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Western Oak Mistletoe (*Phoradendron villosum* subsp. *villosum*) on Non-native Urban Trees of Western Oregon

Running footer: Western Oak Mistletoe On Non-native Trees

3 Tables, 2 figures

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Abstract

Western oak mistletoe (*Phoradendron villosum* subsp. *villosum*) (WOM) occurs on native oaks (*Quercus* spp., Fagaceae) from Baja California, Mexico to the northern Willamette Valley, Oregon, USA. A variety of other native and non-native hardwoods within its native range are also hosts. We used the diverse urban forests of western Oregon (Salem, Corvallis, Eugene, Medford, Central Point, Rogue River, and Ashland) as a natural laboratory to investigate the host range of WOM and to assess the effects of WOM on tree health. During the leaf-off period of deciduous hardwood trees, we surveyed these urban forests for the occurrence of WOM in crowns of non-native trees. We collected data on tree species, tree size, height, mistletoe abundance, and tree condition. We observed WOM in 227 non-native trees, of which 85% were pin oak (*Q. palustris*) or northern red oak (*Q. rubra*), 12% were other oak species, and only 3% were individuals of non-oak species, despite the fact that non-oak genera represented from 81–96% of the urban trees in four cities with tree inventories. WOM tended to occur in larger trees which is consistent with the literature. We found no observable effects of mistletoe infestation on tree condition. The decision to manage WOM should involve oaks only, and depends on whether tree owners are concerned about potential negative effects of heavy infestations on tree health or desire increased biodiversity. Urban forest managers could also consider alternatives to red oak group species if WOM is abundant in the area.

Key points

- We surveyed the occurrence of western oak mistletoe on non-native urban trees to provide insight into major hosts and management.
- Western oak mistletoe occurs almost exclusively on *Quercus* species, especially pin, northern red, and scarlet oaks.
- Mistletoe plants tend to occur in larger trees, and we found no observable relationship between mistletoe infestation and tree condition.

Keywords: *Quercus*, western oak mistletoe, non-native tree hosts, urban forests

Introduction

Mistletoes are parasitic flowering plants that attach to the aboveground stems of trees and shrubs throughout forests and woodlands around the globe (Aukema 2003, Mathiasen et al. 2008). They obtain water and nutrients from the host via a haustorium (a root-like structure that penetrates the tree bark) and can have negative effects on tree health and form. The seed lacks a true seed coat, but in its place is a covering of viscin, a sticky substance that allows the seed to adhere to surfaces (Aukema 2003, Mathiasen et al. 2008). Mistletoes are most diverse in the tropics, but are common in many temperate forests and woodlands (Mathiasen et al. 2008). Western oak mistletoe (WOM, *Phoradendron villosum*, subspecies *villosum*), is a common mistletoe associated with native oaks (*Quercus* species) along the Pacific coast from the northern Willamette Valley in Oregon to northern Baja California in Mexico (Mathiasen 2021). The berries ripen in late fall or early winter and the seed is dispersed (vectored) by birds, especially the western bluebird (Grinnell and Storer 1924, Pritchard et al. 2017). The spatial patterns of bird dispersed mistletoes on the landscape are a result of bird movements after feeding, and mistletoe plants are consistently found to be spatially aggregated on the landscape and are most common in the largest individuals in the host population (Aukema 2003).

In natural forests and woodlands in Oregon and California, WOM occurs on all the oak species (Mathiasen and Kenaley 2016, Mathiasen 2021) and the California Flora (Jepson Flora Project 2025) notes WOM is, "generally on *Quercus* and rarely on *Adenostoma*, *Arctostaphylos*, *Cercocarpus ledifolius*, *Rhus*, and *Umbellularia*". Major oak hosts include Oregon white oak (*Q. garryana*), California black oak (*Q. kellogii*), blue oak (*Q. douglasii*), valley oak (*Q. lobata*), and coast live oak (*Q. agrifolia*). Thomson and Mahall (1983) studied the host specificity of WOM on blue oak, valley oak and coast live oak in central California where their ranges overlap. They found that trees with mistletoe tended to be larger than trees without mistletoe, there were strong geographic patterns in infection incidence for coast live oak, and mistletoe densities did not differ between hosts species implying WOM grows equally well on each host.

Western oak mistletoe is generally thought of as an oak mistletoe, however, the reported host range is quite broad and rare hosts include acacia (*Acacia*), alder (*Alnus*), aspen (*Populus tremuloides*), ash (*Fraxinus*), bay laurel (*Umbellularia californica*), birch (*Betula*), buckeye (*Aesculus*), ceanothus (*Ceanothus*), chinkapin (*Castanopsis*), chestnut (*Castanea*), locust (*Robinia*), pear (*Pyrus*), tanoak (*Notholithocarpus*), manzanita (*Arctostaphylos*), mountain mahogany (*Cercocarpus*), poplar (*Populus*), silver maple (*Acer saccharinum*), sumac (*Rhus*), sycamore (*Platanus*), walnut (*Juglans*), and willow (*Salix*) (Mathiasen 2021). There is no definitive host list for WOM, such as for *P. leucarpum* (Overlease and Overlease 2011), that we are aware of.

Western oak mistletoe is quite common in urban areas of western Oregon where it occurs on native Oregon white oak and California black oak. We have observed that WOM also occurs on non-native trees in urban areas. Urban forests are unique settings that allow for a wide assortment of potential hosts to be exposed to mistletoe seed. Assessments of mistletoe host range and potential for negative impacts on amenity trees are useful to urban forest managers for planning future tree planting and managing current tree populations (Thompson et al. 2008, Thompson 2014, Bilonozhko et al. 2025, Díaz-Limóna et al. 2016). In addition, some biologists suggest managing and maintaining mistletoe in urban areas to increase biodiversity and provide avian food resources (Watson et al. 2020, Watson et al. 2023, Hood et al. 2025).

We used the diverse urban forests of western Oregon cities as a natural laboratory to investigate the primary non-native hosts of *P. villosum* subsp. *villosum*. We asked, 1) What are the non-native tree hosts for WOM in urban forests of western Oregon? 2) Is there evidence of tree condition decline associated with WOM? This information is relevant to arborists and urban forest managers in Oregon and contributes to our understanding of an important parasitic plant.

As a taxonomic note; *Phoradendron villosum* subsp. *villosum* is lumped with eastern (American) mistletoe (*P. leucarpum*) by some systematists (Kuijt 2003) and is considered *P. leucarpum* subsp. *tomentosum* in the California Flora (Jepson Flora Project 2025), We do not agree with this treatment and follow Mathiasen and Kenaley 2016 and Mathiasen 2021.

Methods

During Winter leaf-off of deciduous trees, we surveyed for WOM by driving, walking, and biking city streets, parks, university campuses, and arboreta, attempting to visually examine all non-native tree crowns for the mistletoe plants. Every street in each city was not traveled, as we focused on areas that included trees. For example, although each city was generally grided into neighborhoods, we did not investigate industrial and manufacturing areas with few trees. We attempted to cover the entire city. When entering neighborhoods with trees, we traveled every other street and observed crowns of trees along city sidewalks and in yards. Parks, arboreta, and University campuses were walked. At least two people were present for all surveys. Cities in Oregon, USA included Salem, Corvallis, Eugene, Medford, Central Point, Rogue River, and Ashland. WOM does not occur in Portland. We collected data on tree species, tree size, height, mistletoe abundance, and tree condition for each non-native tree we observed with western oak mistletoe in the crown. We could not always visit the base of each tree due to property access limitations, so we used binoculars to observe trees and count mistletoe plants. Mistletoe abundance for each tree was grouped into three categories; 1= < 5 plants, 2 = 5–20 plants, 3 = > 20 plants. Tree size was estimated from trunk diameter at breast height (DBH, 1.4 m above ground) and grouped by size classes; 1 = < 10 cm, 2 = 10–50 cm, 3 = > 50 cm. Tree height was estimated and grouped into height classes; 1 = < 10 m, 2 = 10–20 m, 3 = > 20 m.

Tree condition was visually assessed based on the overall appearance of the tree and any indicators of poor condition. The purpose was to get a sense whether trees were declining due to WOM presence in their crowns. We rated each tree with one of three condition classes; 1 = poor, 2 = moderate, 3 = good. Trees were rated quickly based the overall look of the tree. Therefore, this data should not be considered quantitative, but a subjective, albeit educated, evaluation of tree condition. Indicators of poor condition include dead twigs and branches within the crown, branches that are dead distal to the mistletoe, bark cracks and peeling, epicormic branches along the main bole of the tree, and thinning crown. Dead branches shed bark and lichens, so can be detected in winter. Poor condition trees may have most of their crown dead or absent, while moderate condition trees had partial crown mortality, and good condition trees have minimal branch mortality.

Identification of oaks was done in the field, with a few foliage, twig, and acorn samples taken for confirmation. We searched for leaves and acorns under the tree, examined twig tips and bud scales, and used bark characteristics and crown form to identify host trees. We used several field guides (Mitchell and Wilkinson 1989, Stein et al. 2001, Sibley 2009) and web-based guides

(University of Wisconsin-Stephens Point, LEAF Winter Tree ID Key 2014. www.leafprogram.org; Oregon State University, Landscape Plants, https://landscapeplants.oregonstate.edu/) for assistance in identification. We did not identify and survey non-infected trees in all these cities due to the time and resources required for such an endeavor. However, we attempted to visually survey the canopy of all trees and then focused on the ones with mistletoe plants.

Potential Hosts in Urban Areas

We used the Oregon Department of Forestry Urban Forestry Tree Plotter Inventory tool (https://pg-cloud.com/Oregon/) for Corvallis, Eugene, Salem, and Medford to gain a perspective on the potential hosts that occur in these cities (Table 1). The other cities that we surveyed do not have available tree inventory data. *Quercus* species represented between 4 and 19 percent of the total trees in the inventories of these four cities, while *Acer* was most common in all cities and *Fraxinus*, *Prunus*, and *Pyrus* are also abundant. Using the Tree Plotter Inventory Tool, we were able to confirm that northern red oak and pin oak are the two most abundant non-native oak species in Eugene and Salem, and English oak, scarlet oak, Shumard oak (*Q. shumardii*) and swamp white oak (*Q. bicolor*) are also present. For Corvallis, we used the Corvallis Tree Database (https://corvallisor.treekeepersoftware.com/index.cfm?deviceWidth=1920) to determine that northern red oak is the most abundant non-native oak, followed by scarlet oak and then pin oak. Data was not available for the other cities we surveyed.

Results

We observed WOM in 227 non-native trees and 97% of these were *Quercus* species. Pin oak (*Q. palustris*), northern red oak (*Q. rubra*) (Figure 1), and scarlet oak (*Q. coccinea*) (Figure 2) were the most commonly infested non-native trees, representing 93% of all observations (Table 2). Four other species of *Quercus* had infestations; English oak (*Q. robur),* willow oak *(Q. phellos*), eastern white oak *(Q. alba),* and southern red oak *(Q. falcata)*. Only two non-oak tree species were documented with WOM; three European white birch (*Betula pendula*), and four silver maple (*Acer saccharinum*) representing 3% of the observations.

All size classes of trees were infested with WOM, and there was a tendency for larger trees to be infested no matter what the abundance of plants in the crown (Table 3). Only six of the 227 trees infested with WOM were < 10 cm in diameter and only nine were < 10 m tall (Figure 2). Only one infested tree was in poor condition, while 14 were in moderate condition, with 212 in apparently good condition. This may imply that WOM is not adversely impacting tree health at these levels of infestation. Of the 42 trees with >20 plants in their crowns, none were in poor condition, one was in moderate condition and 41 were in apparently good condition.

Discussion

Western oak mistletoe is aptly named, as it almost exclusively occurs on oak species. Although it has a broad reported host range (Mathiasen 2021), we only observed two non-oak species with mistletoe plants; European white birch and silver maple. Considering the abundance of other tree species in these cities (Table 1) and that *Quercus* species represent between 4-19% of the urban tree population, WOM apparently must have opportunity to infect these other tree species. Therefore, we conclude that WOM appears to be an oak specialist that rarely occurs on other tree species. We observed seven non-native oak species with mistletoe plants; the most commonly infested species were pin oak, northern red oak, and scarlet oak representing 93 percent of all observations. The high percentage of mistletoe infestation in pin oak, northern red oak, and scarlet oak could be due to their larger abundance compared to other non-native oaks.

Mistletoes tend to be most common and abundant in larger trees within cities (Bilonozhko et al. 2025, Díaz-Limóna et al. 2016, Hood et al. 2025) as well as in natural environments (Aukema 2003, Hood et al. 2025), and WOM is more likely to occur in larger native oak trees in Central California (Thompson and Mahall 1983). This is also the trend with WOM in non-native trees of urban western Oregon (Table 3). The trend for larger trees implies that birds foraging on WOM berries tend to remain in taller trees after feeding. McPherson (1987) studied cedar waxwing (*Bombycilla cedrorum* Vieillot, 1808) foraging on eastern mistletoe and found that when they feed on mistletoe berries, they remained locally until the berry resource was depleted.

Urban forests can be very diverse with many non-native trees, and for this reason they are useful for understanding the potential host range of invasive and native pests and pathogens (Paap et al. 2017, Augustinus et al. 2024). Of all the potential host species in urban western Oregon (Table 1), only oak species appear to be significant hosts. However, since taller trees are more likely to have mistletoe, and mistletoe is generally aggregated on the landscape (Thompson and Mahall 1983, Aukema 2002), it implies the birds fly to taller, nearby roosts after feeding. Therefore, an assumption that all trees had an equal likelihood of seed landing on them is probably not true because taller trees near existing infestations may be more likely to receive seed.

There is no evidence that trees were declining due to western oak mistletoe as most trees appeared in good condition. Koenig et al. (2018) assessed the effects of western oak mistletoe on several native California oak species using long-term monitoring plots and concluded there were negligible negative effects on trees. Their trees mostly had fewer than 20 WOM plants and they considered them moderately infested. It is generally thought that a heavy WOM infestation will eventually have a negative effect on tree condition (Mallams and Mathiasen 2010), while drought and heat stress have been observed to increase branch and whole-tree impacts of mistletoe in several other mistletoe-host systems (Sangüesa-Barreda et al. 2013, Bell et al. 2019, Kubov et al. 2020). The threshold for negative impacts is not well quantified for WOM in Oregon and California and therefore, quantitative ecophysiological studies across increasing abundance of WOM would help determine when mistletoe negatively affects a tree.

On the other hand, WOM may benefit wildlife in urban forests. In natural Oregon white oak in the Willamette Valley, Oregon, trees with abundant WOM were found to have increased bird diversity and abundance compared to lightly-infested trees during the breeding season, and during winter the mature fruits were an important food for western bluebirds (*Sialia mexicana*) and other wildlife (Pritchard et al. 2017). Hood et al. (2025) found that big-leaf mistletoe (*P. leucarpum* spp. *macrophyllum*, or *P. macropyllum* in Mathiasen 2021) had a significant positive effect on avian foraging patterns in urban and natural settings in Central California, especially for insectivorous gleaning birds.

Management

Management of WOM in the urban forests of western Oregon should focus on oaks, and depend on the objectives for growing trees in the urban areas. Future planting could consider the presence of existing oaks and the species selected for planting. Pin oak, northern red oak, and scarlet oak are all very susceptible as are native Oregon white oak and California black oak. Because WOM has the potential to increase in abundance within a tree crown and cause a decline in tree condition, some urban forest managers consider WOM a pest that needs to be managed (Hawksworth 1983, Shaw and Mathiasen 2013). Conversely, others see mistletoe in a positive light, as an adaptable native plant with the potential to increase urban biodiversity, especially for birds (Watson et al. 2020, Watson et al. 2023, Hood et al. 2025).

Management strategies to reduce the negative effects of WOM can include reducing the abundance of mistletoe plants by pruning the infected branches, breaking off the aerial shoots and wrapping the branch at the haustorium with plastic, removing heavily infested oak trees, and avoiding planting oak (Mallams and Mathiasen 2010, Shaw and Mathiasen 2013). If WOM is not seen as a threat, it could be managed to limit its overabundance, and allowed to occur in the urban environment (Hood et al. 2025). Based on our findings, WOM does not appear to be a major tree health issue for urban non-native oak trees in western Oregon, but we authors have seen native Oregon white oak trees that do appear to be declining from very heavy, long-term, infection by WOM. A nuanced approach to managing WOM could include leaving plants in native oak and tolerating low and moderate (< 30 plants in a crown) amounts of mistletoe in crowns of non-native oaks.

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Tables

Table 1. Top 10 most common genera of urban forest trees of four western Oregon cities, with inventories, that were surveyed in this study. (%) = percent of trees of the total in the inventory. Data from Oregon Department of Forestry Urban Forestry Tree Plotter Inventory tool (https://pg-cloud.com/Oregon/).

City			
Corvallis	Eugene	Salem	Medford
Acer (31%)	*Acer* (28%)	Acer (39%)	*Acer* (20%)
Fraxinus (12%)	*Quercus* (16%)	Quercus (13%)	*Quercus* (19%)
Prunus (8%)	*Fraxinus (14%)*	*Pyrus (10%)*	*Pinus (13%)*
Liquidambar (6%)	*Pseudotsuga* (12%)	*Fraxinus* (8%)	*Pyrus* (10%)
Pyrus (5%)	*Prunus* (9%)	Not Specified (8%)	*Fraxinus* (8%)
Quercus (4%)	*Pinus* (5%)	*Pseudotsuga* (5%)	Not Specified (7%)
Malus (2%)	Not Specified (5%)	*Prunus* (4%)	*Cedrus* (6%)
Platanus (2%)	*Liquidambar* (4%)	*Betula* (4%)	*Zelkova* (6%)
Gleditsia (2%)	*Betula* (4%)	*Liquidambar* (4%)	*Ulmus* (6%)
Tilia (2%)	*Crataegus* (3%)	*Tilia* (4%)	*Tilia* (5%)

Table 2. List of host tree species, total number of trees observed with WOM, and percent of total observations for each species of non-native trees with WOM in western Oregon urban forests.

Species	Total Number	Percent of Total
Oak (Quercus) species	220	97%
pin oak (Q. *palustris*)	106	46%
northern red oak (*Q. rubra*)	89	39%
scarlet oak (*Q. coccinea*)	18	8%
English oak (*Q. robur*)	2	1%
willow oak (*Q. phellos*)	2	1%
eastern white oak (*Q. alba*)	2	1%
southern red oak (*Q. falcata*)	1	< 1%
Non-oak species	7	3%
European white birch (*Betula pendula*)	3	1%
silver maple (*Acer saccharinum*)	4	2%

Table 3. Number of western oak mistletoe infested trees by abundance categories of plants in the crown versus diameter, height, and tree condition categories for the 227 trees detected with western oak mistletoe.

	Abundance in Crown		
Diameter	< 5 plants	5–20 plants	> 20 plants
< 10 cm	5	1	0
10–50 cm	23	21	10
> 50 cm	74	61	32
Height			
< 10 m	9	0	0
10–20 m	26	27	11
> 20 m	67	56	31
Tree Condition			
Poor	1	0	0
Moderate	7	6	1
Good	94	77	41

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Figure Captions

Figure 1. Western oak mistletoe in the crowns of northern red oaks (*Quercus rubra*) in urban western Oregon.

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Figure 2. Western oak mistletoe on young scarlet oak tree (*Quercus coccinia*). A) Close-up of plant (left). B. Environment setting (right).

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