An Update on New and Emerging Pests in the Pacific Northwest

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Abstract

Foresters and horticulturists should be aware of the risks of invasive species and should be updated on a regular basis regarding emerging pest threats. In the Pacific Northwest, many new potential threats to natural landscapes and forests have emerged. Recent detections include new species of whiteflies, lace bugs, sawflies, beetles, and earthworms. In addition to detections of new species, some are concerned about the expansion of host associations from prior-established exotic species. This article covers several emerging pest threats to forests, landscapes, and crops grown in the Pacific Northwest. This paper was presented at the joint annual meeting of the Western Forest and Conservation Nursery Association and the Intermountain Container Seedling Growers' Association (Troutdale, OR, September 14–15, 2016).

Introduction

Foresters and horticulturists responsible for the introduction of plants into natural landscapes play a vital role to reduce the risk of invasive species by awareness, prevention, and early detection of potentially damaging species. Invasive species awareness is a dynamic process, requiring frequent updates to keep current. Predictably, several new detections of exotic arthropods happen on an annual basis in the Pacific Northwest. In recent years, several emerging pests have caused concern given their potential to damage Pacific Northwest forests and natural landscapes. Among the recent detections are new species of whiteflies, lace bugs, sawflies, beetles, and earthworms. In addition to detections of new species, some are concerned about expansion of host associations from prior-established exotic species. In some cases, efforts are under way to mitigate establishment of these pests, and for those exotic species that have already become established, to reduce the damage from them. This article discusses several emerging pest issues of concern for landscapes, forests, and crops grown in the Pacific Northwest.

Ash Whitefly

Ash whitefly (*Siphoninus phillyreae* Haliday) was first detected in 2014 in southern Oregon near Medford, and later in Forest Grove, OR in the northern Willamette Valley. Ash whitefly is a small sucking insect that can cause excess honeydew and black-sooty mold on infested leaves and premature defoliation of host trees. Ash whitefly reached nuisance levels in the Portland metropolitan area in 2014 and 2015 when numerous, blizzard-like swarms of whitefly were seen at dusk searching for overwintering host plants in the late summer and fall. Evidence of feeding and reproduction of ash whitefly was found on several common host plants, including Oregon ash (*Fraxinus latifolia* Benth.), ornamental pears (*Pyrus calleryana* Decne.), hawthorn (*Crateagus* sp.), and flowering quince (*Chaenomeles* sp.). In Oregon, ash whitefly has been found to overwinter on the evergreen plant firethorn (*Pyracantha* sp.).

Ash whitefly adults have light yellow bodies and white wings. Their eggs are pale waxy yellow and usually surrounded by white powdery deposits. Young nymphs are nearly translucent but become more opaque as they age and increasingly covered with white waxy secretions. The pupae, or puparia, are very distinct (figure 1a). They are covered with tufts of white wax and have tubercules or long tubes formed around the edge of their bodies topped with clear waxy droplets (Rosetta 2016).

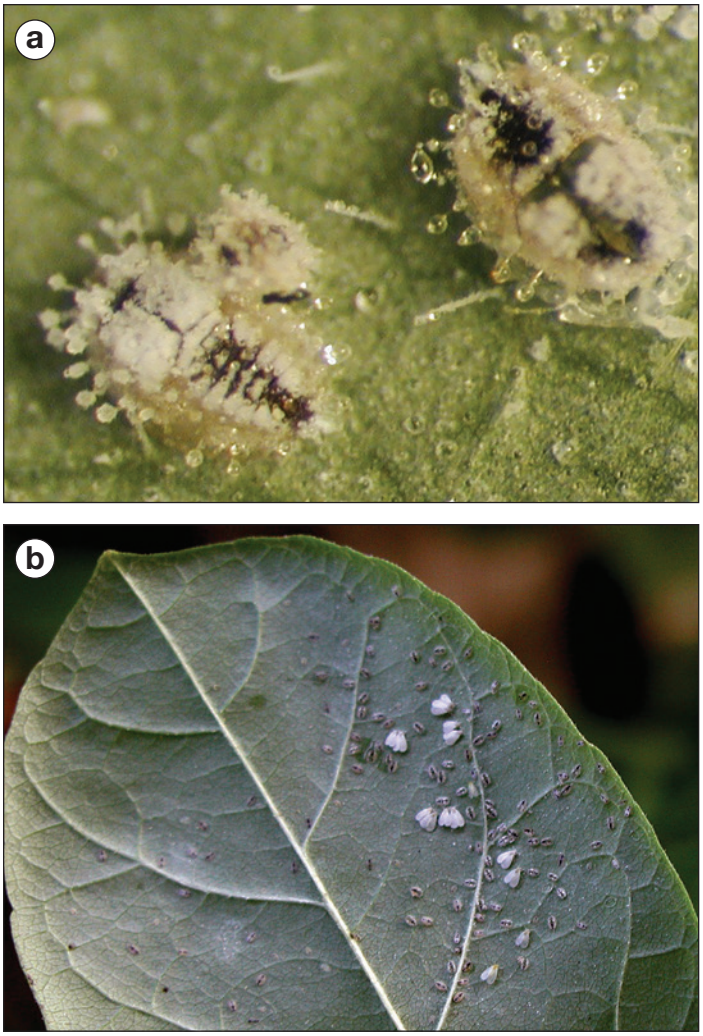

Figure 1. (a) Ash whitefly (*Siphoninus phillyreae* Haliday) puparia are covered with tufts of white wax and have tubercules or long tubes formed around the edge of their bodies topped with clear waxy droplets. (b) Oregon ash (*Fraxinus latifolia* Benth.) is a common host tree species for ash whitefly. (Photos by Robin Rosetta, 2015)

The adult female lives for about 30-60 days. They lay eggs on the undersides of the leaves on host plants. Nymphs emerge from the eggs, and that first "crawler" stage moves to a new site and settles onto the leaves where they remain and feed on the plant sap. They then pupate and later emerge as winged adults (figure 1b). Both the nymphs and adults can feed. The whiteflies can develop from egg to adult stage in 25 days at 25 °C (77 °F) (Bellows et al. 1990). Ash whitefly can develop continuously during the year with several generations per year; development slows with cooler temperatures. The whiteflies emigrate from preferred deciduous summer hosts, such as ash, pear, and hawthorn, to evergreen overwintering hosts in the fall. All stages of the whitefly can overwinter on evergreen host plants.

A classical biological control program was developed by the University of California, Riverside, soon after ash whitefly first appeared in California in 1988 (Bellows et al. 1992). That program was very successful and relied on activity of an imported parasitic wasp (*Encarsia inaron* Walker) and a lady beetle (*Clitostethus arcuatus* Rossi). The parasitic wasp, in particular, is credited with reducing populations of ash whitefly and thus their damage, from 98 percent of ash leaves infested in 1991 to less than 1 percent after establishment in 1992 (Driestadt and Flint 1995). Oregon Department of Agriculture staff detected both the parasitic wasp and the lady beetle in the fall of 2015. By the late summer of 2016, ash whitefly populations were noticeably diminished, and the parasitic wasp was found throughout the Willamette Valley (Hedstrom 2016).

Cabbage Whitefly

An Oregon State University (OSU) Master Gardener first detected cabbage whitefly (*Aleyrodes proletella* Linnaeus) in 2014 from a plant sample submitted from a Portland home garden that was confirmed by the Oregon Department of Agriculture. Named cabbage whitefly due to its preference for Brassicaceous plant hosts (*Brassica oleracea* L.), cabbage whitefly is more of a pest of curly kale (*Brassica oleracea* L. var. *sabellica* L.) (figure 2a) and Brussels sprouts (*Brassica oleracea* L var. *gemmifera* [DC.] Zenker), but less so of cabbage (*Brassica oleracea* L. var. *capitata*) (Trdan et al. 2003). Although it is best known as a pest of crucifers, it does have a wide host range, including sow thistle (*Sonchus* sp.) and other composite species, spurge (*Euphorbia* sp.) plants in the family Euphorbiaceae, columbine (*Aquilegia* sp.) in the family Ranunculaceae, greater celandine (*Chelidonium majus*) in the family Papaveraceae, greenhouse grown gerbera (*Gerbera jamesonii*) in the family Asteraceae (Loomans et al. 2002), and plants in the family Apiaceae (Martin 2015).

Cabbage whitefly is not known to transmit plant viruses. Most damage occurs directly from large numbers of adult and juvenile whitefly sucking on plant sap, producing copious honeydew, and the development of black sooty mold fungus, which feeds on the honeydew. Observations of populations on kale in the Portland metropolitan area have shown very high densities of these whiteflies with relatively little natural enemy suppression.

Adult cabbage whiteflies are small and white with two faint gray marks on their wings, which are held tent-like as they rest (figure 2b). Eggs are laid on

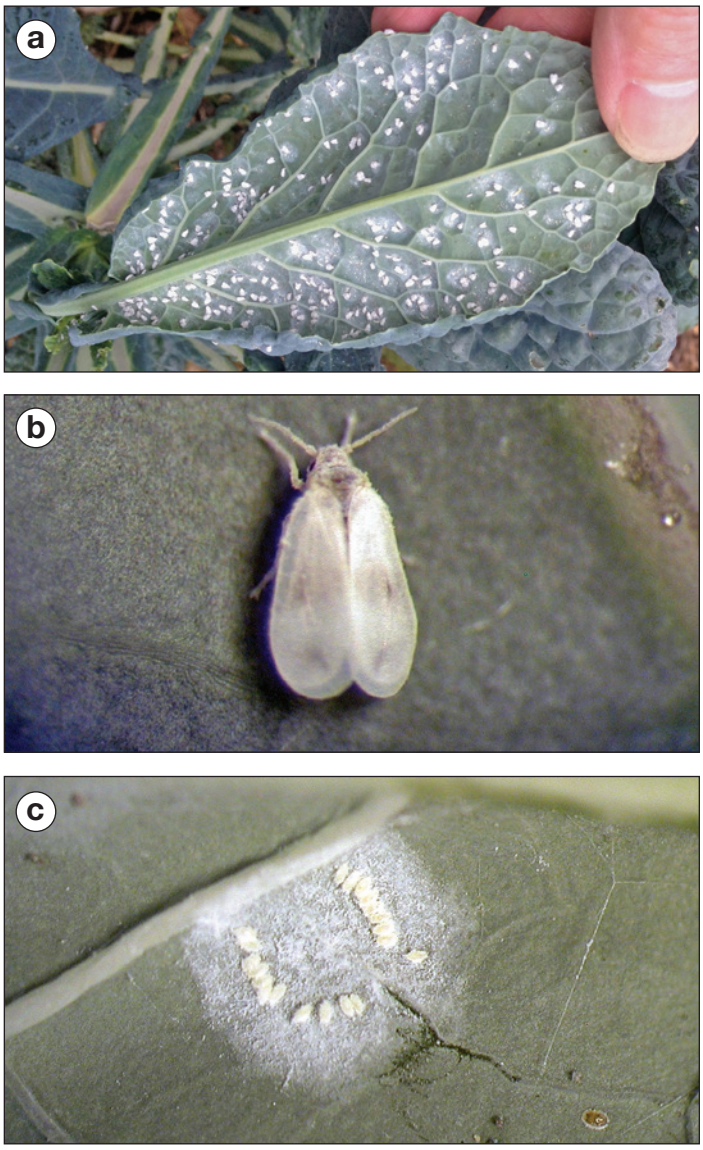

Figure 2. (a) Cabbage whitefly (*Aleyrodes proletella* Linnaeus) populations on kale in Oregon have shown very high densities. (b) Adults are small and white with two faint gray marks on their wings, which are held tent-like as they rest. (c) Eggs are laid on the leaf underside and often in a circle or semi-circle. (Photos by Robin Rosetta, 2016)

the underside of host leaves and often in a circle or semi-circle with noticeable white powdery deposits (figure 2c). The three nymphal stages are flat and oval. Depending on climate, there may be 2 to 6 generations per year depending on climate. Cabbage whiteflies overwinter on plant hosts (ODA 2015).

Cabbage whitefly has been found to be significantly resistant to pyrethroid insecticides in Great Britain, but no cross-resistance to neonicotinoid insecticides has been detected (Springate and Colvin 2011). At least nine species of parasitic wasps have been reared from cabbage whitefly, including commonly used biocontrol species such as *Encarsia formosa*, *E. inaron*, E. *perganiella*, and *Eretmocerus mundus*, but attempts to control cabbage whitefly with augmentative releases have been unsuccessful (Loomans et al. 2002).

Bandedwinged Whitefly

Bandedwinged whitefly (*Trialeurodes abutilonea* Haldeman; BWWF) was detected on sunflowers (*Helianthus* sp.) along Highway 84 near Biggs, OR, in 2015 (Vlach 2017). Limited information is available on the extent and damage so far from BWWF in Oregon. A reference from the University of Kentucky refers to BWWF as an "occasional pest" of greenhouse crops (White 2013), and Sanderson (2017) seems to concur stating that BWWF, "… is relatively rare; it is sometimes found on yellow sticky traps, though rarely on the crop."

In addition to its namesake host, flowering maple (*Abutilon* sp.), a number of other economic hosts exist: that is, approximately 140 host species in 33 plant families (Malumphy et al. 2011). Malumphy et al. (2011) list numerous commercially important ornamental hosts: *Acacia* sp., *Aster* sp., *Bidens* sp., *Brugmansia* sp., *Citrus* sp., *Eucalyptus* sp., *Euphorbia* sp., *Fuchsia* sp., *Hibiscus* sp., *Impatiens* sp., *Pelargonium* sp., *Petunia* sp., *Solidago* sp., and *Veronica* sp. In addition, they report finding BWWF on *Acacia* sp., *Banisteriopsis caapi*, and *Brugmansia* sp. plants imported to England from the United States. BWWF had previously been intercepted on *Hibiscus rosa-sinensis* var. 'Kopper King' plants imported from the United States in 2005. Their list of field and orchard hosts include: *Brassica* sp., *Citrus* sp., *Lactuca* sp., *Phaseolus* sp., and *Solanum* sp. They mention that BWWF has a "preference for feeding on plants belonging to the families Malvaceae and Solanaceae."

BWWF nymphs resemble greenhouse whitefly and are initially translucent but gradually show faint yellow markings (figure 3a). The pupal stage is helpful to distinguish this species from greenhouse whitefly, as it often has a dark longitudinal band down the center. The adult has white wings with two dark zigzag markings on the forewings (figure 3b).

Like most whiteflies, BWWF can damage plants through feeding, honeydew production, and the accompanying growth of black sooty mold. Malumphy et al. (2011) note the adults can vector four viruses: abutilon yellows virus, diodia vein chlorosis virus, sweet potato chlorotic stunt virus, and tomato chlorosis virus.

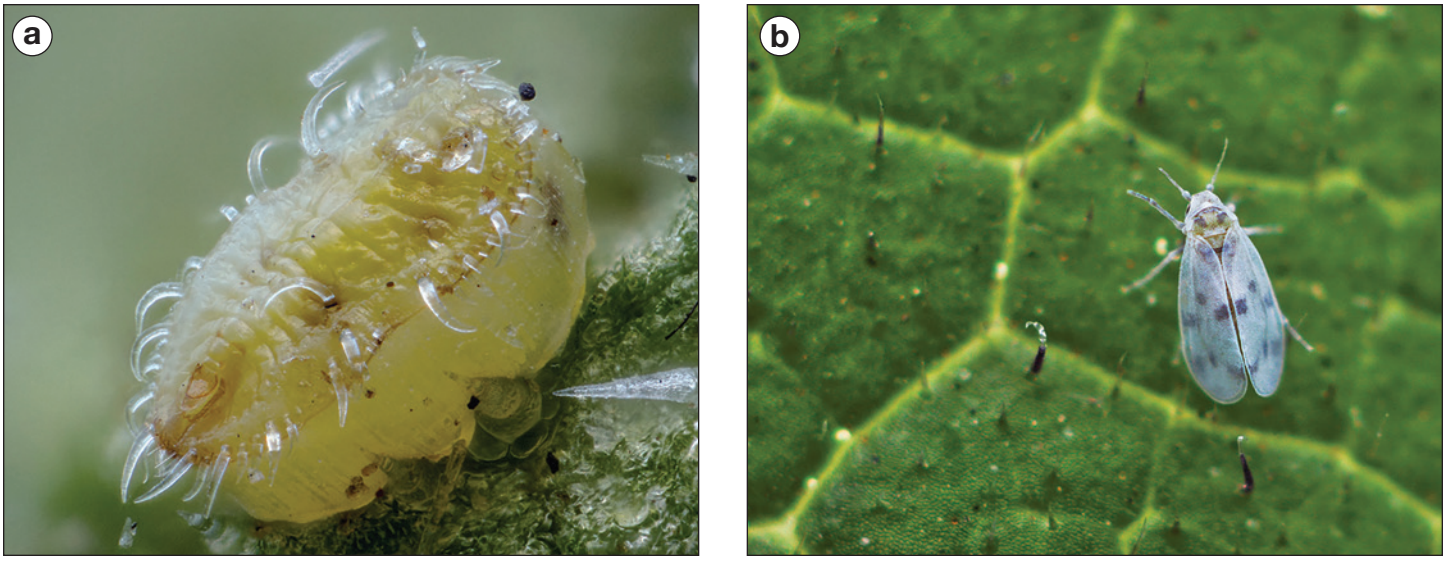

Figure 3. (a) Bandedwinged whitefly (*Trialeurodes abutilonea* Haldeman) pupae have a dark longitudinal band down the center. (b) Adults have white wings with two dark zigzag markings on the forewings. (Photos courtesy of Oregon Department of Agriculture, 2015)

Azalea Lace Bug

Azalea lace bug (*Stephanitis pyrioides* Scott) was officially confirmed in 2009 in Oregon. Since then, azalea lace bug distribution has expanded, and reports of damage are widespread, sometimes severe, to rhododendrons (*Rhododendron* sp.) and azaleas (*Azalea* sp.) in the North Willamette Valley. Soon after establishment, it became clear that azalea lace bug was damaging additional important plant genera, including evergreen huckleberry (*Vaccinium ovatum* Pursh) and salal (*Gaultheria shallon* Pursh) (figure 4a). The known host plants of this pest have expanded by over 20 plant species and three new plant families, based on natural observations and plant trials in Oregon (LaBonte and Valente 2014).

Azalea lace bug generally overwinters in the egg stage although adults can be found as well. The eggs are embedded in the leaf stem or tissue and covered over by a varnish-like coating of fecal material (figure 4b). Upon emergence, the immature lace bugs, or nymphs, are nearly translucent, changing to a light yellowish-green with early feeding. They darken with later molts and become spiny. Adult lace bugs are around 0.635 cm (0.25 in) long. Their wings are held flat and are covered with a network of veins. The wings are lightly colored with white and black patterns, creating a windowpane effect (figure 4c). Adults have a large, bulbous head capsule.

Visible damage from azalea lace bug feeding begins with yellow stippling on the upper surface of the leaves as these piercing-sucking insects feed on the lower surface. Continued feeding causes the stipples to coalesce, turning leaves of rhododendron completely yellow (figure 4d) with green veins, and turning leaves of azaleas white (figure 4e). Heavily damaged leaves turn brown, and affected plants may experience defoliation. Azalea lace bug reduces chlorophyll content, photosynthesis, and transpiration (Rosetta 2013).

Phenological surveys found 3.5 generations a year occur in the Willamette Valley (Flores 2016). Management with green lacewing (*Chysoperla rufilabris* Burmeister) releases and with water sprays targeting the nymphal stage show promise (Flores et al. 2016). A large container nursery has already adopted these tactics, and further industry adoption is expected. Flores (2016) also surveyed which cultivated varieties were infested or not, in order to find more resistant cultivars, and the results were passed to interested stakeholders. Nurseries, public parks, and colleagues have made numerous requests for this information, and they continue these assessments.

Oak Lace Bug

Another new lace bug, tentatively identified as oak lace bug (*Corythucha arcuata* Say), was detected from a public park in Portland on Oregon white oak (*Quercus garryana* Douglas ex Hook.). We still await

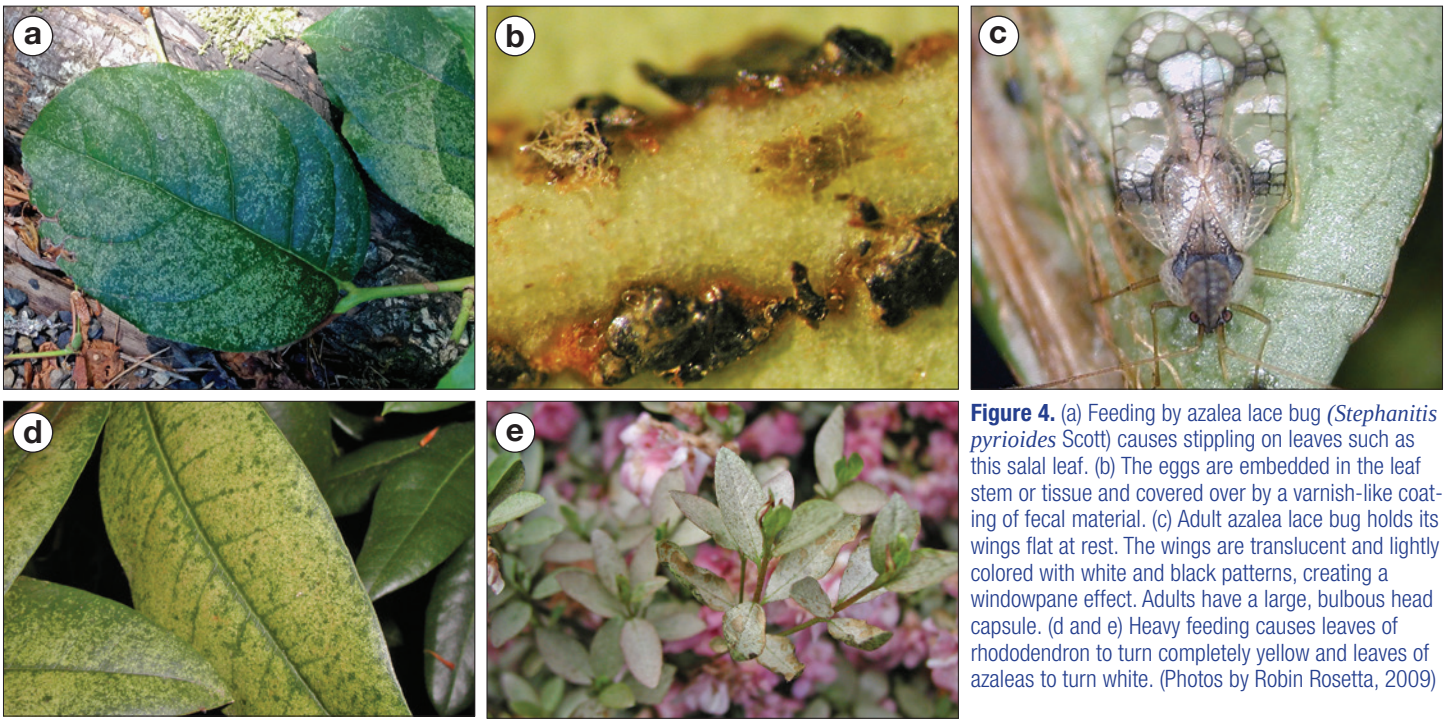

Figure 4. (a) Feeding by azalea lace bug *(Stephanitis pyrioides* Scott) causes stippling on leaves such as this salal leaf. (b) The eggs are embedded in the leaf stem or tissue and covered over by a varnish-like coating of fecal material. (c) Adult azalea lace bug holds its wings flat at rest. The wings are translucent and lightly colored with white and black patterns, creating a windowpane effect. Adults have a large, bulbous head capsule. (d and e) Heavy feeding causes leaves of rhododendron to turn completely yellow and leaves of azaleas to turn white. (Photos by Robin Rosetta, 2009)

official confirmation by USDA for this species but its appearance and key characters are consistent with oak lace bug. If confirmed, this would be the first record of oak lace bug west of the Rockies. Currently, no information exists on the extent of the distribution of oak lace bug in Oregon.

According to a Rutgers Cooperative Extension Advisory (Rettke 2013), oak lace bug has three to four generations per year, with the final generation laying eggs in late summer. Five nymphal stages occur prior to the adult stage. Unlike azalea lace bug, which embeds its eggs in plant tissue, oak lace bug lays its eggs on the surface of the leaf underside in characteristic rows of black eggs (figure 5a). Lace bugs in the genus *Corythucha* are associated with deciduous hosts and overwinter as adults under the bark of host trees. Similar to other lace bugs, oak lace bugs hold their wings flat and have parts of their wings that are translucent, giving a windowpane effect (figure 5b). Oak lace bug adults can be distinguished from azalea lace bug, as their wings have a more rectangular shape compared to the oval shape characteristic of lace bug species in the genus *Stephanitis*.

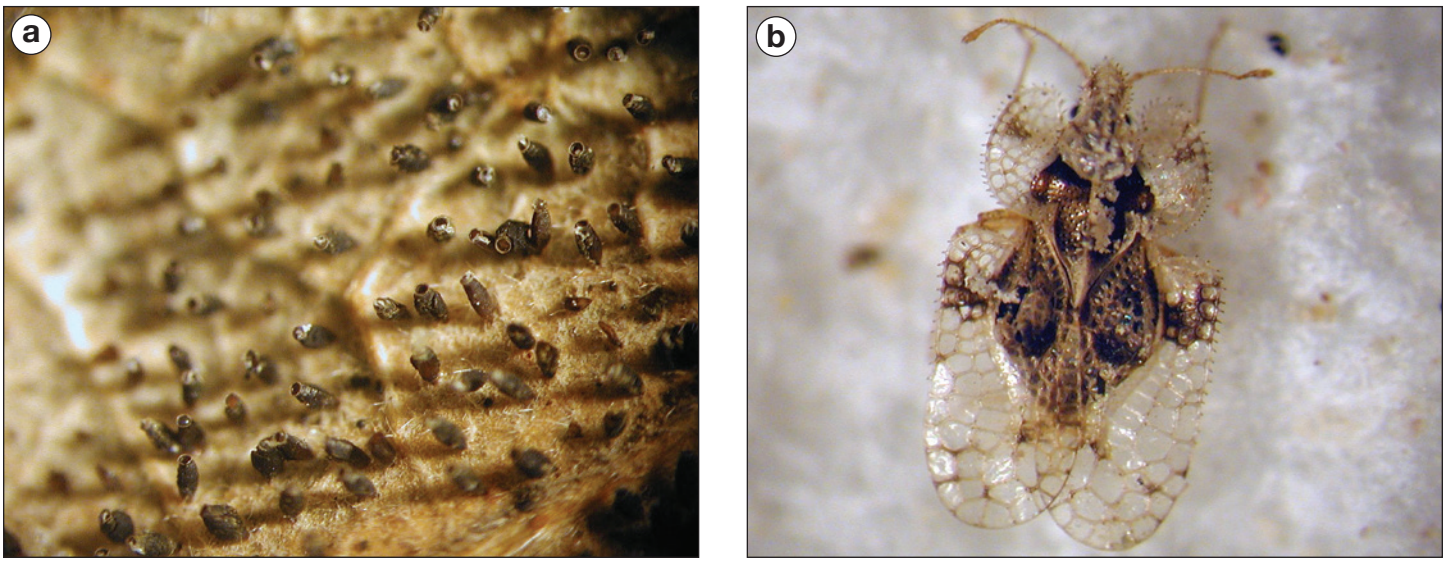

Figure 5. a) Oak lace bug (Corythucha arcuata Say) lays its eggs on the surface of the leaf underside in characteristic rows of black eggs. (b) The wings of oak lace bug adults have a rectangular shape with dark markings on their translucent wings. (Photos by Robin Rosetta, 2015)

Damage from oak lace bug is similar to that of other lace bug feeding, first exhibited as stippling on the top of leaves. Continued feeding can cause leaf discoloration and scorch-like symptoms. Oak trees can tolerate significant oak lace bug damage without plant health consequences, and the damage is mainly cosmetic. If management is required, it is suggested to target the nymphal stage early in the season.

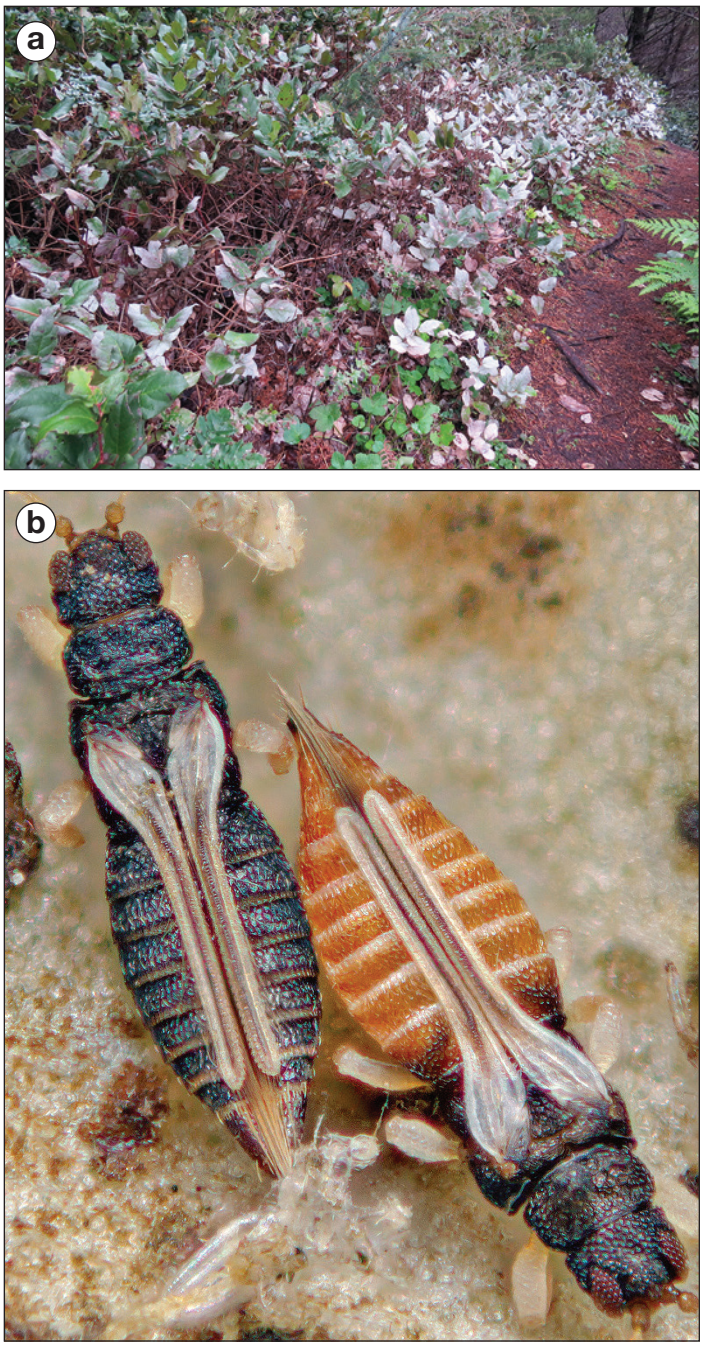

Figure 6. (a) Greenhouse thrips (*Heliothrips haemerroidalis* Bouché) feeding causes salal leaves to turn white, and the damage superficially resembles azalea lace bug injury (figure 4a). (b) Adult greenhouse thrips have a black head and thorax and either a black or orange abdomen with prominent bands. They hold their wings over their abdomen when not in flight. (Photo A by Neil Bell, Oregon State University, 2016; Photo B courtesy of Oregon Department of Agriculture, 2016.)

Greenhouse Thrips

In September 2015, OSU Extension Ask an Expert received a question about damage to salal on the southern coast of Oregon. The salal leaves were turning white or "silvering," and damaged plants were defoliating (figure 6a). The initial concern was that azalea lace bug was causing the damage, as it has been found damaging salal in Oregon, and the damage superficially resembles azalea lace bug injury (figure 4a). Direct observation and sampling by the Oregon Department of Agriculture, however, determined the damage was caused by greenhouse thrips (*Heliothrips haemerroidalis* Bouché). In 2016, greenhouse thrips were detected feeding on salal and Pacific wax myrtle (*Myrica californica* Cham. & Schltdl.) in natural landscapes near Florence on the Oregon Coast (LaBonte 2016). Though prior reports have been made of greenhouse thrips damage on salal, and on Viburnum plants near Seattle, the outbreak in Oregon appears to be more extensive, with reports of damage to salal from Benton, Coos, Curry, Douglas, and Lane Counties (Edmunds 2016a, 2016b; Pscheidt 2015; Young 2017). A search through OSU Insect ID Clinic records revealed entries of thrips damage on wax myrtle in 2004 and on rhododendron in 2005 from Coos County. In addition, the OSU Insect Identification Clinic has images of plant specimens of greenhouse thrips damage on salal, rhododendron, and native fern (*Polystichum imbricans imbricans*) collected from a courtyard on the OSU campus in 2007 (Young 2007). The collector/identifier wrote, "These specimens were brought in as an example of damage that has been observed for the last 3 years on salal growing south of Newport on US 101." Those entries and images suggest greenhouse thrips has been a pest on the southern Oregon coast since as early as 2004.

Greenhouse thrips generally remain on the leaf underside where they pierce plant cell walls and feed on cell contents, removing the green chloroplasts. With extensive feeding, the leaves turn a silver color, nearly devoid of green. Black fecal spotting is also present in areas where they have fed, making the underside of the leaf look "dirty." Larval thrips are light colored with red eyespots. Adult greenhouse thrips have a black head and thorax and either a black or orange abdomen with prominent bands (figure 6b). They hold their wings over their abdomen when not in flight. Additional host plants are reported for greenhouse thrips,

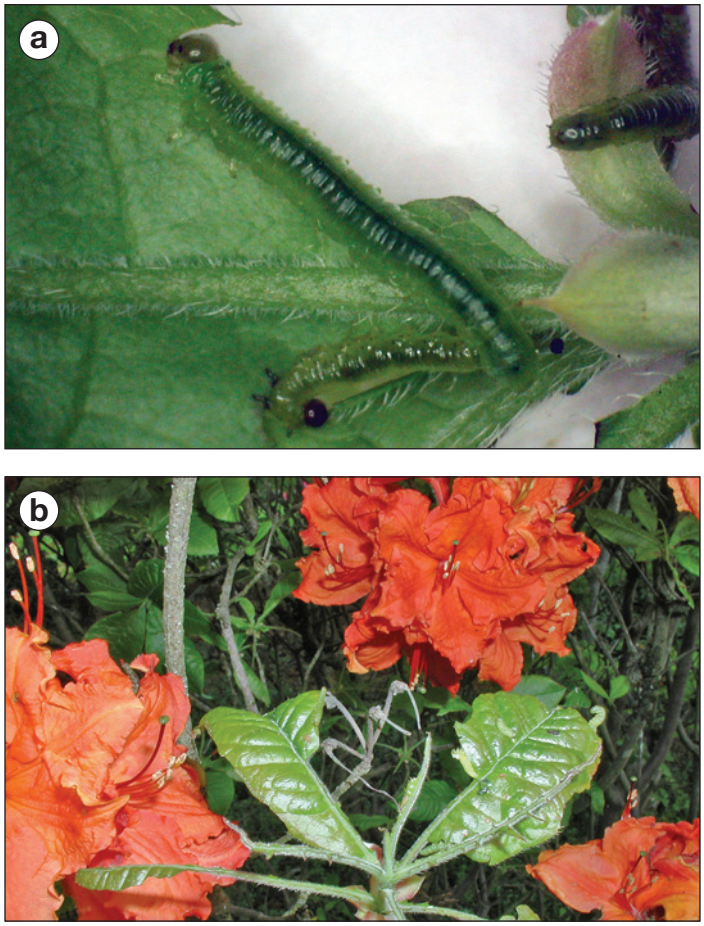

Figure 7. (a) Azalea sawfly (*Nematus lipovskyi* Smith) larvae are light green with a yellow head capsule. They closely match the green color of the azalea leaves. (b) Azalea plant showing defoliation from azalea sawfly. (Photos by Robin Rosetta, 2016)

including woody plants such as azalea, Oregon grape (*Mahonia* sp.), and maples (*Acer* sp.), as well as other evergreen and herbaceous plants like fuchsia (*Fuchsia* sp.) (Collman 2017, LaBonte 2016).

Azalea Sawfly

The azalea sawfly (*Nematus lipovskyi* Smith) may have been present in the Pacific Northwest for some time based on anecdotal reports, but has only been officially determined to be present in Oregon in 2016. Azalea sawfly was documented as present in Washington State in 1996 (Looney et al. 2016). Azalea sawfly is native to the eastern United States, originally described from *Rhododendron molle* Blume (Smith 1974). In addition to *R. molle*, host plants include flame azalea (*R. calendulaceum* Michx.), swamp azalea (*R. viscosum* L.), honeysuckle azalea (*R. luteum* Sweet), and clammy azalea (R. × *obtusum* 'Ledikanense') (Macek and Sipek 2015). Distribution information is limited but the author has noted populations in several locations in the northern part of the Willamette Valley extending south to Corvallis and also found at an Oregon Department of Transportation rest stop on Highway 26 in the coastal mountains.

Azalea sawfly has a single generation per year. The adults are stout-bodied wasps. Macek and Sipek (2015) observed swarming of the females around azaleas prior to oviposition. The female sawflies lay their eggs along the central vein of young developing leaves. Larvae hatch in 7 to 10 days. The larvae are light green with a yellow head capsule (figure 7a). They closely match the green color of the azalea leaves and generally escape detection until severe damage is noticed (figure 7b). The sawflies are gregarious, and numerous larvae can rapidly defoliate individual plants; they consume both leaves and flowers. The larvae eventually drop to the soil to pupate.

European Pine Sawfly

European pine sawfly (*Neodiprion sertifer* Geoff.) was first collected in North America in Somerset County, New Jersey in 1925 (Schaffner 1939). The sawfly was detected in Washington State in 2008 (Looney et al. 2016). In 2015, this sawfly was confirmed from a landscape in Albany, OR.

European pine sawfly larvae resemble caterpillars but have three thoracic legs and seven prolegs. They are grayish-green with two prominent dark lateral stripes as well as several lighter stripes alongside. Adult female sawflies are stout, brownish-black wasps that insert their eggs within slits in rows on pine needles in September through October. They overwinter in the egg stage, and larvae emerge in late April to May. The young larvae feed on the previous year's needles (Hoover and Barr 2002). They reach maturity in late May or early in June, then drop to the ground and spin cocoons in the needle litter. They have one generation per year. Severe defoliation can occur when these gregarious larvae are around (figure 8), and outbreaks can reach epidemic levels. Observations in New Jersey (Schaffner 1939) indicate that European pine sawfly preferentially feeds on red pine (*Pinus resinosa* Aiton), Scots pine (*P. sylvestris* L.), Japanese red pine (*P. densiflora* Siebold & Zucc.), jack pine (*P. banksiana* Lamb.), table mountain pine (*P. pungens* Lamb.), and mugo

pine (*P. mugo* Turra). It has also been found feeding on eastern white pine (*P. strobus* L.), Austrian pine (*P. nigra* Arnold), ponderosa pine (*P. ponderosa* Lawson & C. Lawson), shortleaf pine (*P. echinata* Mill.), and more rarely, pitch pine (*P. rigida* Mill.) when they are growing near preferred host pines.

Crazy Snake Worms

A new species of earthworm has been detected in Oregon, and it may have ecological implications. Crazy snake worms (*Amynthas gracilis* Kinberg), also known as Asian jumping worms, were first detected in the Pacific Northwest in Grants Pass, OR, in 2016 and have since been confirmed from landscapes in McMinnville and southwest Portland (ODA 2016a). Originally from Asia, these exotic earthworms have been implicated in ecological damage in the Northeastern United States where they have been for many decades. In these areas, free of native species of earthworms, they harm the understory habitat due to their rapid turnover of leaf mulch, depriving native plants of sufficient seedbed in which to germinate and thrive and enabling excessive erosion. In Oregon, where native species of earthworms are found, the ecological damage from this introduced exotic species has yet to be determined.

Figure 8. European pine sawfly (*Neodiprion sertifer* Geoff.) damage from a landscape in Albany, Oregon. (Photo courtesy of Oregon Department of Agriculture, 2015)

Figure 9. Crazy snake worms (*Amynthas gracilis* Kinberg) are a pale burgundy color with a light white band separating the front third of their body from the rear. They have a ring of stout bristles on each segment. (Photo courtesy of Oregon Department of Agriculture, 2016)

The earthworms are a pale burgundy color with a light white band separating the front third of their body from the rear (figure 9). They have a ring of stout bristles on each segment, which is a reliable diagnostic character. They are noted for vigorously wiggling when disturbed and having movement similar to a snake across the soil surface.

Japanese Beetle

Japanese beetle (*Popillia japonica* Newman) is a high-priority exotic beetle of concern in the Pacific Northwest. It has a wide host range of over 300 species of plants, including many economic field crops as well as valuable landscape plants. First detected in the United States in 1916 in New Jersey, Japanese beetles have expanded their distribution throughout the Eastern United States. In order to remain free of Japanese beetles, Western States have begun eradication procedures when Japanese beetles have been caught in traps or found through surveys. During 2016, 369 Japanese beetles were trapped in one area of northwest Portland, prompting plans for one of the Oregon Department of Agriculture's largest eradication programs in recent years. Current eradication procedures in Oregon will rely on a newer chemical, Acelepryn® (Chlorantraniliprole), along with the use of entomopathogenic nematodes in sensitive sites (ODA 2016b).

The adult beetles resemble typical scarab or June beetles. They are large and thick with bright metallic green heads and tan-brown elytra or hindwings (figure 10). Small tufts of white hair line the sides and posterior of the beetles. Larvae are C-shaped

beetle grubs with tan head capsules and stout bristles on their posterior. Both adults and beetle grubs feed and damage plants. The adult beetles feed on a wide range of host plants causing chewing damage and defoliation. They are particularly attracted to roses (*Rosa* sp.). The beetle grubs are strongly associated with turf feeding damage and are one of the key turf pests in the Eastern United States.

Figure 10. Japanese beetles (*Popillia japonica* Newman) are large and thick with bright metallic green heads and tan-brown elytra or hindwings. (Photo by Robin Rosetta, 2012)

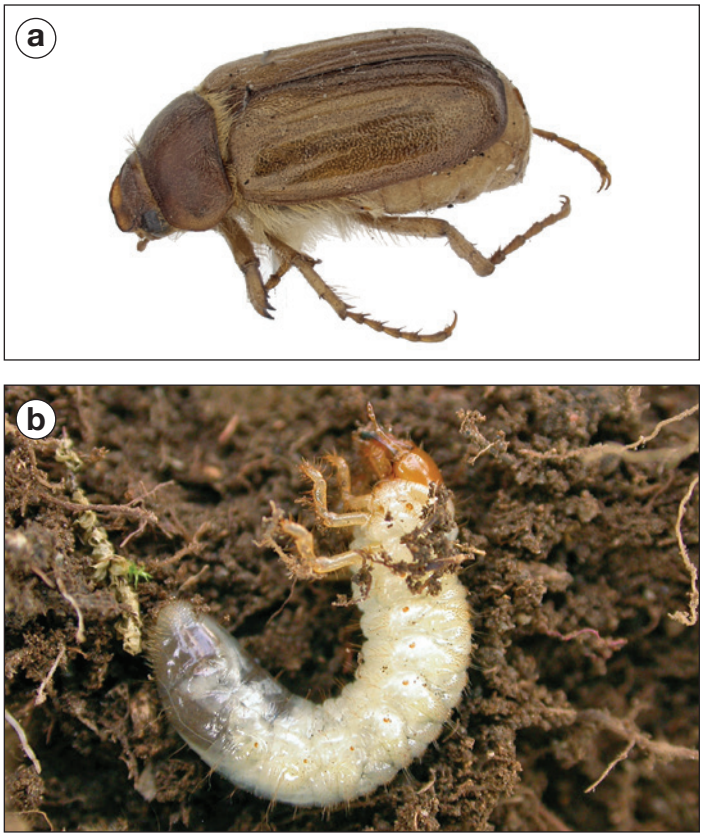

Figure 11. (a) European chafer (*Amphimallon majalis* Razoumowsky) adults are brown with a typical scarab beetle shape. (b) Larvae are large, white, C-shaped grubs with tan head capsules and darkened posteriors. (Photo A by Chris Looney, Washington Department of Agriculture, 2015; Photo B by Todd Murray, Washington State University, 2015)

European Chafer

An additional catch of concern is the detection of European chafer (*Amphimallon majalis* Razoumowsky) in a Japanese beetle trap in the Portland metro area in 2015 (LaBonte 2015). The European chafer was first detected on the west coast in New Westminster, British Columbia, in 2011. It was confirmed from a homeowner sample from SeaTac in the State of Washington in 2015. European chafer is a damaging beetle pest of turf and other cereal and grass plants. A Washington State University Extension Fact Sheet contains a report that they have also been found feeding on the roots of broadleaf plants and conifers (Murray et al. 2012).

These beetles are large and robust with a typical scarab beetle shape. The adults are brown and about 1.27 cm (0.5 in) long (figure 11a). The larva is a large, white, C-shaped grub with a tan head capsule and darkened posterior (figure 11b). The adult beetles mate in the early evening. Females lay eggs in the soil shortly after mating. When the eggs hatch (in about 2 weeks), the young grubs feed on plant roots. European chafer overwinters in the larval stage and pupates in May. Adults emerge in 2 to 3 weeks, in June (Murray et al. 2012). Feeding damage on turf can be severe and may be mistaken for damage from crane flies or cutworms.

Rose Stem Girdler

Rose stem girdler (*Agrilus cuprescens* Ménétriés) has been captured in the Portland area (2015) and in southwest Washington (2014), as well as east of the Cascade Mountains. This beetle borer has the potential to cause damage to important plants in the Northwest, including caneberries (*Rubus* sp.), currants and gooseberries (*Ribes* sp.), and its namesake, roses. A buprestid beetle, it feeds in the cambium and girdles the plants.

Adult rose stem girdler beetles are narrow and flattened, with a coppery red or green color. The larvae are white, long, narrow, and segmented with an enlarged pronotal segment next to the small dark head capsule (figure 12). The rose stem girdler overwinters as a fourth-instar larva within the pith of the canes. Only one generation of rose stem girdler occurs each year. Pupation occurs when temperatures average 12.8 °C (55 °F). Adults emerge from canes in May and June in Utah. Beetles can often be found mating in June and lay their eggs on the stems. Larvae chew through the bottom of the eggs and into the canes. The larvae feed

Figure 12. Rose stem girdler (*Agrilus cuprescens* Ménétriés) larvae are white, long, narrow, and segmented with a small dark head capsule. (Photo by Tom Peerbolt, Peerbolt Crop Management, 2015.)

in a shallow, spiral gallery that may cause ripples on the bark of the cane. They attack both vegetative and fruiting canes on caneberries, and severe infestations can kill plants in 2 to 3 years (Alston 2015).

Viburnum Leaf Beetle

Viburnum leaf beetle (*Pyrrhalta viburni* Paykull) is a chrysomelid beetle, aptly named, as it feeds on leaves of viburnum (*Viburnum* sp.). The damage potential from this beetle is quite extensive if not managed. Viburnum leaf beetle, first introduced from Europe to Ontario, Canada, in 1947, spread to the United States and was first reported in Maine (1994). It has since spread to Connecticut, Massachusetts, New Hampshire, New Jersey, New York (1996), Pennsylvania, Ohio (2002), and Vermont (Weston et al. 2007). Viburnum leaf beetle was first detected in the Pacific Northwest in 2001 in southern Victoria Island in British Columbia. Beetle presence in Washington was confirmed in 2004 from a homeowner sample from Bellingham, WA, in Whatcom County. It has since been found in a number of sites in King, Skagit, Snohomish, and Whatcom Counties in Washington State (Murray et al. 2016).

Viburnum leaf beetle overwinters in the egg stage. Eggs are inserted into pits chewed into the stems, generally in a straight line (figure 13a). Larvae hatch from the eggs in the spring, by mid- to late April, closely synchronized with leaf bud development of arrowwood viburnum (*Viburnum dentatum* L.), a very susceptible host species (Weston et al. 2007). Three larval stages (instars) feed on the upper surface of the leaves. Larvae eventually crawl down the trunk of the plant to pupate in the soil. Pupae remain in the soil for about 10 days. The adults are found in the summer in July. Both larvae

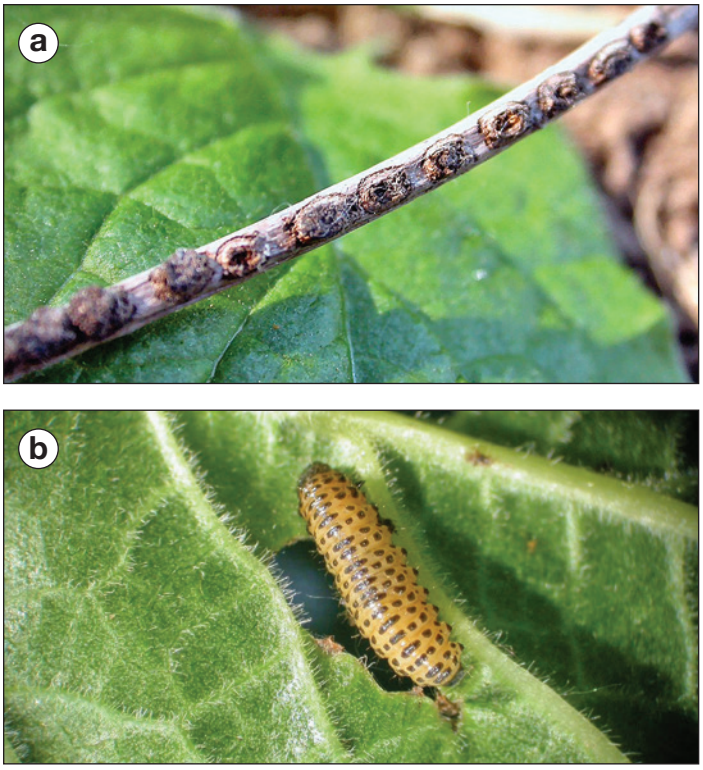

Figure 13. (a) Viburnum leaf beetle (*Pyrrhalta viburni* Paykull) eggs are inserted into pits chewed into the stems. (b) Larger larvae are light-to-dark green with black spots. (Todd Murray, Washington State University, 2004)

and adults feed on leaves. Adult females begin laying eggs in the late summer and fall. She can lay up to 500 eggs during her lifetime; the viburnum leaf beetle has only one generation per year.

Monitoring should begin by looking for egg-laying or oviposition scars on the current year's growth. Early feeding by the larvae will be evident as holes in leaves in the spring. They usually feed on the leaf undersides. Like many leaf beetle larvae, they superficially resemble a caterpillar but lack crochets (hooked appendages) on the prolegs (the fleshy, leglike protuberances in addition to the three pair of true legs). The newly hatched larvae are very small, around 1/8 in long, and are light yellow to tan. Their feeding damage is described as leaf skeletonization. Larger larvae are light to dark green with black spots (figure 13b). The adult beetles are a bronze-brown color and are similar in size to an elm leaf beetle. Feeding by the adults tends to show up as larger holes in the leaves. Damage from egg-laying can also lead to terminal dieback on stems.

Management for this beetle relies on several tactics, including pruning out stems with eggs, use of sticky material (Tanglefoot™) to trap larvae as they crawl down to pupate, chemical management, and plant resistance. Current recommendations are to plant resistant

varieties. Dr. Paul Weston developed a very successful citizen science program to compile a list of susceptible and resistant varieties; that information is available at Cornell University's Viburnum Leaf Beetle Citizen Science website (Weston 2016).

Conclusion

Although some of the pests mentioned in this article have potential to be quite disruptive, the impact of others may be minimized with eradication programs, classical biological control, or may even escape notice due to relative obscurity. Recent exotic insect introductions have focused attention on both the potential of whiteflies for crop damage (e.g., cabbage whitefly on kale) but also on the success of classical biological control programs to diminish these exotic populations, such as the establishment of the parasitic wasps, *Encarsia inaron* (Walker) and *Clitostethus arcuatus* (Rossi) ladybeetles for ash whitefly. Some pests have likely been established for years before official detection, such as greenhouse thrips or azalea sawfly in Oregon, but natural spread and certain weather conditions conducive to pest population growth eventually make their damage more noticeable. Devastating pests such as Japanese beetles have constant monitoring programs, but funding for these programs are often at risk due to variations in State and Federal funding. Given the precarious budgets for pest survey and the sometimes fortuitous detections of pests from the public, a focus on invasive species awareness for growers, landscapers, and forestry personnel is definitely warranted.

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