A New Species of Leipothrix (Acari: Prostigmata: Eriophyidae) on Dipsacus spp. in Europe and Reassignment of Two Epitrimerus spp. (Acari: Prostigmata: Eriophyidae) to the Genus Leipothrix

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ABSTRACT A new species of eriophyid mite, Leipothrix dipsacivagus n. sp. (Acari: Prostigmata: Eriophyidae), collected from Dipsacus laciniatus L. (Dipsacaceae) and Dipsacus fullonum L. in Serbia, Bulgaria, and France, is described and illustrated. Differential diagnosis is provided in comparison with Leipothrix knautiae (Liro) n. comb., and Leipothrix succisae (Roivainen) n. comb., two species that also are proposed here for reassignment from the genus Epitrimerus Nalepa to the genus Leipothrix Keifer, within the family Eriophyidae. L. dipsacivagus n. sp. is being investigated as a candidate for biological control of invasive Dipsacus spp. in the United States.

KEY WORDS Eriophyidae, Leipothrix, systematics, Dipsacus, biological control of weeds

Teasels (Dipsacus L. spp.), belong to the Dipsacaceae, a family of exclusively Old World plants. Two closely related teasel species of Eurasian origin, Dipsacus fullonum L. and Dipsacus laciniatus L. have become invasive weeds in the United States, with either or both species occurring 43 states and declared noxious in five states (Rector et al. 2006). Classical biological control is considered to be an important component of the overall management strategy of these weeds in the United States due to three main factors: the Dipsacaceae is known to be an exclusively Old World family with no important economic species, thus the risk of nontarget feeding by biological control candidates is reduced; invasive Dipsacus spp. are too prominent and widespread to make eradication feasible; and invasive teasels frequently occur in areas with little or no regular weed management, such as roadsides, wetlands, and parklands (Rector et al. 2006). Biological control candidates currently under study for host range and suitability for release include eriophyid mites, insects, and fungi. The new eriophyid mite species Leipothrix dipsacivagus n. sp. was collected during surveys conducted in Serbia, Bulgaria, and France in 2005 and is a candidate for biological control of invasive teasels.

According to Amrine and Staney (1994) and De Lillo and Amrine (2006), only three eriophyid mite species are known to occur on dipsacaceous plants, including hosts in the genera Cephalaria Schrad. ex Roemer & J.A. Schultes, Knautia L., Scabiosa L., and Succisa Haller. These three mite species are Aceria squalida (Nal.), Epitrimerus knautiae Liro, and E. succisae Roivainen. Petanovic (1999) reported the presence of Epitrimerus knautiae in northern Serbia on Dipsacus laciniatus. However, after detailed revision of the material collected in Serbia in 1999, it was confirmed (R.U.P., unpublished data) that this mite, initially identified as E. knautiae (Petanovic 1999), should henceforth be known as a new species: Leipothrix dipsacivagus. Moreover, after careful study of the original and additional descriptions of E. knautiae (Liro 1942, Boczek 1964) and E. succisae (Roivainen 1947), it was determined that these species also should be transferred to the genus Leipothrix.

The genus Leipothrix was established by Keifer (1966) “to receive a species that has the central longitudinal ridge of Epitrimerus, but the legs lack the femoral setae.” Later, Amrine (1996) and Amrine et al. (2003) synonymized Flechtmannia (described by Keifer 1979 as having a moderately long bifurcate antapical gnathosomal seta) with Leipothrix on the basis that all Leipothrix species, including the type species have “antapical seta moderately long and bifurcate, branch may be minute and indicated by sharp bend in seta.” Subsequently Chetverikov (2005), in describing one new species of Leipothrix, briefly discussed the systematics of the genus. He stated in the diagnosis of the genus “setae s. apic. bifurcate or angled, usually consisting of basic and accessory branches” and emphasized that “the main distinctive feature of the genus Leipothrix spp. is the bifurcate setae s. apic. of the gnathosoma.” He also mentioned that in some species the distal part of the basic branch is very short and setae s. apic. have an “angled” form and stated that 11 more Epitrimerus species “probably belong to the genus Leipothrix.” Furthermore, four species of the genus Leipothrix are considered as species incertae sedis.
because the structure of the setae apicales has not been described (Chetverikov 2005).

To the best of our knowledge, movement of Epitrimerus knautiae Liro and Epitrimerus succisae Roivainen to the genus Leipothrix has not been specifically proposed until now. We propose here that these two species be reassigned to the genus Leipothrix due to the absence of femoral setae, following Keifer (1966).

Leipothrix dipsacivagus n. sp. is the first species of eriophyid mite recorded from hosts in the genus Diphuscus. Morphology of L. dipsacivagus n. sp. is described here in addition to notes on its distribution and effect on host plant morphology and development. Differences between L. dipsacivagus n. sp. and both L. knautiae (Liro) n. comb. and L. succisae (Roivainen) n. comb. are summarized and discussed.

Materials and Methods

The morphology of L. dipsacivagus n. sp. was investigated using a phase-contrast microscope (Leica DMLS) and with scanning electron microscopy (JEOI-JSM 6400LV). Before light microscopy, the mites were cleared in lactic acid for several days and then mounted in Keifer’s F or Heinez’s medium. The measurements presented here are based on study of 10 females and four males as well as one larva and one nymph. Morphometry was performed using the software package IM 1000 (Leica, Wetzlar, Germany).

The terminology and setal notation in the description follow the terminology of Lindquist (1996) and Baker et al. (1996). Measurements of the holotype and the range of paratypes (in parentheses) are given in micrometers and refer to the length of the structure, unless otherwise stated. Body length is measured from the anal lobe. The length of legs is taken from the femoral setae except setae femorales I and II. Legs I 37 (33—41), femora 10 (9—14), femoral setae (bv) absent; genua six (5—6), genual setae (l”') 27 (27—30); tibiae nine (7—10), tibial setae (l') four (4—7); tarsi six (4—7); inner fastigial setae (f') 16 (16—22), outer fastigial setae (f”) 20 (20—23); ventromesal setae (u') three (2—3); solenidia six (5—8), knobby; empodia five (4—6), 4-rayed. Legs II: 36 (30—37); femora 11 (9—13), femoral setae (bv) absent; genua six (5—7), genual setae (l”) 14 (14—18); tibiae eight (6—9); tarsi seven (6—7); inner fastigial setae (f') five (4—5), outer fastigial setae (f”) 21 (21—23); ventromesal setae (u’) four (3—4); solenidia six (6—7), knobby; empodia length five (4—6), 4-rayed. Coxae: Coxae I with numerous dotted lines, coxae II with fewer lines. Sternal line 10 (6—10), unforked; coxal setae (l') 16 (9—17), 19 (15—20) apart; coxal setae (l”) 21 (17—18), 11 (7—11) apart; coxal setae (a) 3 (11—17) and 13 (13—17) apart. Opisthosoma: Opisthosoma with longitudinal middorsal ridge fading above setae f. Setae c2 10 (10—17), 63 (57—68) apart, on annulus 17 (15—23); setae d 15 (15—30), 39 (31—46) apart; on annulus 35 (33—39); setae e seven (7—18), 19 (16—21) apart, on annulus 53 (53—71); setae f 30 (27—33), 26 (23—31) apart, on annulus 74 (74—89). Total dorsal annuli 47 (47—55). Dorsal annuli smooth. Total ventral annuli 79 (79—94) with round microtubercles on the edges of annuli; five terminal annuli striated. Setae h2 30 (30—65), eight (7—10) apart; setae h1 two (1—2), five (5—6) apart.

Males (n = 4). Smaller than female, 156 (146—164), 59 (56—65) wide. Gnathosoma: 13 (12—13), downcurved. Coxal setae (ep) two (2); dorsal genual setae (d) angled, consisting of basic and accessory branches, 17, basic branch four (3—6), accessory branch 13 (11—13); apical papila (e) two (1—2), cheliceral stylet 15 (14—17). Prodorsal shield: 16 (15—16) apart, directed centrad convergently. Legs I: 35 (35—39), femora 10 (19—14), femoral setae absent; genua five (5—6), genual setae (l”) 26 (25—26); tibiae seven (7—8), tibial setae (l') three (3—5); tarsi five (5—6); inner fastigial setae (f') 19 (19—22), outer fastigial setae (f”) 18 (18—22); ventromesal setae (u’) three (3—4); solenidia six (6—7), knobby; empodia five (4—6), 4-rayed. Legs II: 32 (32—34); femora 10 (10—12), femoral setae absent; genua five (4—5), genual setae (l”) 13 (13—16); tibiae six (6—7); tarsi five (5—6); inner fastigial setae (f”) four (4—5), outer fastigial setae (f') 24 (17—24); ventromesal setae (u’) two (2—3); solenidia seven (6—7), knobby; empodia five (3—5), 4-rayed. Coxae: Sternal line nine (6—9), unforked; coxal setae (b) 12 (11—14), 13 (7—13)
apart; coxal setae 1a 23 (20–25), six (6–8) apart; coxal setae 2a 25 (25–26), 23 (21–26) apart. Coxisternal area with 13 (13–15) microtuberculated annuli. Genitalia: 11 (9–11), 17 (14–18) wide. Coxal setae 3a 13 (13–14) and 12 (11–13) apart. Opiosthosa: setae c 21 (7–12), 47 (47–49) apart, on annulus 13 (11-13); setae d 19 (16–20), 29 (29–34) apart, on annulus 20 (20–26); setae e 12 (9–12), 14 (13–16) apart, on annulus 38 (38–44); setae f 21 (20–23), 21 (17–24) apart, on annulus 58 (54–66). Total dorsal annuli 49 (43–52), total ventral annuli 62 (59–70). Setae h 29 (28–44), eight (8–10) apart; setae h 1 two (1–2), five (5–6) apart.

**Nymph (n = 1).** 172, 69 wide. Gnathosoma: 13, downcurved. Coxal setae (ep) two (2); dorsal genual setae (d) angled, consisting of basic and accessory branches. 15: basic branch 4, accessory branch 11; apical papila (ep) 1; cheliceral stylet 15. Prodorsal shield: 46, 49 wide. Frontal lobe 4. Scapular setae (sc) 3, 16 apart, directed centrad convergently. Legs I: 24; femora 6, femoral setae absent; genua 4, genual setae (l') 24; tibiae 5; tibial setae (l') 3; tarsi 4; inner fastigial setae (ft') 19. legs II: 22; femora 6, femoral setae absent; genua 3, genual setae (l') 5; tibiae 3; tarsi 2; inner fastigial setae (ft') 3; outer fastigial setae (ft') 15; ventromesal setae (u') 2; solenidia 5, knobbed; empodia 4, 4-rayed. Legs III: 22; femora 6, femoral setae absent; genua 3, genual setae (l') 5; tibiae 3; tarsi 3; inner fastigial setae (ft') 3; outer fastigial setae (ft') 15; ventromesal setae (u') 2; solenidia 5, knobbed; empodia 4, 4-rayed. Coxae: Sternal line 6, unforked; coxal setae h 2, 13 apart; coxal setae 1a 16, eight apart; coxal setae 2a 12, 23 apart. Coxisternal area with 16 microtuberculated annuli. Coxal setae 3a 5, 11 apart. Opiosthosa: setae c 2 9, 43 apart, on annulus 19; setae d 13, 35 apart, on annulus 34; setae e 7, 19 apart, on annulus 48; setae f 19, 18 apart, on annulus 66. Total dorsal annuli 44, total ventral annuli 70. Setae h 29, three apart, setae h 12, six apart.

**Larva (n = 1).** 124, 60 wide. Gnathosoma: 13, downcurved. Coxal setae (ep); dorsal genual setae (d) 8; cheliceral stylet 13. Prodorsal shield: 35, 48 wide. Frontal lobe absent. Prodorsal shield with median line on...
anterior third, two median lines reaching dorsal tubercles, and two submedian lines on anterior half of the shield; lateral fields of the shield punctate. Scapular setae (sc) 2, 14 apart, directed centrad convergently. Legs I: 18; femora 4, femoral setae absent; genua 3, genual setae (l′) 6; tibiae 3; tarsi 3; inner fastigial setae (ft′) 10, outer fastigial setae (ft′) 11; solenidia 4, knobbed; empodia 3, 4-rayed. Legs II: 16; femora 6, femoral setae absent; genua 2, genual setae (l′) 5; tibiae 3; tarsi 3; inner fastigial setae (ft′) 3; outer fastigial setae (ft′) 8; solenidia 3, knobbed; empodia 3, 4-rayed. Coxae: Sternal line 4, unforked; coxal setae 1b 4, 10 apart; coxal setae 1a 12, five apart; coxal setae 2a 12, 19 apart. Coxisternal area with 16 microtuberculated annuli. Coxal setae 3a four and six apart. Opiosthosoma: Setae c 4, 36 apart, on annulus 11; setae d 19, 20 apart, on annulus 18; setae e 4, 14 apart, on annulus 25; setae f 16, 16 apart, on annulus 37. Total dorsal annuli 40, total ventral annuli 47. Setae h2 12, three apart; setae h1 2, seven apart.

Taxonomic Notes, Diagnosis, and Discussion

To the best of our knowledge, movement of *E. knautiae* Liro and *E. succissae* Roivainen to the genus *Leipothrix* has not been specifically proposed until now. We propose here that these two species be reassigned to the genus *Leipothrix* due to the absence of femoral setae, following Keifer (1966), and deducing from the drawings of subapical genual setae that are sharply bent, in original descriptions by Liro (1942) and Roivainen (1947). We support this proposal based on observations of specimens recently collected from *Knautia arvensis* L., in Serbia (R.U.P., unpublished data).

*L. dipsacivagus* sp. nov. is similar to *L. knautiae* (Liro) n. comb., found on *Knautia arvensis* (L.), and *L. succisae* (Roiv.) n. comb., found on *Succisa pratensis* Moench. A comparison of key characters of these three species is presented in Table 1. It should be stressed that the prodorsal shield patterns depicted and described for *L. knautiae* by Liro (1942) and Boczek (1964) are obviously different (Table 1). One possible explanation could be that different seasonal forms exist and were collected by these authors. Morphological differences between distant populations are also possible. *L. dipsacivagus* sp. nov. is the first eriophyid species recorded from *Dipsacus* spp.

**General Discussion.** Regarding the structure of antapical seta as the “key” character of the genus *Lei-
pothrix, it should be stressed that bifurcation is hardly visible on all slides by using phase-contrast microscopy and depends on the position and length of the bifurcate part of the basic branch. Even on scanning electron microscope (SEM) photographs bifurcation is not obvious.

In our opinion the statement “branch may be minute and indicated by sharp bend in seta” contained in an earlier generic key (Amrine 1996) and omitted in a more recent generic key (Amrine et al. 2003) should be returned. The presence of a bend in the dorsal genual seta or an “angled” dorsal genual seta is obvious on each slide and more precisely reflects the real situation.

**Type Material.** Holotype female (slide 967/4), 25 paratypes (19 females, four males and two nymphs), and allotype male of *L. dipsacivagus* sp. nov., were collected from *Dipsacus laciniatus* in a wetland at Bojcinska suma, in northern Serbia, ≈30 km west of Belgrade (global positioning system [GPS]: N 44° 47.765' E 20° 05.955') on 3 July 2005, 3 August 2005, 9 September 2005, and 8 October 2005. Five female paratypes also were collected from *D. laciniatus* along a roadside ditch in New Belgrade (suburb of Belgrade; GPS: N 44° 46.873' E 20° 21.617') on 17 August 2005.}

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**Table 1.** Key differences between females of *L. dipsacivagus* sp. nov.; *L. knautiae*, n. comb. (Liro 1942); *L. knautiae*, n. comb. (sensu Boczek 1964); and *L. succisae*, n. comb. (Roivainen 1947)

<table>
<thead>
<tr>
<th>Character</th>
<th><em>L. dipsacivagus</em> sp. nov.</th>
<th><em>L. knautiae</em> (Liro, 1942)</th>
<th><em>L. knautiae</em> (Boczek, 1964)</th>
<th><em>L. succisae</em> (Roivainen, 1947)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of body</td>
<td>236 μm (193–259)</td>
<td>230 μm</td>
<td>230 μm</td>
<td>220–250 μm</td>
</tr>
<tr>
<td>Length of scapular setae</td>
<td>4 μm (3–6)</td>
<td>10 μm</td>
<td>7–8 μm</td>
<td>9 μm</td>
</tr>
<tr>
<td>Prodorsal shield pattern</td>
<td>Two admedian lines from the base reaching the lobe; two submedian lines, shorter than admedian lines; transverse lines on anterior central part; central field with numerous dashes</td>
<td>One median and two admedian lines: complete, weakly diverging; two submedian lines bifurcate posteriorly; two lines on lateral field</td>
<td>Two longitudinal lines in the middle field and some indistinct lines laterally to dorsal setae</td>
<td>In posterior part of middle field three indistinct longitudinal lines</td>
</tr>
<tr>
<td>Shape of shield lobe</td>
<td>Blunt</td>
<td>Blunt</td>
<td>Blunt</td>
<td>Rounded</td>
</tr>
<tr>
<td>Shape of solenidion</td>
<td>Distinctly knobbed</td>
<td>Weakly knobbed</td>
<td>Slightly knobbed</td>
<td>Distinctly knobbed</td>
</tr>
<tr>
<td>No. of dorsal annuli</td>
<td>47 (47–55)</td>
<td>32–35</td>
<td>38–42</td>
<td>39–42</td>
</tr>
<tr>
<td>Shape and pattern of epigynium</td>
<td>Cover flap divided into two parts; anterior field with 12–15 uneven ridges</td>
<td>Epigynium of one part; anterior field divided into two parts; anterior field with 12–15 uneven ridges</td>
<td>Cover flap divided into two parts; anterior field divided into two parts</td>
<td>Epigynium of one part; anterior field with 12–15 uneven ridges</td>
</tr>
<tr>
<td>Host plant</td>
<td><em>Dipsacus laciniatus</em> L.</td>
<td><em>D. fullonum</em> L.</td>
<td><em>Knautia arvensis</em> L.</td>
<td><em>Succisa pratensis</em> L.</td>
</tr>
</tbody>
</table>

Holotype measurements are presented for *L. dipsacivagus* with range of paratype measurements present in parentheses in the same units.
May 2005. Four female paratypes, one male, one nymph, and two larvae were collected from *D. fullonum* at Montferrier-sur-Lez, France (GPS: N 43° 41.032' E 03° 52.473') on 21 November 2005. Three female paratypes and one larva were collected from *D. laciniatus* at Klokotnitsa, Bulgaria, (GPS: N 42° 00.43' E 25° 27.41') on 31 August 2005. Holotype, allotype and 11 paratype slides are deposited in the Acari Collection, Department of Entomology, Faculty of Agriculture, University of Belgrade, Serbia. Two paratype slides are deposited at the Department of Entomology, Faculty of Plant Protection, Agricultural University, Plovdiv, Bulgaria. Eight paratype slides are deposited at USDA–ARS, European Biological Control Laboratory, Montpellier, France. One female paratype slide each has been deposited at the British Museum, London, England, and the National Museum, Washington, DC.

**Additional Material.** More than 150 paratypes from type locality as well as 25 paratypes from Klokotnitsa, Bulgaria, and 55 paratypes from Montferrier-sur-Lez, France, mostly females; although also including males, nymphs, and larvae.

**Relation to Host Plant.** *L. dipsacivagus* sp. nov. was found on both upper and lower leaf surfaces of *D. laciniatus* and *D. fullonum* as a vagrant, causing rust-like symptoms and wrinkles on the longitudinal folds of the leaves. Experimentally reared *L. dipsacivagus* caused severe russetting and drying of the leaves of young plants. “Witches broom” of the plant itself (i.e., reduced internode lengths and deformed leaves), stunted development, delayed flowering, and galls of the flower heads were observed in the abandoned fields of dense populations of *D. laciniatus* infested with *L. dipsacivagus*. Deformations of flower heads were observed in autumn on new small flower heads, when the rest of the plant was dry. Dense colonies of mites aggregate on these parts and provoke such symptoms.

**Etymology.** The specific designation is derived from the genus of the type host plant + Latin *vagus* for roaming, wandering.

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