2008

NEW RECORDS FOR *ACERIA ANTHOCOPTES* (ACARI: ERIOPHYIDAE) OCCURRING ON CANADA THISTLE IN COLORADO, NEBRASKA, AND WYOMING, U.S.A.

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NEW RECORDS FOR *ACERIA ANTHOCOPTES (*ACARI: ERIOPHYIDAE*)* OCCURRING ON CANADA THISTLE IN COLORADO, NEBRASKA, AND WYOMING, U.S.A.[1]

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ABSTRACT: Canada thistle [*Cirsium arvense* (L.) Scop.] growing in eastern Colorado, Wyoming and western Nebraska were surveyed for the presence and distribution of *Aceria anthocoptes* (Nal.). Of the 34 sites surveyed in 2004, mites were abundant at 42%, present in lesser numbers at 52%, and not present at 6% of the sites. In 2005, two new sites were added and ten sites sampled in 2004 were revisited. Of these 12 sites, mites were abundant at 17%, present to a lesser extent at 58%, and not present at 25% of the sites. The results demonstrate that Canada thistle growing in this region commonly harbor *A. anthocoptes*. How long *A. anthocoptes* has been present in this region is unknown, however, anecdotal evidence demonstrating a dramatic decline in the population of Canada thistle at one Colorado site from 2000 to 2007 suggests that the mite may have been present since 2002.

KEY WORDS: *Aceria anthocoptes*, Canada thistle, biological control, state records

Canada thistle [*Cirsium arvense* (L.) Scop.], is a perennial composite that is native to southeastern Europe and the eastern Mediterranean. Presently it occurs throughout most temperate regions of the world (Moore 1975; Holm et al., 1997). While the date of its introduction into the United States is unknown, Canada thistle was recognized as a troublesome weed as early as 1795 when Vermont established legislation for its control (Moore 1975). Based on the review of weed lists from the United States and southern Canada, Canada thistle was the most frequently listed noxious weed out of 45 noxious weeds included in the study; demonstrating that it continues to be of concern in the temperate regions of North America (Skinner et al., 2000).

Because of the expense involved in the use of chemical and/or cultural methods for weed control, biological control agents are generally considered the primary option for invasive weed control in natural systems. Several insect enemies of Canada thistle have been developed and/or deployed in an effort to control this invasive weed, such as leaf- and bud-feeding beetles [*Altica carduorum* Guerin-Meneville, *Lema cyanella* (L.), and *Cassida rubiginosa* Muller, Coleoptera: Chrysomelidae], stem-boring beetles (*Ceutorhynchus litura* (F.), Coleoptera: Curcu-

[1] Received on February 6, 2008. Accepted on February 25, 2008.

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Mailed on February 19, 2009

lionidae), seed-feeding beetles (*Rhinocyllus conicus* (F.), Coleoptera: Curculionidae), stem-galling flies (*Urophora* spp., Diptera: Tephritidae), and other insects (Rees 1991; Julien and Griffiths 1998; Campobasso et al., 1999; Gassmann 2005). The release and predation of these insect enemies of Canada thistle has had an effect, but satisfactory control has yet to be obtained (Michels, pers. obs).

Recently, an eriophyid mite, *Aceria anthocoptes* (Nal.), that attacks Canada thistle was reported in the United States (Ochoa et al., 2001). This is the only *Aceria* mite species known to attack Canada thistle (Petanoviæ et al., 1997; Magud et al., 2007) and preliminary results suggest that the mite is host specific (Ochoa et al., 2001). Infestations of *A. anthocoptes* on Canada thistle can result in leaf bronzing, epinasty, and dessication (Rancic et al., 2006). As part of an ongoing program to control noxious weeds on Federal installations in Colorado and Wyoming, consideration has been given to the release of *A. anthocoptes* in natural areas at these installations to further increase the predatory pressure on Canada thistle. Although *A. anthocoptes* is widely distributed in the Mid-Atlantic region and has been reported in the north-central states of Minnesota and North Dakota (Ochoa et al., 2001), it was unknown if the mite was present in Colorado, Wyoming, and Nebraska. The objective of this study was to assess the presence and distribution of *A. anthocoptes* in the Colorado-Wyoming-Nebraska region.

METHODS

Collection and processing of samples. Samples of Canada thistle were collected from a total of 36 different sites located in Colorado, Nebraska, and Wyoming during August of 2004 and 2005 (Table 1, Fig. 1). Samples consisted of the stems, leaves, and flowers from the top half of the above-ground portion of the plants. Upon collection, samples were placed in plastic bags and held over ice during transport to the laboratory; where they were held at 4ºC until examined.

Approximately 25 g of plant material was transferred to a 2.5 L flask, 250 ml of water was added, and the contents of the flask were vigorously shaken for 15 s. The water suspension was vacuum filtered through a 0.8 μ Supra Gellman membrane. The suction was removed after all the water passed through the filter but before the membrane dried. A second wash as described above with a fresh membrane immediately followed. The two membranes were then examined under a dissecting microscope for the presence of eriophyid mites. When present, mite specimens were collected, transferred to 70% ethanol, and stored at 4ºC. An additional 25 g sample of plant material was processed as above if no mites were observed on the first set of membranes. No attempt was made to obtain an exact count of the mites present on the membranes. However, the relative abundance of the mites was assessed as follows: not present (NP), no mites observed; present (P), mites present but careful and extensive searching of the membrane was required to retrieve mites, and abundant (A), high numbers of the mites were collected in a short period of time, many remained uncollected.

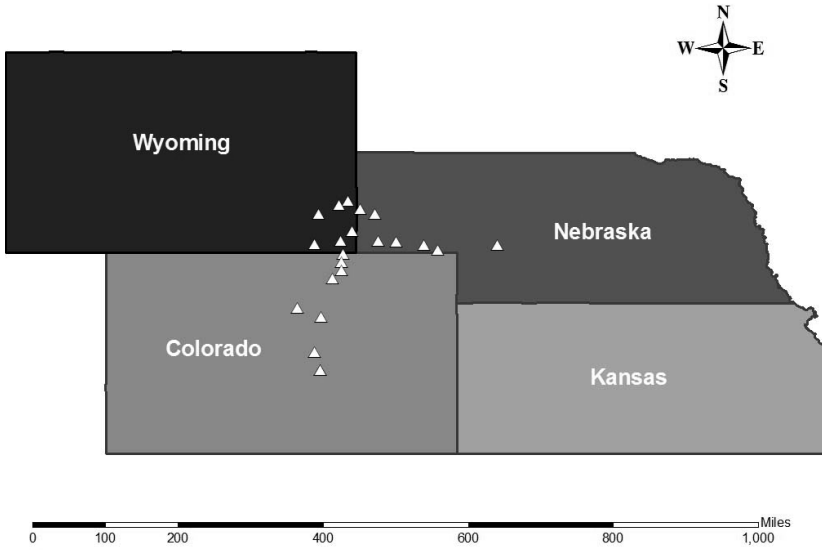

Fig. 1. Map showing sites in Wyoming, Colorado, and Nebraska where Canada thistle (*Cirsium arvense*) plant material was collected.

Canada thistle population density measurements. At one site, designated ARA1 at Ft. Carson, the population density of Canada thistle was monitored from 2000-2007. For each year, the perimeter of the Canada thistle infestation was mapped using either Satlock backpack (2000-2005) or Trimble GeoXT handheld GPS units (2006 and 2007). Once the perimeter was mapped, the area of the infestation was gridded using GPS data collection software, and samples were taken from each grid square by tossing a ½ meter PVC sampling square toward the center of the block. All Canada thistle plants within the sampling square were counted. The number of samples taken in a given year depended on the size of the infestation perimeter, with the grid size remaining constant at 25 m^2.

Microscopic examination of specimens. Mites collected from the Canada thistle samples and stored in 70% EtOH were prepared for microscopic examination as described in Amrine and Mason (1996). The prepared slides were examined under a compound microscope and the identification of the mites was based on standard mite taxonomic keys (Amrine et al., 2003) and specific morphological traits for the species as reported by Petanoviæ et al. (1997).

Table 1. Survey of *Aceria anthocoptes* on Canada thistle (*Cirsium arvense*) growing in Colorado (CO), Wyoming (WY), and Nebraska (NE) in 2004 and 2005. Shaded rows indicate sites that were visited once during both years.

Site no.	State	Location [2]	Year	Latitude °	Latitude '	Latitude "	Longitude °	Longitude '	Longitude "	Elev. (m)	Mite abundance 2004 [1] NP	Mite abundance 2004 [1] P	Mite abundance 2004 [1] A	Mite abundance 2005 [1] NP	Mite abundance 2005 [1] P	Mite abundance 2005 [1] A
1	WY	Torrington	2004	42	1	26	104	12	47	1293	x					
2	WY	Torrington	2004	42	1	21	104	12	58	1288		x				
3	WY	Veteran	2004	41	56	36	104	22	56	1303		x				
4	WY	Chugwater	2004	41	46	16	104	47	59	1714		x				
5	WY	Albin	2004	41	25	7	104	7	34	1654		x				
6	WY	Burns	2004	41	13	30	104	20	57	1661			x			
7	WY	Warren Air Force Base	2004	41	9	25	104	52	23	1872		x				
8	WY	Warren Air Force Base, Nature Trail 3	2005	41	9	5	104	52	6	1847						x
9	NE	Stegall	2004	41	52	17	103	57	35	1275		x				
10	NE	Gering	2004	41	45	46	103	40	29	1228		x				
11	NE	Kimball	2004	41	14	9	103	36	37	1438			x			
12	NE	Potter	2004	41	12	33	103	14	39	1338			x			
13	NE	Lodgepole [3]	2004	41	9	20	102	42	6	1192		x				
14	NE	Lodgepole [3]	2004	41	9	20	102	42	6	1192			x			
15	NE	Sutherland	2004	41	8	39	101	13	28	928			x			
16	NE	Chappell	2004	41	3	5	102	24	49	1120			x			
17	CO	Hereford	2004	40	58	25	104	18	39	1651			x			
18	CO	Near Hereford	2004	40	48	5	104	20	5	1540		x				
19	CO	Briggsdale	2004	40	38	37	104	20	6	1493		x				
20	CO	Near Cornish	2004	40	28	44	104	31	19	1443		x				

Site no.	State	Location [2]	Year	Latitude			Longitude			Elev.	Mite abundance 2004 [1]			Mite abundance 2005 [1]		
				°	'	"	°	'	"	(m)	NP	P	A	NP	P	A
21	CO	Rocky Flats, Lindsey Ranch	2004	39	54	7	105	12	54	1802			x			
21	CO	Rocky Flats, Lindsey Ranch	2005	39	54	7	105	12	54	1802					x	
22	CO	Buckley Air Force Base, Williams Lake	2004	39	42	56	104	45	13	1690			x			
23	CO	Buckley Air Force Base, Runway	2004	39	41	40	104	44	20	1718		x				
24	CO	Buckley Air Force Base, South Aspen Way	2004	39	42	30	104	46	44	1675			x			
25	CO	Air Force Academy Parade Loop	2004	39	1	1	104	52	22	2077			x			
25	CO	Air Force Academy Parade Loop	2005	39	1	1	104	52	22	2077					x	
26	CO	Air Force Academy, Ice Lake 1	2004	38	58	2	104	50	19	1954		x				
26	CO	Air Force Academy, Ice Lake 1	2005	38	58	2	104	50	19	1954				x		
27	CO	Air Force Academy Kettle Lake	2004	38	57	38	104	48	51	1947			x			
27	CO	Air Force Academy Kettle Lake	2005	38	57	38	104	48	51	1947					x	

Site no.	State	Location [2]	Year	Latitude			Longitude			Elev.	Mite abundance 2004 [1]			Mite abundance 2005 [1]		
				º	'	"	º	'	"	(m)	NP	P	A	NP	P	A
28	CO	Air Force Academy Ice Lake 2	2004	38	57	36	104	50	9	1928			x			
28	CO	Air Force Academy Ice Lake 2	2005	38	57	36	104	50	9	1928					x	
29	CO	Ft. Carson, Reservoir	2004	38	43	44	104	48	34	1841		x				
30	CO	Ft. Carson, Reservoir	2005	38	39	47	104	46	53	1745				x		
31	CO	Ft. Carson, ARA1 [3]	2004	38	39	38	104	46	13	1729			x			
31	CO	Ft. Carson, ARA1 [3]	2004	38	39	38	104	46	13	1729		x				
31	CO	Ft. Carson, ARA1	2005	38	39	36	104	46	10	1731				x		
32	CO	Ft. Carson, ARA2 [3]	2004	38	39	20	104	45	51	1713		x				
32	CO	Ft. Carson, ARA2 [3]	2004	38	39	20	104	45	51	1713		x				
32	CO	Ft. Carson, ARA2	2005	38	39	35	104	45	53	1711						x
33	CO	Ft. Carson, Hwy 115	2004	38	38	43	104	51	42	2002		x				
33	CO	Ft. Carson, Hwy 115	2005	38	38	43	104	51	42	2002					x	
34	CO	Ft. Carson, Duckpond	2004	38	35	48	104	51	51	1877	x					
34	CO	Ft. Carson, Duckpond	2005	38	35	48	104	51	51	1877					x	
Total											2	18	14	3	7	2
Percentage for year											6	52	42	25	58	17

[1] NP = mites not present; P = mites present but not abundant, significant searching of the membrane required to retrieve mites; A = mites abundant, high numbers of mites were collected in a short period of time, many remained uncollected.

[2] Warren Air Force Base, Cheyenne, WY; Rocky Flats National Wildlife Refuge - Northwest of Golden, CO; Buckley Force Air Base - Southeast of Aurora, CO; Air Force Academy - North of Colorado Springs, CO; Ft. Carson Military Reservation - Southern part of Colorado Springs, CO.

[3] Sites with the same name and GPS reference point were taken at different locations within the site but were not sufficiently separated to generate unique GPS locations.

RESULTS

Most plant samples collected from populations of Canada thistle located at 34 different sites in three different north-central states during 2004 and 2005 harbored mites and insects of various species. The eriophyid mites collected from the Canada thistle specimens were determined to be of the vagrant type as there were no gall formations present on any of the specimens examined. All eriophyid mites present on the plant tissue exhibited vermiform bodies with posterior opisthosoma annuli, continuous and subequal dorsoventrally (Fig. 2A). The adult females, varying from 130 – 190 μm, had a prodorsal shield with a median line that was complete, uninterrupted and usually straight; two admedian lines that were complete, uninterrupted and slightly curved at the posterior edge; and two submedian lines, one to each lateral side curved close to the bases of the dorsal tubercle of the scapular setae (Fig. 2B). The genital coverflap was ornamented with one rank of lineate ribbing (Fig. 2C). All the above characteristics are consistent with those of *A. anthocoptes* (Ochoa et al., 2001; Amrine et al., 2003; Rancic et al., 2006; Magud et al., 2007).

This mite species was found at 94% of the 34 Canada thistle populations sampled in 2004; it was abundant at 42% of the sites, present in low numbers at 52% of the sites, and not present at 6% of the sites (Table 1). Mite populations declined at 70% of the sites resurveyed in 2005. Of the two new sites surveyed in 2005, *A. anthocoptes* was abundant at one and not present at the other (Table 1). It should be noted that these were one-time samples for the entire year, and although they do give an indication of mite abundance, a thorough sampling of each site over the course of the growing season may have yielded different mite abundance results.

The Canada thistle population located at Ft. Carson, ARA 1 was monitored from 2000 to 2007. The average Canada thistle densities were 14, 13, 5, 1, 3, 4, 2, and 0 plants m^{-2}, respectively.

DISCUSSION

The surveys conducted in 2004 and 2005 confirmed the presence of *A. anthocoptes* in Colorado, Nebraska and Wyoming. Based on the high frequency of occurrence in Canada thistle populations reported here and in a previous survey conducted in the mid-Atlantic region (Ochoa et al., 2001), it appears that *A. anthocoptes* is widely distributed across the U.S. Whether it was introduced into the U.S. from Canada into the west and carried across the continent by the prevailing winds or inadvertently distributed from the east to the west via contaminated feed stock or movement of vehicles and/or people remains unknown.

Interestingly, earlier observations (2002) of plants at this site by one of the authors (Michels, unpublished) revealed damage similar to what was later associated with infestations of *A. anthocoptes* (i.e., leaf bronzing, epinasty, dessication and stunting). As no other biocontrol agent has become established in significant numbers at this site, the general decline over the years and ultimate disappearance of Canada thistle at this site may indicate that *A. anthocoptes* may have been present in Colorado earlier than 2004.

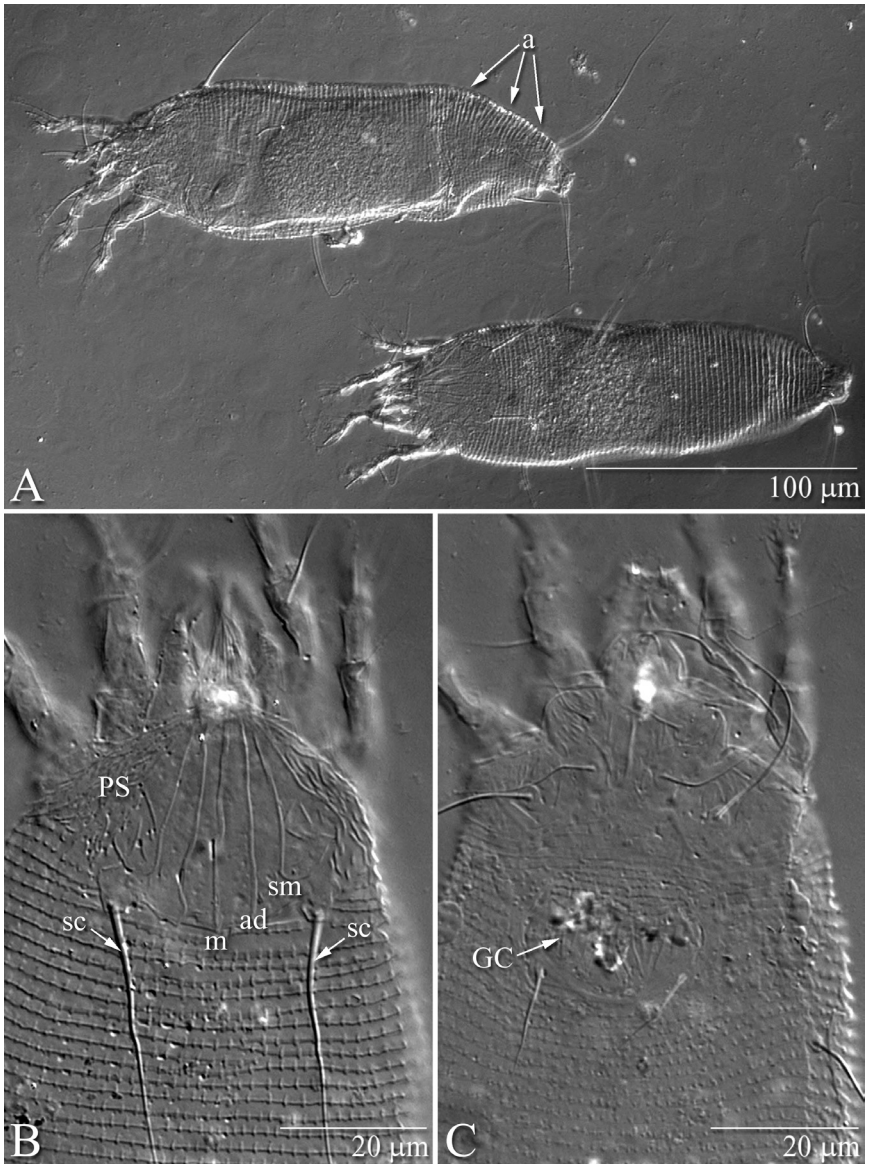

Fig. 2. Microphotograph of *Aceria anthocoptes* females displaying dorsal, ventral, and lateral views: A. general view of dorsal-ventral and lateral sides; B. view of prodorsal shield; and C. view of genital region. a = annuli; ps = prodorsal shield; m = median; ad = admedian; sm = submedian; sc = scapular setae; gc = genital coverflap.

The benefits of using *A. anthocoptes* in the biological control of Canada thistle have yet to be determined. Working within the geographical areas in Colorado where the mite has now been documented to be present, studies are underway to determine the impact of the mite on previously uninfested Canada thistle populations. In addition, studies by our group and others (Richard W. Hansen, USDA-APHIS-PPQ, Ft. Collins, CO, pers. comm.) are being conducted to determine the genetic relationship of *A. anthocoptes* to eriophyid mites found on closely related *Cirsium* species.

ACKNOWLEDGMENTS

Research reported in this paper was supported in part by a grant from the U.S. Department of Defense through the U.S. Fish and Wildlife Service (Agreement 601814J251). The authors thank Bruce Rosenlund, U.S. Fish and Wildlife Service, Project Leader, CO FWAO; Tom Warren, Director, Directorate of Environmental Compliance and Management at Ft. Carson; Dr. Brian Mihlbachler, Natural Resources Manager, U.S. Air Force Academy; Floyd Hatch, Natural and Cultural Resources Coordinator, Buckley Air Force Base; Cathy Pesenti, Environmental Management Flight, F. E. Warren Air Force Base; and Amy Thornburg, U.S. Fish and Wildlife Service, Rocky Flats National Wildlife Refuge site for their continued support and assistance in the noxious weed biological control implementation program.

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