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A new species of *Olopachys* Berlese (Acari: Pachylaelapidae) from Iran with a key to the world species

Samaneh Mojahed\textsuperscript{a}, Jalil Hajizadeh\textsuperscript{a}, Reza Hosseini\textsuperscript{a}, Ali Ahadiyat\textsuperscript{b}

\textsuperscript{a}Department of Plant Protection, Faculty of Agricultural Sciences, University of Guilan, Rasht, Iran.
\textsuperscript{b}Department of Plant Protection, Science and Research Branch, Islamic Azad University, Tehran, Iran.

Original article

**ABSTRACT**

A new species, *Olopachys iraniensis* n. sp. (Mesostigmata: Pachylaelapidae) is described based on adult females collected from soil in Guilan Province, northern Iran. Two identification keys are provided, one for all known species of *Olopachys*, and the other for species recorded from Iran. A brief review on pachylaelapid mites of Iran is also provided.

**Keywords** Acari; *Olopachys*; Pachylaelapidae; new species; soil; Guilan

**Zoobank** http://zoobank.org/7D80D390-FE33-46A5-B60C-D37C36D61A6D

Introduction

Mites of the family Pachylaelapidae Berlese, 1913 are free-living predatory mites that feed on arthropods and soil-dwelling nematodes. In total, approximately 250 species and 16 genera of Pachylaelapidae have been recorded worldwide (Mašán and Halliday 2014). Until now, 25 recorded and described species of pachylaelapid mites are known from Iran (Khanjani and Kamali 2000a, b; Kamali et al. 2001; Ahmadi 2002; Jalaeian et al. 2004; Rahmani et al. 2006; Ahangaran et al. 2010; Babaiean and Kazemi 2011; Kazemi and Ahangaran 2011; Ahadiyat and Cheraghi 2012; Nazari-Tajani et al. 2012; Ahangaran et al. 2012; Ahadiyat et al. 2014; Ahadiyat et al. 2016; Babaiean et al. 2016a, b; Mojahed et al. 2017; Mašán et al. 2018; this study). Guilan Province, in northern Iran, can be considered as one of the most diverse region for Pachylaelapidae in Iran, with 13 found species (Nazari-Tajani et al. 2012; Mojahed et al. 2017; Mašán et al. 2018; this study).

*Olopachys* is a relatively small genus that currently includes 22 described species from the Western Palaearctic Region (Berlese 1910; Sellnick 1950; Reitblatt 1958; Koroleva 1976; Mašán 2007a, 2007b; Özbek 2014, 2016). *Olopachys* was redefined by Koroleva (1977), Karg (1993), Mašán (2007a, 2007b) and Mašán and Halliday (2014) and treated as a genus by these authors, although Berlese (1910) had originally considered it as a subgenus of *Pachylaelaps*. In adult females of *Olopachys*, anal and gnitiventrial shields are fused together into a genitiventrial shield, which does not exist in other pachylaelapid genera. Another distinguishing feature for the genus is the shape of the tubes of the sperm access system (Koroleva 1976, 1977; Karg 1993; Mašán 2007a, 2007b) and Mašán and Halliday (2014) and treated as a genus by these authors, although Berlese (1910) had originally considered it as a subgenus of *Pachylaelaps*. In adult females of *Olopachys*, anal and gnitiventrial shields are fused together into a genitiventrial shield, which does not exist in other pachylaelapid genera. Another distinguishing feature for the genus is the shape of the tubes of the sperm access system (Koroleva 1976, 1977; Karg 1993; Mašán 2007a, 2007b).

The *Olopachys* fauna of Iran is poorly known, with only two species reported from a total of six provinces (Azerbaijan, Golestan, Guilan, Khorasan, Mazandaran and Tehran), namely *Olopachys caucasicus* Koroleva, 1976 and *Olopachys compositus* Koroleva, 1976 (Ahangaran et al. 2010; Babaiean and Kazemi 2011; Ahadiyat and Cheraghi 2012; Zakeri et al. 2012; Kazemi et al. 2012; Nazari-Tajani et al. 2012; Kazemi and Rajaei 2013; Mohammad-Dustar-Sharaf et al. 2016a, b; Rezaie et al. 2016; Saberi et al. 2016; Mojahed et al. 2017). Here we describe a new soil-dwelling species of *Olopachys* from Guilan Province, northern Iran. In addition, we also provide (1) an identification key to *Olopachys* species (females) of Iran, (2) a...
key to the world species of the subgenus Olopachys (Olopachys) and (3) a tabulated checklist for pachylaelapid species found in Iran.

Materials and methods

Mite specimens were collected from soil under poplar and pine trees in Guilan Province, forest areas of the Emanzadeh Hashem in Rasht County and soil under citrus trees in Langrud County. After extraction using Berlese-Tullgren funnels, the mites were removed under a stereomicroscope, preserved in 75% ethanol, cleared in Nesbitt’s fluid and then mounted on microscope slides in Hoyer’s medium. Morphological observations, measurements, and illustrations were made using a compound microscope equipped with differential interference contrast and phase contrast optical systems, and a drawing tube. Photos were taken using a Canon Camera DS126311, attached to the microscope. Measurements are given in micrometers (μm); each measurement corresponds to the average followed (in parentheses) by the respective ranges. Lengths of dorsal, sternal, and genitiventrianal shields were measured from the anterior to posterior margins along their midlines. Maximum widths of dorsal and genitiverrinal shields were taken at their widest points. Width of sternal shield was measured at the mid-level of coxae II. Lengths of dorsal setae were measured from bases of their insertions to their tips. Terminology for dorsal and ventral idiosomal chaetotaxy used in this paper follows that of Lindquist and Evans (1965). Identification of pore-like structures on the idiosomal integument is based on the morphological observations of Athias-Henriot (1969); notation for these structures such as adenotaxy and poroidotaxy follows Johnston and Moraza (1991) and Moraza and Pena (2005). Leg setal notation and chaetotactic formulae are based on Evans (1963). Holotype and two female paratypes of the new species are deposited in the Acarology Laboratory, Department of Plant Protection, Faculty of Agricultural Sciences, University of Guilan, Iran. One paratype female will be deposited in the Acarological Collection, Jalal Afshar Zoological Museum, Department of Plant Protection, Faculty of Agriculture, University of Tehran, Karaj, Iran. The checklist of Pachylaelapidae of Iran is arranged alphabetically according to genera. For each species, only the first record of the species in the literature, for Iran, is cited; further reports of the same species are not mentioned in the checklist.

Results

Olopachys iraniensis n. sp.
Genus Olopachys Berlese, 1910
Pachylaelaps (Olopachys) Berlese, 1910: 256.

Zoobank: E217FB12-5254-4D51-AA22-CD408ABEDC31
Type species: Pachylaelaps (Olopachys) scutatus Berlese, 1910, by original designation. The genus was re-described in detail by Mašán (2007a, 2007b).

Olopachys iraniensis n. sp.
(Figures 1–3, 4C)

Diagnosis (Female)

Movable digit of chelicera with a subterminal tooth and terminal hook, fixed digit with two subterminal teeth and distal hook; base of epistome finely denticulated lateraly, epistome with narrow subdistal neck and long apical serration; posterolateral margins of dorsal idiosoma with one pair of gland pores (gdS4); clunal setae J5 minute; genitiventrianal shield longer than wide, length/width ratio: 1.3 (1.26–1.33), spermathecal tubes hyaline, hook-like, stout, relatively long, with well indicated and observable ductus; soft dorsolateral and opisthogastric integument bearing 14 pairs of setae (r6, R1, R3–R8, JV3–JV5, ZV2–ZV4) and four pairs of poroids (ivo1, ivo2, ivo3, ivp); tarsus II with two spur-like distal setae (pl1, pl2).
Description. Female (n=4)

**Dorsal idiosoma (Fig. 1A)** — Dorsal shield 669 (616–715) long, 403 (385–420) wide, length/width ratio: 1.7 (1.6–1.7), oval-shaped, ornamented with reticular pattern; with twelve pairs of poroids (idj4, idj6, idJ1, idJ2, idJ4, ids4, ids3, ids4, ids5, ids6, idZ2, idZ3); a pair of gland pores (gdS4) present on posterolateral margins, gdZ1 subcircular and well separated from gdS4; shield bearing 30 pairs of setae, smooth and needle-like, clunal setae J5 minute, other setae long. Lengths of dorsal setae: j1 25 (24–26), j2 67 (62–72), j3 79 (78–80), j4 72 (72–74), j5 51 (48–54), j6 84 (78–88), J1 91 (90–94), J2 88 (82–93), J3 86 (78–96), J4 83 (80–90), J5 9 (8–10), z1 52 (48–55), z2 88 (86–90), z4 102 (100–106), z6 65 (62–68), z6 94 (90–96), Z1 93 (88–98), Z2 98 (96–100), Z3 99 (94–104), s2 80 (76–84), s4 95 (88–100), s5 95 (88–100), s6 65 (60–68), SI 51 (50–54), S3 25 (24–28), S4 90 (86–93), S5 89 (84–93).

**Ventral idiosoma (Fig. 1B)** — Sternal shield 217 (208–228) long, 116 (96–135) wide, reticulate and bearing four pairs of setae st1-4 and three pairs of poroids (iv1, iv2, iv4); shield posterior margin concave, reaching level of posterior margin of coxae IV. Length of setae: st1 77 (68–83), st2 73 (68–80), st3 61 (52–67) and st4 71 (68–73). Genitiventral shield 327

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Figure 1 Olopachys iraniensis n. sp. (female): A – Dorsal idiosoma; B – Ventral idiosoma. Scale bar: 100 μm.
(304–348) long, 253 (240–260) wide, longer than wide, length/width ratio: 1.3 (1.26–1.33), abutting sternal shield anteromesally, suboval, reticulate throughout and bearing genital setae st5 70 (68–72), with two pairs of opisthogastric setae JV1 71 (68–76), JV2 70 (64–80), one pair of pore (iv5) and three short circumanal setae. Metapodal plates small and oval. Dorsolateral and opisthogastric soft integument with eight pairs of marginal [r6 47 (46–48), R1 15 (14–16), R3 42 (40–44), R4 43 (42–44), R5 75 (74–76), R6 71 (64–80), R7 75 (74–76), R8 75 (74–76)] and six pairs of opisthogastric setae [JV3 68 (66–70), JV4 58 (56–60), JV5 87 (86–88), ZV2 70 (68–72), ZV3 88 (86–90), ZV4 77 (76–78)], respectively. Opisthogastric integument bearing four pairs of poroids (ivo1, ivo2, ivo3, ivp).

**Gnathosoma** — Hypostomal seta h3 31 (28–34) and h1 30 (28–33) over twice longer than h2 13 (12–15) and palpcoxal setae pc 11 (10–14); corniculi elongated 77 (76–80) and horn-like (Fig. 2A); six transverse rows of denticles, followed posteriorly by a smooth ridge. Palptarsus with 3-tined apotele (Fig. 2B). Epistome with finely denticulate anterolateral margins, median process neck-like, concave laterally, with apical serration of elongate denticles (Fig. 2C). Movable digit of chelicera 62 (60–64), with large subterminal tooth and distal hook; fixed digit 47 (45–49) with two subterminal teeth and tridentate distal hook; pilus dentilis not seen (Fig. 3A).

**Spermathecal apparatus** (Fig. 3B) — Sperm access system associated with coxae IV. Tubes of sperm induction system hyaline, well-developed, stout and slightly curved (somewhat comma-shaped) with thin ductus inside.

**Legs** (Fig. 3C) — Legs normal, shorter than idiosoma. Tarsus I–IV with ambulacrum and two claws. Female tarsus II with two spur-like distal setae (pl1, pl2). Leg lengths (including pretarsi): I 496 (464–520); II 450 (400–544); III 366 (336–408); IV 502 (472–544). Leg IV is the longest and leg III is the shortest one. Legs IV and I longer than legs II and III. Leg chaetotaxy normal for the genus. Leg I: coxa 1-1/0-1/1-0; trochanter 1-1/2-0/1-1; femur 2-2/3-3/1-2; genu 2-3/3-1/2-2; tibia 2-3/2-1/2-2; leg II: coxa 0-0/0-0/1-0; trochanter 1-2/1-0/0-1; femur

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**Figure 2** *Olopachys iraniensis* n. sp. (female): A – Ventral gnathosoma; B – Palp tarsus; C – Epistome. Scale bar: 100 μm for A and C; 50 μm for B.
Male. Not found.

Etymology — The specific name of the new species refers to Iran, the country where the type specimens were collected.

Remarks — *Olopachys iraniensis* n. sp. was found in temperate and humid climate and in the lowland area at an altitude of 113 m a.s.l. This species is similar to *O. digitus* Özbek, 2016; *O. prolixus* Özbek and Halliday, 2015; *O. ovatus* Özbek and Halliday, 2015 and *O. vlastae* Mašán, 2007 in having minute *J5*, two spur like distal setae on tarsus II, and a pair of gland pores on posterolateral margin of dorsal shield (*gdS4*), but this new species can be easily separated from *O. digitus*, *O. prolixus* and *O. ovatus* by the presence of longer and curved spermathecal ducts and from *O. vlastae* by shorter hooke-like and spaced spermathecal tubes. *Olopachys iraniensis* n. sp. has also different number of the lateral and opisthogastric setae (14 pairs) than *O. prolixus* (11 pairs), *O. ovatus* and *O. vlastae* (12 pairs) and *O. digitus* (13 pairs).

Type material — Holotype: female, Iran, Guilan Province, Rasht County, Forest areas of the Emamzadeh Hashem (37°01′19″N 49°37′19″E, 113 m a.s.l.), 17 June 2016, S. Mojahed coll., in soil under poplar tree (*Populus caspica*, Bornm.). Paratypes: one female, with the same location as the holotype, 11 July 2015, S. Mojahed coll., in soil under pine trees (*Pinus halepensis* Miller); two females Guilan Province, Langrud County (37°11′0″N, 50°9′0″E), 6 October 2011, J. Hajizadeh coll., in soil under orange trees (*Citrus sinensis* (L.) Osbeck).

Key to world species of the subgenus Olopachys (Olopachys) (females)

The key to the world species of the subgenus *Olopachys* (*Olopachys*) presented by Özbek (2016) is modified here to accommodate the new species from Iran. The specimens of *Olopachys*
Figure 4 Tubes of the sperm access systems: A – Olopachys ompositus; B – Olopachys caucasicus; C – Olopachys iraniensis n. sp. Scale bar: 50 μm.
iraniensis n. sp., O. compositus Koroleva, 1976 and O caucasicus Koroleva, 1976 were examined, characteristics of other species were obtained from literature.

1. Tarsus II with one spur-like distal seta (pl1) .................................................. 2
   — Tarsus II with two spur-like distal setae (pl1 and pl2) .................................. 3

2. Genitiventrianal shield with three pairs of setae (st5, JV1, JV2); metapodal sclerites small and rounded ................................................. O. scutatus Berlese, 1910
   — Genitiventrianal shield with five pairs of setae (st5, JV1, JV2, ZV2, ZV3); metapodal sclerites absent ......................................................... O. latiscutatus Koroleva, 1976

3. Postero-lateral margins of dorsal shield with one pair of gland pores (gdS4) .......... 4
   — Postero-lateral margin of dorsal shield with two pairs of gland pores (gdS4, gdZ1) .... 2

4. Tubes of sperm access system very long, helically arranged, and longer than distance between (paraxial margins of) coxae IV .......................................................... 5
   — Tubes of sperm access system short, not helically arranged, and shorter than distance between (paraxial margins of) coxae IV .................................................. 6

5. Tubes of sperm access system with uniform shape over their length; dorsolateral and opisthogastric soft integument with 13 pairs of setae [six pairs of r. R. (r6, R1, R3, R5–7)] .............................................. O. suecicus Sellnick, 1950
   — Tubes of sperm access system with two regions of distinct thicknesses, the basal part (close to coxa IV) is thick and crescent-shaped and anterior part is slender and long; dorsolateral and opisthogastric soft integument with 14 pairs of setae [seven pairs of r. R. (r6, R1, R3–7)] .... 4
   ................................................................. O. crescentus Özbek, 2016

6. Dorsolateral and opisthogastric soft integument with 14 pairs of setae [seven pairs of r. R. (r6, R1, R3–7)]; ratio of length/width of genitiventrianal shield > 1.5 (1.54–1.69) .................. O. elongatus Özbeck and Halliday, 2015
   — Dorsolateral and opisthogastric soft integument with at most 13 pairs of setae; ratio of length/width of genitiventrianal shield < 1.5 ................................................ 7

7. Dorsolateral and opisthogastric soft integument with at least 12 pairs of setae ........ 8
   — Dorsolateral and opisthogastric soft integument with at most 11 pairs of setae .... 11

8. Soft integument with at least 13 pairs of marginal and opisthogastric setae .......... 9
   — Soft integument with 12 pairs of marginal and opisthogastric setae .................. 10

9. Tubes of sperm access system with a dark-brown part in apical, soft integument with six pairs of r. R. (r6, R1, R3–R6) and seven pairs of opisthogastric (JV3–JV5, ZV1, ZV3–ZV5) setae ................................................... O. digitus Özbeck, 2016
   — Tubes of sperm access system without dark-brown part in apical, soft integument with eight pairs of r. R. (r6, R1, R3–R8) and six pairs of opisthogastric (JV3–JV5, ZV2–ZV4) setae ....
   ................................................................. O. iraniensis n. sp.

10. Tubes of sperm access systems short, well sclerotized and with ductus well indicated and observable; gland pore gdS4 between setae Z2 and S4; pre-anal setae Jv2 connected by a straight line ...................................................... O. ovatus Özbeck and Halliday, 2015
   — Tubes of sperm access systems longer, weakly sclerotized and with ductus inconspicuous, difficult to discern; gland pore gdS4 and setae S4 aligned transversally; pre-anal setae Jv2 not
connected by a straight line. ......................... O. vlastae Mašán, 2007

11. Soft integument with 11 pairs of marginal and opisthogastric setae; tubes of sperm access system thin and slightly curved. ......................... O. vysotskajae Koroleva, 1976
   — Soft integument with 10 pairs of marginal and opisthogastric setae; tubes of sperm access system thick, strongly recurved, hook-shaped. ........ O. prolixus Özbek and Halliday, 2015

12. Tubes of sperm access system very long, with several bends; length of dorsal shield 730-840 O. compositus Koroleva, 1976
   — Tubes of sperm access system short or normal in length, without bends. .......... 13

13. Tubes of sperm access system thick and strongly sclerotized. ......................... 14
   — Tubes of sperm access system thin and weakly sclerotized. ......................... 18

14. Metapodal plates fused with lateral margins of genitventrianal shield. ................. 15
   — Metapodal plates free. ......................................................... 16

15. Tubes of sperm access system short and uniform in width; genitventrianal shield with about equal length and width. ...................... O. caucasicus Koroleva, 1976
   — Tubes of sperm access system long and expanded apically; genitventrianal shield longer than wide (length/width 1.12) .................. O. hallidayi Özbek, 2014

16. Tubes of sperm access system expanded apically. ........ O. adsharicus Koroleva, 1976
   — Tubes of sperm access system uniform in width. ........................................ 17

17. Tubes of sperm access system longer, apically reaching each other; sternal area between st2 and st3 with sculptural transverse line; lateral and opisthogastric integument with 11 pairs of setae. .................. O. kacheticus Koroleva, 1976
   — Tubes of sperm access system shorter, apically not reaching each other; sternal area between st2 and st3 without sculptural transverse line; lateral and opisthogastric integument with 13 pairs of setae. ..................... O. semicirculus Özbek, 2016

18. Dorsal setae shorter (J4 90–110); length of dorsal shield 650–730; geniti-ventrianal shield approximately subequal in length and width (length 0.34–0.39, width 0.33–0.36); tubes of sperm access system opening near coxae IV. .......... O. annae Koroleva, 1976
   — Dorsal setae longer (J4 120); geniti-ventrianal shield longer than wide (length 0.33–0.40, width 0.30–0.34); tubes of sperm access system opening between coxae III and IV. .......... 19

19. Genu and tibia of legs III and IV with small tubercles; tubes of sperm access system with broadened base. .................................................. O. golubevi Reitblatt, 1958
   — Genu and tibia of legs III and IV without tubercles; tubes of sperm access system relatively thin in basal part. .................................................. O. sklari Koroleva, 1976

Key to species (females) of the genus Olopachys Berlese occurring in Iran

1. Tubes of sperm access system quite long, spiralled apically (Figure 4A). .... O. compositus Koroleva, 1976
   — Tubes of sperm access system short (Figure 4B) or normal in length, straight or moderately curved apically (Figure 3B, 4C). .................................................. 2
2. Tubes of sperm access system much shorter than distance between (paraxial margins of) coxae IV, and uniform in widths, without bends (Figure 4B); metapodal plates fused with lateral margins of genitiventral shield. 

\[O.\ caucasicus\ Koroleva, \ 1976\] — Tubes of sperm access system longer, approximately as long as distance between coxae IV, slightly tapered and strongly curved apically (Figures 3B, 4C); metapodal plates free.

\[Olopachys\ iraniensis\ n. \ sp.\]

**Remarks on Pachylaelapidae of Iran**

The fauna of Pachylaelapidae in Iran is poorly known. So far, 25 species of pachylaelapid mites from four genera are known from Iran (20 species recorded and five species described). The complete identification of mites of the family Pachylaelapidae in Iran requires additional studies in the future. Tabulated checklist of Iranian pachylaelapid mite species based on their genera is as follow (Table 1).

**Table 1** Checklist of the Iranian Pachylaelapid mite species (described species are marked by an asterisk above their names).

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Related references</th>
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<tr>
<td>1</td>
<td>Olopachys caucasicus Koroleva</td>
<td>Ahangaran et al. 2010</td>
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<tr>
<td>2</td>
<td>Olopachys compositus Koroleva</td>
<td>Kazemi and Ahangaran 2011</td>
</tr>
<tr>
<td>3</td>
<td>Olopachys iraniensis n. sp. *</td>
<td>This study</td>
</tr>
<tr>
<td>4</td>
<td>Onchodellus alpinus (Willmann)</td>
<td>Rahmani et al. 2006</td>
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<tr>
<td>5</td>
<td>Onchodellus glandularis (Moraza and Peña)</td>
<td>Ahadiyat and Cheraghali 2012</td>
</tr>
<tr>
<td>6</td>
<td>Onchodellus hispant (Berlese)</td>
<td>Ahmadi 2002</td>
</tr>
<tr>
<td>7</td>
<td>Onchodellus karawaiensi (Berlese)</td>
<td>Khanjani and Kamali 2000a, b</td>
</tr>
<tr>
<td>8</td>
<td>Onchodellus procerus Mašán</td>
<td>Nazari-Tajani et al. 2012</td>
</tr>
<tr>
<td>9</td>
<td>Onchodellus siculus (Berlese)</td>
<td>Ahmadi 2002</td>
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<td>10</td>
<td>Onchodellus squamosus (Koroleva)</td>
<td>Mojahed et al. 2017</td>
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<td>11</td>
<td>Onchodellus strigifer (Berlese)</td>
<td>Ahadiyat and Cheraghali 2012</td>
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<td>12</td>
<td>Pachylaelaps brachiosus Hirschmann and Krauss</td>
<td>Jalaeian et al. 2004</td>
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<td>13</td>
<td>Pachylaelaps costai Hirschmann and Krauss</td>
<td>Jalaeian et al. 2004</td>
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<td>Pachylaelaps grandis Koroleva</td>
<td>Ahadiyat and Cheraghali 2012</td>
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<td>Pachylaelaps imitans Berlese</td>
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<td>Pachylaelaps magnus Halbert</td>
<td>Ahmadi 2002</td>
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<td>Pachylaelaps resinae Karg</td>
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<td>Pachylaelaps insularis (Berlese)</td>
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<td>Ahadiyat et al. 2014</td>
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<td>Pachylaelaps prodigiosus Mašán et al. 2018</td>
<td>Mašán et al. 2018</td>
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<td>22</td>
<td>Pachyseius angustus Hyatt</td>
<td>Babaeian &amp; Kazemi 2011</td>
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<td>Pachyseius persicus * Babaeian and Mašán</td>
<td>Babaeian et al. 2016a</td>
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<td>25</td>
<td>Pachyseius angustoides * Babaeian &amp; Mašán</td>
<td>Babaeian et al. 2016b</td>
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</table>
Acknowledgments

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