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Supplementary descriptions of seven eriophyoid mite species (Acari: Eriophyoidea) recovered from the Viennese Nalepa collection and comparison with Japanese species

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Original research

ABSTRACT

The reason for this study was to compare the morphology of mites from three Japanese samples with topotypes from the Nalepa collection, in order to correctly identify them. With this purpose eriophyoid specimens were recovered from five vials of the Nalepa mite collection in the Natural History Museum of Vienna. We identified seven species and a new combination is established for one of them - *Aceria thomasi* and *Aculops thymi*, from two vials labeled *Thymus serpyllum* (Lamiaceae); *Eriophyes spiraeae* from a vial labeled *Spiraea crenifolia* (Rosaceae); and *Peralox longirostris* n. comb., *Shevtchenkella ulmi*, *Aceria filiformis* and *Aculus mastigophorus* from two vials labeled *Ulmus campestris* (Ulmaceae). A supplementary description is presented for these species. The Japanese samples were collected from ‘Shiso’, *Perilla frutescens* var. *crispa* (Lamiaceae), from *Spiraea thunbergia* (Rosaceae) and from *Juglans mandshurica* (Juglandaceae). The mites collected from ‘Shiso’ were identified as *A. thymi*, but the other two Japanese samples did not match the topotypes. These two samples may be new species and require further taxonomic studies.

Keywords Eriophyidae; Diptilomiopidae; taxonomy; recovering mites; Nalepa’s mite collection

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Introduction

In the taxonomic survey of Japanese eriophyoid mites, we found that a species of the genus *Aculops* transmits the perilla mosaic virus (PerMV) and causes rusting damage to leaves of ‘Shiso’, *Perilla frutescens* (L.) Britton var. *crispa* (Benth.) W. Deane (Lamiaceae) (Takei *et al.*, 2019; Kubota *et al.*, 2020). A second species, identified as belonging to the genus *Eriophyes*, causes edge-rolling damage to leaves of *Spiraea thunbergia* Siebold ex Blume (Rosaceae). A third species, belonging to the subfamily Rhyncaphytopinae, was found on leaves of walnut, *Juglans mandshurica* Maximowicz (Juglandaceae).

The three species are morphologically close to three species collected by Alfred Nalepa over 100 years ago: the *Aculops* species is morphologically close to *Aculops thymi* (Nalepa, 1889) collected from *Thymus serpyllum* L. (Lamiaceae); the *Eriophyes* species is morphologically

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Figure 1 Vials of eriophyoid mites used in the present study. The figure shows the cork stoppers and labels at the tops of the vials and the sediment at the bottoms of the vials. Vial numbers are shown at bottom. The mites were collected from *Thymus serpyllum* (nos. 340 and 341), *Spiraea crenifolia* (no. 117) and *Ulmus campestris* (nos. 355 and 477). The brown pigment in the bottom of the vials is the sediment, which includes mummified mites. All species were collected in Austria.

close to *E. spiraeae* (Nalepa, 1893) collected from *Spiraea crenifolia* (L.) Boiss. (= *Spiraea crenata* L.) (Rosaceae); and the Rhyncaphytoptinae species is morphologically close to *Rhyncaphytoptus gallicolus* (Nalepa, 1922) (syn. *Phyllocoptyches gallicolus* Nalepa, 1922), deutogyne of *R. longirostris* (Nalepa, 1922) collected from *Ulmus campestris* L. (Ulmaceae). However, it was difficult to determine if the Japanese specimens are conspecific to the closely related Nalepa species. This is because Nalepa's taxonomic descriptions are not enough detailed to allow species identification.

Recently, Chetverikov *et al.* (2016) developed a method for recovering mummified materials of eriophyoid mites collected by Nalepa over 100 years ago, which are kept in the Natural History Museum of Vienna (in German: Naturhistorisches Museum Wien, NHMW), Austria, and they successfully made preparation slides capable of species identification. Using this protocol, Marinković *et al.* (2018) recovered mummified eriophyid mite specimens collected by Nalepa and reported the detailed taxonomic traits for three species of the subfamily Cecidophyinae. Therefore, two of us (F. K. and T. G.) visited the museum and got permission to take a part of the Nalepa mite collection to Japan. According to the protocol of Chetverikov *et al.* (2016), we recovered eriophyoid mites from the sediment in the vials and made slide preparations.

Here, we provide supplementary descriptions of the topotype specimens of seven eriophyoid species recovered from mummified materials in the Nalepa mite collection. A new combination is proposed for one of them. The taxonomic relationship of Nalepa's species with the Japanese specimens was discussed.

Material and methods

Recovering mites from Nalepa's collection vials and slide preparation

All specimens used in this study were taken from five vials (nos. 340, 341, 117, 355 and 477) of the Nalepa mite collection (Fig. 1) loaned from the NHMW, Austria. The loan was allowed by Dr. Helmut Sattman, director of the Department of Invertebrate Zoology, NHMW, and Dr. Christoph Hörweg (co-author), head of the Department of Invertebrate Zoology and curator of the Collection Arachnoidea. The specimens were examined at the Laboratory of Applied Entomology and Zoology, Hosei University, Tokyo, Japan.

Over the years, the liquid preservative in the vials had evaporated. The preservative was not recorded, but other records indicate that Dr. Nalepa used either a 1:100:2 mixture of picric acid, distilled water and concentrated hydrochloric acid, or a 100:2 mixture of 94% ethanol and concentrated hydrochloric acid (Nalepa, 1906). Following the protocol of Chetverikov *et al.* (2016), the sediment in each vial was suspended in 5 ml of 70% ethanol, three drops of 5% acetic acid and 10 drops of pure diethyl ether. The vials were then heated for ca. 4 hours at ≥ 75 °C. As a result, within 24 hours, the sediment in the vials was sufficiently dissolved that the mites could be removed. Aliquots of the solutions (300-500 μ l) were transferred to a small watch glass. At this stage, the mites were still pigmented, which made it difficult to observe their features under a phase contrast microscope (BX51[®], Olympus Co., Tokyo, Japan). The mites were thus treated with lactic acid (a clearing agent) as follows. Mites in the watch glass were picked up with a pig eyelash attached to an insect pin and transferred to a hole slide glass containing about 10 μ l of concentrated (>85%) lactic acid solution (manufacturer) under a dissecting microscope. The hole slide glass was then heated for 4-6 h at 95 °C. This clearly revealed the features of the mites under the phase contrast microscope. The mites were then individually transferred with a pig eyelash to a slide glass containing a drop of modified Berlese medium (Amrine and Manson, 1996) under a dissecting microscope. We were able to make 2-18 high quality, permanent slides for each vial (one intact mite per slide). The remaining solution in the vials was allowed to air dry. The vials and slides will be returned to the museum after publication of the manuscript.

Morphological studies

Mites were examined for their different taxonomic characters using a phase contrast microscope (BX51[®]) and drawn by a camera lucida (U-DA[®], Olympus) attached to the microscope. Measurements and illustrations basically follow Amrine and Manson (1996) and de Lillo *et al.* (2010), and measurements are given in micrometers (μ m) and given as average and ranges in parentheses. Count of dorsal and ventral annuli (including incomplete annuli) was carried out from the prodorsal shield to the anal lobe. Some of the setae have been broken during the preparation process, which were omitted from the setal length values. The morphological nomenclature follows Lindquist and Amrine (1996) and systematic classification follows Amrine *et al.* (2003). Photos of each character were taken with the phase contrast microscope equipped with a digital microscope camera (DP21[®], Olympus). The photos were uploaded to Microsoft PowerPoint 2019 (Microsoft Co., Redmond, WA, USA) and schematic mite drawings were obtained by tracing each character with a drawing tool in PowerPoint.

Results

Two eriophyoid mites collected from *Thymus serpyllum* (vial nos. 340 and 341)

Aceria thomasi (Nalepa, 1889)

Phytoptus thomasi Nalepa, 1889 pp. 135-137 t. 6 f. 1-3.

Figure 2 Drawing of *Aceria thomasi* (Nalepa, 1889) (female). A – antero-lateral view of body; B – lateral view of abdomen; C – lateral view of telosoma; D – prodorsal shield; E – coxigenital region of female; F – empodium; G – internal genitalia of female.

Phytoptus thomasi: Canestrini, 1892 pp. 618-619 t. 49 f. 1; t. 44 f. 8; Cotte, 1924 pp. 14-17 pl. 4, f. 19.

Eriophyes thomasi: Liro & Roivainen, 1951 pp. 138-139.

Aceria thomasi: Farkas, 1965 p. 47 fig. 34D; Boczek & Chyczewski, 1978 p. 112; Hellrigl, 2003 p. 100; Amrine & Stasny, 1994 p. 91; Szydło *et al.*, 2010 pp. 144-148 figs. 4-6, 12B, Table 1.

(Figs. 2, 3, Table 1)

Female (n=10) — Body fusiform, 249 (181-292), 68 (62-74) wide, 65 (61-74) thick.

Gnathosoma 23 (19-26), projecting obliquely downwards; chelicerae 20 (16-27), bent down.

Prodorsal shield semicircular in dorsal view, 36 (31-38), 46 (34-55) wide, with a median line complete, broken at anterior 1/3 of prodorsal shield, admedian lines complete, divergent

Figure 3 Phase-contrast light microscope images of *Aceria thomasi*. A – lateral view of body; B – dorsal view of prodorsal shield; C – coxigenital region of female.

to rear, first submedian lines on anterior 2/3 of prodorsal shield, curving outwards, second submedian lines on anterior 1/2 of prodorsal shield, curving outwards, joining first submedian lines posteriorly, short lines and dots present in lateral area of prodorsal shield; scapular tubercles, 30 (27-32) apart on rear shield margin; scapular setae *sc* 32 (23-43, n=8), diverging backward.

Leg I 44 (38-48), femur 13 (7-15), femoral setae *bv* 5 (4-7, n=8) on 1/2 anterior from the base of femur; genu 7 (6-8), genual setae *l''* 15 (10-24, n=7); tibia 9 (8-10), paraxial tibial setae *l'* 4 (2-6, n=9) on 1/2 anterior from the base of tibia; tarsus 10 (9-11), tarsal solenidion ω 9 (6-10), slightly curved with knob apically, tarsal empodium *em* 7 (5-9), simple 4-5-rayed.

Leg II 37 (33-42), femur 10 (8-12), femoral setae *bv* 5 (4-5, n=8) on 1/2 anterior from the base of femur; genu 6 (5-8), genual setae *l''* 6 (4-8, n=9); tibia 7 (5-8); tarsus 9 (7-11), tarsal solenidion ω 8 (6-11), slightly curved with knob apically, tarsal empodium *em* 6 (4-8), simple 4-5-rayed.

Coxisternal plates with some short lines; prosternal apodeme entire, distinct. Anterior setae on coxisternum I *lb* 5 (4-6, n=5), 17 (11-21) apart, ahead of transverse line through proximal setae *la* on coxisternum I, *la* 13 (10-16, n=5), 12 (9-13) apart, ahead of transverse line through proximal setae *2a* on coxisternum II, proximal setae *2a* 22 (18-27, n=5), 32 (28-33) apart.

External genitalia 19 (17-22), 31 (29-33) wide; coverflap subtriangular, with 10-12 longitudinal striae; setae *3a* 13 (8-16, n=8), 25 (23-29) apart. Coxigenital region with 7-10 semiannuli, microtuberculate.

Opisthosoma with subequal annuli dorsoventrally: 83-94 dorsal annuli with semi-ellipsoidal microtubercles on the margin, 78-90 ventral annuli with hemispherical microtubercles on the margin; opisthosomal setae *c2* 13 (10-20, n=8), 68 (55-77) apart on 12-15th annulus; *d* 26 (17-35, n=9), 56 (43-64) apart on 29-34th annulus; *e* 16 (10-22, n=10), 31 (27-34) apart on 47-55th annulus; *f* 18 (12-24, n=10), 28 (23-32) apart on 7-9th annulus from rear; *hl* 6 (5-7, n=9), 9 (8-10) apart and *h2* 49 (35-56, n=4), 13 (12-16) apart.

Male — Not found.

Specimens examined — Ten females on 10 microscopic slides of inventory nos. NHMW29901/1-14 from vial no. 340 and NHMW29902/1 from vial no. 341 in Box TU from the Nalepa mite collection deposited in the NHMW.

Host plant — *Thymus serpyllum* L.

Other host plants — *Thymus pannonicus* All. (= *T. pulegioides* subsp. *pannonicus* (All.) Kerguelen) (Boža, 1983; Petanović & Stanković, 1999), *Thymus praecox* Opiz (Szydło *et al.*, 2010), *Origanum vulgare* L. (Amrine & Stasny, 1994) (Lamiaceae)

Type locality — Austria? (Nalepa Collection Locality. Unknown).

Distribution — Austria (Hellrigl, 2003), Finland (Liro & Roivainen, 1951), Germany (Hellrigl, 2003), Iceland (Szydło *et al.*, 2010), Italy (Canestrini, 1892; Hellrigl, 2003), Montenegro (Jočić & Petanović, 2012), Poland (Boczek & Chyczewski, 1978; Skoracka *et al.*, 2005), Serbia (Boža, 1983; Petanović & Stanković, 1999).

Relation to host — According to Nalepa (1889), the mite causes white erineum on blister with a diameter of 5-8 mm on leaves and flowers of *Thymus serpyllum*.

Remarks — The range of body length and width of *Aceria thymi* (Nalepa, 1889) (original data) almost overlapped with both that of the topotype specimens (present data) and that of specimens collected from Iceland (Szydło *et al.*, 2010). The measurements of all taxonomic characters except setae were not almost different between that of topotype specimens (present data) and that of specimens from Iceland (Szydło *et al.*, 2010), but the lengths of most setae measurements of topotype specimens were relatively a little shorter than that of specimens from Iceland (Table 1).

***Aculops thymi* (Nalepa, 1889)**

Phyllocoptes thymi Nalepa, 1889 pp. 137-138, 152-153 pl. 6 f. 4-6.

Table 1 Comparative measurements of *Aceria thomasi* and *Aculops thymi* taken in the current study and previously published studies. Abbreviations: L–length; W–width; T–thickness; D–distance; No–number.

Characters		<i>Aceria thomasi</i>			<i>Aculops thymi</i>		
		Original (Nalepa, 1889)	Szydło <i>et al.</i> (2010)	Supplemental (Present data)	Original (Nalepa, 1889)	Szydło <i>et al.</i> (2010)	Supplemental (Present data)
		Female (n=?)	Female (n=22)	Female (n=10)	Female (n=?)	Female (n=23)	Female (n=11)
		Min–max	Min–max	Min–max	Min–max	Min–max	Min–max
Body	L	146–215	165–281	181–292	120	132–201	153–178
	W	48–68	58–63	62–74	50	59–64	51–62
	T	–	–	61–74	–	–	53–57
Gnathosoma	L of gnathosoma	–	21–26	19–26	–	19–25	12–30
	L of chelicerae	–	22–25	16–27	–	20–27	13–24
	L of pedipalpal coxal seta <i>ep</i>	–	2–3	–	–	3–4	–
	L of dorsal pedipalpal genual setae <i>d</i>	–	4–5	–	–	7–9	–
	L of subapical pedipalpal tarsal setae <i>v</i>	–	1–1	–	–	–	–
Prodorsal shield	L of prodorsal shield	–	35–40	31–38	–	37–41	37–44
	W of prodorsal shield	–	40–45	34–55	–	50–59	42–60
	L of frontal lobe	–	–	–	–	–	5–8
	L of scapular setae <i>sc</i>	–	44–55	23–43 (8)*	–	15–20	7–13 (11)*
	D of scapular setal tubercles	–	26–32	27–32	–	34–38	33–39
Leg I	L of leg I	–	38–43	38–48	–	30–37	27–36
	L of femur I	–	11–12	7–15	–	9–10	7–13
	L of femoral setae <i>bv</i>	–	11–13	4–7 (8)	–	14–22	5–12 (7)
	L of genu I	–	6–7	6–8	–	4–6	4–5
	L of genual setae <i>l'</i>	–	28–32	10–24 (7)	–	22–26	9–18 (7)
	L of tibia I	nearly as long as tarsus	10–11	8–10	–	7–8	6–8
	L of tibial setae <i>l'</i>	conspicuously long	10–12	2–6 (9)	–	9–10	3–4 (8)
	L of tarsus I	nearly as long as tibia	8–9	9–11	–	7–8	4–7
	L of inner fastigial setae <i>ft'</i>	–	16–21	–	–	15–18	–
	L of outer fastigial setae <i>ft''</i>	–	28–32	–	–	22–26	–
	L of unguinal setae <i>u'</i>	–	5–6	–	–	4–5	–
	L of solenidion ω	–	7–8	6–10	–	6–7	5–8
	L of empodium <i>em</i>	–	7–8	5–9	–	5	3–8
	No. of empodial rays	5	5	4–5	3	4	4
Leg II	L of leg II	–	36–39	33–42	–	31–35	26–32
	L of femur II	–	10–11	8–12	–	10–11	7–10
	L of femoral setae <i>bv</i>	–	11–16	4–5 (8)	–	12–25	5–6 (6)
	L of genu II	–	5–8	5–8	–	4–5	4–6
	L of genual setae <i>l''</i>	–	17–21	4–8 (9)	–	10–15	4–8 (7)
	L of tibia II	–	7–8	5–8	–	6–7	5–7
	L of tarsus II	–	8–9	7–11	–	6–8	5–8
	L of inner fastigial setae <i>ft'</i>	–	9–11	–	–	7–8	–
	L of outer fastigial setae <i>ft''</i>	–	25–30	–	–	22–26	–
	L of unguinal setae <i>u'</i>	–	5–6	–	–	5–6	–
	L of solenidion ω	–	7–9	6–11	–	6–7	7–10
	L of empodium <i>em</i>	–	7–8	4–8	–	5–6	3–5
	No. of empodial rays	–	5	4–5	–	4	4
Coxisternum	L of setae <i>1b</i>	–	16–18	4–6 (5)	–	8–11	3–7 (7)
	D between setae <i>1b</i>	–	13–16	11–21	–	10–11	9–11
	L of setae <i>1a</i>	–	29–32	10–16 (5)	–	16–19	4–9 (8)
	D between setae <i>1a</i>	–	11–12	9–13	–	9–11	6–10
	L of setae <i>2a</i>	–	29–40	18–27 (5)	–	34–39	13–21 (7)
	D between setae <i>2a</i>	–	28–31	28–33	–	20–24	20–25
	No. of annuli between coxisternum II and genitalia	–	–	7–10	–	–	3–9
Opisthosoma	No. of dorsal annuli	–	79–93	83–94	20	23–26	21–26
	No. of ventral annuli	–	69–87	78–90	–	50–54	50–58
	L of setae <i>c2</i>	–	27–35	10–20 (8)	–	17–23	5–10 (9)
	D between setae <i>c2</i>	–	54–59	55–77	–	45–49	44–59
	Position of tubercles of setae <i>c2</i>	–	9–12th annulus	12–15th annulus	–	10–11th annulus	9–14th annulus
	L of setae <i>d</i>	–	50–63	17–35 (9)	–	38–43	7–26 (6)
	D between setae <i>d</i>	–	45–50	43–64	–	31–35	25–39
	Position of tubercles of setae <i>d</i>	–	24–36th annulus	29–34th annulus	–	21–23rd annulus	20–26th annulus
	L of setae <i>e</i>	–	23–36	10–22 (10)	–	15–19	4–12 (10)
	D between setae <i>e</i>	–	24–26	27–34	–	17–21	18–22
	Position of tubercles of setae <i>e</i>	–	39–53rd annulus	47–55th annulus	–	32–36th annulus	26–38th annulus
	L of setae <i>f</i>	–	30–37	12–24 (10)	–	20–24	5–10 (10)
	D between setae <i>f</i>	–	23–26	23–32	–	20–23	18–22
	Position of tubercles of setae <i>f</i>	–	6–8th annulus from rear	7–9th annulus from rear	–	5th annulus from rear	5–6th annulus from rear
	L of setae <i>h2</i>	–	78–85	35–56 (4)	–	40–48	27–32 (2)
	D between setae <i>h2</i>	–	11–13	12–16	–	10	10–12
	L of setae <i>h1</i>	–	5–6	5–7 (9)	–	3–5	3–4 (8)
	D between setae <i>h1</i>	–	8–9	8–10	–	6–7	4–10
Genitalia	L of epigynium	–	17–23	17–22	–	12–14	9–15
	W of epigynium	–	30–32	29–33	20	20–21	19–22
	L of genital setae <i>3a</i>	–	19–27	8–16 (8)	–	12–15	6–8 (8)
	D between genital setae <i>3a</i>	–	22–27	23–29	–	13–15	15–16
	No. of longitudinal striae on genital coverflap	–	11–14	10–12	–	7–11	6–10

*: Numerals in parentheses indicate no. of individuals tested.

Phyllocoptes thymi: Canestrini, 1892 pp. 689–690.

Vasates thymi: Roivainen, 1950 p. 27; Farkas, 1965 p. 82.

Aculops thymi: Amrine & Stasny, 1994; Szydło *et al.*, 2010 p. 148–150 f. 7–8.

(Figs. 4, 5, Table 1)

Female (n=11) — Body fusiform, 167 (153–178), 57 (51–62) wide, 56 (53–57) thick.

Gnathosoma 19 (12–30), projecting obliquely downwards; chelicerae 17 (13–24) slightly curved down.

Prodorsal shield 40 (37–44) including frontal lobe 6 (5–8), obtuse triangular with a blunt point, 49 (42–60) wide, subtriangular; frontal lobe 5–8, obtuse triangular with a blunt point. Prodorsal shield smooth, a low bulging centrally and shallow furrow along with the side of shield; scapular tubercles 36 (33–39) apart on the posterior shield margin; scapular setae *sc* 9 (7–13, n=11), divergent to rear.

Leg I 31 (27–36), femur 10 (7–13), femoral setae *bv* 8 (5–12, n=7) on anterior 2/5 from the base of femur; genu 5 (4–5), genual setae *l''* 12 (9–18, n=7); tibia 7 (6–8), paraxial tibial setae *l'* 3 (3–4, n=8) on anterior 1/4 from the base of tibia; tarsus 6 (4–7), tarsal solenidion *ω* 7 (5–8), slightly curved, with knob apically, tarsal empodium *em* 6 (3–8), simple, 4-rayed.

Leg II 29 (26–32): femur 8 (7–10), femoral setae *bv* 6 (5–6, n=6) on anterior 2/5 from the base of femur; genu 5 (4–6), genual setae *l''* 6 (4–8, n=7); tibia 6 (5–7); tarsus 7 (5–8), tarsal solenidion *ω* 7 (7–10), strongly curved, with knob apically, tarsal empodium *em* 4 (3–5), simple, 4-rayed.

Coxisternal plates smooth; prosternal apodeme entire, distinct. Anterior setae on coxisternum I *lb* 5 (3–7, n=7), 10 (9–11) apart, far from proximal setae *la* on coxisternum I, *la* 6 (4–9, n=8), 9 (6–10) apart, a little ahead of line through proximal setae *2a* on coxisternum II, proximal setae *2a* 17 (13–21, n=7), 25 (20–25) apart.

External genitalia 13 (9–15), 21 (19–22) wide; coverflap subtriangular, with 6–10 longitudinal striae; setae *3a* 7 (6–8, n=8), 15 (15–16) apart. Coxigenital region with 3–9 semiannuli, microtuberculate.

Opisthosoma with 21–26 dorsal and 50–58 ventral annuli, dorsal annuli smooth, ventral annuli with ellipsoidal microtubercles on the margin. Opisthosomal setae *c2* 6 (5–10, n=9), 50 (44–59) apart on 9–14th annulus; *d* 16 (7–26, n=6), 34 (25–39) apart on 20–26th annulus; *e* 7 (4–12, n=10), 20 (18–22) apart on 26–38th annulus; *f* 7 (5–10, n=10), 20 (18–22) apart on 5–6th annulus from rear; *hl* 4 (3–4, n=8), 7 (4–10) apart and *h2* 30 (27–32, n=2), 11 (10–12) apart.

Male — Not found.

Specimens examined — 11 females on 11 microscopic slides of inventory nos. NHMW29903/1–13 from vial no. 340 and NHMW29904/1–5 from vial no. 341 in Box TU from the Nalepa mite collection deposited in the NHMW.

Host plant — *Thymus serpyllum* L.

Other host plants — *Thymus vulgaris* L. (Kozłowski, 1983; Skoracka *et al.*, 2005), *Thymus praecox* Opiz (Szydło *et al.*, 2010), *Thymus callieri* Berb. ex Velen. (Chetverikov *et al.*, 2021), *Teucrium chamaedrys* L. (Amrine & Stasny, 1994) (Lamiaceae).

Type locality — Austria? (Nalepa Collection Locality. Unknown).

Distribution — Iceland (Szydło *et al.*, 2010), Italy (Nalepa, 1898; Canestrini, 1892), Poland (Kozłowski, 1983; Skoracka *et al.*, 2005), Sweden (Roivainen, 1950), Russia (Chetverikov *et al.*, 2021).

Remarks — According to Nalepa (1889), the mites were always found on erineae caused by *Aceria thomasi* on leaves of *T. serpyllum*. The range of body length and width of *Aculops thymi* (Nalepa, 1889) (original data) were shorter than both that of the topotype specimens (present data) and that of specimens collected from Iceland (Szydło *et al.*, 2010). The measurements of all taxonomic characters except setae were not different between that of topotype specimens and that of specimens from Iceland, but the lengths of most setae of topotype specimens were relatively a little shorter than that of specimens from Iceland (Table 1).

Figure 4 Drawing of *Aculops thymi* (Nalepa, 1889) (female). A – lateral view of body; B – dorsal view of body; C – ventral view of body; D – empodium; E – internal genitalia of female.

Figure 5 Phase-contrast light microscope images of *Aculops thymi*. A – dorsal view of body; B – lateral view of body; C – coxigenital region.

One eriophyoid mite collected from *Spiraea crenifolia* (vial no. 117)

Eriophyes spiraeae (Nalepa, 1893)

Phytoptus spiraeae Nalepa, 1893 p. 105; Nalepa, 1895 pp. 635-636 t. 3 f. 7-8 (Additional description).

Eriophyes spiraeae: Nalepa, 1898 p. 29; Amrine & Stasny, 1994 p. 209; Xue *et al.*, 2013 p. 18.

(Figs. 6, 7, Table 2)

Female (n=18) — Body vermiform, 169 (125-212), 49 (46-53) wide, 40 (27-48) thick.

Gnathosoma 20 (16-25), projecting obliquely downwards; chelicerae 18 (13-25), slightly curved down.

Prodorsal shield semicircular in dorsal view, 25 (17-36), 34 (29-39) wide, with a median line absent, admedian lines complete, divergent to rear, curving inwards posteriorly, first submedian lines complete, curving outwards at the middle of prodorsal shield, second and third submedian lines on anterior half of prodorsal shield; scapular tubercles 18 (16-20) apart ahead of rear shield margin; scapular setae *sc* 14 (12-20, n=16), projecting forwards and convergently.

Leg I 32 (27-35), femur 10 (6-12), femoral setae *bv* 6 (4-9, n=15) on anterior 1/3 from the base of femur; genu 5 (4-6), genual setae *l''* 9 (7-15, n=9); tibia 6 (5-7), paraxial tibial setae *l'* 4 (3-6, n=17) on anterior 1/2 from the base of tibia; tarsus 7 (4-8), tarsal solenidion ω 8 (6-11), curved with tiny knob apically, tarsal empodium *em* 6 (3-8), simple, 5-rayed.

Leg II 29 (26-31), femur 9 (7-13), femoral setae *bv* 5 (4-8, n=12) on anterior 1/3 from the base of femur; genu 5 (3-7), genual setae *l''* 7 (5-10, n=6); tibia 5 (3-6); tarsus 7 (6-8), tarsal solenidion ω 9 (8-12), curved with tiny knob apically, tarsal empodium *em* 5 (4-6), simple, 5-rayed.

Coxisternal plates smooth; prosternal apodeme entire, distinct. Anterior setae on coxisternum I *lb* 5 (4-6, n=6), 8 (7-9) apart, near anterior margin of coxisternum I, far from proximal setae *la* on coxisternum I, *la* 6 (3-8, n=5), 8 (7-9) apart, a little ahead of line through proximal setae *2a* on coxisternum II, proximal setae *2a* 12 (11-13, n=5), 25 (23-26) apart.

External genitalia 13 (11-14), 21 (18-24) wide; coverflap subtriangular, with 7–11 longitudinal striae; setae *3a* 12 (7-17, n=17), 17 (13-18) apart. Coxigenital region with 8

Figure 6 Drawing of *Eriophyes spiraeae* (Nalepa, 1893) (female). A – antero-lateral view of body; B – lateral view of abdomen; C – lateral view of telosoma; D – prodorsal shield; E – coxigenital region of female; F – empodium; G – internal genitalia of female.

semiannuli, microtubercles.

Opisthosoma with subequal annuli: 65–78 dorsal, 64–72 ventral annuli with ellipsoid microtubercles on the margin. Opisthosomal setae *c2* 11 (7–19, *n*=8), 48 (45–51) apart on 10–13th annulus; *d* 11 (10–13, *n*=16), 33 (31–37) apart on 21–26th annulus; *e* 9 (7–13, *n*=17), 16 (15–18) apart on 40–45th annulus; *f* 9 (7–11, *n*=15), 25 (24–28) apart on 6–7th annulus from rear; *h1* 6 (5–7, *n*=17), 9 (7–12) apart and *h2* 25 (20–35, *n*=13), 13 (12–14) apart.

Male — Not found.

Specimens examined — 18 females on 18 microscopic slides of inventory nos. NHMW29905/1–18 from vial no. 117 in Box S3 from the Nalepa mite collection deposited in the NHMW.

Host plant — *Spiraea crenifolia* (L.) Boiss. (*S. crenata* L.).

Other host plants — *Spiraea densiflora* Nutt. ex Rydb. (Keifer, 1952; Amrine & Stasny,

Figure 7 Phase-contrast light microscope images of *Eriophyes spiraeae*. A; lateral view of body; B – dorsal view of prodorsal shield; C – coxigenital region of female.

1994; Skoracka *et al.*, 2005), *Spiraea salicifolia* L. (Xue *et al.*, 2013) (Rosaceae), *Taxus baccata* L. (Xue *et al.*, 2013) (Taxaceae).

Type locality — Berlin, Germany. (Nalepa Collection Locality. Unknown).

Additional distribution — China (Xue *et al.*, 2013), USA (Keifer, 1952), Poland (Skoracka *et al.*, 2005).

Remarks — According to Nalepa (1895), *Eriophyes spiraeae* had 6 longitudinal lines with a median line absent on the prodorsal shield and the admedian lines were jointed anteriorly. On the other hand, the topotype specimens had complete admedian lines, a pair of complete submedian lines and two pairs of short submedian lines anteriorly on prodorsal shield and admedian lines were not jointed anteriorly. Direction of scapular setae *sc*, position of scapular

tubercles on the shield, number of abdominal annuli, number of rays on empodium *em* were not different between *E. spiraeae* and topotype specimens.

Two eriophyoid mites collected from *Ulmus campestris* (vial no. 477)

Peralox longirostris (Nalepa, 1922) n. comb

Phyllocoptyches gallicolus Nalepa, 1922 pp. 190-193; Newkirk (1984) as deutogyne.

Phyllocoptes longirostris Nalepa, 1922 pp. 193-194; Newkirk (1984) as protogyne.

Rhyncaphytoptus gallicolus: Amrine *et al.*, 2003 p. 208.

Peralox dentatis Xue *et al.*, 2013 pp. 112-113.

(Figs. 8, 9, Table 2)

Female (n=8) — Body fusiform 245 (207-302), 87 (86-88) wide, 79 (71-85) thick, a deep groove between posterior part of prodorsal shield and first dorsal annulus; subdorsal and lateral longitudinal ridges from 1st dorsal annulus to 7th annulus from rear.

Gnathosoma 43 (31-61), projecting obliquely downwards; chelicerae 73 (33-86), projecting abruptly downwards a little ahead of gnathosoma base.

Prodorsal shield 49 (37-58), 56 (43-68) wide, trapezoidal; frontal lobe 8 (5-12), arc-shaped apically with a wide base, over gnathosomal base, with median line absent, admedian lines complete, parallel anteriorly, curved outward posteriorly, jointed at rear shield margin, many short lines between admedian lines, submedian lines complete, curving outward posteriorly; scapular tubercles 49 (45-52) apart a little ahead of rear shield margin; scapular setae *sc* 33 (28-36, n=8), divergent forward.

Leg I 61 (52-69), femur 17 (13-25), femoral setae *bv* 20 (16-23, n=7) on anterior 1/2 from the base of femur; genu 10 (9-10), genual setae *l''* 37 (34-40, n=3); tibia 15 (12-17), paraxial tibial setae *l'* 9 (7-10, n=7) on anterior 1/3 from the base of tibia; tarsus 12 (11-13), tarsal solenidion ω 11 (9-12), curved with large knob apically, tarsal empodium *em* 8 (6-9), simple, 5-6-rayed.

Leg II 53 (45-58), femur 14 (10-17), femoral setae *bv* 15 (11-21, n=8) on anterior 1/3 from the base of femur; genu 8 (7-10), genual setae *l''* 29 (21-38, n=2); tibia 11 (10-13); tarsus 12 (11-12), tarsal solenidion ω 11 (10-13), curved with large knob apically, tarsal empodium *em* 8 (6-9), simple, 5-rayed.

Coxisternal plates smooth. Coxisternum I separated from each other. Anterior setae on coxisternum I *lb* 9 (7-12, n=6), 15 (15-15) apart, ahead of line through proximal setae on coxisternum I, *la* 28 (25-34, n=5), 15 (13-16) apart, a little ahead of line through proximal setae *2a* on coxisternum II, proximal setae *2a* 44 (38-52, n=5), 36 (35-37) apart.

External genitalia 19 (16-23), 36 (34-37) wide; coverflap bowl-shaped, smooth; setae *3a* 24 (17-38, n=8), 28 (26-30) apart. Coxigenital region with 16-18 semiannuli, microtuberculate.

Opisthosoma with 24-27 dorsal, 75-113 ventral annuli. Dorsal annuli with subdorsal ridge on first dorsal annulus running to above opisthosomal setae *e* and lateral ridges running from above the middle of setae *c2* and setae *d* to above setae *f*, dorsal annuli smooth between subdorsal ridges, with short lines between subdorsal ridge and lateral ridge and semicircular microtubercles on the margin of annuli, ventral annuli with microtubercles marginally; 7 annuli from rear equal dorsoventrally. Opisthosomal setae *c2* 22 (19-24, n=7), 77 (75-78) apart on 14-31st annulus; *d* 62 (53-66, n=6), 67 (60-77) apart on 29-56th annulus; *e* 16 (13-23, n=8), 38 (34-41) apart on 38-76th annulus; *f* 30 (25-37, n=7), 27 (26-28) apart on 4-7th annulus from rear; *h1* 3 (3-4, n=2), 12 (11-13) apart and *h2* 53 (42-66, n=7), 15 (14-15) apart.

Male — Not found.

Specimens examined — 8 females on 8 microscopic slides of inventory nos. NHMW29906/1-11 from vial no. 477 in Box TU from the Nalepa mite collection deposited in the NHMW.

Host plant — *Ulmus campestris* L.

Other host plants — *Ulmus* sp. (Ulmaceae).

Type locality — Austria? (Nalepa Collection Locality. Unknown).

Table 2 Comparative measurements of *Eriophyes spiraeae*, *Peralox dentatis* and *Shevtchenkella ulmi* taken in the current study and previously published studies. Abbreviations: L–length; W–width; T–thickness; D–distance; No–number.

Characters		<i>Eriophyes spiraeae</i>		<i>Peralox longirostris</i>		<i>Shevtchenkella ulmi</i>	
		Original	Supplemental	Original	Supplemental	Original	Supplemental
		(Nalepa, 1895)	(Present data)	(Xue <i>et al.</i> , 2013)	(Present data)	(Farkas, 1960)	(Present data)
		Female	Female	Female	Female	Female	Female
		(n=?)	(n=18)	(n=13)	(n=8)	(n=?)	(n=2)
		Max-min	Max-min	Max-min	Max-min	Max-min	Max-min
Body	L	160	125–212	321–331	207–302	130	147–174
	W	36	46–53	100–105	86–88	53	64–74
	T	–	27–48	95–105	71–85	–	–
	L of gnathosoma	20	16–25	85–88	31–61	20	16–16
Gnathosoma	L of chelicerae	–	13–25	–	33–86	–	10–19
	L of pedipalpal coxal seta <i>ep</i>	–	–	2–3	–	–	–
	L of dorsal pedipalpal genual setae <i>d</i>	–	–	12–13	–	–	–
	L of subapical pedipalpal tarsal seta <i>v</i>	–	–	–	–	–	–
Prodorsal shield	L of prodorsal shield	–	17–36	45–46	37–58	42	51–53
	W of prodorsal shield	–	29–39	82–85	43–68	–	66–74
	L of frontal lobe	–	–	–	5–12	–	7–10
	L of scapular setae <i>sc</i>	–	12–20 (15)*	–	28–36 (8)*	4	5–7 (2)*
	D of scapular setal tubercles	–	16–20	37–42	45–52	26	40–40
Leg I	L of leg I	–	27–35	55–58	52–69	30	27–29
	L of femur I	–	6–12	16–17	13–25	–	8–9
	L of femoral setae <i>bv</i>	–	4–9 (15)	25–27	16–23 (7)	–	5–8 (2)
	L of genu I	–	4–6	8–9	9–10	–	5–5
	L of genual setae <i>l''</i>	–	7–15 (9)	33–36	34–40 (3)	–	10–21 (2)
	L of tibia I	nearly as long as tarsus	5–7	15–16	12–17	–	4–4
	L of tibial setae <i>l'</i>	conspicuously long	3–6 (17)	7–8	7–10 (7)	–	3–4 (2)
	L of tarsus I	nearly as long as tibia	4–8	11–12	11–13	–	6–7
	L of inner fastigial setae <i>ft'</i>	–	–	25–26	–	–	–
	L of outer fastigial setae <i>ft''</i>	–	–	35–38	–	–	–
	L of unguinal setae <i>u'</i>	–	–	7–8	–	–	–
	L of solenidion ω	–	6–11	10–11	9–12	4	4–6
	L of empodium <i>em</i>	–	3–8	7–8	6–9	–	6–6
	No. of empodial rays	5	5	5	5–6	4	4
Leg II	L of leg II	–	26–31	45–48	45–58	25	24–24
	L of femur II	–	7–13	14–16	10–17	–	7–7
	L of femoral setae <i>bv</i>	–	4–8 (12)	16–18	11–21 (8)	–	5–7 (2)
	L of genu II	–	3–7	5–6	7–10	–	4–5
	L of genual setae <i>l''</i>	–	5–10 (6)	8–9	21–38 (2)	–	4–5 (2)
	L of tibia II	–	3–6	11–12	10–13	–	4–4
	L of tarsus II	–	6–8	11–12	11–12	–	5–5
	L of inner fastigial setae <i>ft'</i>	–	–	10–11	–	–	–
	L of outer fastigial setae <i>ft''</i>	–	–	32–35	–	–	–
	L of unguinal setae <i>u'</i>	–	–	6–7	–	–	–
	L of solenidion ω	–	8–12	11–12	10–13	4	6–6
	L of empodium <i>em</i>	–	4–6	10–11	6–9	–	6–6
	No. of empodial rays	–	5	4–5	5	4	4
Coxisternum	L of setae <i>1b</i>	–	4–6 (6)	13–15	7–12 (6)	–	6–7 (2)
	D between setae <i>1b</i>	–	8–13	13–14	15	–	13–14
	L of setae <i>1a</i>	–	3–8 (5)	36–38	25–34 (5)	–	6–12 (2)
	D between setae <i>1a</i>	–	7–9	15–16	13–16	–	10–15
	L of setae <i>2a</i>	–	11–13 (5)	46–72	38–52 (5)	–	16–31 (2)
	D between setae <i>2a</i>	–	23–26	40–43	35–37	–	25–35
	No. of annuli between coxisternum II and genitalia	–	8	20–31	16–18	–	13
Opisthosoma	No. of dorsal annuli	75	65–78	26–27	24–28	18	17
	No. of ventral annuli	–	64–72	88–89	75–113	–	55–64
	L of setae <i>c2</i>	–	7–19 (8)	15–18	19–24 (7)	8	13–13 (2)
	Position of tubercles of setae <i>c2</i>	–	10–13th annulus	24–26th annulus	14–31st annulus	–	10–17th annulus
	D between setae <i>c2</i>	–	45–51	80–82	75–78	–	51–59
	L of setae <i>d</i>	–	10–13 (16)	73–96	53–66 (6)	20	18–26 (2)
	Position of tubercles of setae <i>d</i>	–	21–26th annulus	47–50th annulus	29–56th annulus	–	20–27th annulus
	D between setae <i>d</i>	–	31–37	62–65	60–77	–	32–33
	L of <i>e</i>	–	7–13 (17)	17–20	13–23 (8)	7	6–9 (2)
	Position of tubercles of setae <i>e</i>	–	40–45th annulus	63–66th annulus	38–76th annulus	–	34–41st annulus
	Between setae <i>e</i>	–	15–18	33–36	34–41	–	15–16
	L of setae <i>f</i>	–	7–11 (15)	28–31	25–37 (7)	14	8–12 (2)
	Position of tubercles of setae <i>f</i>	–	6–7th annulus from rear	6th annulus	4–7th annulus from rear	5th annulus from rear	4–7th annulus from rear
	D between setae <i>f</i>	–	24–28	25–26	26–28	–	15–16
	L of setae <i>h2</i>	–	20–35 (13)	68–96	42–66 (7)	30	32–44 (2)
	D between setae <i>h2</i>	–	12–14	–	14–15	–	9–9
Genitalia	L of <i>h1</i>	–	5–7 (17)	2–3	3–4 (2)	1.5	3–4 (2)
	D between setae <i>h1</i>	–	7–12	–	11–13	–	6–7
	L of epigynium	–	11–14	20–22	16–23	11	12–12
	W of epigynium	18	18–24	38–40	34–37	14	22–24
	L of genital setae <i>3a</i>	–	7–17 (17)	16–26	17–38 (8)	–	11–12 (2)
	D of tubercles of genital setae <i>3a</i>	–	13–18	23–28	26–30	–	17
	No. of longitudinal striae on genital coverflap	–	7–11	–	–	–	8

*: Numerals in parentheses indicate no. of individuals tested.

Figure 8 Drawing of *Peralox longirostris* (Naleps, 1922) (female). A – lateral view of body; B – dorsal view of body; C – prodorsal shield; D – coxigenital region of female; E – empodium; F – internal genitalia of female.

Figure 9 Phase-contrast light microscope images of *Peralox longirostris*. A – dorsal view of body; B – lateral view of body; C – coxigenital region of female; D – lateral view of telosoma.

Distribution — China (Xue *et al.*, 2013).

Remarks — Keifer (1962) established the new genus *Peralox*, with *Rhyncaphytoptus ficifoliae* as its type species based on having a deep transverse groove behind the prodorsal shield. This species also had a deep groove between the posterior part of the prodorsal shield and the first dorsal annulus, and the rear 7 annuli were completely joined dorsoventrally. So, we concluded this species belongs to the genus *Peralox* and a new combination was proposed.

***Shevtchenkella ulmi* (Farkas, 1960)**

Oxypleurites ulmi Farkas, 1960 pp. 330–331 figs. 41–43.

Oxypleurites ulmi: Farkas, 1965 p. 105; Huang, 1965 pp. 613–614 figs. 22–28.

Tegonotus ulmi: Newkirk & Keifer, 1971 pp. 7–8.

Shevtchenkella ulmi: Bagdasarian, 1978 p. 938; Amrine & Stasny, 1994 p. 287; Ripka & de Lillo, 1997 p. 151; Xue *et al.*, 2013 pp. 30–31 figs. 18–19; Lotfollahi *et al.*, 2014 pp. 53–54 fig. 2; Denizhan *et al.*, 2015 pp. 39–40.

(Figs. 10, 11, Table 2)

Female (n=2) — Body fusiform, 161 (147–174), 69 (64–74) wide.

Gnathosoma 16 (16–16), projecting downwards; chelicerae 15 (10–19).

Prodorsal shield semicircular in dorsal view, 52 (51–53) (including frontal lobe), 70 (66–74) wide; frontal lobe 8 (7–10), obtuse triangular with a blunt tip. Prodorsal shield almost smooth, with a low bulging between faint admedian lines curving outwards; scapular tubercles 40 (40–40) apart on rear shield margin; scapular setae *sc* 6 (5–7), divergent to rear.

Leg I 28 (27–29), femur 8 (8–9), femoral setae *bv* 7 (5–8) on anterior 2/5 from the base of femur; genu 5 (5–5), genual setae *l'* 16 (10–21); tibia 4 (4–4), paraxial tibial setae *l'* 4 (3–4) on anterior 1/3 from the base of tibia; tarsus 6 (6–7), tarsal solenidion ω 5 (4–6), slightly curved with knob apically, tarsal empodium *em* 6 (6–6), simple, 4-rayed.

Leg II 24 (24–24), femur 7 (7–7), femoral setae *bv* 6 (5–7) on anterior 1/3 from the base of femur; genu 5 (4–5), genual setae *l'* 5 (4–5); tibia 4 (4–4); tarsus 5 (5–5), tarsal solenidion ω 6 (6–6), curved with knob apically, tarsal empodium *em* 6 (6–6), simple, 4-rayed.

Coxisternal plates smooth; prosternal apodeme entire, distinct. Anterior setae on coxisternum I, *Ib* 7 (6–7), 13 (13–14) apart, ahead of line through proximal setae *Ia* on coxisternum I; *Ia* 9 (6–12), 13 (10–15) apart, a little ahead of line through proximal setae *2a* on coxisternum II, proximal setae *2a* 23 (16–31), 30 (25–35) apart.

External genitalia 12 (12–12), 23 (22–24) wide; coverflap with 8 longitudinal striae; setae *3a* 12 (11–12), 17 apart. Coxigenital region with 13 semiannuli, smooth.

Opisthosoma with 17 dorsal annuli projecting laterally and a central longitudinal ridge, 55–64 ventral annuli. Dorsal annuli smooth, projecting laterally; ventral annuli microtuberculate. Opisthosomal setae *c2* 13 (13–13), 55 (51–59) apart on 10–17th annulus; *d* 22 (18–26), 32 (32–33) apart on 20–27th annulus; *e* 8 (6–9), 16 (15–16) apart on 34–41st annulus; *f* 10 (8–12), 15 (15–16) apart on 4–7th annulus from rear; *h1* 3 (3–4), 6 (6–7) apart and *h2* 38 (32–44), 9 (9–9) apart.

Male — Not found.

Specimens examined — 2 females on 2 microscopic slides of inventory nos. NHMW29907/1–3 from vial no. 477 in Box TU from the Nalepa mite collection deposited in the NHMW.

Host plant — *Ulmus campestris* L.

Other host plants — *Ulmus procera* Salisb. (= *U. minor* Mill.) (Xue *et al.*, 2009; Lotfollahi *et al.*, 2014), *Ulmus minor* Mill. (Xue *et al.*, 2009; Xue *et al.*, 2013; Lotfollahi *et al.*, 2014), *Ulmus scabra* Mill. (= *U. rubra* Muhl.) (Ripka & de Lillo, 1997), *Ulmus davidiana* var. *japonica* (Rehd.) Nakai (Huang, 1965), *Ulmus densa* Litv. (Xue *et al.*, 2013), *Ulmus glabra* Huds. (Xue *et al.*, 2013; Denizhan & Çobanoğlu, 2010), *Ulmus laevis* Pall. (Xue *et al.*, 2013) (Ulmaceae).

Type locality — Nógrádverőce, Hungary. (Nalepa Collection Locality. Unknown).

Figure 10 Drawing of *Shevtchenkella ulmi* (Farkas, 1960) (female). A – dorsal view of body; B – ventral view of body; C – empodium; D – internal genitalia of female.

Additional distribution — Hungary (Farkas, 1960; Ripka & de Lillo, 1997), Great Britain (Farkas, 1965), North America (Farkas, 1965), Japan (Huang, 1965), Iran (Xue *et al.*, 2009; Lotfollahi *et al.*, 2014), China (Xue *et al.*, 2013), Turkey (Denizhan & Çobanoğlu, 2010), Serbia (Petanović & Stanković, 1999).

Figure 11 Phase-contrast light microscope images of *Shevtchenkella ulmi*. A – dorsal view of body; B – dorsal view of prodorsal shield; C – coxigenital region of female.

Remarks — The distance between the setae (*sc*) on the prodorsal shield of the mites was shorter in the original description (Farkas, 1960; 26 μm) than in the topotype specimens (40 μm , present data) .

Two eriophyoid mites collected from *Ulmus campestris* (vial no. 355)

***Aceria filiformis* (Nalepa, 1891)**

Phytoptus filiformis Nalepa, 1891 p. 370 no. 65b, pp. 374–375 t. 1 f. 5–6.

Eriophyes filiformis: Nalepa, 1898 p. 14; Liro, 1941 p. 8; Berezantsev, 1981 p. 453.

Aceria filiformis: Farkas, 1965 p. 22 figs. 15a-c; Amrine & Stasny, 1994 p. 47; Ripka & de Lillo, 1997 p. 149; Hellrigl, 2003 p. 91; Denizhan & Çobanoglu, 2010 p. 545; Denizhan *et al.*, 2015 p. 23.

(Figs. 12, 13, Table 3)

Female (n=13) — Body vermiform, 219 (179-237), 31 (28-40) wide, 31 (25-36) thick.

Gnathosoma 18 (14-27), projecting obliquely forwards; chelicerae 16 (12-20), slightly curved downwards.

Prodorsal shield 23 (18-25), 22 (18-24) wide, semioval in dorsal view, with a median line absent, admedian lines complete, broken in the middle of shield, first and second submedian lines complete, more and less sinuate, convergent posteriorly, some lines in the lateral area of shield; scapular tubercles 15-17 apart on rear shield margin; scapular setae *sc* 22 (19-26), divergent to rear.

Leg I 26 (21-29), femur 8 (7-11), femoral setae *bv* 4 (2-5, n=11) on anterior 1/2 from the base of femur; genu 4 (3-5), genual setae *l''* 9 (5-14, n=11); tibia 4 (3-5), paraxial tibial setae *l'* 4 (3-5, n=11) on anterior 1/3 from the base of tibia; tarsus 6 (5-8), tarsal solenidion *ω* 7 (6-8), slightly curved with tiny knob apically, tarsal empodium *em* 6 (5-6), simple, 4-rayed.

Leg II 22 (18-27), femur 8 (5-11), femoral setae *bv* 4 (3-5, n=11) on anterior 1/2 from the base of femur; genu 3 (2-4), genual setae *l''* 4 (3-6, n=11); tibia 4 (3-5), tarsus 5 (3-6), tarsal solenidion *ω* 7 (6-8), slightly curved with tiny knob apically, tarsal empodium *em* 6 (5-8), simple, 4-rayed.

Coxisternal plates with short lines; prosternal apodeme entire, distinct. Anterior setae on coxisternum I *Ib* 3 (2-3, n=3), 11 (11-11) apart, ahead of line through proximal setae *Ia* on coxisternum I, *Ia* 7 (6-8, n=5), 6 (5-7) apart, ahead of line through proximal setae *2a* on coxisternum II, proximal setae *2a* 23 (18-31, n=4), 17 (15-21) apart.

External genitalia 11 (10-12), 13 (12-14) wide, far away from coxisternum II; coverflap bowl-shaped with 6-8 longitudinal striae; setae *3a* 5 (5-6, n=9), 11 (10-12) apart. Coxigenital region with 7-12 semiannuli, microtubercles.

Opisthosoma with subequal annuli bearing semi-ellipsoidal microtubercles, 81-94 dorsal, 75-89 ventral annuli. Opisthosomal setae *c2* 9 (7-11, n=4), 29 (26-31) apart on 10-13th annulus; *d* 17 (13-23, n=11), 25 (24-26) apart on 19-26th annulus; *e* 5 (3-6, n=11), 14 (14-15) apart on 33-46th annulus; *f* 14 (10-22, n=12), 19 (16-20) apart on 5-7th annulus from rear; *h1* 6 (5-7, n=12), 8 (8-8) apart and *h2* 33 (22-40, n=12), 12 (11-14) apart.

Male — Not found.

Specimens examined — 13 females on 13 microscopic slides of inventory nos. NHMW29908/1-16 from vial no. 355 in Box TU from the Nalepa mite collection deposited in the NHMW.

Host plant — *Ulmus campestris* L.

Other host plants — *Ulmus campestris* L. (= *Ulmus glabra* Huds.) (Hellrigl, 2003, Denizhan & Çobanoglu, 2010; Denizhan *et al.*, 2015), *Ulmus carpinifolia* Suckow (= *U. minor* Mill.) (Janežič, 1982; Petanović & Stanković, 1999), *Ulmus montana* With. (= *U. glabra* Huds.) (Nalepa, 1903; Liro, 1941), *Ulmus scabra* Mill. (= *Ulmus montana* With.) (Liro, 1941), *Ulmus laciniata* Mayr (Berezantsev, 1981), *Ulmus propinqua* Koidz. (= *U. davidiana* var. *japonica* (Rehder) Nakai) (Berezantsev, 1981), *Ulmus pumila* L. (Ripka & de Lillo, 1997) (Ulmaceae).

Type locality — Austria? (Nalepa Collection Locality. Unknown).

Distribution. Italy (Hellrigl, 2003), Hungary (Ripka & de Lillo, 1997), Czech (Vaněčková-Skuhravá, 1996), Finland (Liro, 1941), Serbia (Janežič, 1982; Petanović & Stanković, 1999), Turkey (Denizhan & Çobanoglu, 2010; Denizhan *et al.*, 2015), Russia (Berezantsev, 1981).

Remarks — This mite was quite elongate and the genitalia were far away from the coxisternum II. According to Nalepa (1891), the mite caused smallpox-like galls on the leaves and many mites inhabited the space between the leaf mesophyll cells of the host.

Table 3 Comparative measurements of *Aceria filiformis* and *Aculus mastigophorus* taken in the current study and previously published studies. Abbreviations: L-length; W-width; T-thickness; D-distance; No-number.

		<i>Aceria filiformis</i>		<i>Aculus mastigophorus</i>	
Characters		Original (Nalepa, 1891)	Supplemental (Present data)	Original (Nalepa, 1894)	Supplemental (Present data)
		Female (n=?)	Female (n=13)	Female (n=?)	Female (n=2)
		Max-min	Max-min	Max-min	Max-min
Body	L	170	179–237	120–160	144–163
	W	15	28–40	50	62
	T	—	25–36	—	62
Gnathosoma	L of gnathosoma	15	14–27	14	22
	L of chelicerae	—	12–20	—	14
	L of pedipalpal coxal seta <i>ep</i>	—	—	—	—
	L of dorsal pedipalpal genual setae <i>d</i>	—	—	—	—
	L of subapical pedipalpal tarsal setae <i>v</i>	—	—	—	—
Prodorsal shield	L of prodorsal shield	—	18–25	36 *	34–45
	W of prodorsal shield	—	18–24	—	52
	L of frontal lobe	—	—	—	4–5
	L of scapular setae <i>sc</i>	—	19–26 (13)**	—	80–87 (2)**
	D of scapular setal tubercles	—	15–17	—	36
Leg I	L of leg I	—	21–29	—	43
	L of femur I	—	7–11	—	16
	L of femoral setae <i>bv</i>	—	2–5 (11)	—	4 (1)
	L of genu I	—	3–5	—	4
	L of genual setae <i>l''</i>	—	5–14 (11)	—	10 (1)
	L of tibia I	nearly as long as tarsus	3–5	—	6
	L of tibial setae <i>l'</i>	conspicuously long	3–5 (11)	—	4 (1)
	L of tarsus I	nearly as long as tibia	5–8	—	10
	L of inner fastigial setae <i>ft'</i>	—	—	—	—
	L of outer fastigial setae <i>ft''</i>	—	—	—	—
	L of unguinal setae <i>u'</i>	—	—	—	—
	L of solenidion ω	—	6–8	—	7
	L of empodium <i>em</i>	—	5–6	—	5
	No. of empodial rays	3	4	2	2
Leg II	L of leg II	—	18–27	—	33
	L of femur II	—	5–11	—	11–12
	L of femoral setae <i>bv</i>	—	3–5 (11)	—	4 (1)
	L of genu II	—	2–4	—	4–5
	L of genual setae <i>l''</i>	—	3–6 (11)	—	4–7 (2)
	L of tibia II	—	3–5	—	5–5
	L of tarsus II	—	3–6	—	7–8
	L of inner fastigial setae <i>ft'</i>	—	—	—	—
	L of outer fastigial setae <i>ft''</i>	—	—	—	—
	L of unguinal setae <i>u'</i>	—	—	—	—
	L of solenidion ω	—	6–8	—	4–6
	L of empodium <i>em</i>	—	5–8	—	4–5
	No. of empodial rays	3	4	2	2
	L of setae <i>lb</i>	—	2–3 (3)	—	4 (1)
Coxisternum	D between setae <i>lb</i>	—	11–11	—	14
	L of setae <i>la</i>	—	6–8 (5)	—	4 (1)
	D between setae <i>la</i>	—	5–7	—	17
	L of setae <i>2a</i>	—	18–31 (4)	—	18 (1)
	D between setae <i>2a</i>	—	15–21	—	22
	No. of annuli between coxisternum II and genitalia	—	7–12	—	4–5
Opisthosoma	No. of dorsal annuli	—	81–94	45	39–42
	No. of ventral annuli	—	75–89	—	60–60
	L of setae <i>c2</i>	—	7–11 (4)	—	9–13 (2)
	Position of tubercles of setae <i>c2</i>	—	10–13th annulus	—	9–13th annulus
	D between <i>c2</i>	—	26–31	—	57
	L of setae <i>d</i>	—	13–23 (11)	—	23 (1)
	Position of tubercles of setae <i>d</i>	—	19–26th annulus	—	22–24th annulus
	D between setae <i>d</i>	—	24–26	—	34
	L of setae <i>e</i>	—	3–6 (11)	—	7–16 (2)
	Position of tubercles of setae <i>e</i>	—	33–46th annulus	—	38–38th annulus
	D between setae <i>e</i>	—	14–15	—	20
	L of setae <i>f</i>	—	10–22 (12)	—	19–20 (2)
	Position of tubercles of setae <i>f</i>	—	5–7th annulus from rear	—	6–6th annulus from rear
	D between setae <i>f</i>	—	16–20	—	25
Genitalia	L of setae <i>h2</i>	—	22–40 (12)	—	71 (1)
	D between setae <i>h2</i>	—	11–14	—	15
	L of setae <i>h1</i>	—	5–7 (12)	—	3–5 (2)
	D between setae <i>h1</i>	—	8–8	—	9
	L of epigynum	10	10–12	—	17
	W of epigynum	26	12–14	22	26
Genitalia	L of genital setae <i>3a</i>	—	5–6 (9)	—	7 (1)
	D of tubercles of genital setae <i>3a</i>	—	10–12	—	18
	No. of longitudinal striae on genital coverflap	—	6–8	—	—

*: Cited from Farkas (1965).

**: Numerals in parentheses indicate no. of individuals tested.

Figure 12 Drawing of *Aceria filiformis* (Nalepa, 1891) (female). A – antero-lateral view of body; B – lateral view of abdomen; C – lateral view of telosoma; D – prodorsal shield; E – coxigenital region of female; F – empodium; G – internal genitalia of female.

***Aculus mastigophorus* (Nalepa, 1890)**

Phyllocoptes mastigophorus Nalepa, 1890 pp. 60, 67 no.44; Nalepa, 1894 pp. 308–309 pl. 3, f. 1–2 (Additional description); Liro & Roivainen, 1951 p. 189.

Figure 13 Phase-contrast light microscope images of *Aceria filiformis*. A – lateral view of body; B – dorsal view of prodorsal shield; C – coxigenital region of female.

Vasates mastigophorus: Roivainen, 1950 p. 25.

Aculus mastigophorus: Amrine & Stasny, 1994 p. 136.

(Figs. 14, 15, Table 3)

Female (n=2) — Body fusiform, 153 (144-163), 62 (n=1) wide, 62 (n=1) thick.

Gnathosoma 22 (n=1), projecting obliquely downwards; chelicerae 14 (n=1).

Prodorsal shield semioval, 42 (34-45) (including frontal lobe), 52 (n=1) wide; frontal lobe 4-5, obtuse triangular with a blunt tip, with a median line complete, a little obscure, admedian lines complete, divergent to rear, 3 submedian lines in the lateral area of prodorsal shield; scapular tubercles 36 (n=1) apart, ahead of rear shield margin; scapular setae *sc* 84 (80-87), too long, directing forward.

Leg I 43 (n=1), femur 16 (n=1), femoral setae *bv* 4 (n=1) on anterior 1/2 from the base of femur; genu 4 (n=1), genual setae *l'* 10 (n=1); tibia 6 (n=1), paraxial tibial setae *l''* 4 (n=1) on anterior 1/2 from the base of tibia (Fig.15D); tarsus 10 (n=1), tarsal solenidion *ω* 7 (n=1),

Figure 14 Drawing of *Aculus mastigophorus* (Nalepa, 1890) (female). A – dorsal view of body; B – ventral view of body; C – empodium; D – internal genitalia of female.

Figure 15 Phase-contrast light microscope images of *Aculus mastigophorus*. A – dorsal view of body; B – dorsal view of prodorsal shield; C – coxigenital region of female; D – legs (arrow: tibial seta on leg I).

slightly curved with knob apically, tarsal empodium *em* 5 (*n*=1), simple 2-rayed.

Leg II 33 (*n*=1), femur 11 (11-12), femoral setae *bv* 4 (*n*=1) on anterior 1/2 from the base of femur; genu 4 (4-5), genual setae *l''* 6 (4-7), tibia 5 (5-5); tarsus 7 (7-8), tarsal solenidion *ω* 5 (4-6), curved with knob apically, tarsal empodium *em* 5 (4-5), simple, 2-rayed.

Coxisternal plates smooth; prosternal apodeme contact at one point. Anterior setae on coxisternum I *lb* 4 (*n*=1), 14 (*n*=1) apart, ahead of line through proximal setae *la* on coxisternum I; *la* 4 (*n*=1), 17 (*n*=1) apart, a little ahead of line through proximal setae *2a* of coxisternum II, proximal seta *2a* 18 (*n*=1), 22 (*n*=1) apart.

External genitalia 17 (*n*=1), 26 (*n*=1) wide, flat bowl-shaped; coverflap smooth; setae *3a*

7 (n=1), 18 (n=1) apart. Coxigenital region with 4-5 semiannuli, microtubercles.

Opisthosoma with 39–42 dorsal, 60–60 ventral annuli. Dorsal annuli smooth, ventral annuli microtuberculate. Opisthosomal setae *c*2 11 (9–13), 57 (n=1) apart on 9–13th annulus; *d* 23 (n=1), 34 (n=1) apart on 22–24th annulus; *e* 11 (7–16), 20 (n=1) apart on 38–38th annulus; *f* 20 (19–20), 25 (n=1) apart on 6–6th annulus from rear; *h*1 4 (3–5), 9 (9–9) apart and *h*2 71 (n=1), 15 (n=1) apart.

Male — Not found.

Specimens examined — 2 females on 2 microscopic slides of inventory nos. NHMW29909/1–2 from vial no. 355 in Box TU from the Nalepa mite collection deposited in the NHMW.

Host plant — *Ulmus campestris* L.

Type locality — Not listed. Austria? (Nalepa Collection Locality. Unknown).

Distribution — Sweden (Roivainen, 1950).

Remarks — This species had very characteristic long scapular setae on the prodorsal shield. No seta was found on the tibial segment of the leg I of this mite (Nalepa, 1894) and if it was really absent, Amrine and Stasny (1994) suggested that a new genus might be created. However, our examination of the Nalepa specimen revealed that the mite apparently had a seta on the tibial segment of the leg I (arrow in Fig. 15D), so that it was not necessary to create a new genus.

Discussion

The specimens from the samples recovered from two vials (nos. 340 and 341) were belonged to the genera *Aceria* and *Aculops* based on the morphological characteristics of the genera, the former being identified as *Aceria thomasi* and the latter as *Aculops thymi*, based on the original description of Nalepa (1889). On the other hand, the measurements in the homologue symmetric structures other than the setae for *A. thomasi* and *A. thymi* are almost same between topotype specimens (present data) and specimens from Iceland (Szydło *et al.*, 2010), but the setal lengths of topotype specimens was shorter than that of specimens from Iceland (Table 1). The mites that infect Japanese perilla with emaravirus was not morphologically difference from *A. thymi*. Therefore, we concluded that the Japanese pellira mite is correctly *A. thymi*.

We redescribed a mite in the vial collected from *S. crenifolia* (vial no. 117) as *E. spiraeae*. The spiraea gall mite, *Eriophyes* sp. collected from *S. thunbergii* Siebold ex Blume (Rosaceae) in Japan was considered to be morphologically closer to *E. spiraeae*. However, we found that there are some morphological differences between them; namely, *Eriophyes* sp. has median line on prodorsal shield, much more annuli in number in coxigenital region, and the design of lines on the coxisternum I and II. *E. spiraeae* causes malformation to flowers of *S. crenifolia*, while the mites of *Eriophyes* sp. cause edge-rolling damage to leaves of *S. thunbergii*, but do not cause malformation of flowers. Therefore, it is necessary to compare molecular information to clarify the taxonomic species status of the sample collected from *S. thunbergii*, as well as to conduct a more detailed morphological comparison of *Eriophyes* sp. and *E. spiraeae*.

Among the mites in the vial collected from *U. campestris* (vial no. 477), we redescribed two species, *P. longirostris* and *S. ulmi*. We also redescribed two eriophyid mites, *A. filiformis* and *A. mastigophorus*, in the vial no. 355 collected from *U. campestris*. However, the Japanese Rhyncaphytophtinae species collected from walnut, *J. mandshurica*, did not resemble any of the specimens in the Nalepa vials or other described Rhyncaphytophtinae species. Thus, the Rhyncaphytophtinae species needs to be described as a new species. In his original description of *A. mastigophorus* did not draw a paraxial tibial seta on the leg I. However, we confirmed that each *A. mastigophorus* individual in the Nalepa vial has one seta on the tibial segment of leg I (Fig. 15D, arrow).

Nalepa described 331 species, 42 varieties, and 28 subspecies of eriophyoid mites during his research period from 1887 to 1930 (Newkirk, 1984), but detailed taxonomic characters are not shown in his original descriptions. This may lead to misidentification of mite species or

delay species identification by eriophyoid mite researchers. If all old mite collections including Keifer's and others could be restored, just as Chetverikov *et al.* (2016) could restore the old Nalepa's mite collections in their protocol, it would greatly contribute to the taxonomy of Eriophyoidea. In addition, recently, methods for extracting DNA without destroying mite specimens has been developed (Phillips and Simon, 1995; Ota *et al.*, 2011; Sakamoto and Gotoh, 2017; Duarte *et al.*, 2019). This would make it possible to compare the nucleotide sequence between the old mite type specimens and the current specimens. Therefore, we will try to extract DNA from the Nalepa mite specimens nondestructively and compare sequences to confirm whether Japanese mites and the Nalepa mites are conspecific or heterospecific. Furthermore, as many contemporary descriptions contain such data especially COI sequences, which are deposited to GenBank, the addition of molecular information to the traditional morphological traits would contribute greatly to the systematics of eriophyoid mite species.

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Conflicts of Interest

The authors declare no conflicts of interest.

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