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Withius nanus Mahnert, 1988 (Pseudoscorpiones: Withiidae); A new record of phoresy on Goodwin's brush-tailed mouse from Iran

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Abstract

Pseudoscorpions are minute arachnids which can be found in various habitats such as leaf litter, under bark of trees, under stones, phoresy on other arthropods and etc. This finding of a phoresy of the pseudoscorpion, *withius nanus* Mahnert, 1988, which was attached to the body hairs of Goodwin's brush-tailed mouse, *Calomyscus elburzensis* Goodwin, 1938, is the first record of the family Calomyscidae from Iran. In the present study, the redescription, measurements and illustrations of the species including the texts about its act of transporting are given.

Keywords: Arachnida, Rodentia, behavior; the Middle East

1. Introduction

The pseudoscorpions belonging to the family Withiidae those can be generally found in leaf litter, under bark and under stone except *Withius piger* (Simon, ^[24]) which may be collected from seeds, are poorly known in the Middle East. Anyway it consists of just eight species those are distributed around the southwestern Asia and northeastern Africa: *Nannowithius buettikeri* (Mahnert, ^[21]) from United Arab Emirate, Oman and Saudi Arabia; *Nannowithius wahrmani* (Beier, ^[9]) from Israel; *Nannowithius paradoxus* (Mahnert, ^[21]) from Yemen; *Withius hispanus* (L. Koch, ^[18]) from Azerbaijan, Georgia and Turkey; *Withius arabicus* Mahnert ^[21] and *Pseudochernes arabicus* Mahnert ^[23] from Saudi Arabia, *Withius congicus* (Beier, ^[7]) from Yemen and the cosmopolitan species *Withius piger* (Simon) from Turkey, Syria, Azerbaijan and Egypt (Harvey ^[14, 15]). The pseudoscorpion *Withius nanus* Mahnert, ^[22] is redescribed with a few additional systematic data as the first phoresy record of the species. Also, the species is a new record to the fauna of Iran and the Middle East.

2. Materials and Methods

The pseudoscorpion was hand-collected from body surface of Goodwin's brush-tailed mouse (*Calomyscus elburzensis* Goodwin, 1938) which was captured by mice live trap by Allis tissue forceps 5x6 teeth, preserved in 70% ethanol, dissected by black enameled pins, cleared by 60% lactic acid and permanently mounted in Swan's fluid on dished glass microscope slides supported by 18 mm coverslips. An ocular graticule and a drawing tube attaching to an Olympus BH-2 compound microscope were put to practical use for measuring and illustrating the specimen. Systematic arrangement of the trichobothrial setae follows Harvey ^[13], also all measurements and the morphological terminology those are given during this study, follow

Beier ^[6], Chamberlin ^[10], Harvey ^[13], Judson ^[17] and Harvey *et. al.* ^[16]. The prepared specimen is deposited in the Collection of the Acarology Laboratory, Islamic Azad University of Arak (IAUA), Iran.

The following trichobothrial abbreviations were employed: *eb* = external basal; *esb* = external sub-basal; *ib* = internal basal; *isb* = internal sub-basal; *ist* = internal sub-terminal; *est* = external sub-terminal; *it* = internal terminal; *et* = external terminal; *t* = terminal; *st* = sub-terminal; *b* = basal; *sb* = sub-basal. Also, the following abbreviations are used: mm = millimeter; L = length; W = width and D = depth.

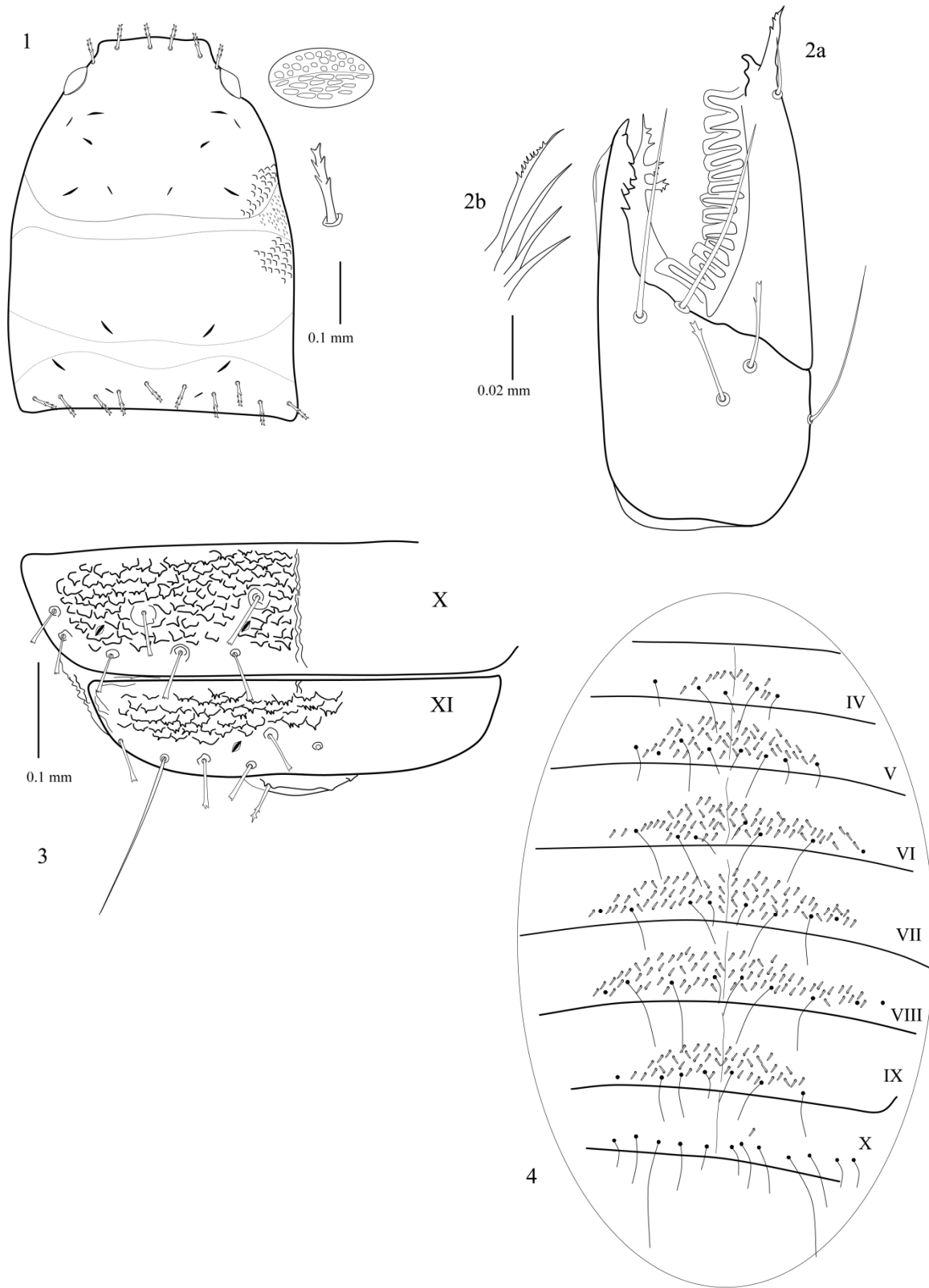


Fig 1-4: *Withius nanus*, male: 1. dorsal view of carapace; 2a. chelicera; 2b. rallum; 3. dorsal view of tergites X-XII; 4. ventral view of sternites IV-X (showing glandular sensory setae).

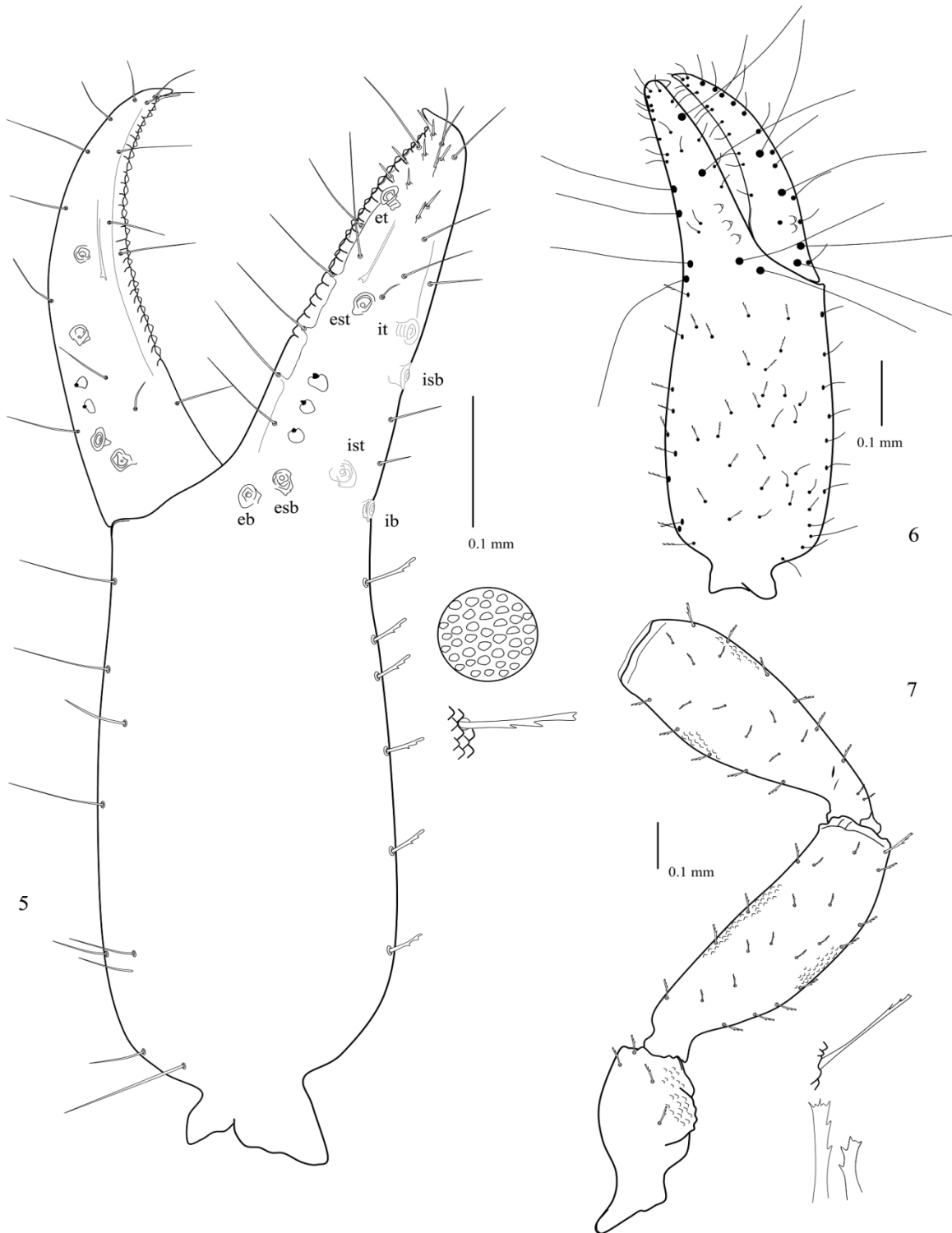


Fig 5-7: *Withius nanus*, male: 5. left chela (showing trichobothrial pattern based on Harvey (1992)); 6. dorsal aspect of right chela; 7. pedipalp.

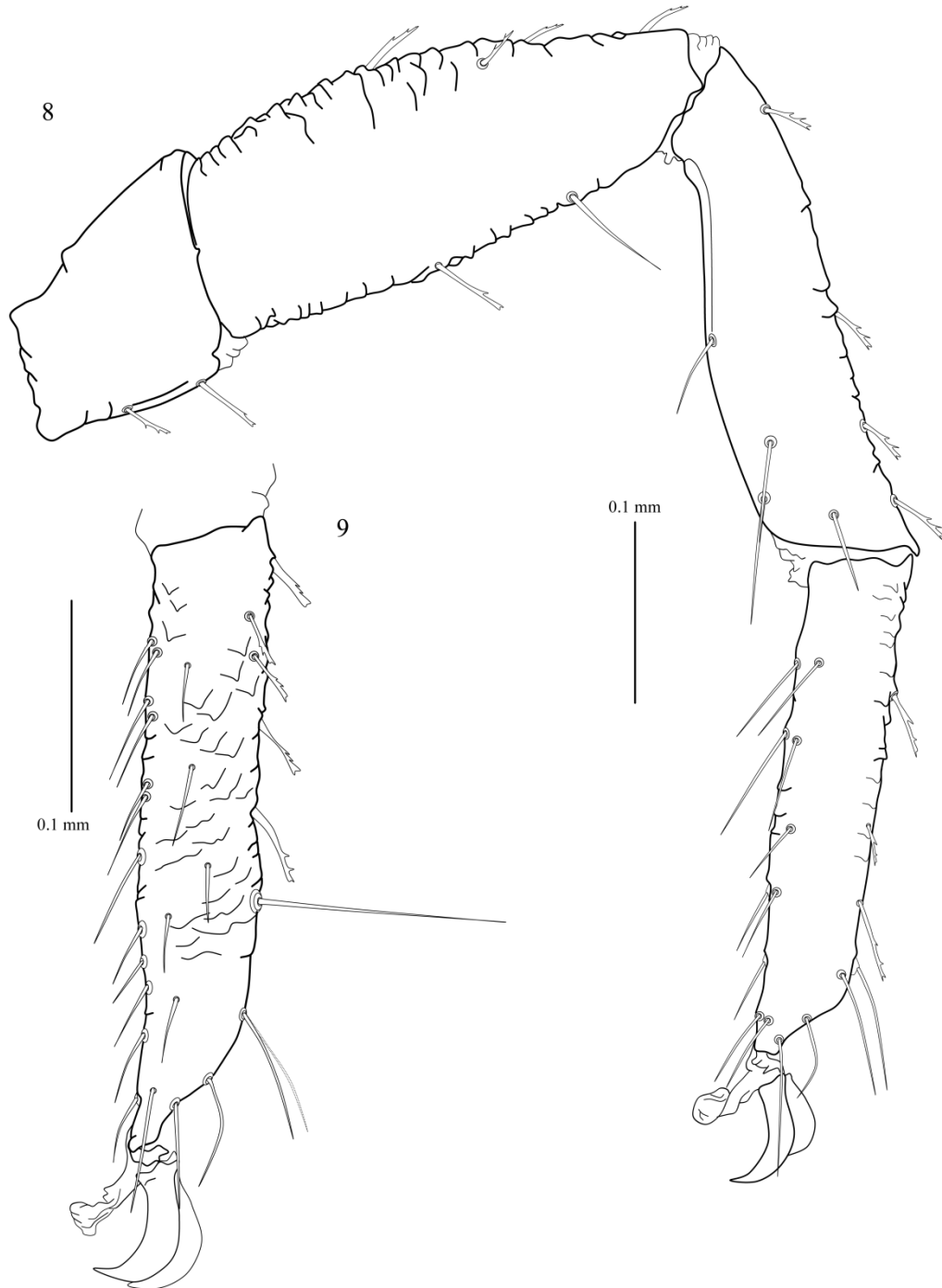


Fig 8-9: *Withius nanus*, male: 8. leg I (trochanter omitted); 9. tarsus IV.

Family Withiidae Chamberlin, 1931
Subfamily Withiinae Chamberlin, 1931

Genus *Withius* Kew, 1911
Withius nanus Mahnert, 1988

Figs (1-9)

Withius nanus Mahnert, 1988: 59-61, figs 41-47.

3. Material examined

IRAN: Khorasan-Razavi province: ♂ attached to the body surface of a rodent, *Calomyscus elburzensis*, Mashhad, Khaje-Morad region, Rocky habitat, June

2014, K. Hamidi (IAUA). [Host and burrow are shown in Fig. 10]

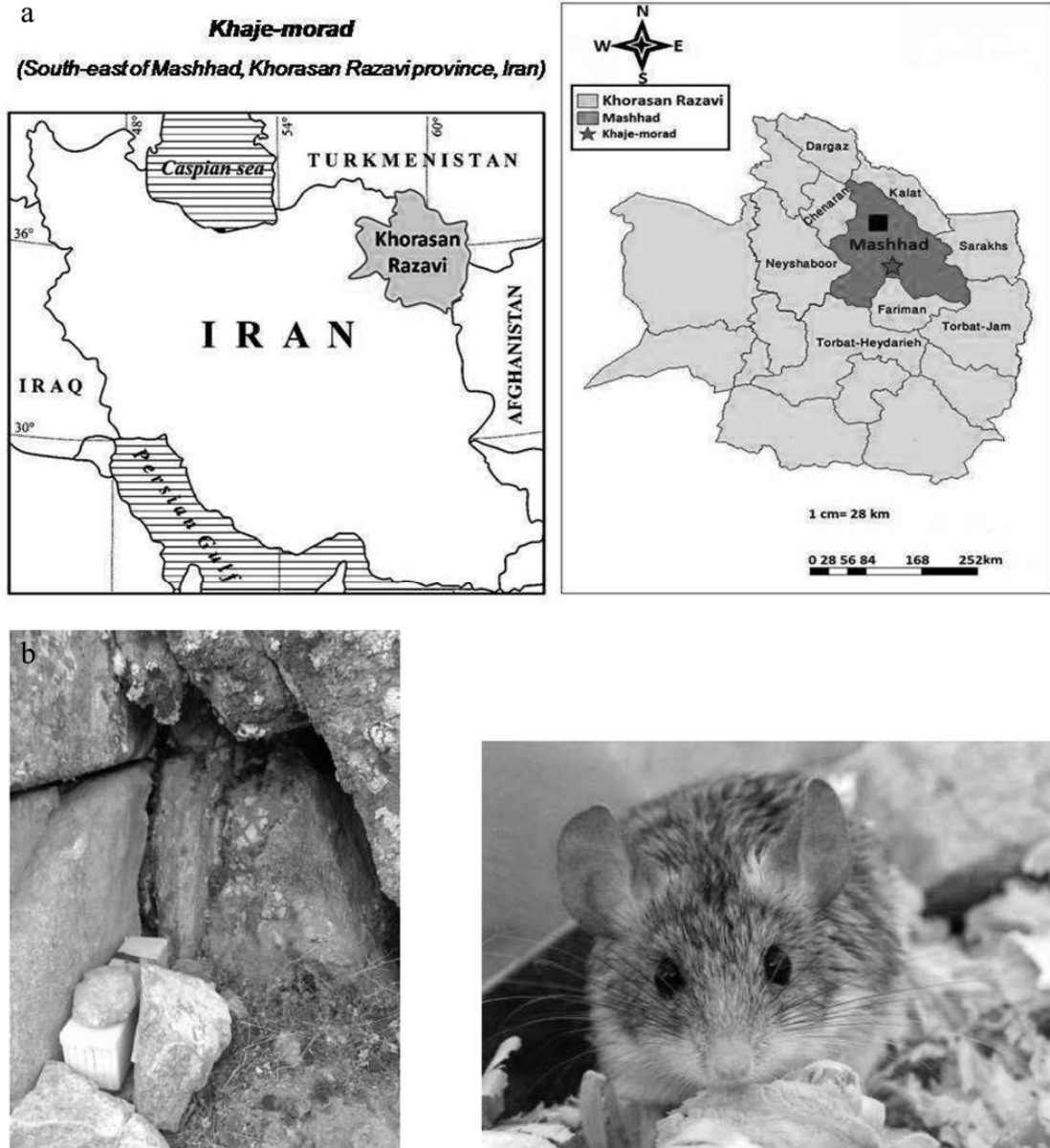


Fig 10: a. geographical location of the collected region; b. burrow; c. *Calomyscus elburzensis*, host.

4. Description

Male (Figs 1-9)

Body length: 1.90 mm

Carapace: reddish brown, lateral margins darker, without pale areas; longer than wide, broadest posteriorly, anterior margin straight, L/W 1.29; normally granulate; all setae short with two medial,

two sub-apical and two apical denticulations (Fig. 1); with 59 setae, anterior margin with 6, 24 in front of anterior furrow, 18 between furrows and posterior margin with 11 setae; hind corner without knob-like enlargements; with 2 corneate eyes, situated in distant about one ocular diameter from anterior margin; 2 transverse furrows present, anterior furrow distinctly

straight and extended laterally, posterior furrow slightly wider than anterior furrow, extended laterally and curved basally (Fig. 1); with 16 slit-like lyrifissures, five pairs situated between eyes and anterior furrow, one pair situated between furrows and two pairs situated on the posterior margin.

Tergites: slightly lighter in color than carapace, without pale areas; lateral projections absent; sclerotized and granulated normally; I-X with median suture line, XI not divided; setae short with three or four apical denticulations (Fig. 3); setae on each half tergites I-III uniseriate, each half tergites IV with one seta situated anteriorly, each half tergites V-X with three setae situated anteriorly, XI with two setae situated anteriorly; tergite XI with two long tactile setae situated latromedially (Fig. 3); with setae arranged: 11: 11: 9: 15: 15: 15: 15: 15: 14: 10: 2.; lyrifissures on half tergites I-XI (left-right): 2+2: 3+3: 2+2: 3+1: 4+2: 3+3: 3+3: 3+2: 2+2: 2+3: 2.

Sternites: lighter in color than tergites; lightly sclerotized; entirely smooth; II partly divided, III-X with median suture line, XI not divided; internal genitalia not suitable for depicting; most setae simple, acute and narrow; IV-X with glandular sensory setae distributed medially (Fig. 4) and arranged regularly as 12: 44: 57: 73: 69: 42: 1; X with 2 long tactile setae arranged as 4T5T3; XI with four tactile setae arranged as T1T3T1T; anterior spiracles slightly larger than posteriors; trachea inflated normally, anterior tracheal trunk distinctly wider and longer than posteriors; with setae arranged: 13: (3)12(3): (3)11(3): 13: 14: 14: 13: 15: 14: 9: 2.

Pleural membrane: roughly striate

Chelicera: brown; small; slightly sclerotized; with 5 setae, *b* and *sb* with two lateral and two terminal denticulations (Fig. 2a); galea with 4 minute rami; galeal setae present; serrula exterior with 13 blades; lamina exterior presents; rallum with 4 blades, distal blade with several lateral denticulations (Fig. 2b); fixed finger with 5 sclerotized teeth; movable finger with one curved apical lobe and one small pointed sub-apical tooth.

Pedipalps: reddish brown; granulated; Pedipalpal coxa with 2 distinct lyrifissures and 18 simple setae, 2 apical setae clearly long, apical lobe with 5 setae; trochanter with a dorsal hump, L/W 2.06; femur with distinct pedicel (Fig. 7), L/W 3.23; prolateral margin of femur with short setae with two lateral and two terminal denticulations, most setae on retrolateral margin short with two lateral and three terminal denticulations, one long denticulate setae situated apically (Fig. 7); patella with distinctly curved pedicel; patella with 2 lyrifissures situated basally; setae on retrolateral margin of patella slightly longer than those on prolateral margin, all setae with two lateral and two

terminal denticulations; patella L/W 2.33; chela with distinct pedicel; chela (with pedicel) L/W 3.00; chela (without pedicel) L/W 2.78; hand (with pedicel) L/W 1.85; retrolateral margin of hand with short setae with two lateral and two terminal denticulations and prolateral margin with slightly long simple setae, one seta longer than others and situated basally; hand (with pedicel) 1.28 longer than movable finger; movable finger longer than width of hand; fixed finger with 8 and movable finger with 4 trichobothria (Figs 5-6); fixed finger with trichobothrium *et* situated slightly closer to tip of finger than to *est*, *est*, *it* and *isb* aggregated medially, *ist*, *ib*, *esb* and *eb* aggregated basally, *est* situated closer to *et* than to *esb*, *it* and *est* situated in the same level, *it* situated anterior to *isb*, *ist* situated slightly anterior to *esb* and *eb* and *ib* situated in the same level; movable finger with trichobothrium *st* situated closer to *t* than to *sb* and *sb* situated very close to *b*; fixed finger with 21 cusped teeth and 3 external accessory teeth; movable finger of males with 26 cusped teeth and 2 external accessory teeth; nodus ramosus presence in both fingers, situated slightly anterior to *est* in fixed finger and situated slightly posterior to *t* in movable finger; venom ducts distinctly elongate in both finger.

Legs: brown; lighter in color than body; strong and granulate; coxae with simple setae arranged as: 9: 8: 9: 17; most setae short with lateral and terminal denticulations; setae on prolateral margin of all tibiae and tarsus simple; sub-terminal setae simple; claws simple and stout; arolia simple and slightly shorter than claws; *leg I*: femur L/D 1.20; patella L/D 2.50: femur and patella immobility joined perpendicular (Fig. 8); femur + patella L/D 3.50; tibia L/D 4.16; tarsus elongate, L/D 4.80; *leg IV*: femur L/D 1.60; patella L/D 2.71; femur + patella L/D 3.20; tibia L/D 4.87; tarsus with one long tactile setae inserted slightly distal to the middle zone (Fig. 9), TS 0.58, L/D 4.83.

Dimensions (L/W, in mm): *Carapace*: 0.62/0.48. *Pedipalp*: trochanter 0.33/0.16; femur 0.55/0.17; patella 0.49/0.21; chela (with pedicel) 0.81/0.27; chela (without pedicel) 0.75; hand (with pedicel) L.0.50; movable finger L. 0.39. (L/D, in mm): *Leg I*: femur 0.12/0.10; patella 0.25/0.10; femur + patella 0.35; tibia 0.25/0.06; tarsus 0.24/0.05. *Leg IV*: femur 0.16/0.1; patella 0.38/0.14; femur + patella 0.48; tibia 0.39/0.08; tarsus 0.29/0.06; TS 0.17/0.29.

5. Results and Discussion

The morphometric characters and the trichobothrial pattern of the newly collected material from Iran are approximately matched to those of *Withius nanus* Mahnert, ^[22]. The observable differences can be noted are the location of the nodus ramosus which is shorter in the types e.g. it is located distad to trichobothrium *t* in the movable chelal finger, the presence of 16-17

blades in serulla exterior and the absence of sensory seta on the sternite X of the types^[22]. These differences are insufficient and confidently it is necessary to collect more specimens for introducing a new species. Therefore, the specimen can be attributed to *Withius nanus*.

Phoresy is a common phenomenon and non-parasitic association in some groups of pseudoscorpions which grab hold hosts by their chela. Finally, the host flies/walks to a new location and carries the pseudoscorpion. Therefore, it is a symbiotic relationship, especially among arthropods, in which one organism transports another organism of a different species. Phoresy can be either obligate or facultative induced by environmental conditions. There are several literatures in respect to the numerous species of pseudoscorpions which mostly belong to the families Atemnidae, Chthoniidae, Cheliferidae, Chernetidae and Olpiidae can be transported by flies, harvestmen, beetles, moths and hymenopteran (Aguiar *et. al.*^[2], Beier^[8], Christophoryová *et. al.*^[11], Mahnert^[23]).

The ecological-behavioral character of *W. nanus* is a most important subject which must be significantly debated here. The types of *W. nanus* were collected from under bark of tree^[22] while it was recently collected as a phoretic type. This occurrence can be found in some species of the family, e.g. the species, *Parawithius gracilimanus* (Mahnert,^[20]), *Dolichowithius emigrans* (Tullgren,^[25]) and *D. mediofasciatus* Mahnert,^[20] can be conveyed by the coleopteran family Passalidae. Also, phoretic relationship may be occurred between *D. mediofasciatus* and the coleopteran family Platypodidae. Moreover, the presence of a phoretic associations between an unknown species of the genus *Parawithius* Chamberlin,^[10] and the family Reduviidae - Hemiptera, the species *Dolichowithius* aff. *longichelifer* (Balzan^[4]) and an unknown host, *Withius simoni* (Balzan^[5]) and the Hymenopteran species *Apis mellifica*, *Withius termitophilus* (Tullgren^[26]) and the species of termites, the species *Stenowithius bayoni* (Ellingsen^[12]) and the southern fiscal shrike and the yellow-billed duck and two species belonging to the genus *Cacodemonius* Chamberlin,^[10] attaching to the coleopteran families Cerambycidae and Passalidae have been previously reported around the world^[1, 2, 3, 8]. Also, the presence of phoretic relationships between a few species of the family withiidae and rats were reported by Beier^[8] e.g. three species *Withius subruber* (Simon^[24]), *Withius kaestneri* (Vachon^[27]) and *Withius angolensis* (Beier^[8]) may be displaced by *Epimys* and *Otomys* rats.

During the present study, the material was attached to the body hairs of *Calomyscus elburzensis* Goodween, a small rodent belonging to the family Calomyscidae (Fig. 10). *Calomyscus elburzensis*, also known as Goodwin's *Calomyscus* or Goodwin's brush-tailed mouse is a species of mouse-like hamster. It is found in northeastern and northern Iran especially in well drained, barren and rocky habitats in the foothills and mountains of north and northeastern of Iran, southern foothills of the Elburz Mountains in Semnan Province, western Afghanistan, and southern Turkmenistan^[19]. Little is known about its ecology where the species is found in barren, dry and rocky mountain sides with little vegetation. It nests in concealed rock crevices, individuals frequently share favorable shelter sites and feeds on *Bromus* grasses. It does not seem to be as exclusively nocturnal, during the summer months it is active only during the hours of darkness, but in autumn and winter it can be seen foraging by day. In this case seeds and leafs of *Amygdalus sp.*, *Artemisia sp.*, *Ephedra sp.*, *Euphorbia sp.* and *Fumaria sp.* can be found in its burrow (Fig. 10), the pseudoscorpion was encountered with the mouse and apparently applied to transmit by him/her. The phoresy of *Withius nanus* is observed for the first time in Iran.

6. Conflict of interest statement

The authors declare that they have no competing interests and have not a financial relationship with the organization that sponsored the research.

7. Acknowledgment

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