Plant Doctor, LLC…aka The Tree Doctor.



1 & INSET

Introduction:

Beech trees (*Fagus*) contribute important diversity components to Michigan's forests and landscapes and serve a wide variety of functions (Photo 1 & inset). Threatening this valuable resource, Beech Bark Disease (BBD) is a lethal "disease" caused by a collaborative interaction between the introduced Beech Bark Scale (BBS=*Cryptococcus fagisuga*) (Photos 2 & 3) and several species of *Nectria* fungi (*Nectria coccinea var. faginata= Neonectria faginata; Nectria galligena=Neonectria ditissima;* possibly *Nectria ochroleuca*), at least two of which were also introduced into North America. Briefly, the BBD insect/disease cycles prescribe that extensive colonization of beech trees by the BBS (Photo 2) results in numerous injuries from their piercing-sucking mouthparts, predisposing trees to infection by the deadly *Nectria* fungi. Cankers formed by *Nectria* sp. eventually lead to decline and death of afflicted trees, also called "Beech Snap" (Photos 4A, 4B & 4C). The lethality of BBD and accompanying beech snap can have legal ramifications, particularly in public areas such as state parks and campgrounds. Because of the concern for beech tree structural failure is such locations, beech trees are sometimes preemptively removed.

BBD was first detected in Michigan in the Ludington area in the late 1990s and early 2000s. Scientists initiated research trials (insecticides and oil sprays, bark scrubbing, high pressure washing, etc.) to try to manage the disease. However, with the author's discovery of the Emerald Ash Borer (EAB) in 2002, research on BBD was largely abandoned by scientists who believed the EAB to be a more important issue in Michigan. Arborists in northern Michigan were clamoring for assistance in managing BBD as it continued to spread and destroy valuable, old landscape trees (Photo 5A). Hence, a collaborative research effort was initiated in 2007.

Experimental Design:

Our operating theory of BBD management was as follows. Because extensive bark colonization by high populations of BBS inevitably invites the deadly *Nectria* fungi to infect trees, preventing colonization of beech trees by the BBS, elimination of the BBS from trees already infested, or drastic reductions in the BBS populations should minimize the risk of *Nectria* infections and subsequent tree death. Preventing, eliminating or reducing BBS populations could prove useful because colonization of beech trees by the BBS may take years, especially in areas where BBD has already destroyed most beech trees and subsequent populations of BBS are low.

Woodland trees at a private landowner location were donated as the primary site for this research near Ludington, Michigan; the tree population was comprised of mature, tall forest (woodland) trees. Typical of woodland trees, there was no foliage or lower branches on the lower two-thirds of the trees. The primary site contained sufficient numbers of trees for three replications per treatment in a completely randomized design. Chemical treatments are summarized in Table 1. Treatments included sprays (340 psi) of Talus (SePRO-Insect Growth Regulator) and injections of various insecticides and fungicides with Arborsystem's Wedgle Direct Injection system. Treatments at the primary wooded site called for one application only of each of the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3


4A


4B


4C

1 Beech trees are prized in landscapes and forests for a variety of reasons (see Inset), especially serving as sources of valuable food for wildlife. Although beech trees are considered by many to be "thin barked", if you've ever cut through the bark, you'd find that they are rather thick-barked with a smooth surface.

2 High BBS infestations such as in this example eventually lead to *Nectria* canker development and tree structural failure known as "Beech Snap".

3 Often confused with BBD is the Woolly Beech Aphid, which poses little to no threat to beech trees. Of interest is that when the woolly aphid senses motion, the entire colony begins to "wave" in unison.

4A B&C *Nectria* infection of beech trees through BBS wounds starts as small cankers (4A) that gradually enlarge over time. High scale infestations and numerous small cankers cause formerly healthy beech trees to exhibit decline symptoms (4B): foliage discoloration, poor growth, early fall color, etc. A final chapter of the BBD complex, the expansion of *Nectria* cankers eventually leads to "beech snap" and tree death (4C).

treatment protocols; no repeated applications were made in succeeding years to try to determine whether BBS and hence BBD could be managed long term by very minimalistic inputs. Beech trees in a landscape in the Ludington area (Photos 1 & 5B) and elsewhere were also treated using various methods but represented real-world arborists' treatment observations only (albeit anecdotal). Treatments at the primary site were applied only once in July 2007 while treatments at landscape sites were applied once or sometimes twice in succeeding years.

Tree sprays with Talus, an insect growth regulator reported to be particularly effective against scale insects, were performed by Gary Kuhlman, aka The Northern Michigan Tree Doctor (Photos 5A & 5B). I, Dr. Roberts, operated as "Head Supervisor". It should be noted that the tree sprays were essentially trunk sprays because all treated trees were so tall that no lower branches or foliage could be reached with the sprays (Photo 1). It should also be noted that the trunk sprays were put on with great force and volume because we wanted the best chance of success with what might be regarded by some as "overtreatment", literally soaking the tree with Talus and blasting the scale from the bark of the tree (Photo 5B). The volume of spray material often collected at the base of the tree is what might be described as a "drench". All trunk injections were performed with Arborsystems' Wedgle by Dan Banks of Banner Sales & Consulting. All trees in this study exhibited scale infestations, although at somewhat varied population levels.

Information and observations were collected every year at all sites. The study was concluded in 2018, 11 years after it was initiated.

Results:

Our first observations within a couple of months after treatment in July 2007 disclosed some interesting information. The trunk injections using Talus Injectable (an experimental compound made by Chip Doolittle at Arborsystems, Inc.) or Whippet were immediately deemed unacceptable because of the large wounds that developed at the injection sites (Photo 6A). These wounds remained quite visible for the next 11 years (Photos 6B & 6C) even though by 2018, they had healed over nicely (Photo 6C). While it might be concluded that the Wedgle injection system was responsible

TABLE 1: Beech Bark Disease Treatments*

TRADE NAME	CHEMICAL NAME	SUPPLIER
Talus	Buprofezin	SePRO
Whippet	Phosphoric Acid	Banner/Arborsystems
Pointer	Imidacloprid	Banner/Arborsystems
Talus Injectable	Buprofezin	SePRO/Arborsystems

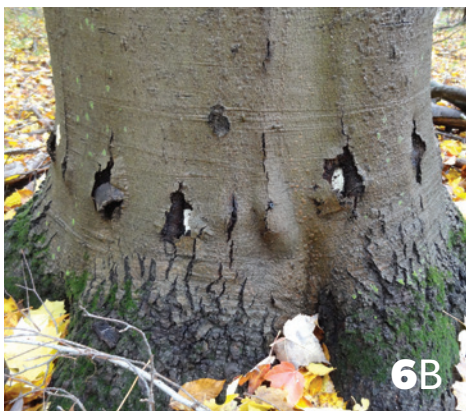
***Two Locations; Three Replicates per Treatment; Treatments applied July 17, 2007**

5A &B Gary and Megan Kuhlman operated The Northern Michigan Tree Doctor business (5A). They kept the tree in Photo 1 alive by utilization of trunk injections with imidacloprid long after many beech trees succumbed to BBD. Nevertheless, they felt they needed some help in combating the lethal BBD threat. They were an integral part of the research disclosed in this publication. In 5B, Gary is applying Talus to the trunk of this landscape tree. He tended to "blast' the scale from the trunk with a "firehose" spray of Talus. Whether woodland or landscape tree, the spray treatment only reached the lower half of the trunks of these large beech trees.

6A In this photo, this beech tree was trunk injected with "Injectable Talus" formulated by Chip Doolittle at Arborsystems, Inc. Unfortunately, this concoction turned to a "flowable latex" upon injection. These injection sites left large, ugly welts in the bark of the trees. Note the dribbling of injectable Talus from the injection sites within hours after injection. Oh well, it's back to the drawing board for Chip to work his formulation magic.

6B Five years after injection with Whippet or Injectable Talus, large sores remained. These wounds were deemed unacceptable from both aesthetic and practical standpoints. Such slow-healing sores could serve as avenues of entry by various diseases and pests.

6C Eleven years after injection with Whippet or Injectable Talus, the sores had largely healed over very nicely…thank you.



for these wounds, that conclusion was apparently not the case. Wherever imidacloprid (Pointer) was injected by Wedgle, there were no visible signs of trunk injury whatsoever (Photo 7). Hence, it appeared that chemical components (or carriers) in both Whippet and Talus injectable were phytotoxic to plant tissue at the injection sites. With the Imidacloprid treatments, wedge checks could still be found five years after treatment (Photo 7); a couple of wedge checks were even found "floating" on the bark 11 years after treatment (but no damage was apparent).

Five Years after Treatment: We were excited with the success of two treatments (see Table 2), Talus sprays and Pointer trunk injections, both of which seemed to provide protection for five years from one treatment in 2007. The Talus-treated trees were completely clean of scale infestations five years after treatment (Photo 8). The Imidacloprid (Pointer) treated trees were largely free of scale infestations, except that an occasional but very sparse incidence of BBS seemed to be reestablishing themselves on the bark. The trunk injections with Talus Injectable and Whippet still exhibited large welts at the injection sites (Photo 6B) five years after treatment. All untreated control trees possessed high populations of scale, but no significant beech snap was observed during the five years after the study had been initiated (Photo 9). Because of concern for beech snap, which was widespread in the Ludington area, the owners of the landscape sites had all of their beech trees removed. The beech forest location remained intact.

11 Years After Treatment: The two treatments that exhibited the most efficacious control five years after treatment also exhibited the best control 10 and 11 years after treatment. By years 10 and 11, BBS was starting to sparsely recolonize some of the tree replicates (Photo 10). Although the nasty appearing wounds created by the Talus Injectable and Whippet in 2007 were still visible, they were healing over very nicely 11 years after treatment (Photo 6C). It was interesting that all treated trees in the study (even the trees with unacceptable injection injury) exhibited full, healthy canopies (Photo 11). All untreated control trees had succumbed to beech snap by year 11 after the experiment had been initiated (Photo 12).

Biological Control: During my visit to assess the study in August 2018, small beetles and their larvae were noted on trees with scale infestations (Photos 10, 13A & 13B). The adults were scurrying around as though they were chasing after something. Likely, they were chasing and feeding on the small, inconspicuous BBS crawlers. It is highly unlikely that the beetle populations can keep up with the exponential scale population increase, but the activity was a joy to watch, nonetheless.

TABLE 2: Management of Beech Bark Disease 5 & 11 Years After Treatment

TREATMENT	TREATMENT DESCRIPTION	RESULT
1	Talus Spray	Excellent
2	Pointer	Exc/Very Good
3	Talus Inj + Whippet	Unacceptable
4	Pointer + Whippet	Unacceptable
5	Talus Spr + Inj + Whip	Unacceptable
6	Untreated Control	No Control

7 Whenever Pointer was used in the Wedgle Direct Injection system, there was no evidence of damage whatsoever to the bark of the trees. This Photo was taken five years after injection. A couple of wedge checks could even be found "floating" on the bark 11 years after injection.

8 In 2012, all Talus-treated trees were scale free five years after treatment. This photo was taken in 2015 of a Talus-treated beech tree, showing promise of control of BBS even eight years after treatment.

9 On untreated control trees, the scale populations continued to increase every year. By 2012 (Year Five of the Study), the populations on these trees were significant but no major "beech snap" was observed (some limb breakage was observed).

10 By year 11, BBS started appearing in sparse but higher populations on Talus and Pointer trees. Note the dark objects among the scale; these are tiny beetles and larvae feeding on the scale insects (also see Photos 13 A & 13B).

11 Regardless of the treatment used in this study (except for untreated control trees), all trees exhibited full, healthy, vibrant canopies, even into year 11.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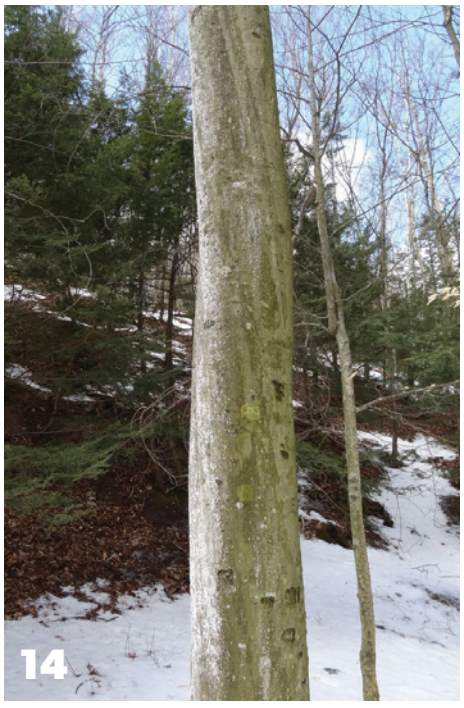
13A

13B



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12 By year 11, all untreated control trees had succumbed to beech snap from the unchecked scale populations and subsequent infection by *Nectria* fungi.

13A &B An adult beetle (A) and immature (B) were witnessed amongst the scale infestations (see Photo 9). The beetles were apparently feeding on the scale crawlers and represent a natural biological control phenomenon. The adults were sometimes observed scurrying around as if chasing their prey.

14 Gary & Megan Kuhlman included the Talus treatments into their regimen of business practices soon after initiation of our study in Ludington in 2007. They had already been using Pointer/Injections with fairly good success. At this site near Leland, Michigan, several beech trees to the right of the tree in this photo had been sprayed with Talus the previous summer. Please note that a slight spray drift from the nearby treated trees apparently destroyed the scale population on the right side of the trunk of this tree in the photo.

Discussion:

Our primary theory to managing the BBD complex is to maintain scale populations at very low or nonexistent levels. Low or no scale populations should minimize/prevent attack by the deadly *Nectria* fungi, which eventually kill beech trees and cause beech snap. We were more than surprised at the efficacy of scale control achieved and the longevity of the inhibitions of scale populations in this study by the Talus treatments and Pointer (imidacloprid) trunk injections. A conclusion reached in this study is that the Talus must be systemic, even though the manufacturers do not advertise this characteristic. When the spray treatments of Talus were applied in 2007, the application could reach only about halfway up the trunks of these large trees, whether in the forest or landscape (Photo 5B); the sprays never reached lateral branches or foliage. Yet, the scale populations appeared to have been cleaned out over the entire tree soon after the treatments were applied. The Pointer trunk injections seemed to perform in a similar manner. I am unaware whether beech trees tend to root-graft with one another, but it is possible that treated trees within root graft range might have shared the chemical treatments (there was no evidence of this phenomenon with the untreated controls because they were generally located greater distances from treated trees to prevent spray drift, etc.). Explained differently, trees that were trunk-injected with imidacloprid might also have received some Talus through root grafts, and vice versa. Because of the initial five-year results, several arborists in the BBD-infested areas of Northern Michigan have adopted the Talus sprays and/or imidacloprid injections into their programs. Some arborists have expressed mixed results with these treatments, but their application techniques might have been different than those we used in this study. Gary and Megan Kuhlman immediately adopted a treatment protocol for some of their customers and witnessed rather dramatic results like those we experienced in this research study (Photo 14). Based upon the results we obtained in this 11-year study, I think that it might be possible to obtain at least 8-10 years of reasonable control of BBD with one good treatment.

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