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Article

Review of the family Digamasellidae (Acari: Mesostigmata) in Iran with three new records and a key to species

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ABSTRACT
Twenty-one species of digamasellid mites were collected from Guilan province in northern Iran. *Oligodentatus shcherbakae* Barilo, 1989, *O. tridentatus* Shcherbak & Bregetova, 1980 and *Dendrolaelaspis longisetosus* (Shcherbak, 1977) are new records for the Iranian mite fauna. Redescriptions, including figures, of the adult female for these three species are provided, based on the material collected from Iran. This paper provides a checklist for 31 digamasellid species recorded from Iran and a taxonomic key for their identification.

KEYWORDS: Gamasina, Guilan, Parasitiformes, redescription, Rhodacaroidea.

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INTRODUCTION

Digamasellidae is a group of predatory mites commonly found in soil, litter, manure, compost and in association with different wood-boring and bark beetles. Some species are found in decaying organic material (their deutonymphs being also associated with some insects living in these habitats, such as scarab beetles), decaying wood, bracket fungi, and galleries of wood boring and bark beetles (Hirschmann 1960; McGraw and Farrier 1969; Shcherbak 1980; Hirschmann and Wiśniewski 1982a; Karg 1993; Ma *et al*. 2014; Faraji *et al*. 2021; Joharchi *et al*. 2022). The known prey of Digamasellidae include nematodes, arthropod eggs, early stages of insects or mites, springtails, and possibly fungi (Walter *et al*. 1988; Lindquist *et al*. 2009; Castilho 2012). For a long time, researchers have used different concepts for the classification of Digamasellidae at the genus and subgenus levels (e.g., Lindquist 1975; Evans and Till 1979; Shcherbak 1980; Hirschmann and Wiśniewski 1982a, b; Karg 1993; Castilho 2012). Family Digamasellidae was first erected by Evans (1957) and then fully defined by Lindquist (1975) based on a limited number of genera. Shcherbak (1980) placed digamasellid mites in the family Rhodacaridae and subfamily Dendrolaelapinae. He recognized nine genera: *Dendrolaelaps*, *Dendrolaelaspis*, *Dendroseius*, *Insectolaelaps*, *Longoseius*, *Longoseiulus*, *Multidendrolaelaps*, *Oligodentatus* and *Orientolaelaps*, for subfamily Dendrolaelapinae. Krag (1993) considered the genera belonging to the family Digamasellidae in the family Rhodacaridae and the tribe Dendrolaelapini. He defined 10 genera: *Cornodendrolaelaps*, *Dendrolaelaps*, *Dendrolaelaspis*, *Dendroseius*, *Digamasellus*, *Insectolaelaps*, *Longoseius*, *Multidendrolaelaps*, *Protogamasellus* and

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Punctodendrolaelaps for tribe Dendrolaelapini. Hirschmann and Wiśniewski (1982a, b) divided genus *Dendrolaelaps* into 14 subgenera. Castilho (2012) presented a key for the 11 genera of Digamasellidae in her unpublished thesis. Castilho *et al.* (2012) listed 13 genera for family Digamasellidae. The family currently comprises about 280 nominal species placed in 14 genera: *Bulbolaelaps* Faraji *et al*., 2021, *Dendrolaelaps* Halbert, 1915, *Dendrolaelaspis* Lindquist, 1975, *Dendrolobatus* Shcherbak, 1983, *Dendroseius* Karg, 1965, *Digamasellus* Berlese, 1905, *Insectolaelaps* Shcherbak, 1980, *Lindquistoseius* Genis, Loots & Ryke, 1969, *Longoseius* Chant, 1961, *Multidendrolaelaps* Hirschmann, 1974, *Oligodentatus* Shcherbak, 1980, *Orientolaelaps* Bregetova & Shcherbak, 1977, *Panteniphis* Willmann, 1949 and *Pontiolaelaps* Luxton, 1984 with worldwide distributions (Shcherbak 1980; Castilho 2012; Castilho *et al*. 2012; Faraji *et al*. 2021; Mohammadi and Hajizadeh 2023). Castilho *et al.* (2012) listed 16 subgenera for the genus *Dendrolaelaps* including: *D.* (*Apophyseodendrolaelaps*) Hirschmann & Wiśniewski, 1982, *D.* (*Cornodendrolaelaps*) Hirschmann & Wiśniewski, 1982, *D.* (*Daeleidendrolaelaps*) Wiśniewski & Hirschmann, 1990, *D.* (*Dendrolaelaps*) Halbert, 1915, *D.* (*Disetodendrolaelaps*) Hirschmann & Wiśniewski, 1982, *D.* (*Duplodendrolaelaps*) Wiśniewski & Hirschmann, 1991, *D.* (*Epistodendrolaelaps*) Hirschmann & Wiśniewski, 1982, *D.* (*Foveodendrolaelaps*) Hirschmann & Wiśniewski, 1982, *D.* (*Ipidodendrolaelaps*) Hirschmann & Wiśniewski, 1982, *D.* (*Majestidendrolaelaps*) Wiśniewski & Hirschmann, 1989a, *D.* (*Monodendrolaelaps*) Wiśniewski & Hirschmann, 1989b, *D.* (*Presepodendrolaelaps*) Hirschmann & Wiśniewski, 1982, *D.* (*Punctodendrolaelaps*) Hirschmann & Wiśniewski, 1982, *D.* (*Sellnickidendrolaelaps*) Hirschmann & Wiśniewski, 1982, *D.* (*Stanidendrolaelaps*) Wiśniewski & Hirschmann, 1993a and *D.* (*Xylodendrolaelaps*) Wiśniewski & Hirschmann, 1993b. In this paper, we follow Castilho (2012) and Castilho *et al*. (2012) classification. Although we have not included the subgenera of the genus *Dendrolaelaps* in this paper because it is not possible to unambiguously assign every species in the genus to the respective subgenera, Hirschmann & Wiśniewski, (1982a) are followed for arranging the species of genus *Dendrolaelaps* in related subgenera.

A comprehensive taxonomic study on Digamasellidae has not been done in Iran, but some species have been investigated by Iranian acarologists. Faraji *et al*. (2006) described *Dendroseius amoliensis* Faraji *et al*. based on specimens collected in northern Iran. During 1996–2020, nine species of *Dendrolaelaps* were reported in Iran by different researchers (Kamali *et al*. 2001; Kazemi and Rajaei 2013; Moradi Faradonbe *et al*. 2018; Nemati *et al*. 2018; Mojaz and Kazemi 2020). Hosseini *et al*. (2019) reported and redescribed the female of *Digamasellus punctum* (Berlese, 1904) from Iran and provided the key to the world species of the genus. Faraji *et al*. (2021) described the genus *Bulbolaelaps* Faraji, Zare & Rahmani, 2021 and new species *Bulbolaelaps bossei* Faraji, Zare & Rahmani, 2021, based on adult females and male specimens collected on gilled fungi on a tree trunk in Zanjan province. Mohammadi and Hajizadeh (2022) described adult male and deutonymph of *Dendroseius amoliensis* based on specimens collected in Guilan province, northern Iran. They recorded *Dendroseius vulgaris* Ma, Ho & Wang, 2014 for the first time from Iran. Mohammadi and Hajizadeh (2023) described *Dendrolaelaps lignicolus* Mohammadi & Hajizadeh, 2023, based on specimens collected in Guilan province. In addition to the seven new species records, they provided a checklist and an identification key for 17 species of *Dendrolaelaps* recorded from Iran (Mohammadi and Hajizadeh 2023). In this article, we provide an alphabetic checklist and a taxonomic key for the separation of digamasellid species reported from Iran so far. Additionally, three species recorded from Iran for the first time are redescribed and illustrated based on the material collected from this country.

MATERIAL AND METHODS

Digamasellids were collected from soil, litter, rice husks, rotten stump, and manure samples in Guilan province. Mites were extracted from samples using modified Berlese funnels. Specimens were sorted

and preserved in 70% ethanol, cleared in Nesbitt's fluid, and mounted on microscope slides using Hoyer's medium. The digamasellids were identified using taxonomic literature (Shcherbak 1980; Barilo 1989; Hirschmann and Wiśniewski, 1982a, b; Karg 1993; Huhta and Karg 2010; Castilho 2012; Hosseini *et al.* 2019; Mohamadi and Hajizadeh 2022, 2023). All measurements are given in micrometers. The length and width of the dorsal shields were taken from the anterior to posterior margins along the midline, and at the level of *r4*, respectively. The length and width of the sternal shield were measured at the maximum length and broadest level (the level between coxae II and III), respectively. The length of the genital shield was measured along the midline from the anterior margin to the posterior margin of the shield, and its width at the broadest level (posteriad setae *st5*). The length and width of the ventrianal shield were taken along the midline from the anterior to posterior shield margin and at the level of setae *Zv3*, respectively. The fixed cheliceral digit was measured from the anterior part of the dorsal lyrifissure to the apical hook, and the movable digit from the base to the apex. The length of the legs (I–IV) were taken from the base of the coxa to the apex of the tarsus (excluding the pre-tarsus). Setae were measured from their insertions to their tips. For each dimension the mean value is given, followed by the range in parentheses. The classification system follows that proposed by Castilho *et al*. (2012). The setal notation for the idiosoma follows Lindquist and Evans (1965) and Lindquist and Moraza (1998), poroidotaxy and adenotaxy follows Athias-Henriot (1975) and leg chaetotaxy follows Evans (1963). The reported number of teeth on the cheliceral digits does not include the apical tooth. Morphological observations, measurements, and illustrations were made using an Olympus BX51 microscope (Olympus Optical Co., LTD., Tokyo, Japan) equipped with differential interference contrast and phase contrast optical systems, a drawing tube, and a Canon camera (EOS Kiss X5; Japan). Illustrations were prepared using Adobe Illustrator software. Voucher specimens of each species, preserved as slide-mounted specimens, are deposited in the Acarology Laboratory, Department of Plant Protection, Faculty of Agricultural Sciences, University of Guilan, Rasht and Jalal Afshar Zoological Museum, Department of Plant Protection, Faculty of Agriculture, University of Tehran, Karaj, Iran.

RESULTS AND DISCUSSION

During this study, 21 species of six genera were determined from specimens collected in Guilan province. Of these, *Oligodentatus shcherbakae* Barilo, 1989, *O. tridentatus* Shcherbak & Bregetova, 1980 and *Dendrolaelaspis longisetosus* (Shcherbak, 1977) are recorded from Iran for the first time.

Dendrolaelaspis Lindquist, 1975

Dendrolaelaspis lobatus (Scherbak & Chelebier, 1977)

Dendrolaelaps (*Dendrolaelaspis*) *lobatus* — Shcherbak and Chelebiev (1977): 471.
Dendrolaelaps (*Dendrolaelaspis*) *lobatus* — Hirschmann and Wiśniewski (1982a): 144.
Dendrolaelaspis lobatus — Shcherbak (1980): 180; Karg (1998): 189; Karg and Schorlemmer (2009): 69; Castilho (2012): 194; Joharchi *et al*. (2022): 74.

Material examined **– Siahkal County**, Deylaman District, Asiabar village (36° 51' 51.5" N, 49° 50' 07.0" E), 13 June 2022, from manure, Three females and one male.

Dendrolaelaspis longisetosus (Shcherbak, 1977)

Dendrolaelaps (*Dendrolaelaspis*) *longisetosus* Shcherbak, in Shcherbak and Gomelauri (1977): 210.
Dendrolaelaps (*Dendrolaelaspis*) *longisetosus* — Hirschmann and Wiśniewski (1982): 142.
Dendrolobatus longisetosus — Shcherbak (1983): 74.

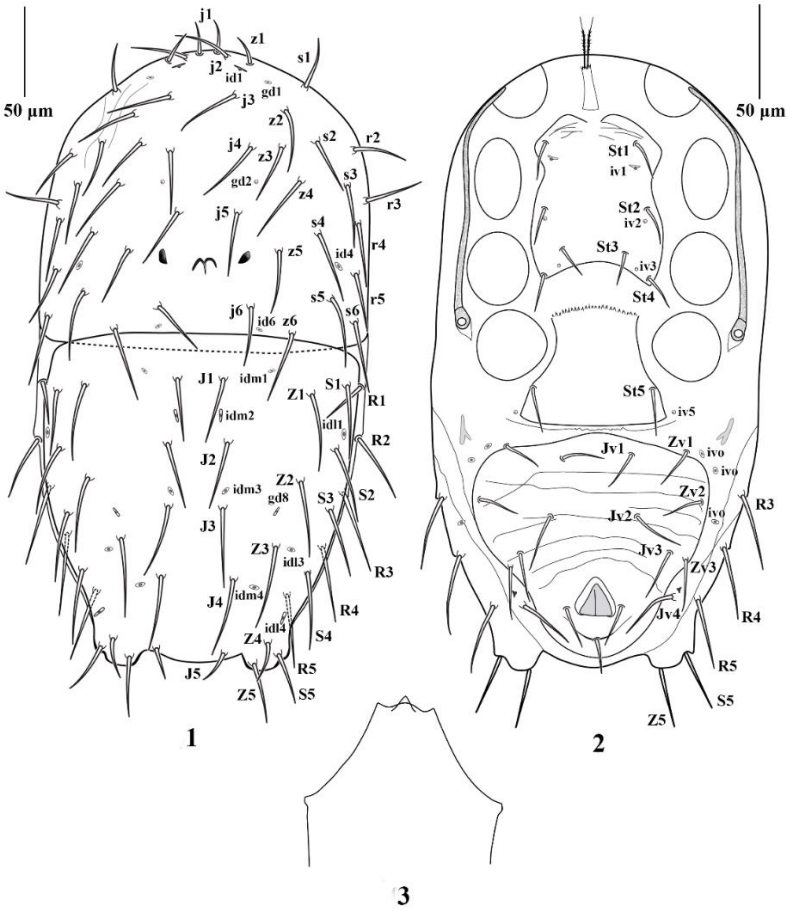
Dendrolaelaspis longisetosus — Shcherbak (1980): 181; Karg and Schorlemmer (2009): 68; Castilho, 2012: 194.

Adult female (n = 3)

Gnathosoma – Epistome with tree short prongs (Fig. 3); palp apotele two-tined; fixed cheliceral digit 26 long, with a few small teeth; movable cheliceral digit 32 long, with four teeth; corniculi horn-like; hypostomal setae smooth, *h1* 20 , *h2* 13 (12–14), *h3* 13 (12–14), *pc* 20.

Idiosoma – 320 long, 180 (176–184) wide.

Dorsal idiosoma (Fig. 1) – Podonotal and opisthonotal shields separate, both smooth. Podonotal shield with 22 pairs setae (*j1-6*, *z1-6*, *s1-6*, *r2-5*), three distinguishable lyrifissures (*id1*, *id4* and *id6*), two pairs of gland pores (*gd1* and *gd2*) and three scleronoduli (in one specimen it seems that the median scleronodulus is a fusion of two scleronoduli). Opisthonotal shield with posterior margin bilobed; with 15 pair setae (*J1-5*, *Z1-5*, *S1-5*, of which *Z5* and *S5* on the posterior dorsal shield lobes), seven pairs of distinguishable lyrifissures (*idm1*, *idm2*, *idm3*, *idm4*, *idl1*, *idl3* and *idl4*) and a pair of gland pores (*gd8*), setae *R1–5* on soft cuticle.



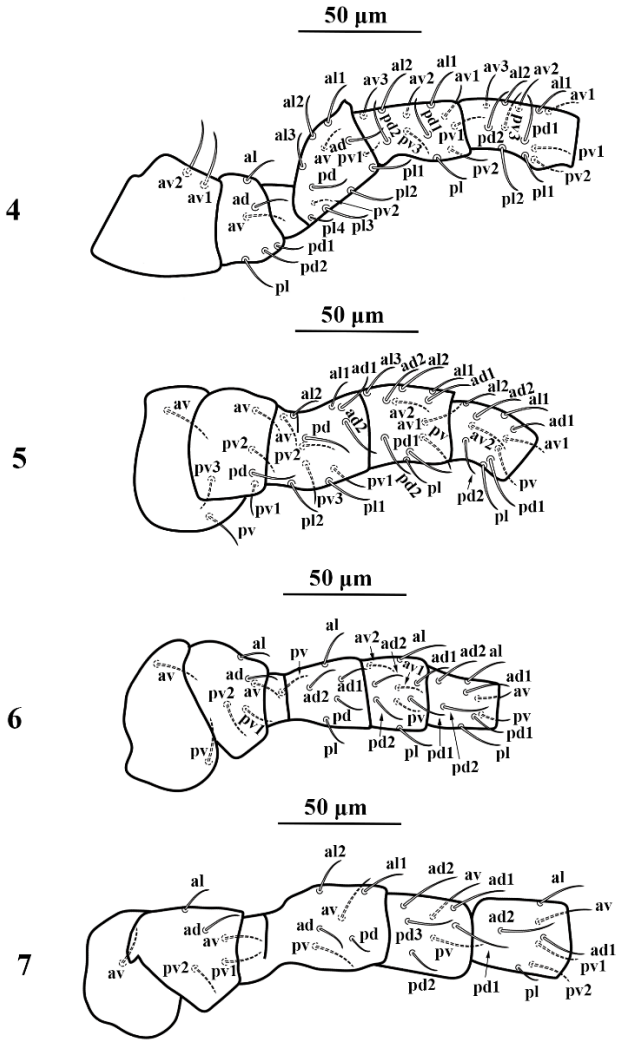
Figures 1–3. *Dendrolaelaspis longisetosus* Shcherbak (female) – 1. Dorsal idiosoma; 2. Ventral idiosoma; 3. Epistome (without scale).

Measurements of setae: *j1* 15 (14–16), *j2* 31 (30–32), *j3* 36 (36), *j4* 33 (30–36), *j5* 32 (30–34), *j6* 32 (31–34), *z1* 15 (14–16), *z2* 34 (32–36), *z3* 32 (31–33), *z4* 35 (34–38), *z5* 34 (34), *z6* 38 (38), *s1* 25 (24–26), *s2* 30 (28–32), *s3* 35 (34–36), *s4* 37 (34–38), *s5* 39 (38–40), *s6* 37 (36–38), *r2* 28 (26–30), *r3* 29 (26–31), *r4* 32 (30–34), *r5* 31 (30–32), *J1* 34 (34), *J2* 36 (32–40), *J3* 39 (38–40), *J4* 40 (40), *J5* 17 (16–18), *Z1* 40 (40), *Z2* 40 (38–42), *Z3* 40 (38–42), *Z4* 21 (20–24), *Z5* 26 (26), *S1* 37 (34–38), *S2*

37 (36–38), *S3* 38 (36–40), *S4* 36 (35–38), *S5* 26 (26); *R1* 21 (20–22), *R2* 33 (32–34), *R3* 35 (32–38), *R4* 35 (34–36), *R5* 32 (30–34). All setae smooth, relatively long and usually inserted in humps.

Ventral idiosoma (Fig. 2) – Tritosternum with elongated base 25 (24–26) and totally separate laciniae. Sternal and genital shields smooth. Sternal shield 93 (90–100) long and 65 (62–68) wide, with four pairs of setae, *st1* 20, *st2* 19 (16–22), *st3* 13 (12–15), *st4* 16 and three pairs of lyrifissures (*iv1*, *iv2* and *iv3*); genital shield 63 (60–64) wide, bearing a pair of setae *st5* 19 (18–20), *iv5* located on soft cuticle. Ventrianal shield broad triangular, transversally striate; length 111 (110–112), width 116 (112–118); with five pairs of preanal setae, *Jv1* 18 (16–20), *Jv2* 23 (22–24), *Jv3* 23 (22–24), *Zv2* 20 (16–22), *Zv3* 24 (22–25) in addition to para-anal 17 (16–18) and post-anal 15 (14–16). Soft cuticle surrounding the ventrianal shield with *Zv1* 18 (16–20), *Jv4* 29 (28–30), three pairs of lyrifissures (*ivo*) and a pair of partially fused metapodal plates on each side; anal opening 21 (20–22) is larger than other species of the genus. Peritremes extending anteriorly to level of middle part of coxa I.

Legs (Figs. 4–7) – Lengths, excluding pretarsi: leg I 259 (244–272), leg II 184 (180–192), leg III 167 (164–172), leg IV 223 (220–228). Chaetotaxy: Leg I: coxa 0-0/2, 0/0-0 (2), trochanter 1-1/1, 2/0-1 (6), femur 3-1/1, 1/2-4 (12), genu 2-0/3, 2/3-1 (11), tibia 2-0/3, 2/3-2 (12), Leg II: coxa 0-0/1, 0/1-0 (2), trochanter 0-0/1, 1/3-0 (5), femur 2-2/1, 1/3-2 (11), genu 3-2/2, 2/1-1 (11), tibia 2-2/2, 2/1-1 (10), Leg III: coxa 0-0/1, 0/1-0 (2), trochanter 1-1/1, 0/2-0 (5), femur 1-2/1, 1/0-1 (6), genu 1-2/2, 2/1-1 (9), tibia 1-2/1, 2/1-1 (8), Leg VI: coxa 0-0/1, 0/0-0 (1), trochanter 1-1/1, 0/2-0 (5), femur 2-1/1, 1/1-0 (6), genu 0-2/1, 3/1-0 (7), tibia 1-2/1, 1/1-1 (7).



Figures 4–7. *Dendrolaelaspis longisetosus* Shcherbak (female) – 4. Coxa–tibia of leg I; 5. Coxa–tibia of leg II; 6. Coxa–tibia of leg III; 7. Coxa–tibia of leg IV.

Material examined – Astaneh-ye Ashrafiyeh County, Chur Kuchan village (37° 16' 26.4" N, 49° 57' 40.1" E), 21 June 2022, from manure, Three females.

Remarks – Comparing the examined specimens with Sherbak's (1980) description, idiosoma length (320 *vs.* 310), idiosoma width (180 *vs.* 140), and movable cheliceral digit (36 *vs.* 34).

Digamasellus Berlese, 1905

Digamasellus punctum (Berlese, 1904)

Cyrtolaelaps (*Gamasellus*) *punctum* — Berlese (1904): 262.
Gamasellus (*Digamasellus*) *perpusillus* — Berlese (1905): 234
Digamasellus punctum — Lindquist (1975): 13; Karg (1993): 346; Bernini *et al*. (1995): 20; Castilho (2012): 198; Hosseini *et al*. (2019): 397.

Material examined – Rasht County, University of Guilan (37° 11' 44.5" N, 49° 38' 30.7" E), 12 September 2021, from manure, two females, one male and one deutonymph; University of Guilan (37° 11' 46.7" N, 49° 38' 17.9" E), 3 January 2022, from the mushroom growing on tree trunk, one female; Sangar district (37° 09' 57.5" N, 49° 41' 21.1" E), 14 October 2021, from rice husks, nine females and one male; Lasht-e Nesha District (37° 21' 57.7" N, 49° 51' 27.9" E), 15 November 2021, from rice husks, ten females; Kolesh Taleshan village (37° 14' 57.4" N, 49° 31' 04.4" E), 22 November 2021, from Mushroom compost, one female; Keshavarz Park (37° 16' 40.5" N, 49° 36' 23.6" E), 24 June 2022, from manure, two females; **Astaneh-ye Ashrafiyeh County** (37° 19' 55.5" N, 49° 55' 57.0" E), 15 November 2021, from peanut shells, two females and one male; **Shaft County**, Mashatuk villlage (37° 16' 46.6" N, 49° 28' 32.9" E), 22 November 2021, from horse manure, two females.

Multidendrolaelaps Hirschmann, 1974

Multidendrolaelaps multidentatus (Leitner, 1949)

Digamasellus multidentatus Leitner, 1949: 62.
Dendrolaelaps (*Epistodendrolaelaps*) *multidentatus* — Hirschmann and Wiśniewski (1982): 27.
Multidendrolaelaps multidentatus — Shcherbak (1980): 185; Karg (1993): 366; Huhta and Karg (2010): 346; Castilho (2012): 215.

Material examined – Rasht County, Faculty of Physical Education and Sports Sciences (37° 10' 57.1" N, 49° 39' 42.5" E), 11 August 2021, from manure, seven females, two males and one deutonymph; Rasht County (37° 16' 20.3" N, 49° 37' 25.3" E), 22 September 2021, from manure, two females and two males; University of Guilan (37° 11' 47.1" N, 49° 38' 42.6" E), 13 October 2021, from chicken manure, six females; Kuchesfahan District (37° 16' 30.7" N, 49° 42' 36.9" E), 15 November 2021, from manure, two females; Kuchesfahan District, Belesbeneh village (37° 16' 30.2" N, 49° 44' 33.1" E), 15 November 2021, from manure, two females; **Shaft County**, Mashatuk villlage (37° 16' 46.6" N, 49° 28' 32.9" E), 22 November 2021, from horse manure, two females; **Astaneh-ye Ashrafiyeh County**, Tamchal village (37° 18' 33.9" N, 49° 57' 18.0" E), 18 July 2022, from manure, six females; Nazok Sara village (37° 19' 25.0" N, 49° 55' 55.7" E), 15 November 2021, from manure, three females; **Sowme'eh Sara County** (37° 18' 25.0" N, 49° 19' 13.3" E), 18 July 2022, from manure, five females and one males.

Oligodentatus Shcherbak, 1980

Oligodentatus shcherbakae Barilo, 1989

Oligodentatus shcherbakae Barilo, 1989: 141.

Adult female (n = 1)

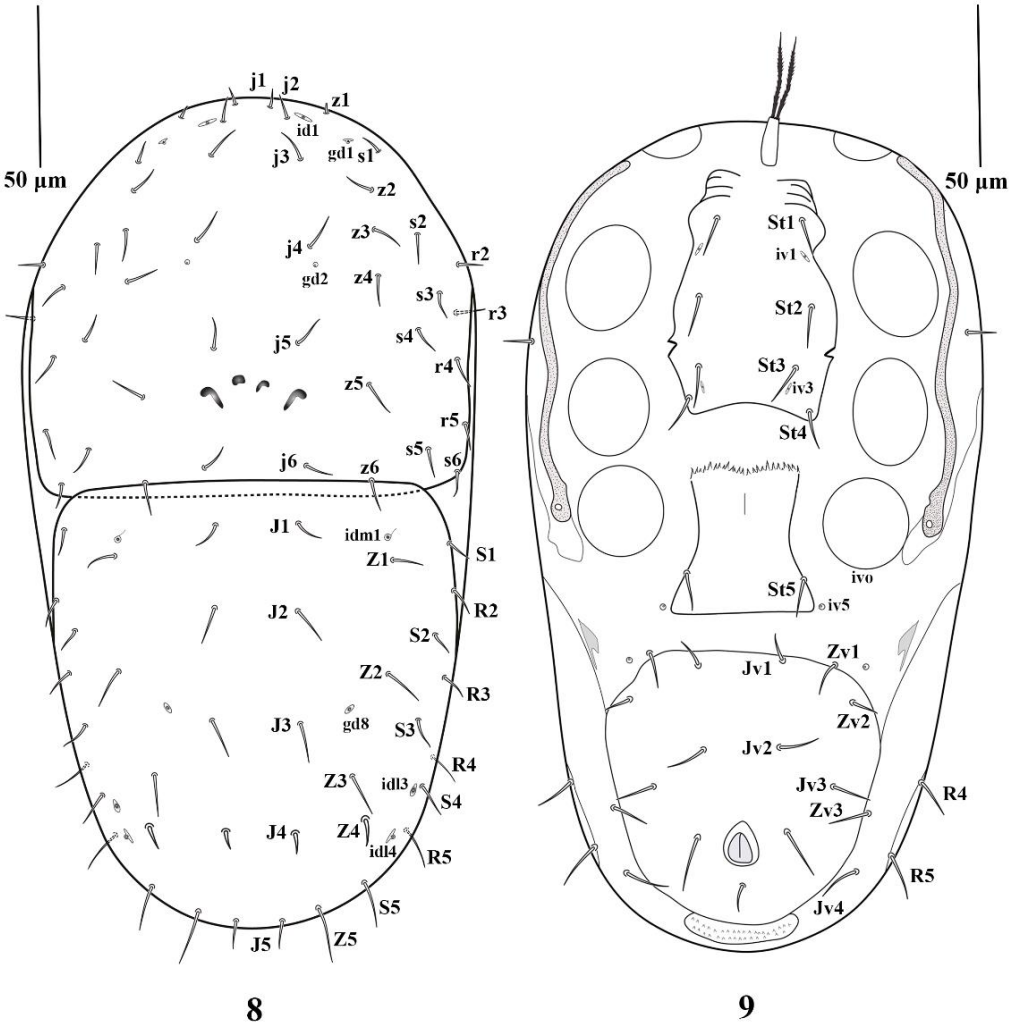
Gnathosoma – Epistome with three prongs relatively equal length; palp apotele two-tined; fixed

cheliceral digit 16 long, with a few small teeth; movable cheliceral digit 19 long, with three teeth; corniculi horn-like; hypostomal setae smooth, *h1* 14, *h2* 3, *h3* 10, *pc* 13.

Idiosoma – 240 long, 120 wide, smooth.

Dorsal idiosoma (Fig. 8) – Podonotal and opisthonotal shields separate, both smooth. Podonotal shield with 21 pair setae (*j1–6*, *z1–6*, *s1–6, r2, r4–5*), a pair of distinguishable lyrifissures (*id1*), two pairs of gland pores (*gd1* and *gd2*) and four scleronoduli between setae *j5* and *j6*, setae *r3* are located outside the shield. Opisthonotal shield with 19 pairs of setae (*J1*–5, *Z1*–5, *S1*–5, *R2*–5), three pairs of distinguishable lyrifissures (*idm1*, *idl3* and *idl4*) and a pair of gland pores (*gd8*) and setae *R1* absent. Measurements of setae: *j1* 4, *j2* 6, *j3* 10, *j4* 10, *j5* 9, *j6* 8, *z1* broken, *z2* 6, *z3* 9, *z4* 9, *z5* 10, *z6* 9, *s1* 6, *s2* 8, *s3* 8, *s4* 8, *s5* 8, *s6* 7, *r2* 7, *r3* 9, *r4* 7, *r5* 8; *J1* 9, *J2* 10, *J3* 10, *J4* 7 slightly thickened, *J5* 7, *Z1* 9, *Z2* 11, *Z3* 12, *Z4* 8 slightly thickened, *Z5* 16, *S1* 7, *S2* 7, *S3* 10, *S4* 11, *S5* 14, *R2* 8, *R3* 8, *R4* 10, *R5* 12. All setae short and smooth.

Ventral idiosoma (Fig. 9) – All ventral shields smooth. Sternal shield 72 long and 44 wide, with four pairs of setae, *st1* 10, *st2* 10, *st3* 11, *st4* 10 and two pairs of distinguishable lyrifissures (*iv1*, *iv3*) between *St3*-*St4*. Genital shield 40 wide, with a pair of setae *st5* 10, *iv5* located on soft cuticle. Ventrianal shield rounded-triangular, length 80 and width 78; with four pairs of preanal setae, *Jv1* 8, *Jv2* 10, *Jv3* 10, *Zv2* 7 in addition to para-anal 15 and, post-anal 7; *Zv1* 10, *Zv3* 10, *Jv4* 12, a pair of lyrifissures (*ivo*) and a pair of partially fused metapodal plates located on the soft cuticle of each side; peritremes extending anteriorly to posterior level of coxa I.



Figures 8–9. *Oligodentatus shcherbakae* Barilo (female) – 8. Dorsal idiosoma; 9. Ventral idiosoma.

Material examined – Rasht County, Bijar Boneh village (37° 18' 21.0" N, 49° 38' 49.0" E), 1 May 2019, from greenhouse soil, one female.

Remarks – Comparing the examined specimens with Barilo's (1989) description, idiosoma (240 *vs.* 220) long, (120 *vs.* 105) wide, *J4* (8 *vs.* 6–7), *Z3* (12 *vs.* 11.5), *Z5* (16 *vs.* 17).

Oligodentatus tridentatus **Shcherbak & Bregetova, 1980**

Oligodentatus tridentatus Shcherbak and Bregetova, in Shcherbak (1980): 174.
Dendrolaelaps (*Oligodentatus*) *tridentatus* — Hirschmann and Wiśniewski (1982): 18.
Oligodentatus tridentatus — Castilho (2012): 220.

Adult female (n= 5)

Gnathosoma **–** Epistome with three prongs of similar length; palp apotele two-tined; fixed cheliceral digit 25 (24–27) long, with 5–6 teeth and a setiform pilus dentilis; movable cheliceral digit 32 (32) long, with three teeth; corniculi horn-like; hypostomal setae smooth, *h1* 20 (16–23), *h2* 11 (10–12), *h3* 20 (14–22), *pc* 19 (17–21).

Idiosoma – 342 (332–348) long, 206 (180–232) wide.

Dorsal idiosoma (Fig. 10) – Dorsal shield reticulate, podonotal and opisthonotal shields separate. Podonotal shield with 22 pair of setae (*j1*–6, *z1*–6, *s1*–6, *r2*–5), five pair of distinguishable lyrifissures (*id1*, *id2*, *id4*, *id5* and *id6*), a pair of glands (*gd2*) and four scleronoduli between setae *j5* and *j6*. Opisthonotal shield with 17 pair setae (*J1*–5, *Z1*–5, *S1*–5, *R4*–5), nine pairs of distinguishable lyrifissures (*idm1*, *idm2*, *idm3*, *idm4*, *idm5*, *idm6*, *idl1*, idl3 and *idl4*) and a pair glands (gd8). Measurements of setae: *j1* 13 (12–14), *j2* 19 (16–20), *j3* 19 (18–20), *j4* 19 (18–20), *j5* 18 (16–20), *j6* 19 (16–20), *z1* 11 (11), *z2* 19 (18–20), *z3* 19 (18–20), *z4* 21 (20–22), *z5* 19 (18–20), *z6* 22 (20–23), *s1* 18 (16–20), *s2* 18 (18), *s3* 20 (18–22), *s4* 21 (20–22), *s5* 24 (22–26), *s6* 23 (20–26), *r2* 18 (18), *r3* 18 (16–20), *r4* 17 (14–20), *r5* 17 (14–18), *J1* 20 (20), *J2* 21 (18–24), *J3* 21 (17–23), *J4* 22 (21–24), *J5* 14 (14), *Z1* 25 (24–27), *Z2* 26 (22–28), *Z3* 25 (24–26), *Z4* 20 (20), *Z5* 45 (44–50), *S1* 22 (20–24), *S2* 18, *S3* 20 (18–22), *S4* 25 (23–26), *S5* 52 (50–56); *R1* 14 (12–15), *R2* 16 (14–18), *R3* 16 (16), *R4* 20 (18–20), *R5* 24 (22–25). All setae smooth.

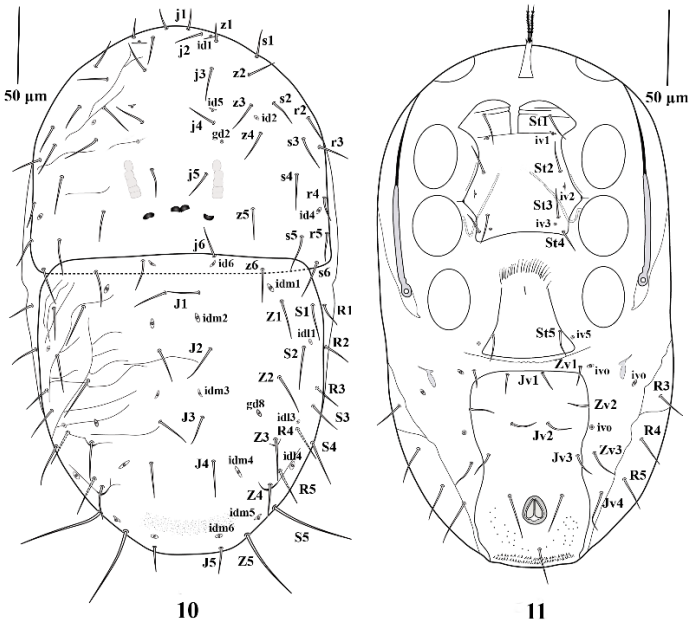
Ventral idiosoma (Fig. 11) – Tritosternum base 24 (22–27), with paired divided laciniae. Ventral shields smooth. Sternal shield 90 (84–94) long and 70 (64–80) wide, with four pairs of setae, *st1* 18 (18), *st2* 18 (17–19), *st3* 17 (16–18), *st4* 16 (16) and three lyrifissures (*iv1*, *iv2*, *iv3*). Genital shield 64 (60–70) wide, with a pair of setae *st5* 17 (16–18), *iv5* located on soft cuticle. Ventrianal shield rectangular, length 128 (126–132) and width 77 (74–78); with five pairs of preanal setae, *Jv1* 13 (12–16), *Jv2* 16 (14–16), *Jv3* 15 (14–17), *Zv2* 14 (12–16), *Zv3* 19 (16–21) 8 in addition to para-anal 24 (22–25) and post-anal 21 (20–22). Setae *Zv1* 14 (12–18), *Jv4* 26 (24–28), three lyrifissures (*ivo*) and a pair of partially fused metapodal plates on the soft cuticle of each side. Peritremes short, extending anteriorly to level of posterior part of coxae II.

Legs (Figs. 12–15) – Lengths, excluding pretarsi: leg I 264 (260–268), leg II 194 (188–204), leg III 182 (172–188), leg IV 229 (220–236). Chaetotaxy: Leg I: coxa 0-0/2, 0/0-0 (2), trochanter 1-1/1, 1/1-1 (6), femur 2-3/3, 2/3-0 (13), genu 2-3/2, 2/2-1 (12), tibia 2-3/2, 2/1-2 (12), Leg II: coxa 0-0/1, 0/1-0 (2), trochanter 0-0/2, 1/2-0 (5), femur 0-3/2, 2/3-1 (11), genu 1-5/1, 2/2-0 (11), tibia 1-3/2, 2/2-0 (10), Leg III: coxa 0-0/1, 0/1-0 (2), trochanter 1-1/1, 0/2-0 (5), femur 1-2/1, 1/0-1 (6), genu 1-3/1, 2/1-1 (9), tibia 1-2/1, 2/1-1 (8), Leg VI: coxa 0-0/1, 0/0-0 (1), trochanter 1-1/2, 0/1-0 (5), femur 0-3/2, 1/0-1 (7), genu 1-2/1, 2/0-1 (7), tibia 1-1/1, 2/1-1 (7).

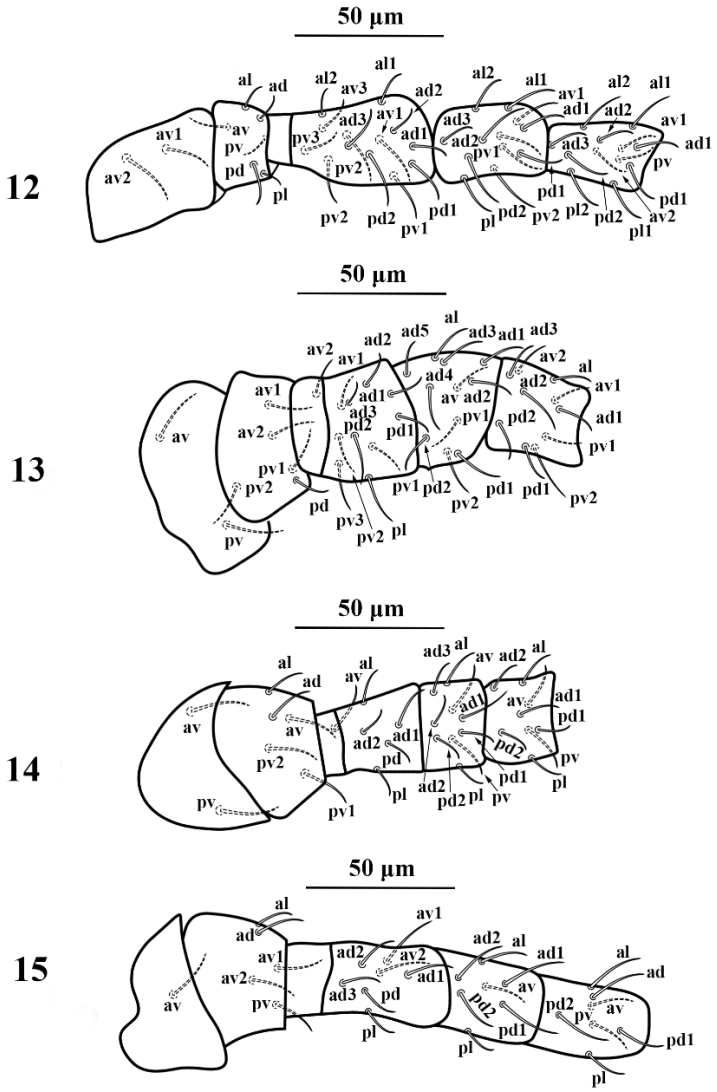
Spermatheca – In the form of a narrow tube that opening in coxa III.

Material examined – Five females and one deutonymph, from manure, Chaboksar County (36° 55' 35.0" N, 50° 37' 58.6" E), 24 November 2009.

Remarks – Comparing the examined specimens with Sherbak's (1980) description, idiosoma (342 *vs.* 310–330), movable cheliceral digit (32 *vs.* 37).



Figures 10–11. *Oligodentatus tridentatus* Shcherbak & Bregetova (female) – 10. Dorsal idiosoma; 11. Ventral idiosoma.



Figures 12–15. *Oligodentatus tridentatus* Shcherbak & Bregetova (female) – 12. Coxa–tibia of leg I; 13. Coxa–tibia of leg II; 14. Coxa–tibia of leg III; 15. Coxa–tibia of leg IV.

Note – Material examined for the genera *Dendroseius* and *Dendrolaelaps* in Guilan Province are given in Mohammadi and Hajizadeh (2022) and Mohammadi and Hajizadeh (2023) articles, respectively.

A list of Digamasellidae species recorded from Iran

The new findings reported in the previous pages raise to 31 the total number of digamasellid species so far known from Iran, as summarized in Table 1.

Table 1. Digamasellid species recorded from Iran, including the new findings reported in this publication, and respective references.

No.	Species	References
1	*Bulbolaelaps bossei* Faraji, Zare & Rahmani, 2021	Faraji *et al*. (2021)
2	*Dendrolaelaps arenarius* Karg, 1971	Moradi Faradonbe *et al*. (2018)
3	*Dendrolaelaps brevipilis* (Leitner, 1949)	Haddad Irani-Nejad *et al*. (2003); Mohammadi and Hajizadeh (2023); Current study
4	*Dendrolaelaps brevipiloides* Hirschmann and [illegible]	Mohammadi and Hajizadeh (2023); Current study
5	*Dendrolaelaps foveolatus* (Leitner, 1949)	Moradi Faradonbe *et al*. (2018)
6	*Dendrolaelaps isochetus* Shcherback & Bregetova, [illegible]	Mohammadi and Hajizadeh (2023); Current study
7	*Dendrolaelaps latior* (Leitner, 1949)	Mohammadi and Hajizadeh (2023); Current study
8	*Dendrolaelaps lignicolus* Mohammadi & Hajizadeh, [illegible]	Mohammadi and Hajizadeh (2023); Current study
9	*Dendrolaelaps longiusculus* (Leitner, 1949)	Abolghasemi and Kazemi (2016); Mohammadi and Hajizadeh (2023); Current study
10	*Dendrolaelaps markewitschi* Shcherbak, 1980	Mohammadi and Hajizadeh (2023); Current study
11	*Dendrolaelaps paradoxa* Shcherbak, 1982	Mohammadi and Hajizadeh (2023); Current study
12	*Dendrolaelaps populi* Hirschmann, 1960	Khezri *et al*. (2006); Pakyari *et al*. (2006); Mohammadi and Hajizadeh (2023); Current study
13	*Dendrolaelaps presepum* (Berlese, 1918)	Asadpoor *et al*. (2012); Nemati *et al*. (2012); Mohammadi and Hajizadeh (2023); Current study
14	*Dendrolaelaps punctatulus* Hirschmann, 1960	Mohammadi and Hajizadeh (2023); Current study
15	*Dendrolaelaps saprophilus* Huhta, 1982	Mohammadi and Hajizadeh (2023); Current study
16	*Dendrolaelaps stammeriformis* Hirschmann & [illegible]	Mohammadi and Hajizadeh (2023); Current study
17	*Dendrolaelaps willmanni* Hirschmann, 1960	Kazemi and Alikhani (2013)
18	*Dendrolaelaps zwoelferi* Hirschmann, 1960	Haddad Irani-Nejad *et al*. (2001, 2003); Kamali *et al*. (2001); Alizadeh and Shirdel (2012); Zarei and Kazemi (2014); Mojaz and Kazemi (2020)
19	*Dendrolaelaspis angulosus* (Willmann, 1936)	Nemati *et al.* (2012), Khalili-Moghadam (2022)
20	*Dendrolaelaspis lindquisti* (Shcherbak, 1978)	Yazdanpanah and Kazemi (2014); Zarei and Kazemi (2014)
21	*Dendrolaelaspis longisetosus* (Shcherbak, 1977)	Current study
22	*Dendrolaelaspis lobatus* (Scherbak & Chelebier, 1977)	Hashemi Khabir *et al.* (2013), Haddad Irani-Nejad *et al.* (2003); Current study
23	*Dendroseius amoliensis* Faraji, Sakenin-Chelav & Karg, 2006	Faraji *et al*. (2006); Mohammadi and Hajizadeh (2022); Current study
24	*Dendroseius vulgaris* Ma, Ho & Wang, 2014	Mohammadi and Hajizadeh (2022); Current study
25	*Digamasellus punctum* (Berlese, 1904)	Hosseini *et al*. (2019); Current study
26	*Insectolaelaps quadrisetus* (Berlese, 1920)	Farmahiny Farahani *et al*. (2013)
27	*Multidendrolaelaps acriluteus* (Athias-Henriot, 1961)	Nemati *et al.* (2012)
28	*Multidendrolaelaps euepistomus* (Hirschmann, 1960)	Jalaeian *et al*. (2004)
29	*Multidendrolaelaps multidentatus* (Leitner, 1949)	Kheradmand *et al*. (2007); Current study
30	*Oligodentatus shcherbakae* Barilo, 1989	Current study
31	*Oligodentatus tridentatus* Shcherbak & Bregetova, 1980	Current study

Key to species of Digamasellidae recorded in Iran (adult females)

This key considers all of the species previously reported from the country, except for the species described as *Dendrolaelaps acriluteus* Athias-Henriot, 1961 and referred by Nemati *et al*. (2012) as *Multidendrolaelaps acriluteus* (Athias-Henriot, 1961). In the available publications, this species is described based only on the deutonymph, and hence it is not included the subsequent key, based only on adult females.

1. Palptrochanter with bulbous ventral protuberance; corniculi weakly formed; hypostomal setae *h1* and *h2* more or less transversely aligned..... ***Bulbolaelaps*** Faraji & Zare & Rahmani .... ***Bulbolaelaps bossei*** Faraji & Zare & Rahmani, 2021
– Palptrochanter without ventral protuberance; corniculi well sclerotised and mainly horn-like; hypostomal seta *h1* is positioned far anterior to seta *h2* 2
2. Seta *Zv1* on ventrianal shield; anal opening conspicuously enlarged, longer than 1/5 the length of the ventrianal shield … ***Digamasellus*** Berlese ..... ***Digamasellus punctum*** (Berlese, 1904)
– Seta *Zv1* on unsclerotised integument next to anterior margin of ventrianal shield; anal opening not enlarged, shorter than 1/5 the length of the ventrianal shield 3
3. Posterior margin of idiosoma bilobed. ***Dendrolaelaspis*** Lindquist 4
– Posterior margin of idiosoma rounded 7
4. Ventrianal shield adjacent to genital shield and with 6 pairs of setae (*Jv1*, *Jv2*, *Jv3*, *Zv2*, *Zv3*, *Jv5*); setae *J4* short and serrate .....***Dendrolaelaspis angulosus*** (Willmann, 1936)
– Ventrianal shield located at a distance from genital shield and with 5 pairs of setae (*Jv1*, *Jv2*, *Jv3*, *Zv2*, *Zv3*); setae *J4* with different lengths and shapes 5
5. Ventrianal shield wide triangular, with indentation at level of *Zv1* .... ***Dendrolaelaspis longisetosus*** Shcherbak, 1977
– Ventrianal shield heart-shaped, without indentation at level of *Zv1* 6
6. Setae *J2* and *S1* club-shaped; posterior end of idiosoma strongly bilobed; lateral margin of the ventrianal shield well rounded ..... ***Dendrolaelaspis lobatus*** (Scherbak & Chelebiev, 1977)
– Setae *J2* and *S1* needle-shaped; posterior end of idiosoma not strongly bilobed; lateral margin of ventrianal shield less rounded ..... ***Dendrolaelaspis lindquisti*** (Shcherbak, 1978)
7. Movable cheliceral digit with at least five teeth (Fig. 12) 8
– Movable cheliceral digit with 1–4 teeth 10
8. Spermatheca opening at base of coxa IV ..... ***Insectolaelaps*** Shcherbak ..... ***Insectolaelaps quadrisetus*** (Berlese, 1920)
– Spermatheca opening at base of coxa III …..... ***Multidendrolaelaps*** Hirschmann 9
9. Peritremes long, reaching beyond insertion of setae *s1* .... ***Multidendrolaelaps multidentatus*** (Leitner, 1949)
– Peritremes reduced, reaching only to insertion level of *st2* or between *st3*/*st4* .... ***Multidendrolaelaps euepistomus*** (Hirschmann, 1960)
10. Movable cheliceral digit with one, two or four teeth; anterior margin of the opisthonotal shield usually with median notch ..... ***Dendrolaelaps*** Halbert 14
– Movable cheliceral digit with three teeth; anterior margin of the opisthonotal shield without median notch 11
11. With seven rows of deutosternal denticles; setae *r4* and *r5* on unsclerotized integument ....***Dendroseius*** Karg 12
– With six rows of deutosternal denticles; setae *r4* and *r5* on podonotal shield ....***Oligodentatus*** Shcherbak 13
12. Ventrianal shield nearly triangular, with posterior margin convex, peritreme extending anteriorly to middle level of coxa III .....***Dendroseius amoliensis*** Faraji, Sakenin-Chelav & Karg, 2006

– Ventrianal shield subrectangular, with posterior margin only moderately curved, peritreme relatively long, anteriorly to level coxae II ..... ***Dendroseius volgaris*** Ma, Ho & Wang, 2014
13. Ventrianal shield rectangular, peritremes short, extending anteriorly to level between coxae III and II ..... ***Oligodentatus tridentatus*** Shcherbak & Bregetova, 1980
– Ventrianal shield rounded triangular; peritremes long, extending anteriorly to posterior part of coxa I ..... ***Oligodentatus shcherbakae*** Barilo, 1989
14. Epistome prongs further apart than usual (distance between middle and lateral prongs equal or more than length of middle prong) ..... ***Dendrolaelaps presepum*** (Berlese, 1918)
– Epistome tips not further apart than usual 15
15. Insemination opening in transverse gap between basifemur and telofemur III 16
– Insemination opening in middle of femur III or on border between femur and genu III 18
16. Ventrianal shield quadrate with five pairs of setae (*Jv1, Jv2, Jv3, Zv2, Zv3*); setae *Jv3* long, twice longer than *Jv1* ..... ***Dendrolaelaps latior*** (Leitner, 1949)
– Ventrianal shield not quadrate and with five pairs of setae (*Jv1, Jv2, Jv3, Zv2, Jv5*); *Jv3* short, less than twice the length of *Jv1* 17
17. Ventrianal shield pear-shaped or rectangular, wider at posterior than at anterior edge; spermatheca long and tubular with a bubble-like end ..... ***Dendrolaelaps punctatulus*** Hirschmann, 1960
– Ventrianal shield trapezoid, slightly wider at posterior than at anterior edge; spermatheca long and tubular, divided into a thicker proximal part and thinner distal part ..... ***Dendrolaelaps saprophilus*** Huhta, 1982
18. Insemination apparatus spiral 19
– Insemination apparatus straight or slightly curved 28
19. Insemination apparatus wound several times in a spiral (3 to 7 times); dorsal shield partly with granulation fields and indentations in region between *z3* and *z4* ..... ***Dendrolaelaps zwoelferi*** Hirschmann, 1960
– Insemination apparatus usually not very twisted (1 to 3 times, but in some species not twisted); dorsal shield usually without granulation fields and indentations in region between *z3* and *z4* .. 20
20. Ventrianal shield usually with two pairs of setae (*Jv2, Jv3*); spermatheca short and angular; posterior end of opisthonotal shield with four separate circular pores ..... ***Dendrolaelaps isochetus*** Shcherback & Bregetova, 1980
– Ventrianal shield with more than two pairs of setae, spermatheca not so short and angular; posterior end of opisthonotal shield without such circular pores 21
21. Ventrianal shield with three pairs of setae (*Jv2, Jv3, Zv2*) 22
– Ventrianal shield with more than three pairs of setae 25
22. Seta *Zv2* inserted on ventrianal shield, away from the margin 23
– Seta *Zv2* inserted on edge of the ventrianal shield 24
23. Ventrianal shield rectangular, with straight edges; spermatheca spiral, without swollen end; setae *Z3* as long as *Z5* ..... ***Dendrolaelaps foveolatus*** (Leitner, 1949)
– Ventrianal shield quadrate with curved edges; spermatheca spiral, with swollen and bag-shaped end; setae *Z3* shorter than *Z5* ..... ***Dendrolaelaps markewitschi*** Shcherbak, 1980
24. Ventrianal shield with wavy margins; spermatheca short, spiral with one twist ..... ***Dendrolaelaps brevipilis*** (Leitner, 1949)
– Ventrianal shield with straight margins; spermatheca long, spiral with three twists ..... ***Dendrolaelaps brevipiloides*** Hirschmann & Wiśniewski, 1982
25. Ventrianal shield with four pairs of setae (*Jv2, Jv3, Zv2, Jv5*) 26
– Ventrianal shield with more than four pairs of setae 27
26. Ventrianal shield quadrate; spermatheca in form of a long and trumpet-like tube, located in middle of femur III; peritreme extending to insertion level of setae *z2* ..... ***Dendrolaelaps stammeriformis*** Hirschmann & Wiśniewski, 1982

– Ventrianal shield rectangular; spermatheca tubular, extending from trochanter to middle of femur III and two-branched in trochanter; peritreme extending anteriorly to level between setae *s1* and *z1* .....***Dendrolaelaps paradoxa*** Shcherbak, 1982

27. Ventrianal shield rectangular, with five pairs of setae (*Jv2, Jv3, Zv2, Zv3, Jv5*); spermatheca in form of a short tube in femur III ..... ***Dendrolaelaps willmanni*** Hirschmann, 1960

– Ventrianal shield rectangular-oval, with six pairs of setae (*Jv1, Jv2, Jv3, Zv2, Zv3, Jv5*); spermatheca spiral with two twists, extending from middle of femur III to trochanter III ....***Dendrolaelaps arenarius*** Karg, 1971

28. Ventrianal shield rectangular, with two pairs of setae (*Jv2, Jv3*) ....***Dendrolaelaps longiusculus*** (Leitner, 1949)

– Ventrianal shield with more than two pairs of setae 29

29. Ventrianal shield quadrate, with rounded lateral edge, with four pairs of setae (*Jv1, Jv2, Jv3, Zv2*); spermatheca in form of a straight and wide tube in femur III, with a small funnel at border of genu ..... ***Dendrolaelaps populi*** **Hirschmann, 1960**

– Ventrianal shield rectangular with wavy lateral edges, with five pairs of setae (*Jv1, Jv2, Jv3, Zv2, Zv3*); spermatheca it is not clearly discernible, sperm induction pore short and rounded, located in distal rim of femur III ..... ***Dendrolaelaps lignicolus*** Mohammadi and Hajizadeh, 2023

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مروری بر خانواده Digamasellidae (Acari: Mesostigmata) ایران، همراه با سه گزارش جدید و کلید شناسایی گونه‌ها

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چکیده

بیست و یک گونه از کنه‌های خانواده Digamasellidae از استان گیلان، شمال ایران جمع‌آوری شد. گونه‌های *Oligodentatus shcherbakae* Barilo, 1989، *O. tridentatus* Shcherbak & Bregetova, 1980 و *Dendrolaelaspis longisetosus* (Shcherbak, 1977) برای فون کنه‌های خانوادهٔ Digamasellidae ایران گزارش جدید هستند. بازتوصیفی شامل شکل مادهٔ بالغ برای سه گونه مذکور بر اساس نمونه‌های جمع‌آوری شده از ایران فراهم شده است. این مقاله فهرستی از ۳۱ گونه از کنه‌های خانواده Digamasellidae گزارش شده از ایران به همراه کلید شناسایی گونه‌های خانواده را ارایه می‌کند.

واژگان کلیدی: Gamasina، گیلان، Parasitiformes، بازتوصیف، Rhodacaroidea.

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