



New records of Onychiurinae (Collembola: Onychiuridae) for the Iranian Springtail fauna

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ABSTRACT. The fauna of Onychiurinae were investigated in different parts of Kermanshah province during 2013–2014. Specimens were collected from both leaf litter and surface layer of the soil in Oak forest (*Quercus infectoria*), Elm trees and grasslands). Totally four species from three genera were found. All of them are new for Kermanshah province and *Protaphorura levantina* (Christiansen, 1956) and *Vibronychiurus archivari* (Christiansen, 1956) were not previously recorded in Iran; it is also the first time that the genus of *Vibronychiurus* Pomorski, 1998, is collected and reported for the country.

Key words: fauna, soil, Iran new records, Onychiurids, Kermanshah.

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Introduction

Species of the class Collembola are one of the most abundant soil animals in almost all terrestrial ecosystems (Hopkin 1997). Among them, Onychiurinae is one of the most common subfamilies of the family Onychiuridae, which representatives can be easily recognized by reduction of the furca (up to complete absence) and by the almost complete absence of pigmentation (Pomorski 1998).

Although the family Onychiuridae totally comprises about 50 genera and 630 species in the world (Bellinger *et al.* 1996–

2015), only 13 species from six genera were known from Iran. These species have been found in various regions including Central provinces, Mazandaran, Guilan, East Azarbaijan, Zanzan and Mazandaran provinces associated with soils characterized by high organic matter content (Cox 1982; Daghighi 2012; Yahyapour 2012; Yoosefi-Lafooraki and Shayanmehr 2013; Falahati Hossein Abad *et al.* 2013).

The first study on the Onychiuridae of Iran was carried out by Cox (1982). He

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listed 70 species belonging to 30 genera and five families from the northwestern and north-central provinces of the country, but only four of them were belonging to the family Onychiuridae (Cox 1982). Later, other Iranian researchers have added a few species (4 species and two genera) of this family to the Collembolan fauna of Iran (Daghighi 2012; Yahyapour 2012; Yoosefi-Lafooraki and Shayanmehr 2013; Falahati Hossein Abad *et al.* 2013). In the recent checklist Shayanmehr *et al.* (2013), they listed nine species from Onychiuridae and three species from Tullbergiidae which were previously classified as Onychiuridae. The most recent paper of Yoosefi-Lafooraki (2014) on the Colomblan fauna of Mazandaran province 61 species including the four new finding of Onychiuridae have been recorded for the Iranian fauna.

Kermanshah is one of Iranian provinces which located in the middle of the western part of Iran. The primary investigation on the springtails in this area was made by Kahrarian *et al.* (2012). They reported six families, 15 genera and nine species and none of which belongs to Onychiuridae. After that some other papers on the Collembolan fauna of Kermanshah were published (Ghahramaninezhad *et al.* 2013; Kahrarian and Arbea 2013; Kahrarian *et al.* 2013, 2014), but still there is lacking enough about Onychiurid species. Therefore, our aim of this present study was to better evaluate the Onychiurinae fauna in this area.

Material and methods

The study was carried out during April, 2013 to September, 2014. Material of Onychiurinae specimens was collected in a total of 16 sites ranging in elevation from 1034 m a.s.l. to 2302 m a.s.l. from the surface layer of soil and leaf litter of Oak forest (*Quercus infectoria*), Elm tree and grasslands (Table 1). The samples were retained in plastic boxes and then were transferred to the laboratory. Samples were extracted

using Berlese-Tullgren Funnel. Specimens were mounted in Faure's medium, after clearing in lactophenol, and were studied using Olympus™ BX51 microscopes. The nomenclature of morphological features followed Deharveng (1983), Fjellberg (1998, 1999), Weiner (1996) and Pomorski (1998, 2002). Material is housed in the Islamic Azad University of Kermanshah Branch, Kermanshah, Iran (No: 48 Material), and the State Museum of Natural History, Ukrainian National Academy of Sciences, L'viv, Ukraine (No: 144 Material).

The following abbreviations were used for the morphological characters: ASE = antennal segments; PAO = post-antennal organ; AS = anal spines, VT = ventral tube, MVO = male ventral organ, PSO = pseudocelli, PSX = parapseudocelli, PSP = pseudoporus.

Results

A total of four species of Onychiurinae belonging to three genera were collected and identified from Kermanshah province, all of them are reported for the first time in Kermanshah province. The information on collected species is presented in Table 1. The species *Protaphorura levantina* (Christiansen, 1956) and *Vibronychiurus archivari* (Christiansen, 1956) are new for the fauna of Iran; it is also the first time that the genus *Vibronychiurus* Pomorski, 1998, is collected and reported for the fauna of Iran.

Genus: *Protaphorura* Absolon, 1901

Protaphorura levantina (Christiansen, 1956)

Examined material: 32 specimens (27♀♀ and 5♂♂), soil and leaf litter under Oak trees (*Quercus infectoria*), Patagh area, Sar-e-pol-e-Zahab County, 14.II.2014 and 23.III.2014; 23 ex, soil Wheat farm, Habibvand village, Sar-e-pol-e-Zahab County, 23.III.2014; 11 specimens (9♀♀ and 2♂♂), soil and leaf litter under Oak trees (*Q. infectoria*), Shabankareh village, Paveh County, 11.XI.2013 and

18.I.2014; 2♀♀, soil and leaf litter under Oak trees (*Q. infectoria*), Dehlilli village, Paveh County, 18.I.2014; 18 specimens, soil and leaf litter under Oak trees (*Q. infectoria*), Chahar zebare-oliya area, Kermanshah county, 9.XII.2013 and 23.III.2014; 1♀, Wheat farm, Mahidasht (Hassanabad village), Kermanshah county, 23.III.2014; 1♀, Grassland, Siah Khor village, Eslamabad-e-Gharb county, 9.XII.2013 and 23.III.2014.

Remarks. *Protaphorura levantina* was originally described from mountainous area of Lebanon and Syria (Christiansen 1956). In 2000, Gruia, Poliakov and Broza redescribed this species on the base of materials from Israel.

Description: Antennae slightly shorter than head, its base well marked. ASE I with 10 chaetae, ASE II with 17 chaetae. Antennal sense organ consisting of five guard chaetae, five papillae, two smooth sensory rods, two straight and granulated sensory clubs, ventro-lateral microsensillum present. ASE IV subapical organite in unprotected cavity without clear cuticular papilla. Microsensillum on ASE IV in usual position on the level of second proximal row of chaetae. ASE IV ventrally with very numerous chaetae (ca. 60). Sensilla indistinct on ASE IV.

PAO of middle length with 26–30 simple vesicles (Fig. 6). Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A.

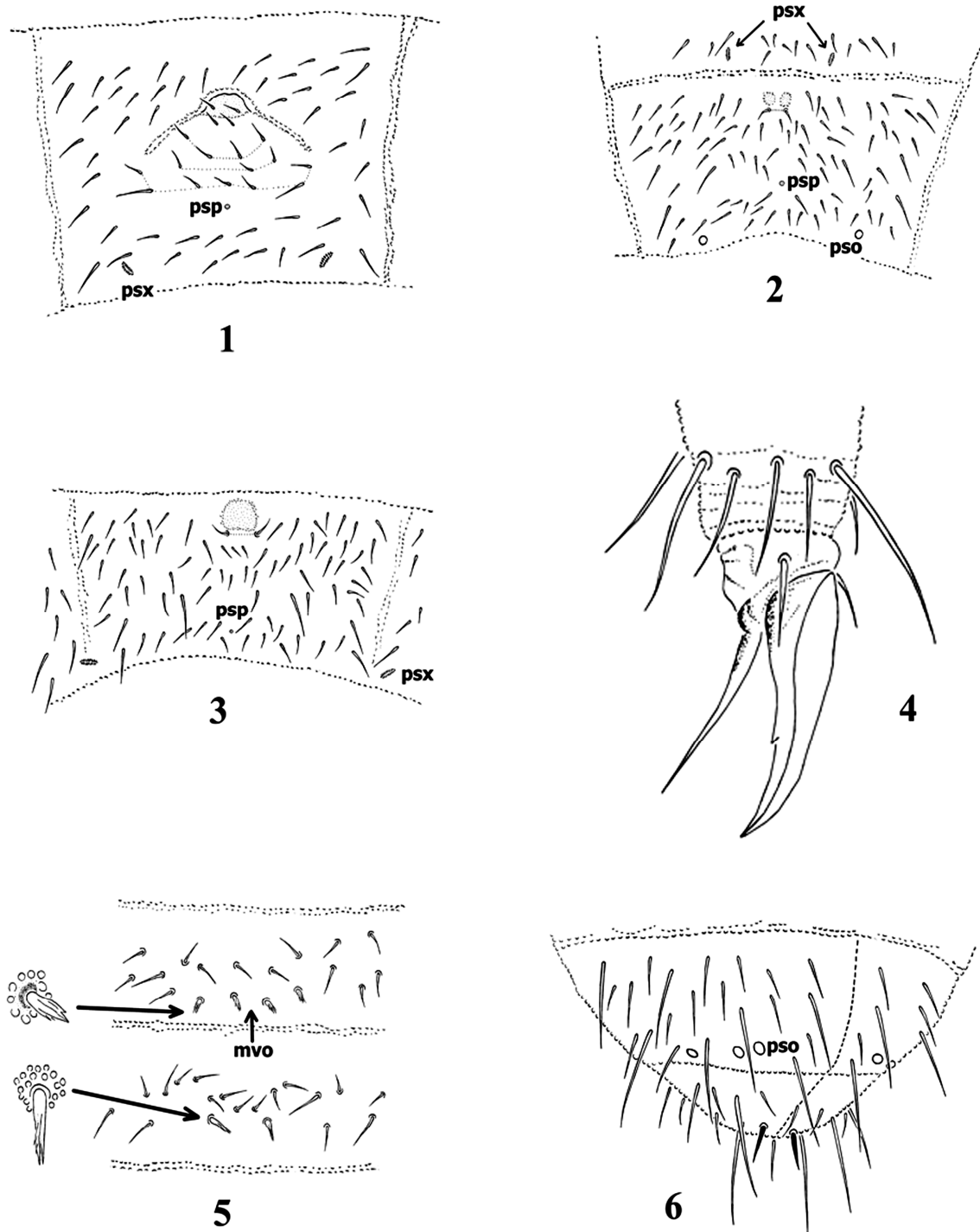
PSO formula dorsally 32/022/33342, ventrally 1/000/0000. Subcoxae 1 of I–III legs with one PSO and one PSX each. Submedial PSO *a* and *b* on abdominal terga I–II located close together, i.e. much closer than on abdominal tergum III, both set posteriorly to macrochaeta *p5*. P *sx* present on head and abdominal sterna I–IV, VI (PSX formula 1/000/111101^m).

Dorsal chaetotaxy more or less symmetrical. Dorsal chaetae poorly differentiated

into macrochaetae and microchaetae. Sensory chaetae *s'* indistinct on body. On head *p2* chaetae on the same level as *p1* and *p3*. Chaetae *p6* on head located anterior to PSO *b*. Thoracic tergum I with 10–12+10–12 chaetae, chaeta *m* often absent, but specimens with *m* also examined (chaetotaxy type *i3*–(*m*) with frequent variations). Both thoracic terga II and III with lateral microsensilla and with 5+5 axial microchaetae. Chaetae *s'* often absent on abdominal terga I–III (rarely present asymmetrically). On abdominal tergum IV in axial area between *M2* and *P2* macrochaetae located 9–10 chaetae, medial chaeta *m0* present (rarely absent). Abdominal tergum V usually with 1 unpaired microchaeta *p0* and without chaetae *s'*. Abdominal tergum VI with 1 medial chaetae *m0*. Mutual position of prespinal microchaetae distinctly convergent type. *M/s* ratio on abdominal tergum V as 14.0–15.3/8.1–8.6 (*AS* = 10). *AS* have the same length as inner edge of claw and 2.8–3 times longer than their basal diameter.

Thoracic sterna I–III with 1+1, 2(3)+2(3), 2+2 chaetae respectively. VT with ca. 8–9+8–9 chaetae and 2(1)+2(1) chaetae at base. Abdominal sternum IV with 68–74 chaetae (Fig. 1). Furcal rudiment: cuticular fold (located near the middle of sternum) with 2+2 dental microchaetae in 2 rows. Chaetotaxy of manubrial field rather variable: 4 chaetae present in *ma*-row, 2–3 chaetae in *mm*-row, 6–7 chaetae in *mp*-row (Fig. 1). MVO absent.

Subcoxae 1 of I, II and III legs with 5, 6–7, 5–6 chaetae, subcoxae 2 with 1, 5, 5, coxae with 9, 10, 14, trochanters with 18–19, 20–21, 18, femora with 11, 11, 10, tibiotarsi with four rows of chaetae (distal whorl (*A*+*T*)+*B*+*C*): 11+8+3, 11+8+1–2, 11+8+3–4 chaetae, respectively. Claw without inner tooth. Empodial appendage 0.8–0.9 times as long as inner edge of claw, without basal lamella.



Figures 1-6. 1. *Protaphorura levantina*, chaetotaxy of abdominal sternum IV; 2 and 5. *Orthonychiurus folsomi*; 2. chaetotaxy of abdominal sternum IV, 5. chaetotaxy of central part of abdominal sterna II and III; 3, 4. and 6. *Vibronychiurus archivari*, 3. chaetotaxy of abdominal sternum IV; 4. distal part of leg III; 6. chaetotaxy of abdominal terga V-VI.

***Protaphorura sakatoi* (Yosii, 1966)**

Examined material: 6 specimens, soil and leaf litter under Elm tree, Harasam village, Eslamabad-e-Gharb county, 23.III.2014.

Remarks. This species has reported in Central and South Eastern Europe, Crimea Mts., Russia (Caucasus Mts., Southern Siberia), Afghanistan, Kazakhstan and Tadzhikistan (Kaprúš and Pomorski 2008), Recently it was also found in Iran (Mazandaran) by Yoosefi Lafouraki (2014).

Description: ASE IV with subapical organite in unprotected cavity without clear cuticular papillae. Microsensillum on ASE IV in usual position on level of second proximal row of chaetae. Sensilla on ASE IV indistinct. Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A. Submedial PSO *a* and *b* on abdominal terga I and II in nearby position, much closer than on abdominal tergum III. On head the p_2 chaetae on the same level as p_1 and p_3 , chaetae p_6 located anterior to pseudocelli *b*. Thoracic tergum I with 13–16+13–16 chaetae (chaeta *m* present). Chaetae *s'* absent on abdominal terga I–III and V. Mutual position of prespinal microchaetae usually of subparallel type. M/s ratio on abdominal tergum V as 17.7–21.7/12.7–14.6, anal spines = 10. Anal spines 0.8–0.9 times as long as inner edge of claw.

PSX formula on abdominal sterna I–VI as 110001. PSX are absent on Thoracic sterna. VT with ca. 9–10+9–10 chaetae, and 2–3 chaetae at base. Manubrial field with 15 chaetae in 3 rows (ma row with 4, mm row with 4 and mp row with 7 chaetae). Claw with (rarely without) small denticle. Empodial appendage shorter than claw (0.8 of inner edge of claw), without clear basal lamella.

Genus: *Vibronychiurus* Pomorski, 1998

***Vibronychiurus archivari* (Christiansen, 1956)**

Examined material: 24 specimens (19 ♀♀ and 5 ♂♂), soil and leaf litter under Oak

trees (*Q. infectoria*), Osmanevar area, Cheshmeh sorkh village, Kermanshah County, 18.I.2014; 10 specimens (9♀♀ and 1♂), soil and leaf litter under Oak trees (*Q. infectoria*), Osmanevar area, Patat village, Kermanshah County, 18.I.2014.

Remarks. *Vibronychiurus archivari* was described by Christiansen (1956) from Lebanon. Redescription of *V. archivari* was given by Pomorski (2006) based on the study of the type material.

Description: ASE I with 9 chaetae, ASE II with 17 chaetae. ASE IV with subapical organite in unprotected cavity without clear cuticular papilla. Sensilla indistinct on ASE IV.

PAO with 9–13 finely granulated vesicles. Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A.

PSO formula dorsally 32/022/33333 and ventrally 0/000/0000. Subcoxae 1 of I–III legs with one PSO and one PSX each. PSX present on head and some abdominal sterna (PSX formula 2/000/110100).

Dorsal chaetotaxy more or less symmetrical. Dorsal chaetae well differentiated into macro-, meso- and microchaetae. Sensory chaetae *s'* indistinct on body. On head p_2 chaetae moved forward with respect to p_1 – p_3 , chaetae p_6 located between pseudocelli *a* and *b*. Thoracic tergum I with 8–12+8–12 chaetae. Both thoracic terga II and III with lateral microsensilla and with 3+3 axial microchaetae. On abdominal tergum IV in axial area between *M2* and *P2* macrochaetae located 7–8 chaetae, 1 or 2 unpaired *m0* chaetae present (rarely absent). Abdominal tergum V without unpaired chaetae. Abdominal tergum VI with one unpaired chaetae *m0* (Fig. 6). AS 0.7 times as long as inner edge of claw and 7–8 times longer than their basal diameter.

Table 1. Information on identified species from Kermanshah provinces (Iran).

Genus/Species	County/area/Village	N	E	Elevation
Genus: <i>Protaphorura</i>				
<i>P. levantica</i>	Sar-e-pol-e- Zahab/ Patagh	34°25.733', 046°00.136'		1034
	Sar-e-pol-e- Zahab/ Patagh	34°25.294', 046°01.759'		1404
	Sar-e-pol-e- Zahab/Habibvand	34°25.938', 045°56.730'		1454
	Kermanshah/Chahar zebat-e-oliya	34°13.134', 046°40.074'		1592
	Eslamabad-e-Gharb/Siahkhor village	34°07.999', 046°36.690'		1442
	Mahidasht/Hassanabad village	34°11.643', 046°40.005'		1605
	Paveh/Shabankareh village	34°52.978', 046°30.760'		1632
	Paveh/Dehlily village	34°50.216', 046°30.760'		1431
	Paveh/Dehlily village	34°50.295', 046°32.643'		1602
<i>P. sakatoi</i>	Eslamabad-e-Gharb/Harasam	33°51.399', 046°50.868'		2302
Genus: <i>Orthonychiurus</i>				
<i>O. folsomi</i>	Dalaho/Kerend-e-Gharb	34°16.190', 046°14.765'		1554
	Osmanevand/Cheshmeh Sorkh village	33°58.319', 047°18.018'		1913
Genus: <i>Vibronychiurus</i>				
<i>V. hermonicus</i>	Osmanevand / Patat village	33°57.746', 047°18.723'		1955
	Osmanevand / Cheshmeh Sorkh village	33°58.319', 047°18.018'		1913

VT with ca. 7+7 chaetae and 2+2 chaetae at base. Abdominal sternum IV with 78–83 chaetae (Fig. 3). Furca reduced to small depression, in contact with border between abdominal sterna III and IV, with two posterior chaetae. Manubrial field with 20–24 chaetae in 4–5 rows (Fig. 3). MVO absent.

Subcoxae 1 of I, II and III legs with 5, 5, 5–6 chaetae respectively. Tibiotarsi with four rows of chaetae (distal whorl (A+T)+B+C): 11+8+2 each leg. Claw with small denticle (Fig. 4). Empodial appendage as long as inner edge of claw, without clear basal lamella.

Genus: *Orthonychiurus* Stach, 1954

***Orthonychiurus folsomi* (Schäffer, 1900)**

Examined material: 42 specimens (34♀♀ and 8♂♂), soil and leaf litter under pine trees, Kerend-e-gharb city, Dalaho County, 18.I.2014; 2♀♀, soil and leaf litter under Oak trees (*Q. infectoria*), Osmanevand area, Cheshmeh Sorkh village, Kermanshah County, 18.I.2014.

Remarks. *Orthonychiurus folsomi* is known from North America, Europe, Australia, Germany, Norway-Bergen (Fjellbergs 1998; Christiansen and Bellinger 1980; Jordana *et al.* 1997) Japan and China (Sun *et al.* 2013). It has been previously reported from Iran (Yahyapour 2012).

Description: ASE I with 7 chaetae, ASE II with 15 chaetae. ASE IV with subapical organite in unprotected cavity without clear cuticular papilla. Sensilla indistinct on ASE IV.

PAO with 10–12 finely granulated vesicles. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type AB.

PSO formula stable dorsally: 32/022/33342 and variable ventrally: 3(2)/000/2(1) 1 1(0) 1. Subcoxae 1 of I–III legs with 2 PSO each. PSX absent on head and present on some abdominal sterna (PSX formula 0/000/0(1) 0100).

Dorsal chaetotaxy more or less symmetrical. Dorsal chaetae well differentiated into macro- and microchaetae. Sensory chaetae *s'* indistinct on body. Thoracic

tergum I with 9-12+9-12 chaetae. Both Thoracic terga II and III with lateral microsensilla and with 3+3 axial microchaetae. On abdominal tergum IV one or two unpaired chaetae present (often *p0* absent). Abdominal tergum V without unpaired chaetae. Abdominal tergum VI with one unpaired chaetae *m0*.

VT with ca. 6(7) + 6(7) distal chaetae, no frontal and basal. Abdominal sternum IV with 85-89 chaetae (Fig. 2). Furca reduced to two small depressions, in contact with border between abdominal sterna III and IV, with 1-2 small posterior chaetae. Manubrial field with 26-29 chaetae in 4-5 rows (Fig. 2).

In adult males MVO present as 2 + 2 modified chaetae developed on abdominal sternum II. In addition, we also found two adult males in which this organ is represented as 2 + 2 and 1 + 1 modified chaetae on abdominal sterna II and III respectively (Fig. 5).

Subcoxae 1 of I, II and III legs with 5, 5, 6 chaetae. Tibiotarsi with four rows of chaetae (distal whorl (A+T)+B+C): 9+7+2, 9+8+2 and 9+7+1 chaetae respectively. Claw with a pair of weak lateral teeth, inner tooth present or absent. Empodial appendage as long as inner edge of claw, without clear basal lamella.

Discussion

A total of four species of Onychiurinae belonging to three genera were collected and identified from Kermanshah province. All of them are reported for the first time in Kermanshah and two species including *Protaphorura levantina* (Christiansen, 1956) and *Vibronychiurus archivari* (Christiansen, 1956) are new for the fauna of Iran. It is also the first time that the genus *Vibronychiurus* Pomorski, 1998, is collected and reported for the fauna of Iran. Iranian specimens of *P. levantina* generally fit both descriptions by Christiansen, 1956 and Gruia *et al.* (2000). In spite of this, many

important diagnostic characters remained unknown (number of PSX on the body, chaetotaxy details of labium, labrum, legs, abdominal sternum IV etc.). So, we have supplemented a description of this species by studying new material collected in Iran. The Iranian specimens generally fit both these descriptions although differ in some characters. However, Iranian specimens of *P. levantina* differs from Israeli ones by location of *p2* chaetae on head (in Iranian specimens *p2* chaetae situated on the same level as *p1* and *p3*, in Israeli ones *p2* chaetae are displaced forward in relation to *p1* and *p3*) and by absent in most individuals *s'* chaetae on abdominal Sterna I-III (present in Israeli specimens). Lebanese and Syrian specimens of this species differ from Iranian ones by present of *s'* chaetae on abdominal tergum V (absent in Iranian specimens) and by complete lack of tooth on claw of all legs (always present in Iranian specimens).

Iranian specimens of *P. sakatoi* completely fit the descriptions of Pomorski (1998) and Kapruś and Pomorski (2008). *Vibronychiurus archivari* was described by Christiansen (1956) from Lebanon and redescription by Pomorski (2006) based on the study of the type material. However, the type material was strongly crumpled and for this reason some diagnostic characters were not studied. It is the first citation of this genus in Iran. Iranian specimens generally fit this redescription although differ in some characters. In addition, collected material of this species allowed us to supplement the existing description. Iranian population of *V. archivari* differs from Lebanon one by number of vesicles in PAO (9-13 v. 14), number of chaetae on VT (7+7 v. 6+6) and presence of small denticle on the claw (absent in Lebanon specimens).

Orthonychiurus folsomi has been previously reported from Iran (Yahyapour 2012). The literature describes a large inter-

and intra-population variability of this species (Fjellberg 1998, Jordana *et al.* 1997). Iranian material of *O. folsomi* also shows the variability of such characters as the number of PSO and PSX on the ventral side of body, the number of modified chaetae in the MVO and ordinary chaetae on body, as well as the presence/absence tooth on inner edge of claws.

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گزارش‌های جدید از زیرخانواده Onychiurinae (Collembola: Onychiuridae) برای فون پادمان ایران

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چکیده: فون پادمان زیرخانواده Onychiurinae در بخش‌های مختلف استان کرمانشاه در طی سال‌های ۱۳۹۲-۱۳۹۳ مورد بررسی قرار گرفت. نمونه‌ها از برگ‌های ریخته شده در سطح خاک و لایه سطحی خاک جمع‌آوری شدند. در مجموع چهار گونه از سه جنس جمع‌آوری شد. همه گونه‌ها برای استان کرمانشاه و گونه‌های (Christiansen, 1956) *Protaphorura levantina* و (Christiansen, 1956) *Vibronychiurus archivari* برای اولین بار از ایران گزارش شدند. همچنین جنس *Vibronychiurus* Pomorski, 1998 برای اولین بار از ایران گزارش می‌شود.

واژگان کلیدی: فون، خاک، ایران، گزارش جدید، Onychiurids، کرمانشاه.