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FIRST REPORT OF THE ALFALFA BLOTCH LEAFMINER (DIPTERA: AGROMYZIDAE), AND SELECTED PARASITES (HYMENOPTERA: EULOPHIDAE) IN MINNESOTA AND WISCONSIN, USA

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ABSTRACT

Alfalfa blotch leafminer, *Agromyza frontella*, has been a serious pest of alfalfa, *Medicago sativa*, in the northeastern U.S. and in eastern Ontario, Canada. Until recently, the western edge of the *A. frontella* distribution in the U.S. was limited to eastern Ohio. We document for the first time, the occurrence of *A. frontella* in Minnesota and Wisconsin. Alfalfa stems damaged by *A. frontella*, based on adult feeding punctures, obvious blotched leafmining or the presence of larvae, were first found in 3 northern Minnesota counties during October, 1994. Infested counties included Lake of the Woods, Cook and Lake, all bordering western Ontario, Canada. In 1995, *A. frontella* was again found in Cook and Lake counties, where 99–100% of the stems, and 18–35% of the trifoliates/stem, contained larvae or exhibited obvious feeding damage. In 1996, following a more expanded survey, a total of 11 and 5 counties, in Minnesota and Wisconsin, respectively, showed some level of *A. frontella* feeding damage (stem samples ranged from <5 to 100% infested). Based on additional counties surveyed 11 October, 1996, where *A. frontella* was not found, we now have a reasonable estimate of the southern edge of the distribution in Minnesota and Wisconsin. A total of 2 and 6 *A. frontella* adults were identified from sweep-net samples taken from fields with obvious feeding damage during 1995 (Lake Co.) and 1996 (Cook Co.), respectively. Three eulophid (Hymenoptera) parasites were reared from *A. frontella*-infested alfalfa stems collected during October, 1994 in Cook Co., Minn., including: *Diglyphus begini*, *D. pulchripes*, and *Diglyphus* sp., prob. *isaea*, all of which are new records. Our hypothesis is that *A. frontella* moved into Minnesota from Ontario Canada, via alfalfa hay purchased by northern Minnesota growers.

The alfalfa blotch leafminer, *Agromyza frontella* (Rondani) (Diptera: Agromyzidae), was first discovered in the United States in 1968 (Miller and Jensen 1970) and in eastern Ontario, Canada in 1972 (Harcourt 1973). As of 1981, the leafminer's distribution in U.S. alfalfa, *Medicago sativa* L., was

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limited to the northeastern states, with the western edge of the distribution reaching eastern Ohio (Hendrickson and Plummer 1983). Losses by *A. frontella* in the northeastern U.S. were estimated to exceed $13 million annually (Hendrickson and Plummer 1983). Despite rapid expansion during the 1970s, *A. frontella* was suppressed by a variety of introduced parasitic Hymenoptera (Hendrickson and Plummer 1983). Although more than 20 species of parasites are known to attack *A. frontella* (Coote and and Ellis 1986), the braconid, *Dacnusa dryas* (Nixon), imported from western Europe (Drea and Hendrickson 1986), has clearly provided the most effective biological control of the leafminer in North America (Drea and Hendrickson 1986, Harcourt et al. 1988). The purpose of this paper is to document the: (1) current extent of a recent expansion of the leafminer's range into the upper midwestern U.S., (2) magnitude of *A. frontella* infestation levels in Minnesota and Wisconsin, and (3) incidence of selected parasites recovered from *A. frontella* in Minnesota.

MATERIALS AND METHODS

Minnesota surveys for *A. frontella* were conducted during Sept.-Oct., from 1994-1996. Wisconsin counties were monitored only during 1996. Because of time constraints, most samples were limited to fields bordering rural highways. At all locations, single-stem samples were taken to quantify feeding damage within each field; at selected Minnesota sites, sweep-net samples were taken to collect *A. frontella* adults for identification. Depending on alfalfa stand quality, a range of 10–100 single-stem samples were taken in each field by walking "Z"- shaped transects, with individual stems pulled at random along each transect. Stems were cut at the soil surface, placed in paper or plastic bags, and held in coolers for transport to the laboratory. Five sets of 20 pendulum sweeps (N=100/field) were taken in Minnesota alfalfa fields sampled in Cook and Lake counties during 1995 and 1996; samples were placed in plastic bags, returned to the laboratory and held in a freezer prior to identification of *A. frontella* adults.

Stem samples were evaluated in the laboratory by recording the number of stems infested, with one or more leaflets showing at least one of the following: (1) presence of *A. frontella* maggots, (2) obvious "blotched" leafmining feeding damage, or (3) characteristic "pin-hole" feeding punctures made by adult *A. frontella*. Obvious feeding punctures and blotching damage were based on color photographs of *A. frontella* feeding behavior (Bereza 1979). The total number of infested trifoliates per stem was also recorded and defined as at least one leaflet per trifoliate infested with *A. frontella* maggots, showing obvious blotching damage, or adult feeding punctures.

Adult *A. frontella* specimens, collected by sweep-net sampling, were identified in 1995 and 1996 by comparison with *A. frontella* adult voucher specimens, previously identified in Ohio, using the following characters from Steyskal's classification (Steyskal 1972): arista-bearing antennal segment (=3rd) round, vs. elongate; subcostal vein distinct to costa—not joining R1 before wedge-shaped area; halteres ivory white—not black, except on stalk; body and legs dully black—without yellow, metallic blue, or shiny black color; and 4 long pairs of dorsocentral bristles—other species often with 3 or less.

Parasites of *A. frontella* were reared by placing alfalfa stems, infested with *A. frontella*, in water, within a 30 × 30 × 60 cm nylon-mesh sleeve cage, and allowing all parasites to emerge (from either *A. frontella* larvae or pupae). All Hymenoptera were preserved in 75% ethanol prior to identification. Voucher specimens of all parasites and adult *A. frontella,* obtained from

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sweep-net samples, were placed in the Insect Museum, Dept. of Entomology, University of Minnesota, St. Paul, MN.

RESULTS

On 5 October 1994, we documented for the first time in Minnesota, high levels of *A. frontella*, averaging 50–100% of the alfalfa stems showing obvious feeding damage, adult feeding punctures, or the presence of one or more *A. frontella* larvae (data not shown). Infested counties included Lake of the Woods, Cook and Lake, all bordering southern Ontario, Canada. In 1995, *A. frontella* was again found in Cook and Lake counties (Table 1), where 99-100% of the stems, and 18-35% of the trifoliates/stem, contained larvae or exhibited obvious feeding damage. In 1996, following a more expanded survey, a total of 11 and 5 counties, in Minnesota and Wisconsin, respectively, showed some level of *A. frontella* feeding damage (Table 1, Fig. 1). Based on additional counties surveyed 11 October, 1996, where *A. frontella* was not found, we now have a reasonable estimate of the southern edge of the distribution in Minnesota and Wisconsin (Fig. 1). A total of 2 and 6 *A. frontella* adults were identified from sweep-net samples taken from fields with obvious feeding damage during 1995 (Lake Co.) and 1996 (Cook Co.), respectively. The present *A. frontella* distribution has now expanded into the fringe of major alfalfa production regions of central Minnesota, and is well into major production areas of western Wisconsin.

Several eulophid parasites were reared from *A. frontella*-infested stems, taken from Cook Co. Minnesota, 5 October 1994. Identified parasites include: 10 *Diglyphus begini* (Ashmead), 4 *Diglyphus pulchripes* (Crawford), and 3 *Diglyphus* sp., prob. *isaea* (Walker), all of which represent new distribution records for Minnesota.

DISCUSSION

Despite earlier westward movements of *A. frontella* in N. America (e.g., Hendrickson and Plummer 1983), this report is, to our knowledge, the first documentation of *A. frontella* in Minnesota and Wisconsin. Because of the common practice of northern Minnesota growers to purchase alfalfa from Canadian suppliers, our hypothesis is that *A. frontella* likely entered the state as early as 1991 via alfalfa purchased in the Thunder Bay, and/or Rainey River, Ontario region. The primary grower with *A. frontella*-infested alfalfa in Cook Co., had purchased hay in Thunder Bay in 1991 and 1992, but not in 1993, indicating *A. frontella* had successfully overwintered during 1992-1993 and 1993-1994, prior to our Minnesota collection in October, 1994. The Thunder Bay area has been known to harbor *A. frontella* infestations since 1991 (J. Heard, unpublished data). Unfortunately, unlike much of eastern Ontario, *D. dryas* has not yet become well established in western Ontario.

Given the isolated, small *A. frontella*-infested fields (< 5 ha each) surrounded by forests, it was initially surprising to see the high level of southward migration in 1996. However, Hendrickson and Plummer (1983) reported *A. frontella* migration rates of 48–80 km/yr. Thus, a 200 km distance, e.g., from Cook to Chisago Co., Minn., over 2-3 yr, would not be insurmountable.

Many studies have attempted to quantify the *A. frontella*/yield loss relationship (for review, see Hendrickson and Plummer 1983). Conservative estimates from these studies indicate that yield losses typically average 5-7%, over a wide range of infestation levels. Based on these reports, Harcourt

Table 1. Incidence of *A. frontella* in Minnesota and Wisconsin alfalfa, 1995–1996

Sample	County	City(C) or Township (T)	Field	Mean % Stems Infested	Mean % Trifoliates Infested	Number of Stems (*n*)
Minnesota						
11 Sep., 1995	Cook	Grand Marais(C)	1	100	18.2	100
11 Sep., 1995	Cook	Grand Marais(C)	2	99	24.0	100
11 Sep., 1995	Cook	Grand Marais(C)	3	100	35.4	100
11 Sep., 1995	Lake	Two Harbors(C)	1	100	30.2	100
11 Sep., 1995	Lake	Two Harbors(C)	2	100	31.5	100
23 Sep., 1996	Cook	Grand Marais(C)	1	61	8.0	83
23 Sep., 1996	Cook	Grand Marais(C)	2	13	0.4	82
23 Sep., 1996	Cook	Grand Marais(C)	3	19	2.4	84
23 Sep., 1996	Lake	Two Harbors(C)	1	100	15.5	82
24 Sep., 1996	Pine	Pine City(C)	1	98	19.7	50
1 Oct., 1996	Lake of the Woods	Zipple(T)	1	96	27.1	25
11 Oct., 1996	Benton	Graham(T)	1	≤5*	—*	20
11 Oct., 1996	Chisago	North Branch(C)	1	92	15.8	50
11 Oct., 1996	Isanti	Dalbo(T)	1	30	2.4	43
11 Oct., 1996	Isanti	Pine Brook(T)	2	50	4.0	44
11 Oct., 1996	Kannebec	South Fork(T)	1	36	3.9	50
11 Oct., 1996	Mahnomen	Tembina(T)	1	100	28.1	23
11 Oct., 1996	Mahnomen	Tembina(T)	2	100	27.9	25
11 Oct., 1996	Mahnomen	Popal Grove(T)	1	86	16.1	22
11 Oct., 1996	Mahnomen	Beaulieu(C)	1	95	15.6	21
11 Oct., 1996	Mahnomen	Beaulieu(C)	2	30	3.1	20
11 Oct., 1996	Mille Lacs	Foreston(C)	1	52	4.5	46
11 Oct., 1996	Mille Lacs	Borgholm(T)	1	≤5*	—*	10
11 Oct., 1996	Morrison	Two Rivers(T)	1	≤5*	—*	20
Wisconsin						
24 Sep., 1996	Burnett	Hertel(C)	1	100	37.8	23
24 Sep., 1996	Sawyer	Ojibwa(C)	1	100	37.3	25
11 Oct., 1996	Barron	Almena(C)	1	100	20.2	45
11 Oct., 1996	Polk	Lamar(C)	1	60	4.2	40
18 Oct., 1996	St. Croix	Somerset(C)	1	10	0.6	40

*Fields with low *A. frontella* infestations; more extensive sampling was not possible because of poor, or recently planted alfalfa stands.

(1983) concluded that 30% of the leaflets with blotched mining was a reasonable economic injury level. As indicated by our survey (Table 1), several fields in Minnesota and Wisconsin approached this level of damage. Though damage by *A. frontella* in a given field may not be critical, the loss incurred over several million hectares in the upper midwestern U.S. could be significant for the midwest dairy industry. Of particular concern for southern Minnesota and Wisconsin, is the possibility that *A. frontella* may complete 3-5 generations/yr at these latitudes (Guppy 1981), and potentially cause economic losses on each of the 3-4 cuttings.

Given the recent movement of *A. frontella* into new, major alfalfa production regions, and lack of evidence for *D. dryas* in Minnesota, we suggest a renewed effort be made to release *D. dryas* in recently infested areas. Previous

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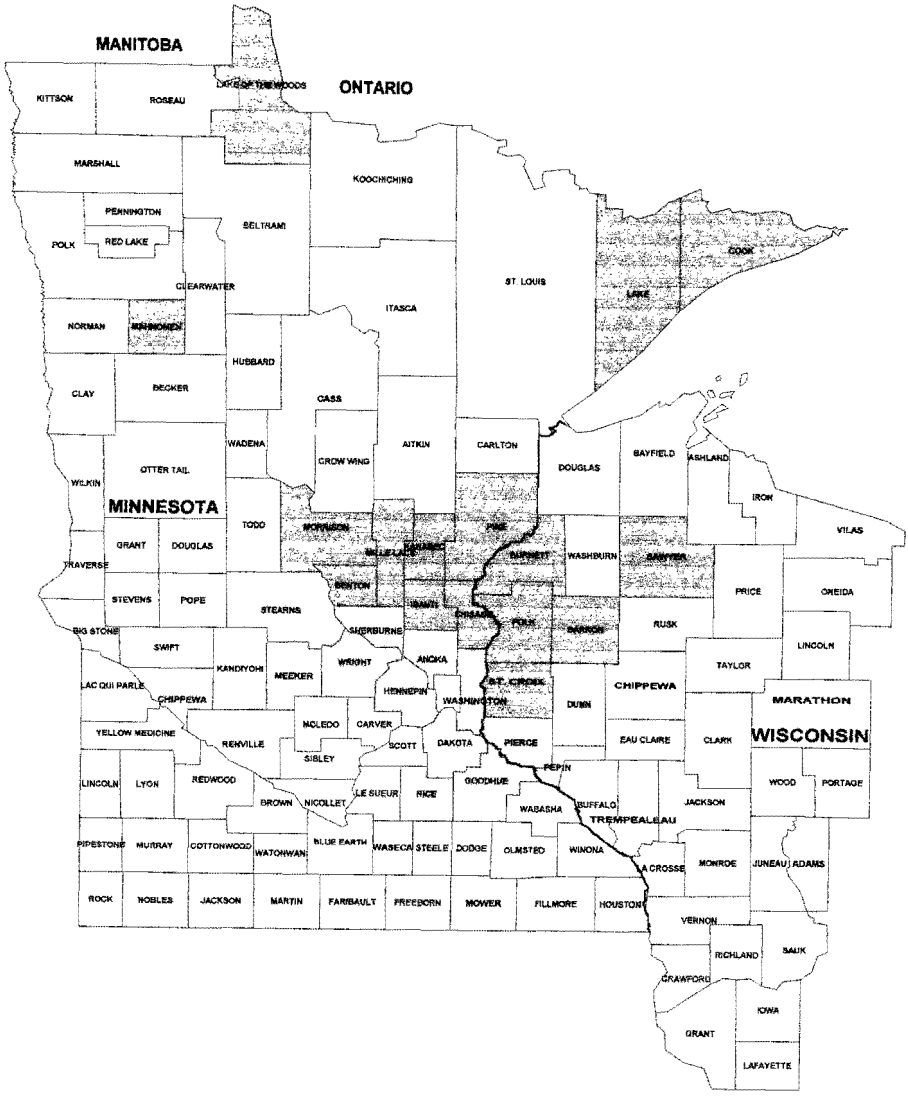

Figure 1. Distribution of *A. frontella*, in Minnesota and Wisconsin, U.S., based on surveys conducted during Sept.–Oct., 1994–1996 (dark shading = counties positive for *A. frontella* for at least one of 3 yr; light shading = counties surveyed in 1996, but *A. frontella* not found).

research in other regions of N. America has shown that *D. dryas* is the best long-term solution, with *A. frontella* control usually complete within 5 yr of release (Hendrickson and Plummer 1983, Harcourt et al. 1988). In the interim, economic injury levels and sampling plans (Harcourt 1983) should be validated for *A. frontella* in the midwestern U.S., to minimize unnecessary insecticide use, and avoid disruption of an increasingly effective biological control program for the alfalfa weevil, *Hypera postica* (Gyllenhall), in Minnesota (Flanders et al. 1994).

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