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The Host Specificity of *Phyllocoptes nevadensis* Roivainen (Acari: Eriophyidae), a Candidate for the Biological Control of Leafy and Cypress Spurges

J. L. LITTLEFIELD[1] and R. SOBHIAN[2]

[1]Department of Entomology, Montana State University,
P.O. Box 173020, Bozeman, Montana 59717, USA

[2]USDA-ARS European Biological Control Laboratory,
Parc Scientifique, Agropolis II, 34397 Montpellier cedex 5, France

Abstract

Eriophyid gall mites have been considered for the biological weed control due to their apparent host specificity, short generation development and apparent damage. Of recent interest are mites associated with weedy *Euphorbia* spp, principally leafy spurge, *Euphorbia esula*, and cypress spurge, *Euphorbia cyparissias*. Surveys and eriophyid host records indicate that seven species of mites are associated with Euphorbia species in Europe. *Phyllocoptes nevadensis* Roivainen is a leaf rolling mite found in France and Spain and is apparently damaging to cypress spurge causing plant stunting. Studies were initiated in Montpellier, France and at Bozeman, Montana to determine the host specificity of the mite. Tests conducted in France on *Croton* sp, *Ricinus communis*, *Euphorbia colbrata*, *E. esula* (USA), *E. heterophylla*, *E. milii*, and *E. cyparissias* indicated that the mite may be restricted to the genus *Euphorbia*. To determine the utilization of species within the genus, 14 species belonging to four subgenera of *Euphorbia* were tested under quarantine in Montana. Mites were able to develop on nine plant species belonging to the subgenera *Esula*, *Agaloma* and *Chamaesyce*, including native species *E. incisa*, *E. marginata*, *E. glyptosperma*, *E. maculata* and *E. serpyllifolia*. Of the six accessions of North American leafy spurge tested, all supported mite development. Mites were not able to survive on the two *Poinsettia* species, or on the natives, *E. robusta* and *E. corollata*. Plant damage was only noted on cypress spurge and to a much lesser extent on several leafy spurge plants. Although additional information is needed to assess damage to these non-target *Euphorbia* spp, the apparent lack of host specificity of the mite may lead to concerns regarding potential impacts on perennial endangered or threatened spurge species; therefore the mite is probably not suitable for release in the United States.

Introduction

Leafy spurge (*Euphorbia esula* L. complex) is an aggressive, persistent, deep-rooting perennial plant of Eurasian origin that has become dominant on rangelands and pastures, displacing useful forage plants in North America. Leafy spurge now extends throughout much of southern Canada and the northern United States (Britton 1921, Dunn 1979, Hanson and Rudd 1933). Leafy spurge produces a milky latex that is poisonous to some animals and can cause blistering and irritation on the contacted skin, and similar results to the digestive tract when ingested by man and some animals. In cattle, it causes scours and weakness, and in larger ingested amounts, can cause death (Kingsburg 1964). Cattle usually refuse leafy spurge as food unless it is given to them in weedy hay or when better for-

age is not available.

Leafy spurge reproduces both by vegetative regrowth and the production of large quantities of seeds which are often distributed by birds, wildlife, man, water, etc. (Selleck *et al.* 1962, Best *et al.* 1980). Leafy spurge plants are able to maintain high root reserves through an extensive root system, ranging from a massive network of small roots near the soil surface, to deep penetrating tap roots. This ability to maintain high root reserves permits the plant to recover quickly from physical and most chemical damage (Muemscher 1940).

A conservative estimate of loss in the United States, in terms of expenditures for controlling leafy spurge and loss of productivity was given by Noble *et al.* in 1979 as $10.5 million annually. Derscheid and Wrage (1972) reported that the problem is most severe on undisturbed lands, but on cultivated cropland areas, it can reduce crop yields by 10 - 100% (Derscheid and Wrage 1972). Thompson, *et al.* (1990) recently concluded that in North Dakota, one million acres of leafy spurge had depreciated land values by $137 million and had a total economic impact of $105 million in that state for 1989.

Cromroy (1979) outlined unique characteristic that make eriophyid mites potential biological control agents for weeds, including their apparent host specificity. Literature reviews by Petanovic and Stevanovic (1996) indicate eleven eriophyid species associated with the genus Euphorbia in Europe. One such species is *Phyllocoptes nevadensis* Roivainen, which had been found infesting cypress spurge in France.

The objective of releasing *P. nevadensis* in North America is to establish another biological weed control agent to assist in biological control of the leafy spurge. Although several *Aphthona* species (Coleoptera: Chrysomelidae) are established and are greatly reducing spurge at establishment sites, additional biocontrol agents are needed, especially on more mesic sites. Since many gall mites often require humid conditions, these organisms may be suitable control agents in riparian areas. The influence of this biological control agent would be to stress the plant depressing seed production and reduce the storage of carbohydrates within the roots.

Phyllocoptes nevadensis

Phyllocoptes - The genus *Phyllocoptes* (family Eriophyidae) is comprised of approximately 145 known species (Davis *et al.* 1982). Members of this genus are widely distributed and feed on a variety of hosts. Only three species have been reported on plants in the family Euphorbiaceae: *P. acuminatus* Manson (on *Codiaeum* sp in Samoa), *P. euphorbiae* Farkas (*Euphorbia cyparissias* L. and *E. salicifolia* Host in Hungary, Poland and Yugoslavia), and *P. nevadensis* (see Field Hosts) (Davis *et al.* 1982, Boczek and Petanovic 1996, Petanovic and Stevanovic 1996). Some species of *Phyllocoptes* produce a variety galls, erinum, rusts, leaf rolls or curls, whereas others are vagrants.

Distribution - *Phyllocoptes nevadensis* has been collected in Granada, Spain and in the Cevennes Mountains (elevation 600-700 m), about 70 km north of Montpellier, France (Roivainen 1953, Sobhian unpublished data).

Field hosts - *Phyllocoptes nevadensis* has only been recorded on three plant species: *Euphorbia luteola*, *E. esula* (both in Spain) and *E. cyparissias* (France) (Roivainen 1953, Sobhian unpublished data).

Biology and ecology - Little is known about the specific biology/ecology of *P. nevadensis* but based upon our observations made in the field and laboratory, it appears to be typical of Eriophyids in general. Several generations of the mite develop per season.

Overwintering occurs on root buds/shoots at the base of the plant. Feeding by the mite cause leaf rolls or curls and infested plants appear stunted. Mites feed at the base of the leaves usually at the apical tip, but may also feed within the curls of distorted leaves. Leaves twist or curl along its edges due to feeding. Unlike *Aceria malherbae* Nuzz., which induces gall formation which curl or rolls leaves of field bindweed and requires this gall tissue to lay eggs (Rosenthal and Platts 1990), *P. nevadensis* will lay eggs on non-distorted leaves.

HOST SPECIFICITY TESTING

Test population -

This mite was found on *E. cyparissias* in the mountains of Cevennes, about 70 km north of Montpellier, France. Species identification was made by E. de Lillo, University Bari, Italy.

No-Choice Host Suitability Test (Laboratory) France

Methods -

Host specificity testing was carried out in 1993 at the USDA-ARS, European Biological Control Laboratory, Montpellier, France by R. Sobhian. On 10 August, infested plants were collected and held overnight in a refrigerator. Plants were then inspected under a stereomicroscope to determine the presence of the mites and for the removal of any predacious mites. Infested branches were divided into 42 equal portions and were then placed on the test plants of the family Euphorbiaceae. Six replications per plant species were utilizied. Plants consisted of: *Croton* sp, *Ricinus communis* L., *Euphorbia colbrata*, *E. esula* (USA), *E. heterophylla* L., *E. milii* Ch.d.Moulins, and *E. cyparissias* (control). Plants were harvested on 27August and inspected for the presence of mites and curled leaves.

Results & Discussion -

The preliminary host specificity tests would indicate that this species is fairly host specific, being confined to plant species within the genus *Euphorbia*, subgenus *Esula*. Four plants of *E. cyparissias* and one plant of *E. esula* were infested. No mites were located on the other plant species. Leaf curling of the infested *E. esula* was not evident, but mites were found among the stem leaves. It is possible that this plant was not in the proper stage for gall development. The host range of *P. nevadensis* is apparently sufficiently limited to warrant further investigation of its host specificity of economically and ecologically important Euphorbias of North America.

No-Choice Host Suitability Test (Laboratory) Montana

Methods -

Host specificity studies for *P. nevadensis* were initiated at the Insect Quarantine Laboratory, Montana State University - Bozeman. No-choice tests were performed on eight plants of each species with *E. cyparissias* (MT) used as a control. Several tests were conducted based upon plant or mite availability. Plants were grown to the pre-bud stage and infested with mites by placing galled material on the plant. Plants were arranged in a randomized design within rearing cages. Plants were maintained at ambient temperatures

of 21° C and with a 14:10 L:D photoperiod. Each test was continued for approximately 30 days for symptoms to appear and a second generation of mites to develop. Buds or leaf material were then dissected to determine the presence of living mites, and evidence of reproduction and leaf curl.

Table 1.
No-choice host Specificity Tests of *Phyllocoptes nevadensis* – Bozeman, Montana

Plant Species	% Infestation	Damage
Test 1.		
Euphorbiaceae:		
Euphorbia		
Subgenus Esula:		
E. cyparissias L. (Control)	90	Yes
Subgenus Agaloma:		
E. corollata L.	0	No
E. marginata Pursh	50	No
Subgenus Chamaesyce:		
E. glyptosperma Engelm.	70	No
E. maculata L.	60	No
E. serphyllifolia Pers.	20	No
Subgenus Poinsettia:		
E. cyathophora Murray	0	No
E. pulcherrimum L	0	No
Test 2.		
Euphorbiaceae:		
Euphorbia		
Subgenus Esula:		
E. characias L.	0	No
E. cyparissias (Control)	100	Yes
E. esula L. (ND)	40	No
E. incisa Engelm.	70	?[1]
E. lathyris L.	100	? [1]
E. myrsinites L.	10	No
E. robusta (Engelm.)	0	No
Test 3.		
Euphorbiaceae:		
Euphorbia		
Subgenus Esula:		
E. cyparissias (Control)	100	Yes
E. esula (CO)	100	No
E. esula (ID)	100	No
E. esula (MT - Columbus)	100	No
E. esula (MT - Story Hills)	100	Yes
E. esula (NE)	100	No

[1] Some rudimentary curling of leaves.

Results and Discussion

Fourteen species and six accessions of leafy spurge were tested against *P. nevadensis* (Table 1). Mites were able to develop on nine plant species belonging to the subgenera Esula, Agaloma and Chamaesyche, including native species *E. incisa Engelm.*, *E. marginata* Prush, *E. glyptosperma* Engelm., *E. maculata* L. and *E. serpyllifolia* Pers. All of the six accessions of leafy spurge tested supported mite development. Mites were not able to survive on the two Poinsettia species, as well as, the native species *E. robusta* (Engelm.) and *E. corollata* L.

Leaf twisting or curling was only noted consistently on the control plants, *E. cyparissias*. Although a few twisted leaves were observed on *E. lathyris* L. and *E. incisa*, it was not certain whether this was mite induced or environmental since the twisting was rudimentary compared to that observed on *E. cyparissias*. As for leafy spurge, damage was noted on accession MT - Story Hills, on leaves that were first fed upon by the mite. Subsequent observations made on infested leafy spurge plants suggests leaf curl occurred when the plant stem was slowly elongating allowing mites a longer opportunity to feed and to buildup numbers. Whereas, when the stem was rapidly elongating, no leaf curling was observed. The wider leaves and longer internodes associated with leafy spurge, compared to cypress spurge probably resulted in less leaf curl due to mite feeding.

Based upon the results of the host specificity tests conducted at MSU, it appears that *P. nevadensis* would not be a suitable biological control agent of leafy spurge since the mite apparently does not damage the plant to a great extent, and that the host range is fairly broad within the genus *Euphorbia*. This mite is damaging to *E. cyparissias* and could be a possible biocontrol agent if it can be determine that feeding on other *Euphorbia* species (especially threatened and endangered species) was not damaging.

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References.

Best, K.F., G.G. Bowes, A.G. Thomas, and M.G. Maw. 1980. The biology of Canadian weeds. 39. *Euphorbia esula* L.. Can. J. Plant Sci. 60:516-663.

Britton, N.L. 1921. The leafy spurge becoming a pest. J. New York Bot. Gard. 22:73-75.

Boczek, J., and R. Petranovic. 1996. Eriophyid mites as agents for biological control. pp. 127-131. *In* V.C. Moran and J.H.Hoffman [eds.], Proceedings of the IX International Symposium on Biological control of Weeds, Stellenbosch, South Africa. Jan. 1996.

Cromroy, H.L. 1979. Eriophyoidea in biological control of weeds. pp. 473-475. *In* J. G. Rodriguez [ed.], Recent Advances in Acarology. Vol 1. Academic Press, NY.

Davis, R., C.H.W. Flechtmann, J.H. Boczek, and H.E. Barke. 1982. Catalogue of Eriophyid mites (Acari: Eriophyioidea). Warsaw Agricultural Press, Warsaw. 254 pp.

Derscheid, L.A., and L.J. Wrage. 1972. Leafy spurge. S. Dakota State Univ. Ext. F. S. 449, 4 p.

Dunn, P.H. 1979. The distribution of leafy spurge (*Euphorbia esula*) and other weedy *Euphorbia* spp. in the United States. Weed Sci. 27: 509-516.

Hanson, H.C., and V.E. Rudd. 1933. Leafy spurge life history and habits. N.D. Agric. Exp. Stn. Fargo. Bull. 266. 24 pp.

Kingsburg, J.M. 1964. Poisonous Plants of the United States and Canada. Prentiss Hall Inc., Englewood Cliffs, New Jersey, 626 pp.

Muemscher, W.C. 1940. Poisonous Plants of the United States. Macmillan Co: New York. pp.

142-144.

Nobel, D.L., P.H. Dunn, and L.A. Andres. 1979. The leafy spurge problem. Proceedings of the leafy Spurge Symposium. North Dakota Cooperative Extension Service, Fargo. pp. 8-15.

Petranovic, R., and V. Stevanonic. 1996. Eriophyoid mites (Acari: Eriophoidae) on leafy spurges (*Euphorbia* spp.) (Euphorbiaceae) in Yugoslavia - their potential use in biological control. p.233. *In* V.C. Moran and J.H.Hoffman [eds.], Proceedings of the IX International Symposium on Biological control of Weeds, Stellenbosch, South Africa. Jan. 1996.

Roivainen, H. 1953. Some gall mites (Eriophyidae) from Spain. Archivos do Instituto de Aclimatacion 1:9-41.

Rosenthal, S.S., and B.E. Platts. 1990. Host specificty of *Aceria malherbe* (Acari: Eriophyidae), a biological control agent for the weed, *Convolvulus arvensis* (Convolvulaceae). Entomophaga 35:459-463.

Selleck, G.W., R.T. Coupland, and C. Frankton. 1962. Leafy spurge in Saskatchewan. Ecol. Monogr. 32:1-29 (1962).

Thompson, F., J.A. Leitch, and F.L. Leistritz. 1990. Economic impact of leafy spurge in North Dakota. N. Dakota Farm Res. 47(6): 9-11.