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First record of *Aceria kuko* in Slovakia

*Martin Suvák**

Botanical Garden, Pavol Jozef Šafárik University, Košice, Slovakia

**Corresponding author: martin.suvak@upjs.sk*

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Abstract: A sample of goji leaves with blisters was brought from a private garden in Vyšná Kamenica to the Botanical Garden of Pavol Jozef Šafárik University in Košice to identify the problem. The respective plant (*Lycium chinense* Miller cv. Big Berry) was bought through the internet and these distortions occurred after some time during cultivation. The mites found on the deformed leaves were examined using a light microscope and a scanning electron microscope (SEM) as well. The identity of *Aceria kuko* (Kishida, 1927), the goji berry gall mite, was confirmed. Other available possible host plants in Košice and the surroundings were checked with no positive findings. However, typical foliar galls on goji plants have been indirectly observed (through the television) in Malinovo near Bratislava. Due to the risk from this mite species not only to the goji (*Lycium* sp.) but also to the pepper (*Capsicum annuum* Linnaeus) and some other Solanaceae plants, the respective authorities of the Slovak phytosanitary service were informed.

Keywords: goji berry gall mite; *Lycium* sp.; goji berry; non-native species; phytosanitary risk

The goji berry gall mite *Aceria kuko* (Kishida, 1927) is one of the eriophyid mites known as pests of some medicinal and ornamental plants from the family Solanaceae. It is usually associated with *Lycium* sp. (*Lycium chinense* Miller and *Lycium barbarum* Linnaeus, both known as the goji berry, wolfberry, matrimony vine or boxthorn), though *Capsicum annuum* Linnaeus (sweet pepper) and *Solanum nigrum* Linnaeus (black night shade) are reported as alternative hosts (Ostoja-Starzewski 2009). Another two important solanaceous crops like *Solanum lycopersicum* Linnaeus (tomato) and *Solanum tuberosum* Linnaeus (potato) are considered, but not confirmed, as potential hosts thus far (Anderson & Ostoja-Starzewski 2010). The specimens of *A. kuko* themselves are very tiny, with the adults measuring 160–290 μm in length (Ripka & Sánchez 2017), but the macroscopic symptoms on the host plants are usually very conspicuous blisters, bead-like galls up to 5 mm in diameter, occurring mostly on the leaves (Ostoja-Starzewski 2009). More details on the biology of this eriophyid mite species are presented by Kim (1968) and Chinone (1968).

There are several *Aceria* species associated with *Lycium* sp. plants worldwide, Ostoja-Starzewski (2009) lists seven similar species (excluding synonymies). Some of them cause blister symptoms on the host plants and a microscopic evaluation is required to reliably distinguish *A. kuko* from similar ones (Manson 1972; Ostoja-Starzewski 2009; Ripka et al. 2015; Ripka & Sánchez 2017).

This mite species comes from South-East Asia and its first European record is known from Great Britain in 2008, where the infested plants (*Lycium* sp.) were imported from China via the Netherlands (Ostoja--Starzewski 2009). Later, the occurrence of this mite species was confirmed in Germany (EPPO 2011), Greece (Bardas 2012), Slovenia (Seljak 2013), Romania (Balan et al. 2014), Hungary (Ripka et al. 2015), Cyprus (Seraphides 2014), France (ANSES 2015), Serbia (Vidović et al. 2015), Bulgaria (BFSA 2016), Bosnia and Herzegovina (Zovko & Ostojić 2017), Croatia (Oštrkapa-Međurečan & Masten Milek 2018), Macedonia (Trajčevski 2018) and the Czech Republic (Hrudová & Šafránková 2018).

MATERIAL AND METHODS

The Botanical Garden of Pavol Jozef Šafárik University in Košice (BG PJŠU) operates (among others)

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counselling services related to plant health problems for the wide public especially in East Slovakia. A sample of goji berry leaves with blisters was brought by the owner of a private garden from the village of Vyšná Kamenica (N 48°47.300', E 21°29.300') on June 16th 2019. This grower bought two plants of *L. chinense* cv. Big Berry through the internet. He planted both plants in the garden and after some time one of these plants expressed blisters on its leaves, the second one seemed to stay healthy.

The sample from Vyšná Kamenica was examined under light microscope to scan both the living and dead individuals of eriophyid mites from the leaf blisters. Later, some isolated mites were prepared for analysis under a scanning electron microscope (SEM) (VEGA3, TESCAN, Slovakia). The details of the mites were compared with the corresponding structures of the closely related eriophyid mites known to cause deformations on *Lycium* sp. plants (Manson 1972; Ripka et al. 2015; Ripka & Sánchez 2017).

After analysing this sample from Vyšná Kamenica, the available *Lycium* sp. plants and some other potential host species from the family Solanaceae within the area of the BG PJŠU in Košice (both outside and in greenhouses) and the surroundings were directly checked for the occurrence of similar blister symptoms. Mediated information from more remote regions of Slovakia was also taken into account.

RESULTS AND DISCUSSION

The samples of goji berry from Vyšná Kamenica had blisters (Figure 1) which are typical symptoms of an *A. kuko* infestation. The preliminary analysis in the reflecting light showed many mobile eriophyid mites (Figure 1B). Even more details could be seen transmitted light using a microscope with higher magnification and later using a scanning electron microscope (SEM) (Figures 2–4). The identity of *A. kuko* was confirmed after comparing the scanned samples with the description of this species provided by other authors (Manson 1972; Ripka et al. 2015; Ripka & Sánchez 2017). Ripka and Sánchez (2017) especially presented a very detailed re-description of *A. kuko* with the measurements of the body parts of the females, males and nymphs and with illustrations to distinguish this species from similar *Aceria eucricotes* (Nalepa, 1892) also associated with *Lycium* sp. plants. Due to some distortions of dead mites from Vyšná Kamenica, not all the signs could be clearly seen. However, the selected distinguishing

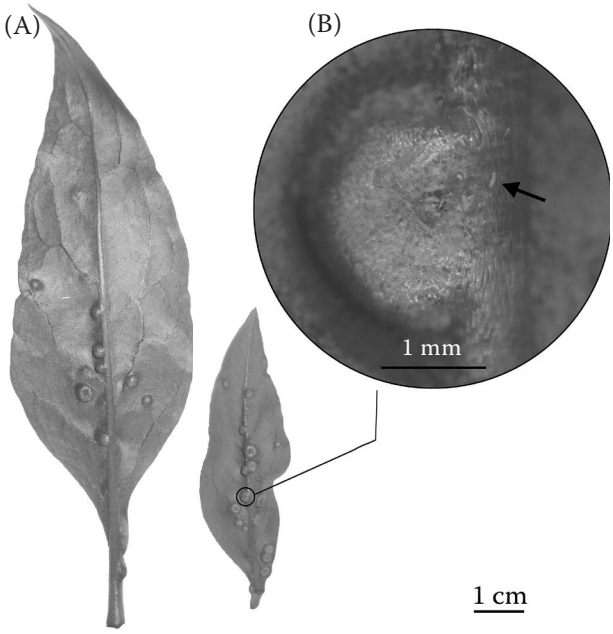

Figure 1. (A) The sample of two goji berry leaves with blisters from Vyšná Kamenica (June 16th 2019) with (B) an arrow indicating one specimen of *Aceria kuko*

features of *A. kuko* presented by Ripka and Sánchez (2017) were shown to be in accordance with the studied mites from Vyšná Kamenica: several microtubercles were present in the irregular rows between the tubercles of the scapular setae close to the posterior shield margin (Figure 2), they had smooth 5–7 dorsal semiannuli near the anal lobes, the tibia of leg I was longer than the tarsus of the respective leg.

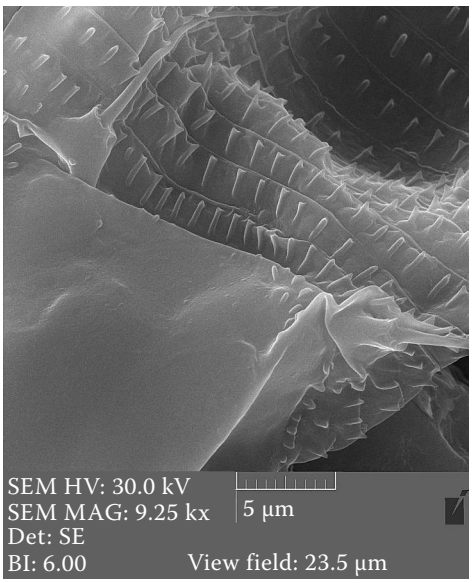

Figure 2. The SEM micrograph of *A. kuko*, the posterior region of the prodorsal shield, between the scapular tubercles

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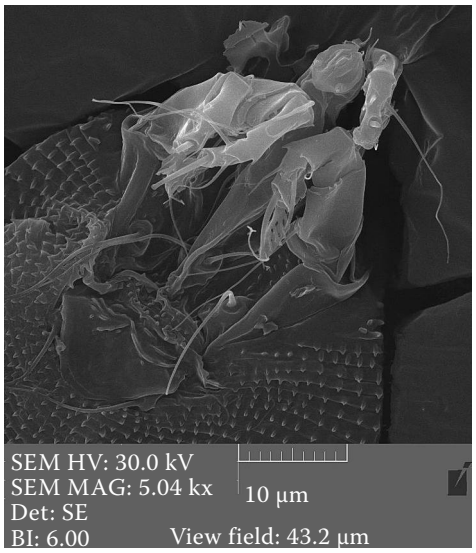

Figure 3. The SEM micrograph of *Aceria kuko*, the female coxigenital region

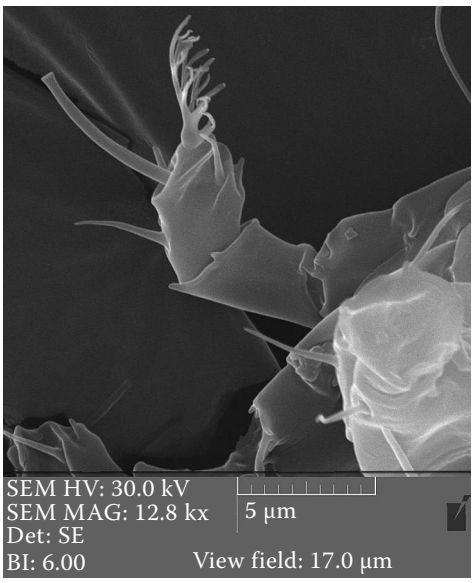

Figure 4. The SEM micrograph of *Aceria kuko*, the tarsal empodium and the solenidion of leg II

Manson (1972) compared *A. kuko* (under the synonymic name *Eriophyes tjyingi* Manson, 1972) with *Aceria pallida* Keifer, 1964, another similar eriophyid mite causing blisters on *Lycium* sp. plants. He mentioned distinguishing features for *A. kuko*: some dash like markings on the hind coxae and no spinulate microtubercles. These signs were also seen on the examined sample from Vyšná Kamenica, though some variability in the microtubercles were expressed over the body surface. On the other hand, Huang (2008) considers *A. kuko* and *A. pallida* to be the same species with variable external characteristics (admedian lines). A higher intraspecific variability in the position and shape of the microtubercles is presented by Liu et al. (2016) for the protogynes and deutogynes of *A. pallida* regarding the possible seasonal adaptation to phoresy (dispersal by insect vectors). Like in other arthropod groups, problems of interspecific and intraspecific variability in the Eriophyidae, with increasing knowledge in the future, could lead to taxonomic changes in some of the actually valid species (Lindquist et al. 1996). For now, *A. kuko* (in respect to the characteristics mentioned above) is considered as a separate and different species from *A. pallida* (Manson 1972; Ostoja-Starzewski 2009; Ripka et al. 2015).

A. kuko could represent a serious risk not only to goji plants, but also to several other important crops from the family Solanaceae (especially sweet pepper). In extreme cases, a severe infestation can result up to a 100% fruit production loss of the goji berries if all the flower buds are distorted by galls (Ciceoi & Mardare 2016). Therefore, the responsible phytosanitary institution in Slovakia – Central Control and Testing Institute in Agriculture (CCTIA) was informed about the confirmed occurrence of this mite species in Vyšná Kamenica. The owner of the respective goji plants repeatedly applied the recommended acaricides. After about 5 months, no new symptoms were expressed on the new shoots of the first plant (with blisters on the older leaves) and the second plant (formerly symptomless) still looked healthy. Therefore, *A. kuko* seems to be eradicated in Vyšná Kamenica for now, though this site remains under supervision. The internet supplier of the respective plants was also contacted. They did not admit that their plants could be a source of this new pest. However, another explanation is quite improbable in this situation. Dispersal by winds, insects or other natural vectors are usually possible only over short distances, but there were no suitable hosts in the vicinity of the infested plant, which means no close source of infestation. Distribution over longer distances is usually encountered in the international plant trade where mites are transferred with their host plants (Ostoja-Starzewski 2009; Hrudová & Šafránková 2018). Therefore, the isolated occurrence of *A. kuko* in Vyšná Kamenica looks to be connected with the supplier distributing insufficiently treated goji plants of unknown origin.

The BG PJŠU has its own collection of various Solanaceae plants, including *L. chinense*, *L. barbarum*, *L. europaeum* and other species which could be

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hosts for *A. kuko* (*C. annuum* cultivated both outdoor and in greenhouses, *S. nigrum* as weed species outside). All these plants have been checked, but no the respective symptoms (foliar galls) have been found so far. The preliminary monitoring in other sites in the city of Košice and the close surroundings was also negative. However, recently (November 30th 2019) a goji plant with typical blisters was seen in a TV presentation for hobby growers from the village of Malinovo (the campus of the local secondary school of horticulture) near the city of Bratislava. Evidently, everyone involved had no knowledge of such a pest there. To raise public awareness of the risk and importance of goji berry gall mites, all relevant authorities (the TV producer, the teacher from the mentioned school and the phytosanitary inspectors from CCTIA) were informed in this context. Although the plant from Malinovo could not be examined in detail, it is a strong indication that *A. kuko* can be more widespread in Slovakia than supposed, but it has remained unnoticed until now.

As goji berries are becoming more popular in Slovakia, there is an increasing risk of other future introductions of *Aceria kuko* with imported plants. Like in other Central European countries, the main threat of spreading this mite species lies in the uncontrolled trade with host plants and insufficient phytosanitary measures (Ciceoi & Mardare 2016; Hrudová & Šafránková 2018). It is recommended to carefully check such plants for the occurrence of typical blisters. Positively identified infested plants should be destroyed or thoroughly treated with acaricides. Treating it can be connected with previous artificial defoliation, if possible, as is suggested by Li et al. (2019) for problems caused by similar *A. pallida* mite species. Since the expression of these symptoms can take some time, even healthy looking imported susceptible plants (especially of unknown origin) should be held in isolation for several months to minimalise the risk. There is also a need to raise awareness among the wider public not only of this new pest, but also of the threats of invasive species associated with cultivated plants in general.

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