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Potential control of weedy spurges by the rust *Uromyces scutellatus*[1]

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Abstract:

In a location with cypress spurge (*Euphorbia cyparissias* L. #[2] EPHCY) and naturally occurring *Uromyces scutellatus* (Pers.) Lev. s.str., the percent of shoots deformed by this systemic rust increased from 6% in 1981 to 48% in 1982, followed by a decrease in both deformed and normal shoots in 1983 and 1984. After inoculation in 1981 of two cypress spurge crowns at a location near Zürich by teliospores of *Uromyces alpestris* Tranzsch., more than 80% deformed shoots were obtained in 1983 and 1984. Inoculations of cypress spurge root segments by *U. scutellatus* s.str. or *U. alpestris* in experimental plots in 1982 gave 50 to 100% infected plants, and in most cases more than 50% deformed shoots in 1984. The collection of *U. alpestris* studied (E-52) could be a promising candidate for mycocontrol of cypress spurge because of its pathogenicity and specificity.

Additional index words:

Weed mycocontrol, rust fungi, *Uromyces alpestris*, EPHCY.

Introduction

Leafy spurges [*Euphorbia esula* L. # EPHES, *E. waldsteinii* (Sojak) A. Radcliffe-Smith, *E.* × *pseudovirgata* (Schur.) Soó (8)] are serious weeds in North America. They

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[2] Letters following this symbol are the WSSA-approved computer code from Composite List of Weeds, Weed Sci. 32, Suppl. 2. Available from WSSA, 309 West Clark St., Champaign, IL 61820.

have invaded more than 1 million ha of rangeland and are steadily occupying new areas[3]. Chemical control of these weeds is too expensive and not sufficiently effective. Wide distribution and low economical value of infested lands and the alien origin of leafy spurges in North America make them promising candidates for biocontrol (2). Several insects (4), some fungal pathogens (1, 6, 9), and grazing by sheep (7) have been studied as control measures.

Rust fungi of the species complex *Uromyces scutellatus* s.l. are possible mycocontrol candidates. Four species of this group are specialized on both the leafy spurges and the very closely related cypress spurge, which is also a common weed. These species are *Uromyces alpestris*, *U. scutellatus* s.str., *U. kalmusii* Sacc., and *U. striolatus* Tranzsch. (3). The first two are brachycyclic with strongly reduced formation of urediniospores; the second two are microcyclic. All of them are supposed to infect rhizome buds by germinating basidiospores in autumn (5) and to develop spermogonia followed by telia (with or without sporadic urediniospores besides teliospores) on leaves of deformed shoots during the second spring after infection. Experimental data on *U. scutellatus* are lacking. Host specialization and the heavy damage to infected plants make this rust group interesting for possible biocontrol of weedy spurges.

This contribution describes observations in natural stands and infection attempts in natural stands and experimental plots. As leafy spurges are very rare in Switzerland, our data were obtained with the closely related cypress spurge.

Materials and methods

Fungi and plants. *Uromyces scutellatus* s.str. (strain E-45) and *U. alpestris* (strain E-52), both from cypress spurge, were studied. Strain E-45 was collected at a location in Benglen (Zürich area, elevation about 600 m, observed since 1981) while strain E-52 was collected near Sufers (Graubünden, elevation 1700-1900 m). Teliospores were preserved on dried plant material at 2°C and about 60% relative humidity.

Three ecotypes of cypress spurge were used in the experimental plots. Ecotype 5.4.12 was from Pfaffhausen, Zürich area, at an elevation about 600 m; 5.4.13 was the original host of E-52 from the Sufers region; and 5.4.14 was from the Zürich-Hönggerberg area, at an elevation about 500 m. The plants were grown from healthy crowns collected from natural stands. Root segments with buds were planted into clay pots (21 cm high, 14 cm in diameter) or directly into the soil of experimental plots. For potted plants, a mixture of sterilized soil (Potgrond, de Baat, Netherlands), quartz sand, and perlite (3:1:1, v/v/v) was used. Pots were placed in the soil within the plots. Two to three times per year shoots of individual plants were cut to stimulate bud production and prevent expansion of powdery mildew and insects. Treatments to control insects were made if necessary.

Observations in natural stands. Plants in natural stands were observed at 1- to 2-week intervals during the spring and at 3- to 4-week intervals later in the season. Time of

[3] Walker, A. 1982. Biological control of weeds with plant pathogens. Background statement. USDA ARS NER, Beltsville Agric. Res. Ctr., S-3.

appearance of disease symptoms, percentage of deformed shoots (counted on designated areas of about 1 m^2 in May of each year), death, and eventual recovery of diseased shoots were recorded.

Inoculation methods. In the natural stand, dried leaves bearing telia were spread around the rhizosphere of individual crowns. About 50 leaves per crown were used. For experimental trials, root segments with buds were planted together with 30 to 40 leaves with telia per segment. At least four plants per trial were inoculated; three to five non-inoculated plants (root segments) served as controls.

Estimation of infection. After a second overwintering period, the number of deformed shoots per trial was determined. A record of disease symptoms during the preceding season was kept. Significant differences between experimental trials were evaluated using Snedecor's *t*-test.

Results and discussion

Observations in natural stands. Since May 1981, six cypress spurge stands at a location in Benglen (near Zürich) with naturally occurring *Uromyces scutellatus* s.str. (E-45) have been observed (Figure 1). In 1981, very few diseased plants were found. A marked increase of the rust in 1982 (48% deformed spring shoots compared to 6% in 1981) was followed by a distinct decrease in fungus and plant population in 1983. In 1984, no deformed shoots occurred; the number of normal shoots was greatly reduced compared to 1982. The persistence of the rust at this location can only be ascertained during the next several years.

Artificial inoculation in a natural stand. Two crowns (about 30 cm from each other) in a healthy cypress spurge stand at Benglen were inoculated in November 1981 with *Uromyces alpestris* (E-52). Deformed shoots (80%) occurred first in spring 1983; in 1984 total number of shoots drastically decreased and 87% were deformed (Figure 2). The injury by this subalpine strain to plants at Benglen was marked and may be lethal. During the next several years its spread in the new biotope should be apparent.

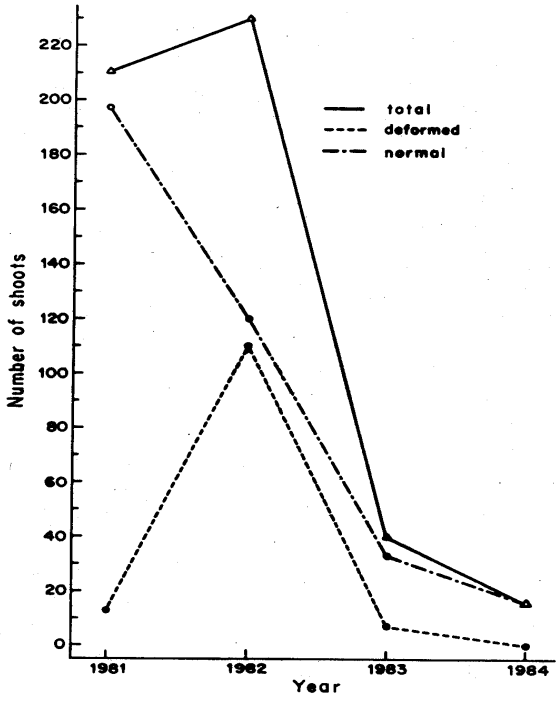

Figure 1. Shoot number each May of a natural population of cypress spurge spontaneously infected by *Uromyces scutellatus* s.str. (E-45). Data are summarized from six 1–m^2 areas of a location.

Artificial inoculations in experimental plots. Several trials with *U. scutellatus* s.str. (E-45) and *U. alpestris* (E-52) were started during 1982 (Tables 1 and 2; Figure 3). Inoculations with E-45 showed a significant difference in infection depending on the time of inoculation. Plants inoculated in August 1982 produced 52% deformed shoots in 1984, while those inoculated in November 1982 produced only 19% (Figure 3, A and B). In both cases the experiment was started with root segments. Plants inoculated in August probably had more time to grow and produce new buds before the teliospores germinated. Thus, more substrate was available for the attack by E-45.

Inoculations of its original host (5.4.13) by E-52 are difficult to evaluate because of the low viability of the plants (Tables 1 and 2). As with many subalpine plants, this ecotype is sensitive to transplanting to lower altitudes. Part of the inoculated plants, however, probably died

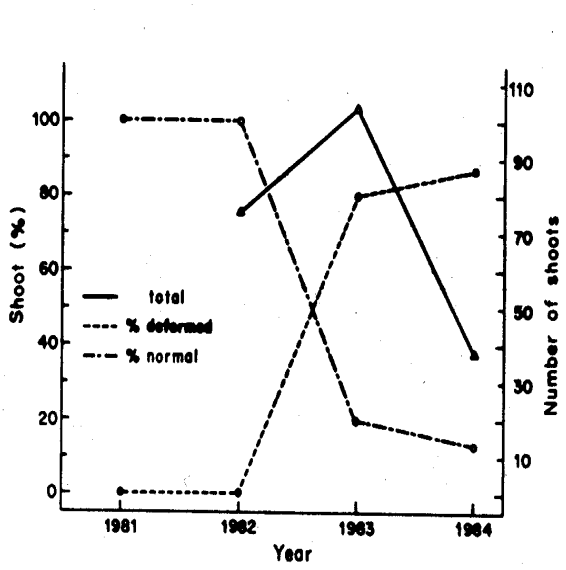

Figure 2. Percent normal and deformed shoots and total number of shoots each May of a natural population of cypress spurge after artificial inoculation with *Uromyces alpestris* (E-52) teliospores on November 24, 1981.

Table 1. Infection experiments with E-45, E-52, and cypress spurges grown directly in soil.

Inoculation date (1982)	Rust Strain[a]	Spurge Ecotype[b]	Year[c] 1982	1983		1984	
			I	S	D	S	D
			(plant no.)				
August 30	E-52/81	5.4.13	4	1	1[d]	0	
	E-52/82	5.4.13	4	1[d]	0	0	
	Control	5.4.13	3	3	0	1	0
	E-45/82	5.4.12	4	4	0	4	4
	Control	5.4.12	3	3	0	3	0
November 8	E-45/82	5.4.12	5	5	0	4	3
	E-52/82	5.4.12	5	5[e]	1[f]	3	2

[a] Strains E-52 and E-45 refer to *U. alpestris* and *U. scutellatus* respectively; 81 and 82 indicate the year of collection (1981, 1982).
[b] Ecotype 5.4.13 was the original host of E-52 collected at Sufers; 5.4.12 was collected at Pfaffhausen.
[c] I, S, and D refer to the initial plant number, the number of plants that survived, and the number of plants with deformed shoots, respectively.
[d] A single shoot occurred in spring 1983; then the plant died.
[e] One plant produced chlorotic sterile shoots with some shortened leaves during 1983; in 1984 all shoots were deformed.
[f] The plant produced no deformed shoots during the spring and summer 1983; a small deformed shoot appeared in October 1983; the plant did not survive to 1984.

Table 2. Infection experiments with E-52 and cypress spurges grown in pots started on December 10, 1982.

		Year[c]				
		1982	1983		1984	
Rust strain[a]	Spurge ecotype[b]	I	S	D	S	D
		(plant no.)				
E-52	5.4.13	4	/[d]	0	0	
Control	5.4.13	5	/	0	0	
E-52	5.4.12	11	/	1[e]	7	3
Control	5.4.12	5	/	0	4	0
E-52	5.4.14	5	/	0	4	0
Control	5.4.14	5	/	0	5	0

[a] Strain E- 52 refers to *U. alpestris*, collected 1982.
[b] Ecotype 5.4.13 was the original host of E-52 collected at Sufers; 5.4.12 was collected at Pfaffhausen; 5.4.14 at Zürich.
[c] I, S, and D refer to the initial plant number, the number of plants survived, and the number of plants with deformed shoots, respectively.
[d] / Indicates the data was not recorded.
[e] One plant produced a single deformed shoot in spring 1983 and all shoots deformed in 1984; it is one out of three plants inoculated by teliospores in which dormancy was broken by heat shock (30 minutes at 50°C); two of them survived to 1984, one produced normal shoots.

as a result of the infection. Damage to plants of the colline ecotype 5.4.12 by E-52 was severe both in plot and pot experiments (Table 1 and 2; Figure 3 C, D). The other colline ecotype of cypress spurge (5.4.14) seems to be resistant against this strain (Table 2).

In comparison to E-45, E-52 seems to be more virulent in natural stands (Figures 1 and 2) as well as in experimental trials (Figure 3). The host range of E-52 probably does not transgress the limit of the species *Euphorbia cyparissias*. Since 1981, it has been kept in a nursery on its original host plants together with other cypress spurge ecotypes and *Euphorbia* species (*E. amygdaloides* L., *E. dulcis* L., *E. esula*, *E. lathyris* L., *E. stricta* L., *E. verrucosa* L., *E. waldsteinnii*). So far only cypress spurges have been infected. Yet host specificity of E-52 probably is not too limited, since four out of five cypress spurge ecotypes available were infected. This strain seems to be a good candidate for the biocontrol of cypress spurges.

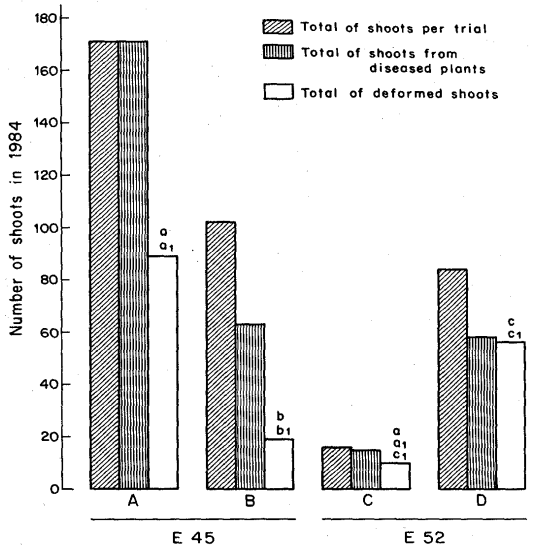

Figure 3. Damage to cypress spurge 5.4.12, by *Uromyces scutellatus* s.str. (E-45) and *U. alpestris* (E-52) in experimental trials. Initials A, B, and C root segments were inoculated on August 30, November 8, and November 8, respectively, and grown directly in the soil, whereas D root segments were inoculated on December 10 and grown in pots. Columns with different letters are significantly different at the 1% level. Letters a, b, and c refer to percent deformed shoots of diseased plants; a_1, b_1, and c_1, to percent deformed shoots of total shoot number.

Acknowledgments

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