A new epigean pseudoscorpion species (Pseudoscorpiones: Neobisiidae) from northeast of Iran, with an identification key to the species of the family Neobisiidae from Iran

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Abstract: A new epigean species—Roncus khorasanicus sp.n.—is described on the basis of the description of the adult stage (males) found in north-eastern Iran. A detailed description of the selected morphological characters and accurate illustrations of several diagnostic characters of the new species are provided. Moreover, an identification key to the species of the family Neobisiidae from Iran is presented.

Key words: Arachnida, fauna, new species, taxonomy, leaf litter, western Asia

1. Introduction
The genus Roncus L. Koch, 1873 belonging to the family Neobisiidae Chamberlin, 1930 currently contains 127 described species. Little is known about the Roncus species distributed in western Asia and there are no detailed description/redescription of them (Nassirkhani and Mumladze, 2019). Therefore, it is not possible to compare some diagnostic characteristics for all of the species, e.g., the presence/absence of the microsetae located proximal to the trichobothria eb and esb, or number of microsetae between the trichobothria eb and esb. These characters have been repeatedly used to separate the species by some authors such as Gardini (1983), Gardini and Rizzerio (1985), Hendericks and Zaragoza (2000), Zaragoza and Štáhlavský (2008), and Zaragoza and Hendericks (2009). Nassirkhani and Mumladze (2019) provided a key to the Roncus species recorded for the Middle East and Caucasian regions based on the morphological and morphometric characteristics presented in the literature. However, reexamination of these species seems to be mandatory.

The diversity of the Pseudoscorpiones is not well known for Iran, one of the largest countries in the Middle East. Though 65 valid pseudoscorpion species (belonging to 32 genera of 12 families) were recorded from Iran, studies are relatively scarce and scattered as the new species/records are regularly reported (Redikorzev, 1918; Beier, 1951, 1971; Mahnert, 1974; Judson, 1990; Malek-Hosseini and Zamani, 2017; Nassirkhani and Takalloozadeh, 2013a, 2013b; Nassirkhani, 2014a, 2014b, 2015; Nassirkhani and Hamidi, 2015; Nassirkhani and Shoushtari, 2015a, 2015b, 2016; Nassirkhani et al., 2016, 2017, 2018; Nassirkhani and Doustaresharaf, 2018, 2019; Zamani et al., 2019; Cokendolpher et al., 2019). Among the 136 Roncus species, only three have been reported from Iran so far (Harvey, 2013)1. In particular, R. microphthalmus (Daday, 1889) from East Azerbaijan Province, R. corimanus Beier, 1951 from Mazandaran and Guilan Provinces and R. viti Mahnert, 1974 from Guilan Province. In this paper a description of new Roncus species from north-east Iran is provided. As a result, the number of Roncus species in Iran rose to four species. In addition, an identification key for the Iranian members of the family Neobisiidae is provided to facilitate their recognition.

2. Materials and methods
The examined specimens were directly collected by hand through sieving leaf litter and humus from a cultivated area. The collected specimens were preserved in ethanol 75%, cleared by lactic acid 70%, and after careful dissection were permanently mounted on microscope slides using


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Swann’s medium (fluid), and studied and illustrated with an Olympus CH–2 compound microscope equipped with a drawing tube.

The morphological nomenclatures and measurements were adapted from Chamberlin (1931), Harvey (1992), Harvey (2013), Harvey et al. (2012), Judson (2007), and Zaragoza (2017). The depository of the studied material is the Zoological Museum of the Ferdowsi University of Mashhad, Iran (ZMFUM), and the Collection of Acarology Laboratory, Islamic Azad University of Arak, Iran (IAUA). All measurements are in millimeters and measured with Nikon MM-40 measuring microscope.

2.1. Abbreviations
Trichobothriotaxy, as in Chamberlin (1931); D: depth; 
fa: retrolateral lyrifissure of fixed chela finger; fb: dorso-retrolateral lyrifissure of fixed chela finger; fk: dorso-distal lyrifissure of fixed chelal finger; hp: proximal lyrifissure of chelal hand; L: length; ma, ma, ma; retrolateral lyrifissures of movable chelal finger; T, TS: tactile seta; W: width.

3. Results
3.1. Taxonomy
Family Neobisiidae Chamberlin, 1930
Genus Roncus L. Koch, 1873
Roncus khorasanicus sp. n.

3.2. Etymology
The specific epithet is derived from the type locality.

3.3. Diagnosis
Roncus khorasanicus sp. n. differs from the other congeners by the following combination of characters: carapace with two small corneate eyes, transverse furrows absent, epistome long, knob-like and apically rounded, pedipalpal femur and chelal hand slightly granulated, pedipalpal femur with one tubercle on retrolateral and two tubercles on prolateral margin, chelal hand more or less rounded in dorsal view, microsetae proximal to trichobothria eb-esb absent, two short setae located between trichobothria eb and esb, movable chelal finger distinctly longer than chelal hand (with pedicel) and pedipalpal femur, trichobothrium ist located proxmed to middle, claws simple and without dorsal tooth, and morphometric characteristics, e.g., pedipalpal femur 0.60–0.65 mm long and 3.52–3.61× longer than broad, and chela (with pedicel) 1.07–1.18 mm long and 3.45–3.68× longer than broad.

3.4. Description
Carapace (Figure 2A): light brown, posterior border pale and partly desclerotized; entirely smooth; widest at the middle, 1.16–1.24× longer than broad; with one pair of small eyes with convex lenses (distance from anterior margin 0.062–0.067 mm, diameter of eyes 0.045–0.050 mm); with 24 setae, preocular microsetae absent, anterior margin with four and posterior margin with six setae, chaetotaxy: 4: 8: 6: 6; transverse furrows absent; epistome prominent, knob-like, and apically rounded (length 0.025–0.027 mm, width 0.030 mm); glandular pores present, three on each side in ocular zone; two micropores on posterior margin; anterolateral corners without small protuberances; with 7–8 lyrifissures, two situated in ocular zone, close to each eyes and 5–6 located near posterior margin.


Sternites: yellowish brown; entirely smooth; slightly sclerotized; anterior operculum with 15 setae, 4–5 short discal setae, 10–11 longer setae located along anterior margin of genital aperture (Figure 2B); posterior operculum with 15 setae, 4–5 longer setae situated along posterior margin of genital aperture (Figure 2B); genital organ with two long lateral genital sacs and one short median genital sac, genital opening with 3+3 internal setae (Figure 2C); chaetotaxy: 15: (3)15(3): (2)12(2): 14: 13: 13: 13: 4T1T4: 1T1T1: 2.

Pleural membrane: granulate.

Chelicera: brown; hand with six acuminate setae; galea knob-like, with a small hyaline convexity; galeal seta situated submedially; hand at base of fixed finger somewhat granulated (Figure 2D); fixed finger with 19–21 close-set teeth reaching to base; movable finger with 12–14 teeth reaching to middle of the segment, distal teeth medium in size, median teeth large, and basal teeth minute (Figure 2D); serrula interior with 16–19 and exterior with 24–27 blades; rallum with eight denticulate blades on a low hyaline promontory, proximalmost blade shortest.

Pedipalps: brown, chela slightly darker in color than femur and patella; dorsal surface of trochanter finely granulated, prolateral half of femur distinctly granulated, patella entirely smooth, distal half of chelal hand distinctly granulated at base of fixed finger (Figure 2E); coxa including manducatory process with 11 setae, manducatory process with five acuminate setae, seta located at base of manducatory process longest; trochanter with small dorsal tubercle, L/W 2.10–2.22; femur with short pedicel, prolateral margin with two tubercles located in basal half of the segment, one tubercle located medially on retrolateral margin, with one glandular pore located distally, with a number of long setae without enlarged
alveoli in basal two thirds of the segment (Figure 2E), L/W 3.52–3.61; patella with short and stout pedicel (L=0.16–0.18 mm); patella distinctly shorter than femur, with three lyrifissures situated basally and two lyrifissures located distally, L/W 2.47–2.50; chela (with pedicel) L/W 3.45–3.68; chela (without pedicel) L/W 3.13–3.37; chelal setae simple; movable finger distinctly longer than hand (with pedicel); movable finger 1.54–1.60× longer than hand (with pedicel); chelal hand more or less rounded in dorsal view (Figure 2E); hand (with pedicel) L/W 1.55–1.67; true microsetae on chelal fingers absent; two short setae situated between eb and esb in lateral view, short setae/microsetae proximal to trichobothria eb and esb absent; fixed finger with three lyrifissures: one (fa) located at same level of esb and one (fb) at same level of isb in retrolateral view, and one (fd) at same level of et in dorsal view; movable finger with three lyrifissures in lateral view: one (ma,) located slightly distal of b, one (ma,) between trichobothria sb and st, and one (ma,) between st and t; chelal hand with one lyrifissure (hp) located close to pedicel and one glandular pore located distally in retrolateral view; two sensilla present, one sensillum located close to dental margin, approximately in the middle of distance between sb and st, and other sensillum situated slightly distal to sb; fixed finger with 59–62 similar contiguous teeth, reaching slightly distal of trichobothrium ib, all teeth with dental canal; movable finger with 51–54 contiguous teeth, not reaching to the level of trichobothrium b, distal teeth cusped and large, gradually reduced in size, basal teeth flattened but distinguishable, all teeth with dental canals; nodus ramosus of venom duct in fixed chelal finger situated distinctly distal to et.

**Trichobothriotaxy:** fixed finger with 8 and movable finger with 4 trichobothria; fixed finger with trichobothrium it located in the middle of et and est, ist situated distad to middle of the finger (TS=0.55–0.57), ist
distinctly closer to it than to ib, isb on retrolateral face, ib situated basally closer to esb than to isb, eb and esb located basally; movable finger with trichobothrium st situated distinctly closer to t than to sb, sb distinctly situated in midway between b and st; distance b–sb longer than distance t–st (Figure 2F).

Legs: light brown, slightly lighter in color than carapace; smooth; coxa I with short, triangular and pointed anterolateral process, mediolateral face with rounded membranous layer (Figure 2G); coxal chaetotaxy: 6–7:6:5–6:7; subterminal setae bifid; claws symmetric; aroliae simple and shorter than claws (Figure 2H). Leg I: femur L/D 2.99–3.16; patella L/D 2.20; femur 1.59–1.73x longer than patella; tibia L/D 4.43; metatarsus L/D 2.43–2.50; tarsus L/D 5.00–5.60; tarsus 1.64–1.66x longer than metatarsus. Leg IV: femur L/D 1.33–1.75; patella L/D 1.50–2.00; femur + patella L/D 2.85–3.75; tibia with a long tactile seta situated proximal to middle (TS=0.58–0.62), L/D 4.62–5.00; metatarsus with a long tactile seta situated basally (TS=0.22), L/D 2.57–2.75; tarsus with a tactile seta situated proximal to middle (TS=0.41–0.44), L/D 4.50–5.00.

Dimensions (in mm): Body length: 2.12–2.28. Carapace: 0.66–0.67/0.54–0.57. Pedipalp: trochanter

Figure 2. *R. khorasanicus* sp. n., holotype ♂: A) carapace, dorsal view; B) Coxae IV and sternites II–III, ventral view; C) internal genitalia, in part, ventral view; D) right chelicera, dorsal view (serrulae omitted); E) left pedipalp, dorsal view; F) right chela, retrolateral view; G) left coxa, ventral view; H) distal portion of tarsus IV (showing claws, arolia, and sub-terminal seta), retrolateral view.
0.38–0.40/0.18; femur 0.60–0.65/0.17–0.18; patella 0.50–0.52/0.20–0.21; chela (with pedicel) 1.07–1.18/0.30–0.32; chela (without pedicel) 0.97–1.08; hand (with pedicel) L.0.48–0.50; movable finger L. 0.74–0.80. Leg I: femur 0.35–0.38/0.12; patella 0.22/0.10; tibia 0.31/0.07; metatarsus 0.15–0.17/0.06–0.07; tarsus 0.25–0.28/0.05. Leg IV: femur 0.28–0.35/0.20–0.21; patella 0.32–0.40/0.20–0.21; femur + patella 0.60–0.75; tibia 0.40–0.55/0.11–0.13; metatarsus 0.18–0.22/0.07–0.08; tarsus 0.27–0.35/0.06–0.07.

3.5. Remarks
According to the identification key provided by Nassirkhani and Mumladze (2019) and the description provided by Mahnert (1974) *R. khorasanicus* sp. n. resembles most closely to *R. viti*. Due attention to the presence of two small corneate eyes, the chaetatoxay of the carapace and the tergite I (posterior margin of carapace and tergite I with six setae), the presence of a small tubercle on dorsal surface of the trochanter, loss of microsetae located proximal to trichobothria *eb* and *esb* (judging from Mahnert 1974), the granulation pattern of the pedipalp (i.e. femur clearly granulate, patella entirely smooth, dorsal and mediolateral face of chela hand granulated) (see Mahnert, 1974), the more or less rounded shape of the chela hand in dorsal view (see Mahnert, 1974), the trichobothriotaxy especially the position of trichobothrium *ist* on the fixed chela finger, and the morphometric characteristics, e.g., the movable chela finger distinctly longer than the chela hand (with pedicel) (ratio > 1.5×) and somewhat longer than the femur, and length of the pedipalpal femur (Length < 1.00 mm), the new species, *R. khorasanicus* sp. n., from northeastern part of Iran resembles *R. viti* which was originally described from Guilan province, northern Iran by Mahnert (1974).

Comparatively, the prolateral and retrolateral margins of the pedipalpal femur of *R. viti* bear no tubercles (see Mahnert, 1974) whereas in *R. khorasanicus* sp. n., there are two tubercles on the prolateral and one tubercle on the retrolateral margin of the pedipalpal femur. This is the most important difference between these two species. Moreover, the posterior transverse furrow on the carapace of *R. viti* is present (see Mahnert, 1974), while both transverse furrows are completely absent in *R. khorasanicus* sp. n.

Also, these two species can be separated from each other on the basis of some morphometric characteristics (Table), e.g., the pedipalp femur of *R. viti* is 3.9× longer than wide whereas it is 3.5–3.6× longer than wide in *R. khorasanicus* sp. n. (Figure 3). The size of epistome is the minor difference between the species, e.g., the carapace of *R. viti* has a smaller epistome than that of *R. khorasanicus* sp. n. (see Mahnert, 1974).

**Female:** Unknown

**Key to the species of the family Neobisiidae from Iran**

A total of 13 species belonging to the Neobisiidae family have been up to now recorded from Iran. The present key is prepared on the basis of the morphological and morphometric characters mentioned in the literature and can be used for recognizing the adult stage of the family from Iran.

1. Galea with knob-like shape ........................................ 2
   - Galea elongated and apically branched .................... 11
2. All rallar blades denticulate and located on a low hyaline promontory .......................................................... 3
   - 4–5 distal blades of rallum serrate, the others smooth and acuminate; only 2 distal rallar blades located on a high hyaline promontory ................................................................. 6
3. Chela (with pedicel) stout, 2.5–2.7× longer than broad ...................................................................................... 11
   - Chela (with pedicel) more slender than above, 3.0–4.2× longer than broad ......................................................... 4
4. Movable chelal finger distinctly longer than pedipalpal femur; trichobothrium *ist* located distinctly distad to middle of the fixed chelal finger .......... 5
   - Movable chelal finger slightly longer than pedipalpal femur; trichobothrium *ist* located approximately in the middle of the fixed chelal finger ... *Roncus microphthalmus* (Daday, 1889) (Azerbaijan Province)
5. Pedipalpal femur 3.9× longer than broad; prolateral/retrolateral margins of the pedipalpal femur loss of tubercle/s ........ *Roncus viti* Mahnert, 1974 (Guilan Province)
   - Pedipalpal femur 3.5–3.6× longer than broad; prolateral margin of the pedipalpal femur with two and its retrolateral margin with one tubercle .............................................. *Roncus khorasanicus* sp. n. (Khorasan Province)
6. Fixed chelal finger with acute and separate teeth, two long teeth separated by one short tooth ................................................................. Neobisium (Neobisium) fuscimanum (C.L. Koch, 1843) (Mazandaran Province)

- Fixed chelal finger with more or less equal sized teeth

7. Mediolateral face of pedal coxa I without denticles ......................................................................................................................... 7

- Mediolateral face of pedal coxa I with small denticles

8. Notch on the median side of the patella not reaching to the middle of the patellar club length, patellar club shaped as oblong oval ................................................................. 10

- Notch on the median side of the patella reaching to middle of the patellar club length, patellar club apparently subovoid ................................................................. 9

9. Pedipalpal femur relatively short and stout, 3.0–3.4× longer than broad; chelal hand almost rounded in dorsal view and fingers stout and shortened ................................................................. Neobisium (Neobisium) crassifemoratum (Beier, 1928) (West Azerbaijan Province)

- Pedipalpal femur relatively long and narrow, 3.7–3.9× longer than broad; chelal hand almost oviform in dorsal view and fingers thinner and somewhat elongated ................................................................. Neobisium (Neobisium) erythrodactylum (L. Koch, 1873) (Mazandaran Provinces)

10. Anterolateral process of pedal coxa I shortened ................................................................. Neobisium (Neobisium) alticola Beier, 1973 (Azerbaijan and Lorestan Provinces)

- Anterolateral process of pedal coxa I elongated . Neobisium (Neobisium) anatolicum Beier, 1949 (East Azerbaijan Province)

11. Patella with distinctly curved, long and relatively thin pedicel, longer than broad ................................................................. Acanthocreagris ronciformis (Redikorzev, 1949) (Khorasan and Mazandaran Provinces)

- Patella with short and stout pedicel, as long as wide ...

12. With four eyes; pedipalpal femur length 0.49–0.59 mm ................................................................. Acanthocreagris iranica Beier, 1976 (Ilam, Lorestan, and Mazandaran Provinces)

- Without eyes; pedipalpal femur length 0.67–0.68 mm ..

Table. Comparison of measurements (in mm) and proportions of the pedipalp segments between R. viti Mahnert, 1974 and R. khorasanicus sp. n. ((+) = with pedicel; (−) = without pedicel).

<table>
<thead>
<tr>
<th>Pedipalp segments</th>
<th>R. viti Mahnert, 1974, 1♂</th>
<th>R. khorasanicus sp. n., 3♂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of trochanter</td>
<td>0.44</td>
<td>0.38–0.40</td>
</tr>
<tr>
<td>Length of femur</td>
<td>0.73</td>
<td>0.60–0.65</td>
</tr>
<tr>
<td>Breadth of femur</td>
<td>0.19</td>
<td>0.17–0.18</td>
</tr>
<tr>
<td>Ratio</td>
<td>3.94</td>
<td>3.52–3.61</td>
</tr>
<tr>
<td>Length of patella</td>
<td>0.58</td>
<td>0.50–0.52</td>
</tr>
<tr>
<td>Breadth of patella</td>
<td>0.23</td>
<td>0.20–0.21</td>
</tr>
<tr>
<td>Ratio</td>
<td>2.50</td>
<td>2.47–2.50</td>
</tr>
<tr>
<td>Length of chela (+)</td>
<td>1.29</td>
<td>1.07–1.18</td>
</tr>
<tr>
<td>Breadth of chela</td>
<td>0.35</td>
<td>0.30–0.32</td>
</tr>
<tr>
<td>Ratio</td>
<td>3.67</td>
<td>3.45–3.68</td>
</tr>
<tr>
<td>Length of chela (−)</td>
<td>1.21</td>
<td>0.97–1.08</td>
</tr>
<tr>
<td>Ratio</td>
<td>3.46</td>
<td>3.13–3.37</td>
</tr>
<tr>
<td>Length of chela hand (+)</td>
<td>0.50</td>
<td>0.48–0.50</td>
</tr>
<tr>
<td>Length of movable finger</td>
<td>0.84</td>
<td>0.74–0.78</td>
</tr>
<tr>
<td>Movable finger/chela hand (+)</td>
<td>1.69</td>
<td>1.54–1.56</td>
</tr>
</tbody>
</table>

Nomenclatural acts
This work and the nomenclatural acts it contains have been registered in ZooBank. The ZooBank Life Science Identifier (LSID) for this publication is: http://zoobank.org/urn:lsid:zoobank.org:pub:1E71C127-49C9-4F56-8394-64919C6043C3.

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