



Mortality of Great Rhododendron (*Rhododendron maximum*) in Virginia

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Introduction

Since 2015 Extension specialists from Virginia Tech have visited and collected plant and soil samples from several large areas of dying great rhododendron (*Rhododendron maximum*) in Virginia's mountainous regions (figs. 1-3). In 2016 Virginia Tech specialists met with personnel from the Virginia Department of Forestry and the U.S. Forest Service, as well as other experts, to revisit some of these sites. No consistent cause of this mortality has yet been identified. It is possible that a variety of factors are stressing the rhododendrons in these areas to a point where opportunistic pathogens or insects can successfully attack and kill them. The following information summarizes our observations and diagnostic results from four separate great rhododendron mortality sites in Virginia. This information is not equivalent to a research study, which would also include samples taken from healthy great rhododendron for comparison; however, we are confident that we have ruled out two diseases that are frequently mentioned both online and anecdotally as a cause of this mortality, specifically *Phytophthora* root rot and *Botryosphaeria* dieback.



Figure 1: Great rhododendron (*R. maximum*) in bloom. (Photo by Dow Gardens, Bugwood.org)



Figure 2: A symptomatic great rhododendron (*R. maximum*; right) next to a healthy great rhododendron (left) along the Blue Ridge Parkway. (Photo by Mary Ann Hansen)



Figure 3: Dead great rhododendron (*R. maximum*) in the forest understory. (Photo by Elizabeth Bush)

Great Rhododendron (*Rhododendron maximum*)

Great rhododendron is a common broadleaf evergreen plant found throughout Virginia's mountainous regions. It is a thicket-forming, understory shrub with iconic white or light pink flowers, most often found in moist and shady areas. Although this plant produces seeds, it typically spreads clonally by vegetative growth. It should not be confused with the Catawba rhododendron (*Rhododendron catawbiense*), which has smaller hairless leaves and lilac-purple flowers, and prefers locations with full or partial sun on rocky slopes and ridges.

History of Rhododendron Mortality in Virginia

Following queries from citizens regarding widespread mortality of rhododendrons along the Blue Ridge Parkway, Virginia Cooperative Extension specialists investigated several of these locations in Floyd and Patrick counties in 2015. Since then we have confirmed reports of widespread mortality of great rhododendron in Floyd, Albemarle, and Patrick counties, on both private and federal lands. Complaints of areas with similar symptoms have also been received by the Virginia Tech Plant Disease Clinic from Grayson, Carroll, and Augusta counties. Anecdotal information suggests that this mortality has been occurring on great rhododendron in multiple locations in the mountainous regions of Virginia for much longer. Outside Virginia, similar symptoms on great rhododendron have been reported in the Great Smoky Mountains National Park and the Nantahala National Forest since the 1980s (Baird et al. 2013, 2014).

Symptoms and Signs

Declining great rhododendron typically displays wilted foliage, reddish-brown discolored leaves, marginal leaf spots, thinning canopies, and dieback. Highly symptomatic or dead plants may also have discolored, stained, or water-soaked wood in lower stems or structural roots (fig. 4), insect emergence holes on affected stems, and/or white fungal mycelium under the bark near the base of the plant that is visible when bark is removed (fig. 5). Larger diameter (likely older) rhododendrons appear to be the main plants

affected. Impacted rhododendrons tend to be clustered, and mortality of great rhododendron can be extensive throughout a given location. No symptoms have been observed or reported on Catawba rhododendron, including Catawba rhododendron located near affected great rhododendron.



Figure 4: Cross-section of a symptomatic great rhododendron (*R. maximum*) stem with discolored, water-soaked wood. (Photo by Mary Ann Hansen)



Figure 5: A white mycelial mat of the fungus *Armillaria* spp. at the base of an excavated, symptomatic great rhododendron (*R. maximum*), visible after the bark was removed. (Photo courtesy of Stephen Fraedrich)

Causal Agent(s)

Overall, no single pathogen or pest has been identified that can completely account for the observed mortality. However, several opportunistic pathogens and pests have been recovered from affected plants. Results are summarized by category, as follows.

Fungi

Several different fungi were cultured from discolored

woody stem or root tissues of symptomatic plants collected by VCE personnel (*Xeromphalina campanella*, *Trichoderma tomentosum*, *Rigidoporus* sp., and *Phialocephala* sp.). Of these, only *Phialocephala* sp. was consistently recovered from plants at sites visited by VCE personnel; however, none of these fungi has ever been reported to be pathogenic on rhododendron. Although the fungus *Armillaria* was not observed on affected rhododendrons by VCE specialists, Ed Barnard and representatives of the U.S. Forest Service observed signs of *Armillaria* on declining great rhododendron plants in several locations in Virginia (Ed Barnard, personal communication). *Armillaria mellea* and *Armillaria gallica* (fungi that cause a disease commonly known as Armillaria root rot) were cultured from some of the samples they collected and identified by DNA sequencing (Stephen Fraedrich, Rabi Olatinwo, Mee-Sook Kim, and Ned Klopfenstein, personal communication). *Armillaria* is a fungal genus that causes root rot in woody plants, but it is typically considered an opportunistic pathogen or saprophyte following stress on hardwoods (Wargo and Shaw 1985). No bacteria or water molds (e.g., *Phytophthora* species) were recovered by culturing from roots or stems of affected rhododendron at any of the four sites. Both *Phytophthora* root rot and *Botryosphaeria* dieback, which are common diseases of rhododendron species, have been ruled out as possible causes of this decline based on multiple attempts to culture these plant pathogens from symptomatic tissues..

Insects

The black stem borer (*Xylosandrus germanus*), a small bark beetle (fig. 6), was collected from dead great rhododendron at one of the decline sites in Virginia; however, it was not consistently associated with declining rhododendron plants. This species is known to attack stressed woody plants as an opportunistic pest (Ranger et al. 2010).



Figure 6: Black stem borer (*Xylosandrus germanus*). (Photo by Pest and Diseases Image Library, Bugwood.org)

Nematodes

High numbers of plant parasitic ring nematodes (*Mesocriconema* [fig. 7], *Bakernema*, *Crossonema*, and *Xenocriconema* spp.) were consistently extracted from soil at great rhododendron decline sites in Virginia. Lower levels of root-knot (*Meloidogyne* sp.), spiral (*Helicotylenchus* sp.), pin (*Paratylenchus* sp.), lance (*Hoplolaimus* sp.), and a few other plant parasitic nematode genera were also found at some sites; however, we did not sample healthy sites in Virginia for comparison. High nematode populations (including ring, root-knot, spiral, and lance nematodes) were also found in the Great Smoky Mountains National Park study in both healthy and affected plots (Baird et al. 2013, 2014). Nematode population densities necessary to cause damage to rhododendron have not been established, so it is unclear what role nematodes may play in the observed mortality.



Figure 7: Ring nematode (*Mesocriconema* sp.) extracted from soil in the root zone of declining rhododendron plants. (Photo by Jon Eisenback)

Mammals

At two sites in Virginia, vole tunnels (fig. 8), likely of the woodland vole (*Microtus pinetorum*), were observed. The woodland vole spends the majority of its time below ground consuming fibrous plant roots, so it can be difficult to associate damage by woodland voles with plant decline. Rhododendrons are not usually a preferred food species, but when vole populations are high, they may spill into less desirable habitats. It is common for voles to feed heavily in one location and then move on to another area; hence, plant symptoms may not be evident until after voles are gone (Jim Parkhurst, personal communication). However, vole tunnels were not observed at all sites; therefore, we do not think voles are a primary factor in rhododendron mortality.



Figure 8: Vole tunnels near the base of a symptomatic great rhododendron (*R. maximum*). (Photo by Elizabeth Bush)

Site and Environmental Conditions

Soil samples were collected for pH testing at two of the symptomatic sites in Virginia; pH measurements ranged from 3.9 to 4.9, a range that is acceptable for great rhododendron. Nutrient analysis was not performed on these samples. Baird et al. (2013, 2014) tested soil nutrient levels at the sites they studied but reported no clear trends in nutrient availability with respect to great rhododendron mortality. However, Baird et al. (2013) did report an increase in dieback after several years of drought. The progression of decline with respect to weather conditions has not been investigated in Virginia.

Concluding Remarks

In the areas with high mortality of great rhododendron that we examined, we found no single factor that could definitively account for the symptoms observed. It is possible that the mortality is not caused by a single pathogen or pest, but is a result of a complex of abiotic and biotic factors (e.g., environmental stresses that predispose rhododendron to attack by opportunistic pathogens and/or pests). This would be similar to a disease complex called “oak decline,” in which long-term factors (e.g., age, climate changes, and site quality) and short-term factors (e.g., insect defoliation, drought, and frost) weaken oak trees and allow opportunistic insects and pathogens to invade and kill them. In areas with oak decline, crowding, older trees, and low species diversity are also factors that are associated with tree mortality (Oak 2005). A similar situation could be involved in the mortality of great rhododendron in the Appalachian Mountains in Virginia.

In the early 20th century, disturbances, such as logging and chestnut blight, and changes in forest management, including fire suppression, allowed great rhododendron to significantly expand its presence in the forest understory in many areas of the Appalachians (Baker and Van Leer 1998; Elliott and Vose 2012). As great rhododendron matures, it can suppress growth of other plant species, thus leading to a near monoculture of this species in the understory (Anderson 2008). In the areas we visited, great rhododendron was, in fact, the predominant understory species, and overall plant diversity was low. Although we did not determine the average age of the stands we visited, the age of one dead great rhododendron plant was estimated at 67 years, based on the number of annual rings; most great rhododendron plants in these stands had similar stem diameters. In a study conducted in the mountains of North Carolina, researchers found that great rhododendron can live up to 120 years, but the average age in areas favorable for growth was about 60 years (Elliott and Vose 2012). The land use history in the areas we visited may have led to a large cohort of similarly aged mature rhododendron in these locations (Ralph Lutts, personal communication).

Mature plants with extensive root systems place a high demand on available water and nutrients and may be more sensitive to periods of environmental stress. For example, in forest areas exhibiting oak decline, mature

oaks in crowded sites were more sensitive to moisture stress during drought and less able to recover when moisture was again abundant. The stressed oaks in these sites were more prone to attacks by opportunistic fungi, including *Armillaria* spp., and opportunistic insect pests (Clatterbuck 2006). Comparably, most of the dead and dying rhododendron plants we observed appeared to be mature or approaching maturity, with opportunistic insects and pathogens present in some of the sampled plants.

The mortality of great rhododendron along the Blue Ridge Parkway and other areas of Virginia's scenic mountainous regions is dramatic and can be alarming to those observing it for the first time. In the past the cause of these symptoms has been erroneously attributed to either Phytophthora root rot or Botryosphaeria dieback, two diseases that commonly cause dieback of rhododendron species in landscape settings. We have definitively ruled out both of these diseases as possible causes of the widespread mortality we observed: neither Phytophthora root rot nor Botryosphaeria dieback were found to be associated with any of the great rhododendron samples we collected at any of the sites. Our results support earlier findings from Baird et al.'s (2003 & 2004) extensive studies of rhododendron mortality in the Great Smoky Mountains in Tennessee and the Nantahala National Forest in North Carolina, as well as results from forest surveys conducted by the U.S. Forest Service from Virginia to Georgia in 2004-06 (Steve Oak, personal communication). We speculate that widespread mortality of great rhododendron in the mountainous regions of Virginia is due to environmental stress, followed by opportunistic pests and pathogens that attack stressed plants, rather than to one single primary pest or pathogen. Thus, we will likely continue to see decline in mature stands of great rhododendron in areas of the forest that experience prolonged periods of environmental stress.

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