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

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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; Babaeian and Kazemi 2011; Kazemi and Ahangaran 2011; Ahadiyat and Cheraghali 2012; Nazari-Tajani *et al*. 2012; Ahangaran *et al*. 2012; Ahadiyat *et al*. 2014; Ahadiyat *et al*. 2016; Babaeian *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; Özbek and Halliday 2015; Özbek 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 genitiventral shields are fused together into a genitiventrianal 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; Kazemi and Ahangaran 2011; Ahadiyat and Cheraghali 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

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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 Emamzadeh 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 genitiventrianal 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*, *idz6*, *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), *z5* 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), *S1* 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). Genitiventrianal shield 327

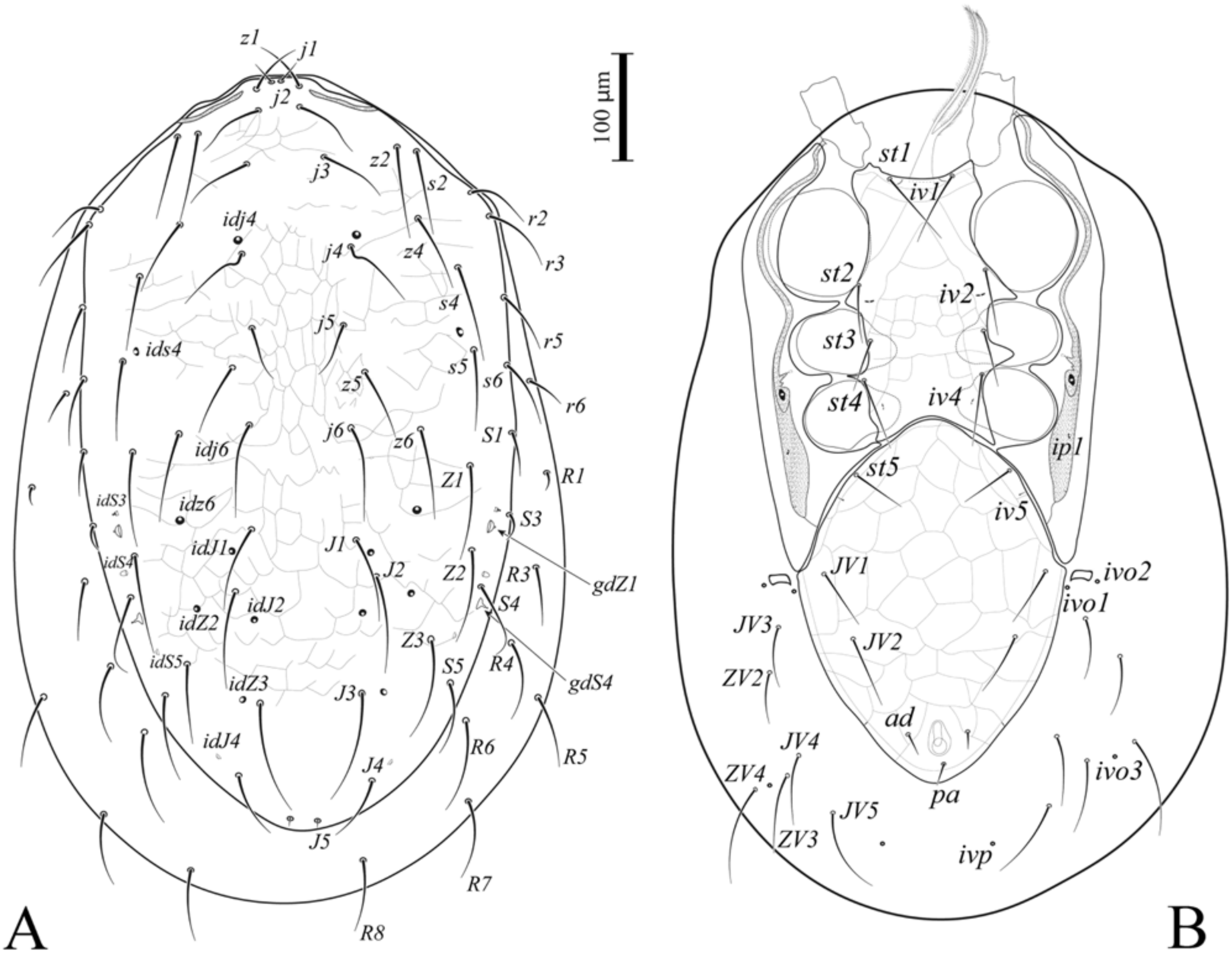

Figure 1 *Olopachys iraniensis* n. sp. (female): A – Dorsal idiosoma; B – Ventral idiosoma. Scale bar: 100 µm.

(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 (somehow 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

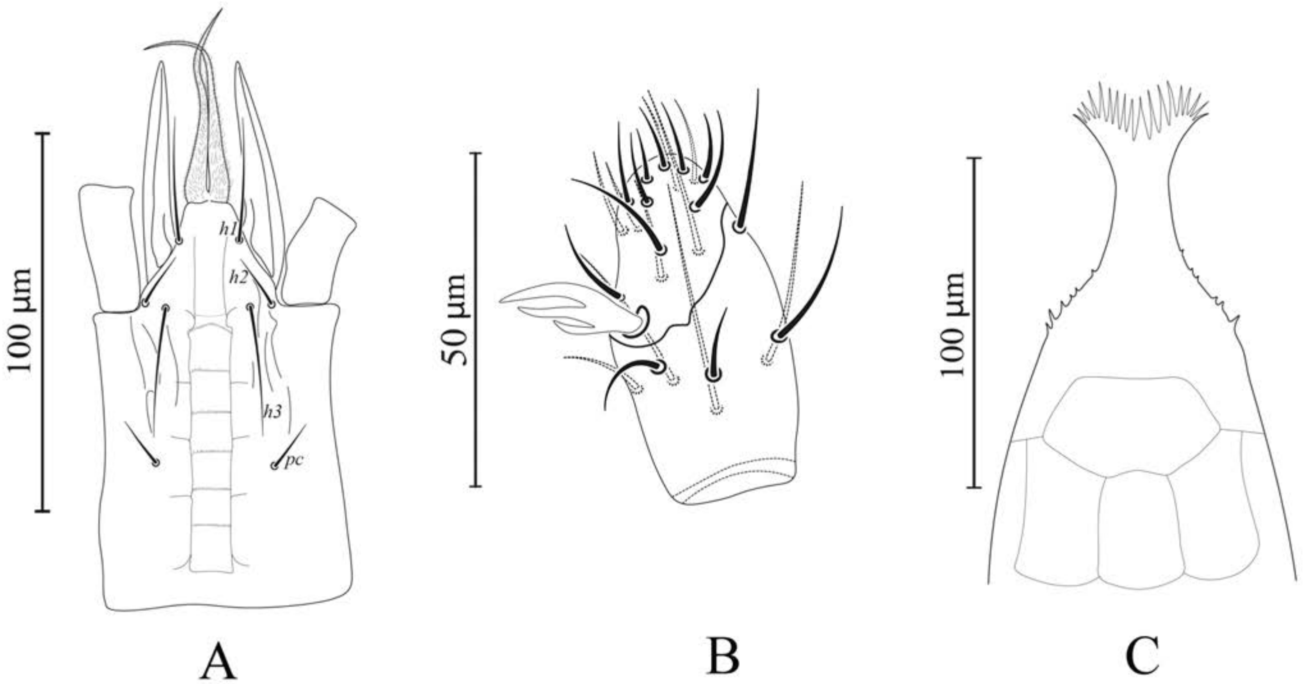

Figure 2 *Olopachys iraniensis* n. sp. (female): A – Ventral gnathosoma; B – Palp tarsus; C – Epistome. Scale bar: 100 µm for A and C; 50 µm for B.

2-2/3-1/2-1; genu 2-3/2-2/0-2; tibia 2-3/1-0/2-2, tarsus 3-3/4-3/2-3; leg III: coxa 0-0/0-0/0-0; trochanter 1-2/1-0/0-1; femur 1-2/1-0/1-1; genu 1-2/2-0/1-1; tibia 1-2/1-1/1-1, tarsus 3-4/3-2/3-3; leg IV: coxa 0-0/0-0/0-0; trochanter 1-1/0-0/2-1; femur 1-2/1-0/1-1; genu 1-2/2-0/1-1; tibia 1-1/2-1/1-1, tarsus 3-3/4-3/2-3.

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*

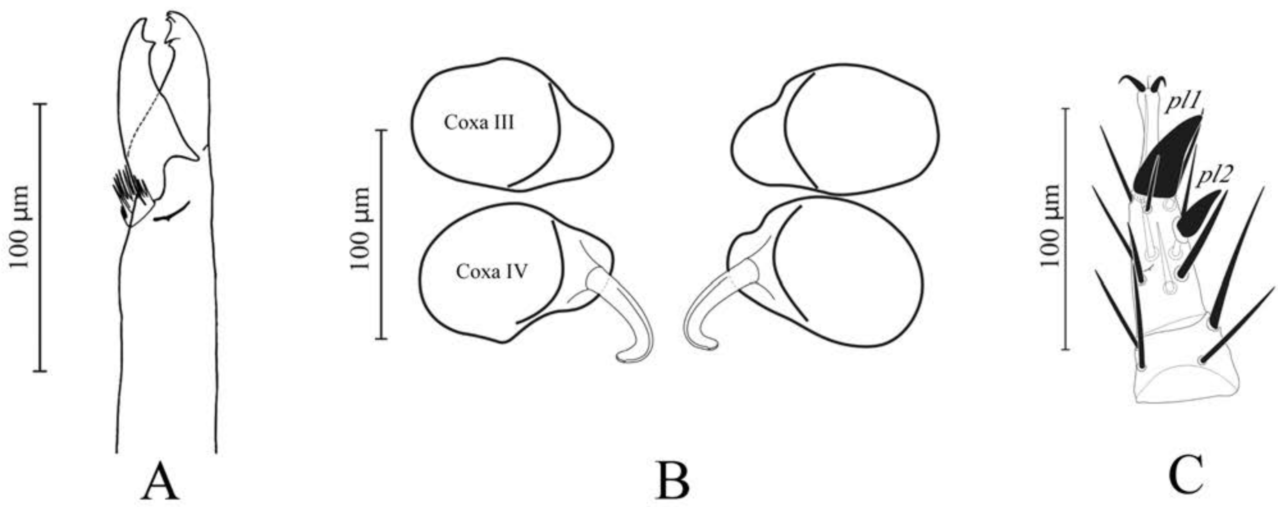

Figure 3 *Olopachys iraniensis* n. sp. (female): A – Chelicera; B – sperm access system; C – tarsus II. Scale bar: 100 µm.

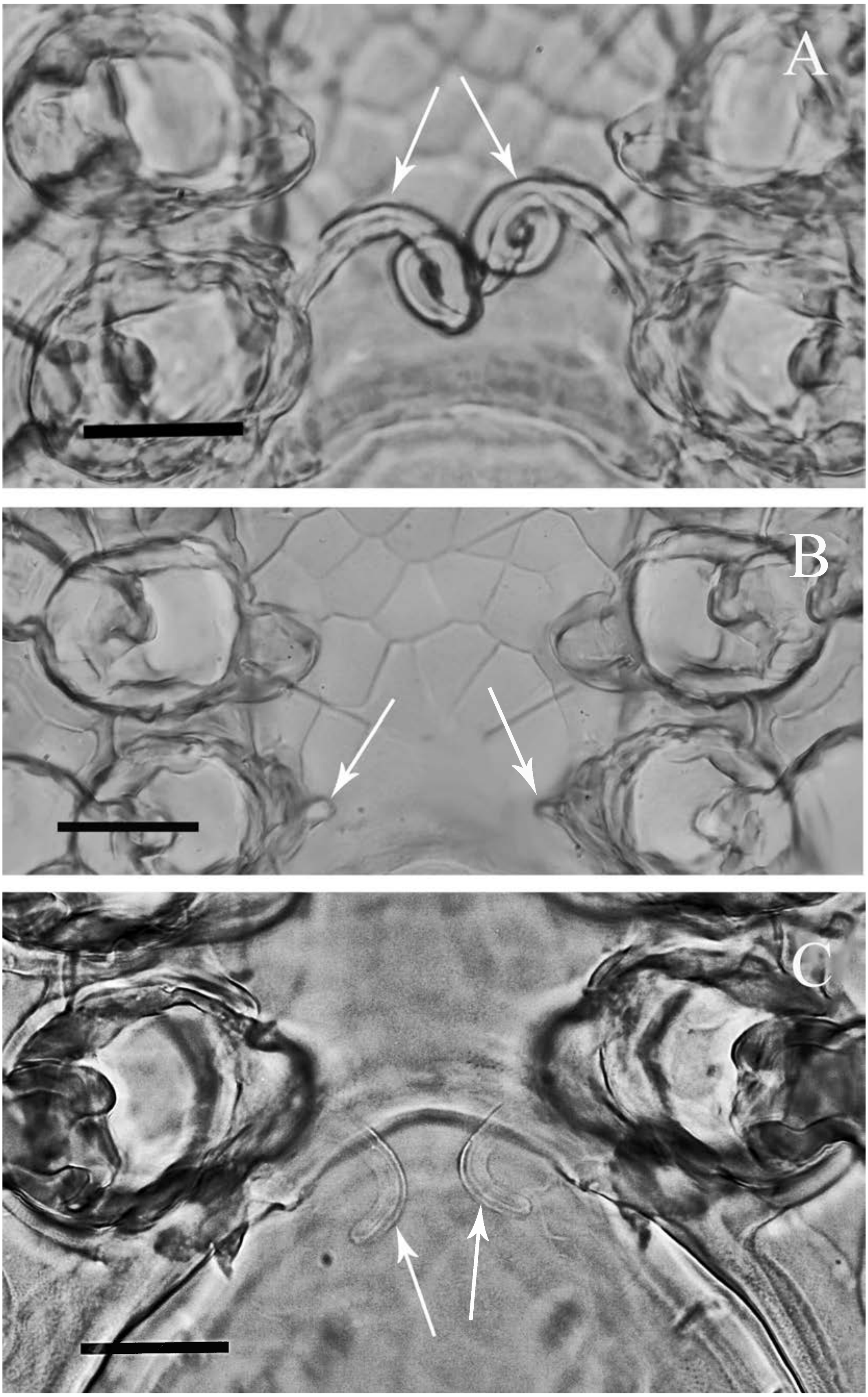

Figure 4 Tubes of the sperm access systems: A – *Olopachysc ompositus*; B – *Olopachys caucasicus*; C – *Olopachys iraniensis* n. sp. Scale bar: 50 µm.

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. latiscutus* 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*)] . . . . *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* Özbek 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* Özbek, 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* Özbek 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 genitiventrianal shield 15
— Metapodal plates free 16

15. Tubes of sperm access system short and uniform in width; genitiventrianal shield with about equal length and width . . . . *O. caucasicus* Koroleva, 1976
— Tubes of sperm access system long and expanded apically; genitiventrianal 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 genitiventrianal 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).

No.	Species	Related references
1	*Olopachys caucasicus* Koroleva	Ahangaran *et al*. 2010
2	*Olopachys compositus* Koroleva	Kazemi and Ahangaran 2011
3	*Olopachys iraniensis* n. sp. *	This study
4	*Onchodellus alpinus* (Willmann)	Rahmani *et al*. 2006
5	*Onchodellus glandularis* (Moraza and Peňa)	Ahadiyat and Cheraghali 2012
6	*Onchodellus hispani* (Berlese)	Ahmadi 2002
7	*Onchodellus karawaiewi* (Berlese)	Khanjani and Kamali 2000a, b
8	*Onchodellus procerus* Mašán	Nazari-Tajani *et al*. 2012
9	*Onchodellus siculus* (Berlese)	Ahmadi 2002
10	*Onchodellus squamosus* (Koroleva)	Mojahed *et al*. 2017
11	*Onchodellus strigifer* (Berlese)	Ahadiyat and Cheraghali 2012
12	*Pachylaelaps brachiosus* Hirschmann and Krauss	Jalaeian *et al*. 2004
13	*Pachylaelaps costai* Hirschmann and Krauss	Jalaeian *et al*. 2004
14	*Pachylaelaps grandis* Koroleva	Ahadiyat and Cheraghali 2012
15	*Pachylaelaps imitans* Berlese	Ahmadi 2002
16	*Pachylaelaps magnus* Halbert	Ahmadi 2002
17	*Pachylaelaps pectinifer* (G. Canestrini)	Jalaeian *et al*. 2004
18	*Pachylaelaps resinae* Karg	Kamali *et al*. 2001
19	*Pachylaelaps insularis* (Berlese)	Ahangaran *et al*. 2012
20	*Pachylaelaps* (*Longipachylaelaps*) *vicarius* Mašán	Ahadiyat *et al*. 2014
21	*Pachylaelaps prodigiosus* Mašán *et al*. 2018	Mašán *et al*. 2018
22	*Pachyseius angustus* Hyatt	Babaeian & Kazemi 2011
23	*Pachyseius masanisimilis** Ahadiyat and Ghasemi Moghadam	Ahadiyat *et al*. 2016
24	*Pachyseius persicus** Babaeian and Mašán	Babaeian *et al*. 2016a
25	*Pachyseius angustoides** Babaeian & Mašán	Babaeian *et al*. 2016b

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