SYMPOSIUM NOTES

The Status of Beech Bark Disease in Northern Hardwood Forests:

A research update from the Beech Bark Disease Symposium of 2004

By JENNIFER A. LUCAS, CELIA A. EVANS, MARK J. TWERY

Abstract

*Since the 1996 article about Beech Bark Disease in Adirondack forests by Dick Sage appeared in AJES, we have gained some valuable information about effects of the disease on forest structure and wildlife. However, a lack of public awareness and research funding have limited the progress in understanding factors affecting spread and severity of the disease, mechanisms of disease resistance, and the future demographics of American beech (*Fagus grandifolia*) in our forests. This paper reviews some of the research findings with respect to the effect of the invasive disease complex on forest structure and composition and wildlife populations. We present outcomes of recent research on disease resistance and discuss the application of all this information to silviculture and forest management. We draw heavily on research presented at the Beech Bark Disease Symposium held in Saranac Lake in June 2004. Our hope is to raise awareness about the great impact the disease has already had, and the continued impact it is likely to have in the future as it persists in long affected forests and spreads throughout the range of this stately tree.*

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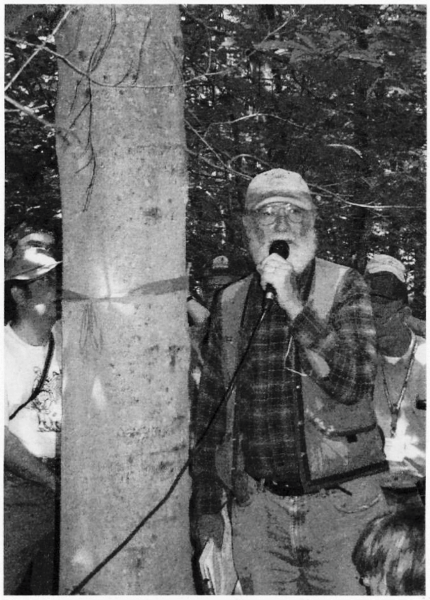

MATT AYRES

*Dr. Dave Houston. BBD expert, discusses the concept of 'resistance' to BBD. This beech has remained relatively healthy though there is evidence now of the beech scale (*Cryptococcus fagisuga*) on the bark.*

In 1996 Dick Sage, then coordinator of the Adirondack Ecological Center at Huntington Forest and local expert on beech bark disease (BBD) in Adirondack forests, wrote an article for this journal on the impact of the disease on Adirondack forests (Sage 1996). In the 9 years since that article appeared we have gained a better understanding of the influence of the disease on the structure of northern hardwood forests (Houston 2005, Cogbill 2005) and the realized and potential impacts on co-occurring plant communities and wildlife populations (Costello 1992, Hane 2005, Kearney et al. 2005, Storer et al. 2005, and Jakubas 2005, and others). However, compared to other threats to Adirondack forests, our knowledge of factors that influence disease severity and spread, disease resistance, and our progress toward applied management options is still inadequate. At the end of his article, which was intended, as this one is, to inform the Adirondack community about the effects of this invasive disease complex, Sage (1996) wrote, "*I find it hard to believe that a real impact of this magnitude has received so little recognition outside the scientific community.*" Unfortunately, not enough has changed, and, if funding for research is an indicator of recognition within the scientific community, the significant impact of BBD has not, in general, been recognized there either.

In June of 2004, the USDA Forest Service sponsored a three-day symposium on BBD in Saranac Lake, N.Y. The symposium had multiple purposes – to compile current knowledge, to introduce people working on similar aspects of the system in different geographic areas, and to generate information that could be used to develop a new research agenda. The primary topics were: biogeography of beech; effects of BBD on structure and composition of forests and wildlife populations; genetics of the disease and the genetics of disease resistance; the value of modeling the disease system; and silvicultural and management implications. Following research presentations and discussion, the participants broke into small groups to identify knowledge gaps and research needs for each of the topics. The symposium attracted nearly 100 registrants, which demonstrated an overdue resurgence of interest in the science and management of beech bark

disease. This article will be a reminder and update about the status of the disease since the 1996 article and we will draw heavily on the information presented and discussed at the symposium and presented in the USDA published proceedings from that meeting.

Introduced into Nova Scotia around 1890, BBD has moved through the Northeastern United States infecting American beech (*Fagus grandifolia* Ehrh.) trees as far south as the Great Smoky Mountains (Wiggins et al. 2001) and as far west as Michigan (O'Brien et al. 2001). Diseased forests in the Adirondack Park and much of New England and Maine are in the "aftermath" stage of BBD infestation (Shigo 1972, Houston 2005). In the aftermath stage, large beech are mostly absent and smaller trees (both root sprouts and mature) often continue to succumb to the disease (Shigo 1972, Houston 1975, Grove and Houston 1996). Research in these forests has documented large increases in coarse woody debris and gap formation in relation to beech mortality. McGee (2000) reported that the disease-killed trees accounted for approximately 22% of coarse woody debris in Adirondack northern hardwood forests. A study in central New York reported that beech trees made up 52% of the gaps in the northern hardwood forest while they represented only 26% of the canopy trees (Krasny and Whitmore 1992). In New Hampshire forests, growth of severely infected trees was reduced by 40% relative to healthy beech trees (Gavin and Peart 1993). Several studies have now shown that sugar maple (*Acer saccharum*) regeneration (and sometimes other co-occurring species) is reduced in highly diseased stands (Hane 2003, Hane 2005, McNulty and Masters 2005, and Kearny et al. 2005). At Huntington Forest in Newcomb, N.Y., gaps in the canopy from downed beech have contributed to an increase in the shrub layer dominated by witch hobble (*Viburnum alnifolium*) and beech saplings (McNulty and Masters 2005).

Sage (1996) reported that BBD-induced mortality was greatest in trees with diameter at breast height (dbh) of 16 inches (41 cm) or greater, but that 90% of trees with dbh greater than 6 inches (15.2 cm) showed some evidence of disease. In a continuation of that research, McNulty and Masters (2005) observed an increased infestation of the scale insect and/or the fungus on smaller beech since 1989. In order to project the impacts of BBD into the future, scientists will need to know how the populations of disease-causing agents are responding to changes in size of available host trees.

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The symptoms of beech scale (white spots) and Nectria *fruiting bodies (small brick-red spots) are seen here together along with the 'tarry spots' indicative of the fungal infection.*

Changes in forest structure and composition raise big questions about the impact of the disease on wildlife species that are dependent upon beechnut production. In northeastern forests beechnuts are essential for black bears' (*Ursus americana*) overwintering and reproduction rates. Jakubas et al. (2005) studied the relationship between beechnut availability, female reproduction age, and birth years in the Northeast and determined that proportions of reproducing females in forested areas that contained a high density of beech increased in years following a good beech mast crop. Marten (*Martes americana*) populations have been observed to have an inverse relationship to alternate year beech mast (Jakubas et al. 2005). The changes in overall forest structure may actually benefit some wildlife species. Storer et al. (2005) suggest that the presence of more standing dead beech may increase woodpecker populations and down beech may increase salamander populations in forests. Petrillo and Witter (2005) also observed an increase of insect populations, particularly arthropods, in the presence of down beech. Yet, the loss of a species such as beech may affect other species, especially birds, because a shift of forest canopy structure can influence nesting and foraging (Storer et al. 2005).

Costello (1992) reported a significant decline in beechnut production by individual trees when 25% or more of the canopy was dead. At Huntington forest, McNulty and Masters (2005) found that despite smaller trees being infected and decreasing numbers of beech over 25 cm, overall mast yields were greater between 1994 and 2003 than between 1988 and 1993. This increase may have been due to the many smaller beech in the aftermath forest just reaching reproductive maturity in those years (McNulty and Masters, 2005). One other possibility that could be examined is that in response to moderate levels of BBD infection trees may increase their beechnut production since increased reproductive investment has been shown to be a relatively common response to physiological stress (Hagen et al. 2003). Based on the limited information presented here, it is clear that the relationship between BBD progression and the abundance of beechnuts within a forest is complex and likely to be non-linear, and it is critical to our understanding of future impacts on wildlife.

Genetic variation in beech has been shown to influence the severity of the disease (Krabel and Petercord 2000,

Houston and Houston 2000), thus being able to identify and propagate resistant trees is important for developing restoration strategies (Koch and Carey 2005, Loo et al. 2005). Recent evidence shows higher nitrogen content in bark correlates with greater scale infestation (Wargo1988, Latty et al. 2003) which suggests that bark nitrogen content may explain some resistance to scale infestation. Variability in bark N-concentration may be genetically based (D.R. Houston, pers. comm.). Researchers working on the propagation of resistant beech report that root cuttings and bud segments consistently die when they overwinter (Koch and Carey 2005, Loo, et al. 2005). Loo et al. (2005) found that grafting of specimens has been more successful. Exactly which genetic indicators specify whether a beech is susceptible or resistant to the disease is not yet known, but may be essential for determining which trees should be kept in a managed forest for timber purposes. The only current way to determine whether a tree is resistant is a method developed by D.R. Houston (USDA Forest Service, retired) which requires scoring the bark, intentionally subjecting the tree with the scale insect eggs and then waiting for a year to observe how the tree reacted (Koch and Carey 2005). This method is time consuming and provides no information about the genetic mechanism of resistance.

Managers are extremely challenged by the persistence of the disease and have little scientific information regarding the current status of the disease complex that will aid in building management strategies for the future. Beech is a desirable species in that it provides the primary source of hard mast in the northern hardwood forest. It has often been discriminated against by managers focused on timber value, because it is slow growing, is hard to dry for lumber, and takes up considerable growing space while shading out more valuable timber trees. At first, shortsighted managers thought BBD would solve their "beech problem" by removing the beech, but in many cases it has done just the opposite. The challenges of managing BBD differ between those forests in the aftermath zone and those in the advancing front. Where BBD has not reached yet, there remains the question of salvaging large beech trees before they lose value from death or disfiguration. Where BBD has already killed many of the large beech, managing the residual forest with many root suckers of susceptible stock is difficult. Maintaining enough beech to provide mast for wildlife is a primary goal for many managers, as is simply maintaining an important native tree species. Straightforward management practices such as removing hazard trees and discouraging spread of logs from inside to outside infested areas are in general use (Heyd 2005). Before arrival of BBD, Heyd (2005) also recommends reducing the proportion of beech in a stand, maintaining a moderate level of stocking under 100 sq. ft. per acre, and favoring retention of smooth-barked, fast-growing trees. Once BBD has reached an area, retention of any trees that appear to be resistant to the scale and management to reduce damage to root systems may also help reduce the long-term impact. In aftermath zones, Ostrofsky (2005) has recommended intermediate stand treatments to reduce the proportion of beech by methods that treat individual stems, such as herbicide or heat treatment. Leaving only resistant beech in otherwise clearcut blocks tends to be unsuccessful, because the trees often succumb to exposure.


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This standing dead beech shows heavy evidence of historical Nectria *fungus damage.*

Many challenges in beech management remain for future examination. As new knowledge of the complex is developed, further understanding of how to maintain beech in the northern hardwood forest will be gained. We hope that the next article, rather than lamenting a lack of concern, understanding and resources with which to battle BBD, will share the great successes that research breakthroughs have made possible for managing this invasive disease complex.

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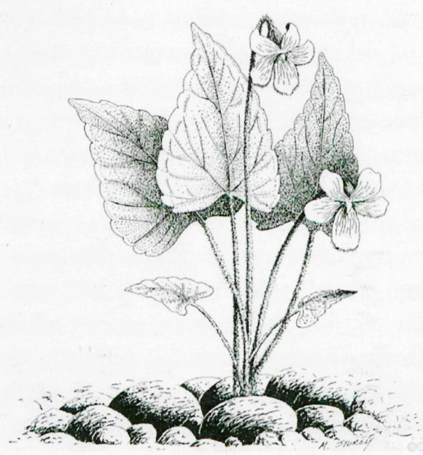

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