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Suitability of Various Species of *Viburnum* as Hosts for *Pyrrhalta viburni*, an Introduced Leaf Beetle[1]

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Abstract

Viburnum leaf beetle [(*Pyrrhalta viburni* (Paykull)], a newly introduced pest of viburnums in the United States, feeds selectively on plants in the genus *Viburnum*. We measured in the laboratory the ability of larvae of viburnum leaf beetle to complete development and propensity of adults to feed on a number of species of *Viburnum* ranging in susceptibility from completely susceptible to quite resistant as determined by earlier field observations. As expected, larvae completed development on viburnums rated as 'susceptible,' but were largely unable to do so on those rated as 'moderately' or 'highly' resistant. The pattern of host acceptance by adults was less consistent, with some adults feeding considerably on species not found to be susceptible in the field. Several accessions were not fed on at all by adults, indicating the presence of deterrent or toxic factors. Our results suggest that the species previously identified as resistant in the field are unsuitable hosts for viburnum leaf beetle, and will not likely be devastated by the pest even if all susceptible hosts are eliminated from an area.

Index words: viburnum leaf beetle, host resistance.

Species used in this study: *Viburnum carlesii* Hemsl.; *Viburnum plicatum* Thunb. f. *tomentosum* 'Mariesii' (Thunb.); *Viburnum prunifolium* 'Early Red' L.; *Viburnum* x *rhytidophylloides* J. Sur.; *Viburnum sargentii* 'Susquehanna' Koehne; *Viburnum sieboldii* Miq.; *Viburnum trilobum* 'Bailey's Compact' Marsh.; and *Viburnum wrightii* Miq.

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Significance to the Nursery Industry

Viburnum leaf beetle has the potential to become a major landscape pest because of its ability to kill susceptible viburnums if allowed to defoliate shrubs for several years in succession. We expect *P. viburni* to become widespread in the United States because its native range includes at least all of continental Europe. Observations in the field suggest that a number of species of *Viburnum* are resistant to feeding by the beetle; information on species susceptibility will permit landscape and nursery managers to target pest control efforts toward those plants least able to defend themselves and to plan future plantings with resistant species in mind. In addition, knowledge of *Viburnum* susceptibility will be useful for breeders that are seeking resistant plant material to incorporate into their germplasm.

Introduction

Viburnum leaf beetle, *Pyrrhalta viburni* (Paykull), is a newly introduced pest of viburnums in the United States from Europe (by way of Canada) that causes extensive defoliation to several popular viburnums used in the landscape as well as several species occurring in natural habitats. Although this pest feeds only on viburnums, not all species are equally susceptible. Based on earlier field observations, we found American cranberrybush viburnum (*V. trilobum* Marsh.), European cranberrybush viburnum (*V. opulus* L.), Sargent viburnum (*V. sargentii* Koehne), Rafinesque viburnum (*V. rafinesquianum* Schult.), and arrowwood viburnum (*V. recognitum* Fern/*V. dentatum* L.) to be most susceptible to the pest (2). [Note: There is disagreement among taxonomists regarding the classification of arrowwood viburnums. We will treat them as a single group, and refer to them as *V. recognitum*/*V. dentatum* for those that are familiar with either classification system]. Unfortunately, these highly susceptible species will typically die after 2–3 years of repeated infestation if the pest is not controlled. Other viburnums are only moderately affected by the beetle, or are left untouched. Most resistant viburnums are thicker-leaved accessions such as leatherleaf viburnum (*V. rhytidophyllum* Hemsl.) or Koreanspice viburnum (*V. carlesii* Hemsl.) and its hybrids (e.g. Burkwood viburnum, *V.* x *burkwoodii* Burkw. & Skipw; and Judd viburnum, *V.* x *juddii* Rehd.) (2).

P. viburni is particularly damaging to susceptible plants because both the larvae and adults feed on the foliage, seriously depleting plant reserves. The insect has one generation per year, starting with larvae that emerge in late April or early May in upstate New York from overwintering eggs. The larvae feed for 5–6 weeks on newly expanded leaves, leaving only major veins when populations are high. After they complete their development, the larvae drop to the soil and pupate in a small chamber several centimeters below the soil surface. Adults emerge several weeks later, and feed on the leaves of the same plants that served as hosts for the larvae. Adults continue to feed and lay eggs for the remainder of the summer and into early fall. The eggs laid by the adults, which can be seen primarily on the underside of young shoots, remain dormant until the following spring.

In an attempt to pinpoint the reasons for resistance of viburnums to viburnum leaf beetle, we tested eight species of *Viburnum* in the laboratory for their ability to support larval development and feeding by adults. The eight species (Table 1) encompass the range of susceptibility we documented earlier (2), and include many popular species of *Viburnum* currently found in the landscape.

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Materials and Methods

Insects. Insect colonies and experiments were maintained under a 12:12 (L:D) photoperiod. Larvae and adults of *P. viburni* were obtained from eggs collected in the field during the winter preceding the experiment. Egg-infested twigs of *V. recognitum* were held in the refrigerator until needed, and then transferred to an incubator maintained at 17C (63F) for three days, and finally to a chamber held at 22C (72F) until hatching. Newly hatched larvae were transferred to *V. trilobum* (collected from the wild) for rearing to adult, or transferred to one of the test species for the larval development experiment (described below). The foliage for larval rearing was maintained in water picks (13 mm dia × 10 cm) (1/2 in × 4 in) in vented plastic boxes (27.5 × 20 × 9.5 cm) (10 3/4 × 7 7/8 × 3 3/4 in) containing a layer of moistened, fine, white sand (2 cm (3/4 in) deep) and topped with a piece of hardware cloth (3 mm (1/8 in) mesh) to keep the leaves out of direct contact with the sand. After larvae had completed development, all remaining foliage was removed, and the rearing boxes were held at 22C (72F) and monitored daily for adult emergence. Adults for bioassay were taken from the colony container within 24 hours of emergence.

Plant material. Eight species of *Viburnum* (= treatments) were used in this experiment, covering seven *Viburnum* 'sections' (groupings based on morphological traits) as classified by Krüssmann (1) and included in our earlier field evaluation of viburnum susceptibility (2). Although we used representatives of the sections evaluated for susceptibility in the field, most of the cultivars were different because the field evaluation was conducted in Rochester, NY (where viburnum leaf beetle populations were very high), whereas we were restricted to locally available plants for the experiments reported here because fresh foliage was needed on a regular basis. The species (and cultivars, where known) are listed in Table 1. The plants were all maintained in the Cornell Plantations, Ithaca, NY, and had been in the ground for at least 5 years, most considerably longer. Leaves were collected as needed by clipping branch terminals, and then held for no more than one week in the laboratory (with the cut ends of the twigs in water) prior to being used in the bioassays.

Bioassays. Larval development was measured by placing 5 newly emerged larvae on a test leaf whose stem was inserted into moist potting medium (ProMix BX:fine sand 1:1 by vol) held in a plastic cylinder (8.5 cm dia × 8 cm) (3 3/8 × 3 1/8 in.) with a vented lid at 22C (72F). The number of larvae alive was recorded at regular intervals, and leaves were replaced as they became depleted. The potting medium was moistened as needed. After larvae finished their development, the cylinders were kept at 22C (72F), and monitored daily for adult emergence. Five to seven replicates were used for each treatment (plant species).

Host acceptance by adults was assayed with a no-choice test by confining individual, newly emerged adults on a detached test leaf held in a petri dish (9 cm dia × 20 mm) (3 1/2 × 3/4 in) with moistened filter paper. Leaves were replaced when feeding was extensive, and were maintained until the insects died or until the experiment was terminated after 3 weeks. Leaves were scanned with a flatbed scanner (Hewlett Packard ScanJet 5100C) at the time of replacement and at the end of the experiment in order to quantify leaf area consumed by adults. Leaves were scanned at 300 dpi and saved in TIFF format to maximize data retention. Adult longevity was recorded to the nearest half week. After death, each adult was sexed by examination of the last ventral abdominal sternite, which we have found to be a reliable character for determining sex of *P. viburni* (unpublished data). Eight to ten beetles (replicates) were used for each plant species.

Quantification of leaf area consumption and data analysis. Leaf area consumed by adults was quantified by comparing the leaf area remaining after feeding with the area of the same leaf as if it had not been fed upon. Leaf areas were readily quantified using Scion Image software (Scion Corporation, Frederick, MD) after leaf scans were converted to black and white bitmap images using PhotoShop 5.0 (Adobe Systems, Inc., San Jose, CA). Because scans of the leaves were not made before the experiment, the area of the intact leaf had to be reconstructed by manually 'filling in' the leaf areas consumed by the adults (using a drawing tool in Scion Image). Consumption was then estimated by subtracting the leaf area after feeding from the reconstructed area of the intact leaf. Areas from Scion Image were in expressed in pixels, which were converted to mm^2 by multiplying the pixel areas by the appropriate conversion factor obtained from a scan of a leaf disk of known size (1 cm (3/8 in) diam). Total leaf area consumed was calculated by summing the leaf area consumed for all leaves fed upon by adults, and feeding rate was calculated by dividing the total consumption by the life span of each individual.

Larval development and adult feeding and life span data were analyzed using the Kruskal-Wallis test followed by the Wilcoxon rank sum test because variances were not homogeneous (and could not be made homogeneous by transformation). When variables (i.e., larval survivorship, percent

Table 1. List of species of *Viburnum* evaluated in this study.

Species name	Common name	Taxonomic section[z]	Resistance rating[y]
Viburnum carlesii Hemsl.	Koreanspice viburnum	2	resistant
Viburnum plicatum f. *tomentosum* 'Mariesii' (Thunb.)	doublefile viburnum	4	resistant
Viburnum prunifolium 'Early Red' L.	blackhaw viburnum	5	moderately resistant
Viburnum x *rhytidophylloides* J. Sur.	leatherleaf viburnum	2	resistant
Viburnum sargentii 'Susquehanna' Koehne	Sargent viburnum	9	susceptible
Viburnum sieboldii Miq.	Siebold viburnum	1	resistant
Viburnum trilobum 'Bailey's Compact' Marsh.	American cranberrybush viburnum	9	susceptible
Viburnum wrightii Miq.	Wright viburnum	8	not rated

[z]Taxonomic section as classified by Krüssmann (1)

[y]Resistance ratings from Weston et al. (2)

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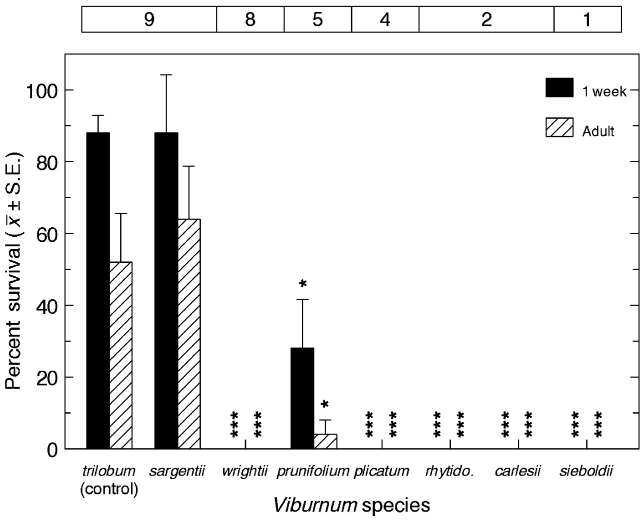

Fig. 1. Survival of larval *Pyrrhalta viburni* on eight species of *Viburnum* in the laboratory. Solid bars indicate survival one week after introduction of larvae, and hatched bars indicate survival to the adult stage. Asterisks indicate values that are significantly different from the control (*V. trilobum*) as determined by Wilcoxon rank sum test following Kruskal-Wallis test: *, $P < 0.05$; ***, $P < 0.001$. Numbers in bar across the top of the graph indicate the taxonomic section number of each species as categorized by Krüssmann (1).

adult emergence, adult consumption rate, and adult life span) were found to be significantly different among test species as determined by Kruskal-Wallis, each was compared to the corresponding value for *V. trilobum* with the Wilcoxon rank sum test because this species has consistently been among the most susceptible viburnums in the field. Differences between sexes in average adult consumption rate (untransformed) and total foliar consumption (transformed with square-root transformation to homogenize variances) was tested with one-way analysis of variance.

Results and Discussion

Larval survivorship among the test species differed significantly, with no larvae surviving past one week on several of the test viburnums (Fig. 1). As expected, larval survivorship was high, and 50–65% of larvae reached adulthood on *V. trilobum* and *V. sargentii* (and was not significantly different between these two species). The only other species on which larvae completed development was *V. prunifolium* L., but the percent of larvae becoming adults (4%) was significantly less than on *V. trilobum*. Surprisingly, no larvae survived past one week on *V. wrightii* Miq. This was unexpected because *V. wrightii* is in the same Section as *V. recongitum/V. dentatum*, which we have found to be among the most susceptible species in the field (2).

Consumption of foliage by adults was more erratic. Neither average consumption rate nor total consumption was significantly different between males and females ($F = 1.15$, $P = 0.29$, df = 1,56; $F = 1.00$, $P = 0.32$, df = 1,56; respectively), so data for the two sexes were pooled. Average and total consumption rates were significantly different among treatments as determined by the Kruskal-Wallis test ($H = 59.4$, $P < 0.0001$; $H = 56.2$, $P < 0.0001$; respectively). As expected, average consumption rate and total consumption of *V. sargentii* foliage was not significantly different from that of *V. trilobum*, and averaged roughly 16 mm^2/d and 220 mm^2 total, respectively, for these two species (Fig. 2). Adults, however, also fed on *V. wrightii* and *V.* x *rhytidophylloides* at a rate not significantly different from that of *V. trilobum*. Although total consumption of *V. wrightii* foliage was numerically much less than that of *V. trilobum*, total consumption of *V. wrightii* (ca. 100 mm^2) and *V. rhytidophylloides* (ca. 140 mm^2) foliage was not statistically different from that of *V. trilobum*. Unexpectedly, almost no feeding by adults was observed on *V. prunifolium* and *V. plicatum* Thunb. f. *tomentosum* (Thunb.), which is surprising because other cultivars of these species had been found to be moderately susceptible in the field (2). One obvious explanation is that the susceptibility of these cultivars differs from that of the cultivars evaluated in the field. The cultivar of *V. plicatum* f. *tomentosum* evaluated in the field was 'Newport,' whereas the cultivar evaluated here was 'Mariesii.' The cultivar of *V. prunifolium* evaluated in the field was unknown, but it is undoubtedly not 'Early Red' because it was a more upright, tree-like cultivar, unlike 'Early Red,' which is definitely shrub-like. Aside from being non-preferred, it appears that *V. plicatum* f. *tomentosum* 'Mariesii' may possess toxic components in its leaves because no adults survived on this species through the fourth day of the experiment (Table 2) ($H = 22.8$, $P = 0.0019$); we know from other experiments that adults can survive at least through 4 days without food (unpublished data). *V. sieboldii* Miq. may also possess toxins; only one adult survived past 4 days on this species.

No-choice bioassays represent the most stringent test of host-plant resistance because the insect faces starvation if it does not consume the test plant. Thus, plants that are not fed upon under no-choice situations must possess high levels of deterrent factors or toxins. This is apparently the case for *V. prunifolium* 'Early Red', *V. plicatum* f. *tomentosum*

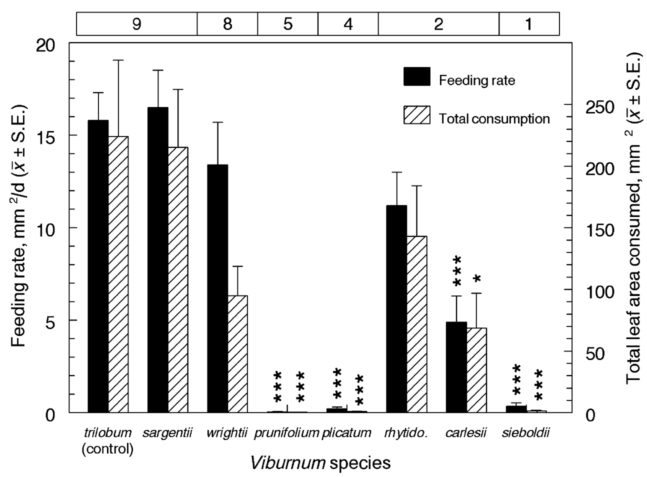

Fig. 2. Feeding rate and total consumption of leaf area by adult viburnum leaf beetle on eight species of *Viburnum* in the laboratory. Solid bars represent daily feeding rate, and hatched bars represent total leaf area consumed by each adult during the experiment. Asterisks indicate values that are significantly different from the control (*V. trilobum*) as determined by Wilcoxon rank sum test following Kruskal-Wallis test: *, $P < 0.05$; ***, $P < 0.001$. Numbers in bar across the top of the graph indicate the taxonomic section number of each species as categorized by Krüssmann (1).

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Table 2. Life span of adult viburnum leaf beetles confined with detached leaves from eight species of *Viburnum*.

Test species	Life span (d)[z]	*P*[y]
V. trilobum	14.2 ± 3.6	—
V. sargentii	14.2 ± 3.2	ns
V. wrightii	6.9 ± 1.6	ns
V. prunifolium	5.5 ± 0.5	ns
V. plicatum	4.0 ± 0.0	0.006
V. rhytidophylloides	13.0 ± 3.5	ns
V. carlesii	11.6 ± 3.4	ns
V. sieboldii	4.3 ± 0.3	0.02

[z]Values are means ± standard errors.

[y]Significance level of difference between each test species and *V. trilobum* as determined by Wilcoxon rank sum test; ns — difference not significant.

'Mariesii', and the accession of *V. sieboldii* used in our study. On the other hand, feeding by test insects on a particular plant in a no-choice test is not a reliable indicator of the resistance of that plant in the field because mobile, free-living insects can move to another plant. Thus, feeding observed on *V.* x *rhytidophylloides* and *V. carlesii* in this study means that, although these species are not normally fed upon by adults in the field, the factors conferring resistance are not overwhelmingly deterrent or toxic to the adults. In addition, the potency of these resistance factors is environmentally plastic; we have seen modest levels of feeding on leaves of *V.* x *rhytidophylloides* in the field when shrubs are in shaded locations, as opposed to virtually no feeding on shrubs grown in full sun (2).

The ability of viburnum leaf beetle larvae to develop on a potential host is probably a better indicator of resistance than feeding by adults in a no-choice test because larvae are not likely to leave the plant on which they emerge. If larvae cannot complete development on a particular plant, then infestation is not likely to be lethal to the plant because it is the combined feeding by both larvae and adults that most likely makes infestation by this pest so damaging to susceptible hosts. Thus, even though adults can feed on a number of the test species of viburnums included in our study, of the species evaluated, only *V. trilobum* and *V. sargentii* are likely to sustain life-threatening damage in the field. Combining the results of this study with our earlier field observations of susceptibility, it appears that the species of *Viburnum* that are most at risk to destruction by viburnum leaf beetle are in Krüssmann's Section 9 (Opulus). Aside from *V. trilobum* and *V. sargentii*, the other members of this section are *V. edule* (Michx.), *V. kansuense* Brandis, and *V. opulus*. We have not yet evaluated *V. edule* or *V. kansuense*, but our field observations of *V. opulus* have shown this species to be just as susceptible as *V. trilobum* or *V. sargentii* (2). Members of Section 8 (Odontotinus) are variable; some, such as *V. recognitum*/*V. dentatum* and *V. rafinesquianum*, are highly susceptible, whereas others, such as *V. wrightii* and *V. setigerum* Hance., are fairly tolerant. Members of the remaining *Viburnum* sections may sustain light feeding damage, but are not, to our knowledge, devastated by the pest.

Viburnum leaf beetle has the potential to become a major landscape pest because of its ability to kill susceptible viburnums if allowed to defoliate shrubs for several years in succession. We expect *P. viburni* to become widespread in the United States because its native range includes at least all of continental Europe. Observations in the field suggest that a number of species of *Viburnum* are resistant to feeding by the beetle; information on species susceptibility will permit landscape and nursery managers to target pest control efforts toward those plants least able to defend themselves and to plan future plantings with resistant species in mind. In addition, knowledge of *Viburnum* susceptibility will be useful for breeders that are seeking resistant plant material to incorporate into their germplasm.

Literature Cited

1. Krüssmann, G. 1984. Manual of Cultivated Broad-leaved Trees and Shrubs. Timber Press in cooperation with the American Horticultural Society, Beaverton, OR.

2. Weston, P.A., B.C. Eshenaur, and R.E. McNiel. 2000. *Viburnum* resistance. American Nurseryman 192:51–53.

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