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Aceria artemisiifoliae Vidović & Petanović (Acari: Eriophyoidea) on common ragweed – the second record in the world

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Abstract: Common ragweed – *Ambrosia artemisiifolia* L. (Asteraceae) is an invasive plant species in Europe native to North America. Most of the records of known eriophyid mites on different ragweed species are from their native range. Our field experiments in Slovakia, 2016–2023, aimed to identify specific species feeding on common ragweed. We searched for symptomatic plants and collected growing tips, which were then preserved in 70% ethanol for further study. A recently described species of eriophyid mite, *Aceria artemisiifoliae* Vidović & Petanović (Acari: Eriophyoidea), was found in western and eastern Slovakia. This is the first record of the species in Slovakia and the second record in the world. It remains unclear whether this species is invasive like *Ambrosia*, and whether it could be used as a potential biological control agent.

Keywords: eriophyid mite; new record; invasive species; *Ambrosia artemisiifolia*; leafy rosette

Eriophyoidea is an economically important group due to the direct damage they can cause to their host (Van Leeuwen et al. 2010; de Lillo et al. 2018) and their ability to transmit plant diseases increases their harmfulness (Oldfield & Proeseler 1996; Gamliel-Atinsky et al. 2010). Most are monophagous and have intimate relationships with their hosts; therefore, they are promising biological control agents in weed management (Smith et al. 2010; Marini et al. 2021).

To date, thirteen species of eriophyid mites have been described on *Ambrosia* spp. The species were summarized by Vidović et al. (2016). Ten of them have been described in the native range of *Am-*

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brosia spp. – in North America [*Aceria ambrosiae* Wilson, 1959, *A. ambrosioides* Keifer, 1966, *A. astibonis* Keifer, 1960, *A. boycei* (Keifer, 1943), *A. caborcensis* Keifer, 1965, *A. franseriae* Wilson & Oldfield, 1966, *A. potosensis* (Keifer, 1976), *Aculus ambrosiae* (Keifer, 1943), *Paraphytoptus pannolus* Keifer, 1962, and *Heterotergum schlingeri* Wilson & Oldfield, 1966)], and only one each from Cuba (*Eriophyes ambrosiae* Cook, 1906), Georgia — former USSR (*Aceria izhevskii* Livshits, Mitrofanov and Sharonov, 1983) and Serbia (*Aceria artemisiifoliae* Vidović & Petanović, 2016).

There are three types of lifestyles in eriophyid mites: vagrant or free-living, gall-inducing or refuge creating and refuge-seeking. Vagrant species of Eriophyoidea usually do not cause any visible damage. However, when their population density is high, they can cause russeting, bronzing, silvering or chlorosis of infested plant parts (Westphal & Manson 1996; Petanović & Kielkiewicz 2010b). These superficial symptoms are less diverse and less specific than those of gall-inducing species. Galls induced by eriophyids are extremely diverse in shape, size, and colour (Westphal 1992; Westphal & Manson 1996). They provide nutrition and protection from predators and adverse external conditions (Desnitskiy et al. 2023). Refuge-seeking eriophyids sequester themselves, e.g. in leaf axils, in leaf glands, or even squeeze through leaf stomata to feed and reproduce in the mesophyll layer (Chetverikov 2004; Oldfield 2005; Petanović & Kielkiewicz 2010b). Eriophyid mites pass through two immature stages – larva (1st instar) and nymph (2nd instar). A quiescent (resting) period exists between larva and nymph, nymph and adult. Immatures usually resemble adults but are smaller. Some species have two types of females – protogyne and deutogyne (Manson & Oldfield 1996). Deutogyne is the secondary female that promotes survival in adverse conditions (Krantz & Ehrensing 1990). The crucial factor for survival and reproduction is the proper host plant. The only active mode of dispersal of eriophyids is limited by ambulatory movement within the plant or by the movement to the other plant upon contact. Passive modes of dispersal are their transport by airflows, rain, and phoresy on animal carriers. Carrier dispersal is a random behaviour in eriophyid mites (Lindquist & Oldfield 1996; Michalska et al. 2010). The most common transport by airflow means a considerable risk of finding a suitable host plant (Sabelis & Bruin 1996).

Eriophyoidea are among the smallest arthropods, measuring 86–500 µm in length. They are often invisible to the naked eye and the symptoms are usually only seen in large populations (Lindquist et al. 1996). Their microscopic size and the tendency to hide within plant structures make them difficult to intercept. Therefore, eriophyids have a high potential to be an adventive mite species (Navia et al. 2010).

METHODS

Symptomatic common ragweed plants with a potential presence of eriophyid mites were collected from different habitats in Slovakia. The field surveys were carried out at irregular intervals from July to September 2016–2023. The collected growing tips of *Ambrosia artemisiifolia* L. with eriophyid mites were kept in sealed sample bottles containing 70% ethanol. The plant material was sent to Serbia. The mites were removed from the plant samples by direct examination under a stereomicroscope in the laboratory. Mite specimens were mounted in Heinz's medium (Dobrivojević & Petanović 1982) and then examined using an OLYMPUS BX53 research microscope with phase contrast and measured using the software package cell Sens Entry 2 (SC-EN-V2) on the same microscope. All examined material was deposited in the Acarology Collection, Department of Entomology and Agricultural Zoology, Faculty of Agriculture, University of Belgrade, Serbia.

RESULTS AND DISCUSSION

Vagrant eriophyid mite *Aceria artemisiifoliae* individuals (Figures 1 and 2) were found on *Ambrosia artemisiifolia* L. (Asteraceae) plants at five localities in the west and east parts of south Slovakia (Table 1). Symptomatic plants were observed in twelve other localities, except for the central part. The presence of the eriophyid mite on asymptomatic plants was not investigated. The morphological characteristics of male and female protogyne and deutogyne were the same as in the original description by Vidović et al. (2016). *A. artemisiifoliae* lives on the surface of the aboveground plant organs between the trichomes, preferably in terminal buds and male and female reproductive organs (Vidović et al. 2016). In Slovakia, symptoms were most pronounced just

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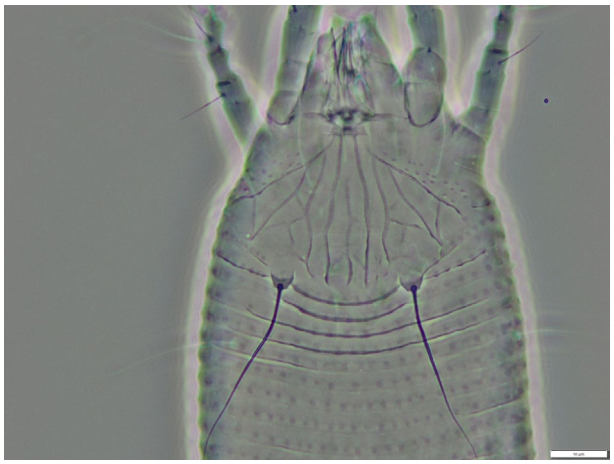

Figure 1. *Aceria artemisiifoliae* — prodorsal shield (photo Nikola Andjelković)

Figure 2. *Aceria artemisiifoliae* — 5-rayed empodium on the legs (photo Nikola Andjelković)

before inflorescence development in early July. The most prominent symptoms were stunting and yellowing or pale greening of the leaves at the growing tips and their close clustering, forming a leafy rosette (Figures 3, 4 and 5). Later, inconspicuous desiccation of the tip of developing male inflorescence emerging from the apex was observed. The symptomatic plants showed signs of suppression of apical dominance (Figure 6). Young, soft, and meristematic tissues are the most favoured, probably because of their high nutritional value (Petanović & Kielkiewicz 2010a). The feeding of vagrant species often results in russeting (or other discolouration) of the damaged tissue due to their short cheliceral stylets (Lindquist et al. 1996). According to Vidović et al. (2016), the eriophyid mite *A. artemisiifoliae* destroyed only the first layer of protodermal or epidermal cells of developing inflorescence, causing symptoms like leaf russeting. Although the damage was superficial, it contributed to Serbia's delayed development of inflorescence and length reduction. Apart from the direct damage caused by piercing, chemicals in the saliva of eriophyid mites are thought to cause local changes in the metabolism and balance of plant hormones (Chetverikov et al. 2015). Delayed inflorescence development may be a result of these hormonal changes.

This is the world's only second record of the *A. artemisiifoliae* mite. However, based on our observations, we believe that it is at least present in neighbouring countries, as the symptomatic plants were also observed in Italy around Milan in 2016 (Busto Arsizio, Corbetta, Magenta, and Magnago) and western Hungary in 2021 (Kiscsősz, Csót, Baglad and Lenti). Information on the biology, ecology, and seasonal development of *A. artemisiifoliae* is lacking. Eriophyid mites are known to be highly host-specific and monophagous (de Lillo et al. 2018). Vagrant species living on annual host plants can theoretically have wide or narrow host ranges. A wider host range usually means congeneric plant species with similar plant chemistry (Skoracka et al. 2010). *A. artemisiifolia* is the annual host plant of the eriophyid mite *A. artemisiifoliae* and other con-

Table 1. Locations with recorded and determined *Aceria artemisiifoliae* (Acari: Eriophyoidea) on common ragweed (*Ambrosia artemissiifolia*) in Slovakia

No.	Location	GPS	Date	No. of specimens
1	Malá nad Hronom	47°51'23"N 18°40'44"E	August 30, 2016	≈ 10 Eriophyid mites
	Malá nad Hronom	47°51'23"N 18°40'44"E	September 28, 2022	≈ 190 Eriophyid mites
2	Sikenička	47°55'43"N 18° 41'34"E	August 30, 2016	≈ 15 Eriophyid mites
3	Strážne	48°22'23"N 21° 50'47"E	August 25, 2016	≈ 10 Eriophyid mites
4	Veľký Horeš	48°22'22"N 21° 54'10"E	August 25, 2016	≈ 10 Eriophyid mites
5	Malé Trakany	48°24'02"N 22° 07'56"E	August 26, 2016	≈ 20 Eriophyid mites

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Figure 3. Yellowing or pale greening of the *Ambrosia artemisiifolia* leaves at the growing tips and their close clustering forming a leafy rosette (photo Peter Tóth)

Figure 5. Leafy rosette and elongation of the growing tip of *Ambrosia artemisiifolia* (photo Peter Tóth)

Figure 4. Yellowing or pale greening of the *Ambrosia artemisiifolia* leaves at the growing tips and their close clustering forming a leafy rosette on lateral shoots (photo Peter Tóth)

Figure 6. The symptomatic *Ambrosia artemisiifolia* plants showing signs of apical dominance suppression (photo Peter Tóth)

generic host plant species do not occur in Slovakia. Therefore, the mode of deutogynes survival in the off-season remains to be clarified. We observed only unspecific symptoms of the eriophyid mite. However, the damage caused by a low population density of a vagrant species should be negligible (Petanović & Kielkiewicz 2010b). The presence of the eriophyid mite on symptomless plants was confirmed in Serbia (Vidović et al. 2016). In Slovakia, symptomless plants were not examined for their presence. As some of the symptoms previously attributed to eriophyid mites were proven to be induced by phytoplasmas (Rančić et al. 2005), there is a need for more intensive investigation and detailed recognition of specific symptoms.

Interestingly, this eriophyid mite was discovered in Europe, where its host plant is invasive. This means that they could not have evolved together in Europe. Therefore, we think that some native species have adapted to *Ambrosia* or that this yet undescribed adventive species was accidentally introduced later with plant material from the host plant's area of origin. The eriophyid mite can reduce the reproductive capacity of *Ambrosia* directly (Vidović et al. 2016) and likely also indirectly, as it belongs to the group of mites that transmit viruses (Oldfield & Proeseler 1996, Smith et al. 2010; de Lillo et al. 2018). The species can be considered as a potential biological control agent. However, further extensive research is needed to fully understand its biology, ecology, virulence, and the effectiveness of natural enemies.

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