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Complementary description of three *Amblyseius* species (Acari: Mesostigmata; Phytoseiidae) and keys to the world species of *duncansoni* and *largoensis* species subgroups

Muhammad Kamran ^a, Fahad Jaber Alatawi ^a

^aDepartment of Plant Protection, College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia.

Original research

ABSTRACT

Three phytoseiid species: *Amblyseius excelsus* Chaudhri, Akbar & Rasool, *A. adhatodae* Muma, and *A. isuki* Chant & Hansell, collected from Pakistan, are re-described with more detailed descriptions and illustrations. The species, *A. bajulus* Chaudhri, Akbar & Rasool, is considered as junior synonym of *A. isuki* instead of *A. obtusus* (Koch). The identification keys to the world species of *duncansoni* and *largoensis* species subgroups are presented.

Keywords *bajulus*; diagnosis; *excelsus*; *adhatodae*; taxonomy


Introduction

Amblyseius Berlese (Phytoseiidae) is one of the largest genera in the subfamily Amblyseiinae Muma, with 434 nominal species worldwide (Demite *et al.* 2024). It was erected by Berlese (1914) based on the type species, *Amblyseius obtusus* (Koch, 1839). It is distinguished from the other genera belonging to the subtribe Amblyseiina by combination of following characters: setae *s4*, *Z4*, and *Z5* greatly longer (ratio of setae *s4*: *S2* >3:1); both cheliceral digits of normal in size, setae *JV2* present; ventrianal shield well-developed, rarely divided; genu and tibia III each with one macroseta or rarely none (Chant and McMurtry 2003, 2004).

Denmark and Muma (1989) reviewed the genus *Amblyseius* and proposed three subgenera based on number of teeth on fixed digit of chelicerae and length of macrosetae on leg IV, subgenus *Amblyseius* Berlese with 16 species groups (72 species), subgenus *Pauciseius* Denmark & Muma with three species groups (12 species) and subgenus *Multiseius* Denmark & Muma with 12 species groups (51 species). Chant and McMurtry (2004, 2007) ignored this sub generic division and species groups and suggested only five species groups in *Amblyseius*; *pusillus* species group Chant & McMurtry, *sundi* species group Denmark & Muma, *obtusus* species group Chant, *americanus* species group Denmark & Muma, and *largoensis* species group McMurtry & Moraes. These species groups were based on relative length of setae *z4*, shape of spermathecae and venterianal shield, and presence/absence of setae *Z1*. Later, Denmark and Evans (2011) followed sub generic division of *Amblyseius* proposed by Denmark and Muma (1989) but ignored species grouping in *Amblyseius*.

Until now, 25 *Amblyseius* species have been reported from Pakistan (Chaudhri *et al.* 1979; Halliday *et al.* 2018). The species, *A. bajulus* Chaudhri, Akbar & Rasool 1979 was synonymized with *A. obtusus* (Koch, 1839) based on original descriptions and illustrations (Daneshvar and Denmark 1982; Denmark and Muma 1989). In the present study, *A. excelsus* Chaudhri, Akbar & Rasool, 1979, *A. adhatodae* Muma, 1967, and *A. isuki* Chant & Hansel,

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Corresponding author
Muhammad Kamran 
murafique@ksu.edu.sa

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1971 are re-described based on new material collected from different localities in Pakistan. In addition, keys to the world species of *duncansoni* and *largoensis* species subgroups of *Amblyseius* are presented.

Material and methods

The phytoseiid mites were collected from a diversity of host plants in different localities across Pakistan during the year 2023. The mite specimens were collected by shaking the plant foliage over a white piece of paper and preserved in 70% ethanol. Mite specimens were mounted in Hoyer's medium and identified under a phase contrast microscope (BX51, Olympus®, Japan) using diagnostic keys and available literatures. The taxonomic literature of different species groups of the genus *Amblyseius* was collected to develop world species diagnostic keys of *duncansoni* and *largoensis*, species subgroup. Different mite body parts were imaged using an Auto-montage software system (Syncrosopy, Cambridge, UK) attached with phase contrast microscope (DM2500, Leica®, Germany). The illustrations were drawn with Adobe Illustrator (Adobe System Inc., San Jose, CA, USA). All measurements are given in micrometers (µm). The morphological terminology used in this study follows that of Lindquist and Evans (1965), Rowell *et al.* (1978), and Chant and Yoshida-Shaul (1992). All the collected specimens have been deposited in the Museum of Arthropods (KSMA, Acarology section), Department of Plant Protection, College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia.

Results and discussion

Family Phytoseiidae Berlese

Subfamily Amblyseiinae Muma

Tribe Amblyseiini Muma

Subtribe Amblyseiina Muma

Genus *Amblyseius* Berlese

Amblyseius Berlese, 1914: 143; Chant and McMurtry, 2004: 188

Species group *americanus* Denmark & Muma, 1989

Species subgroup *duncansoni* Chant & McMurtry, 2004

Amblyseius excelsus Chaudhri, Akbar & Rasool (Figures 1–4)

Amblyseius excelsus Chaudhri, Akbar and Rasool, 1979: 68.

Material examined

Two females, one male, grasses (Poaceae), Kaghan, (34.7840417° N, 73.5207167° E), 19 July 2023, three females, one male, grasses (Poaceae), Mansehra, Khyber Pukhtun Khawa (34.4062372° N, 73.3375557° E), 20 July 2023; two females, one male, grasses (Poaceae), Kuttan, Neelam valley, Azad Jammu and Kashmir (AJK) (34.5593598° N, 73.7921257° E), 18 July 2023; two females, two males, grasses (Poaceae) Shahkot, Neelam valley, AJK (34.5671687° N, 73.8912957° E), 18 July 2023; three females, grasses (Poaceae), Kiran, Neelam Valley, AJK (34.6318277° N, 73.9191069° E), 18 July 2023; all collected by M. Kamran.

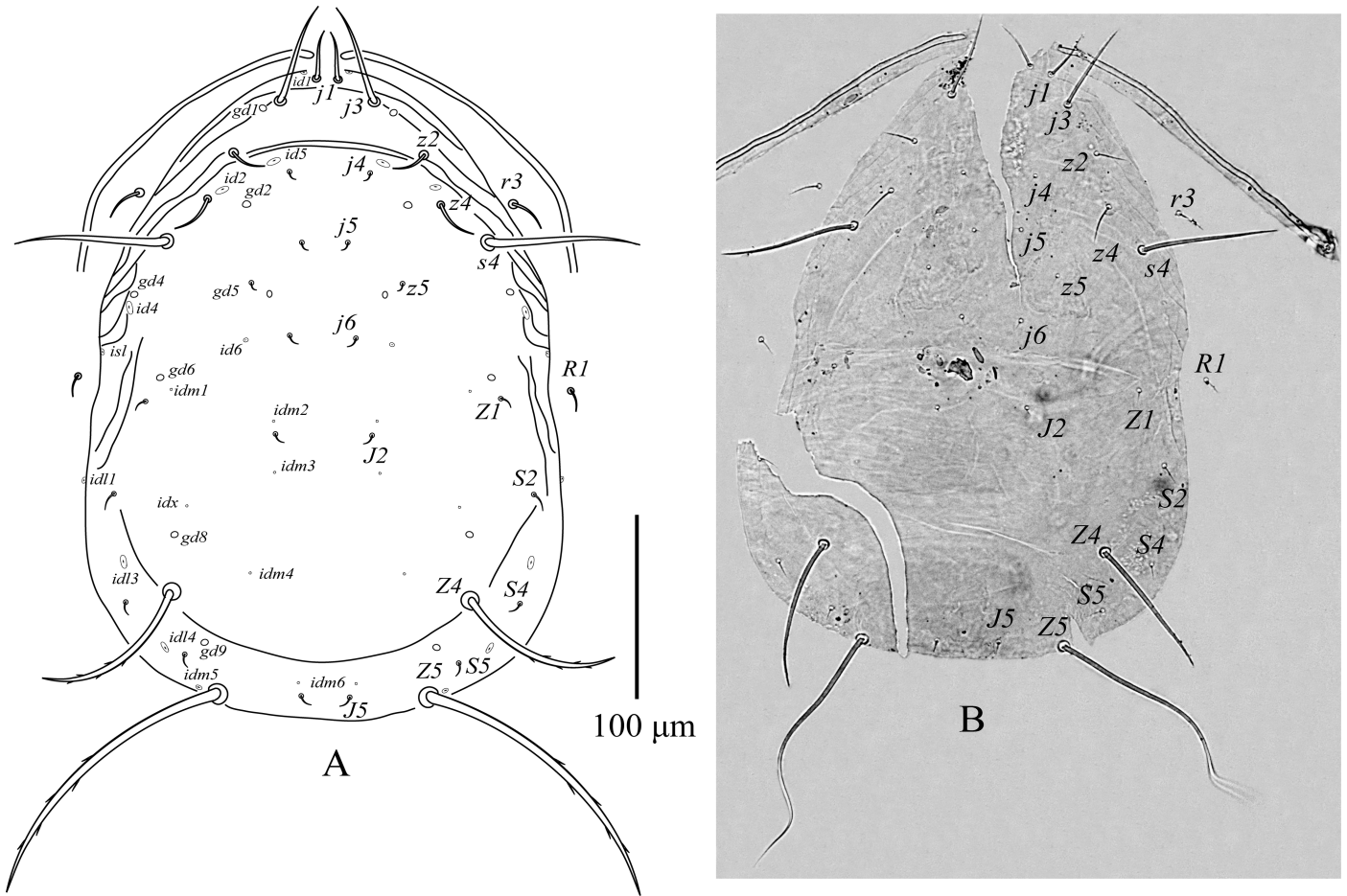


Figure 1 *Amblyseius excelsus* Chaudhri, Akbar & Rasool: Female, A – Dorsum. B – Photograph of Dorsum.

Previous record and Distribution

Balakot, Abbotabad, Muzaffarabad (Pakistan) (Chaudhri *et al.* 1979); Jammu Kashmir, India (Rather 1985).

Complementary Description of female (n = 12)

Dorsum –(Figure 1A, B). Dorsal shield mostly smooth with few striations anterolaterally from setae *j3* to *R1*, 330–349 long and 215–231 wide at the level of *s4*; with seven pairs of solenostomes (*gd1*, *gd2*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*) and 16 pairs of poroids (*id1*, *id2*, *id4*, *id5*, *id6*, *idm1*, *idm2*, *idm3*, *idm4*, *idm5*, *idm6*, *isl*, *idl1*, *idl3*, *idl4*, *idx*). Setae length: *j1* 25–28, *j3* 45–56, *j4* 5–7, *j5* 6–7, *j6* 7–8, *J2* 7–8, *J5* 7–8, *z2* 19–22, *z4* 21–26, *z5* 4–5, *Z1* 8–9, *Z4* 82–90, *Z5* 155–175, *s4* 75–84, *S2* 12–13, *S4* 8–9, *S5* 8 7–8, *r3* 21–23, *R1* 11–13. All setae smooth, except for *Z4* and *Z5*, finely serrate near tips. Peritreme extending to the level of *j1*.

Venter — (Figure 2A). Sternal shield smooth, posteriorly almost flat, with three pairs of setae (*st1-st3*) and two pairs of poroids (*iv1*, *iv2*); distance *st1-st3* 65–70, *st2-st2* 70–78, *st4* and poroid *iv3* tylochorous; genital shield smooth, distance *st5-st5* 70–75; a transversely elongate platelet between genital and ventrianal shields. Ventrianal shield subpentagonal, slightly constricted at the level of solenostomes, with sparsely striae, about 6–7 transverse lines, 125–135 long, 90–98 wide at *ZV2* level, and 85–89 wide at anus level; with three pairs of pre-anal setae (*JV1*, *JV2*, and *ZV2*) along with para-anal and post-anal setae, a pair of solenostomes (*gv3*), crescentic shape, posteromesad *JV2*; four pairs of setae (*JV4*, *JV5*, *ZV1*,

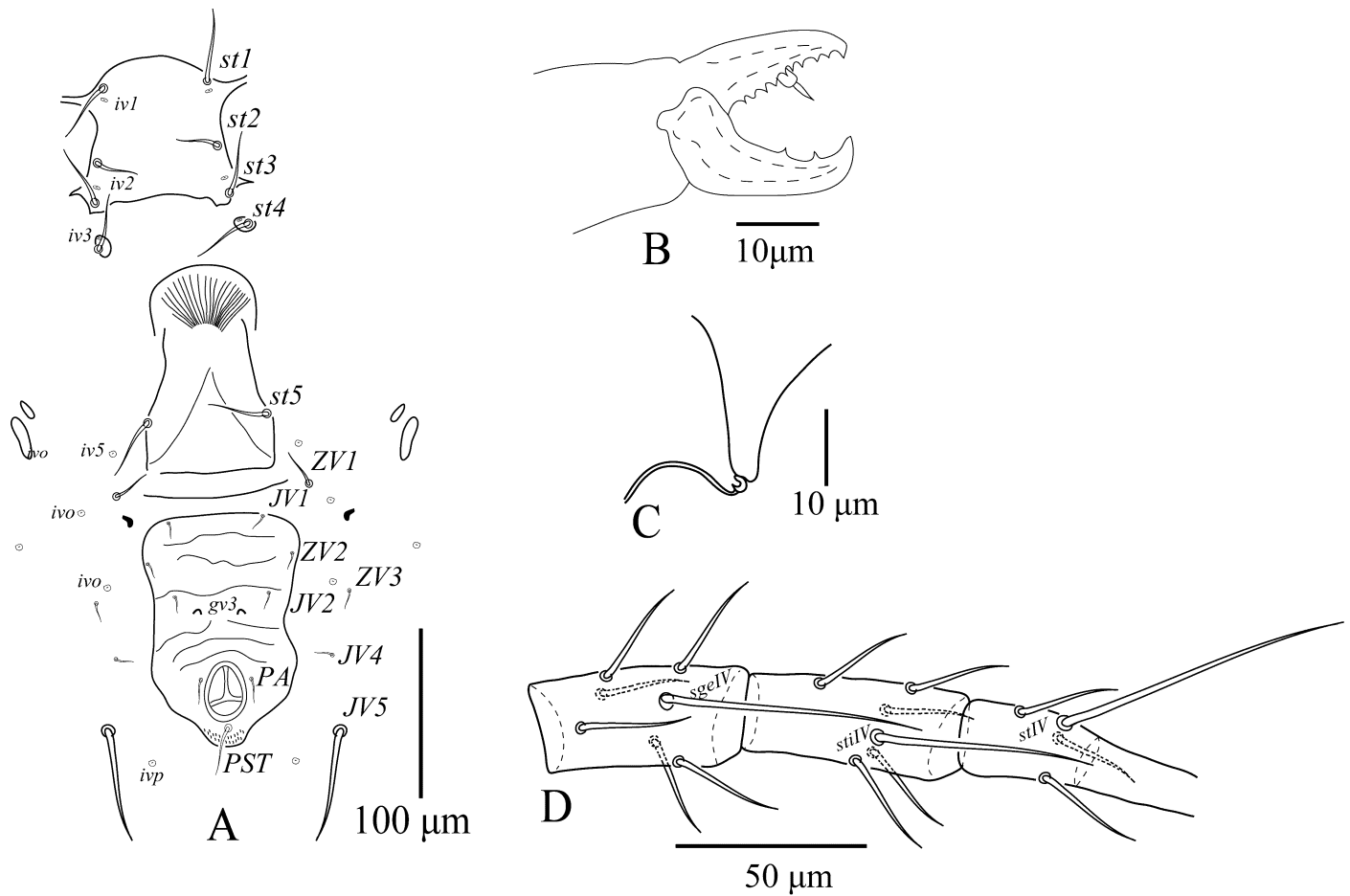


Figure 2 *Amblyseius excelsus* Chaudhri, Akbar & Rasool: Female, A – Venter; B – Chelicera; C – Spermatheca; D – Leg IV, genu, tibia, and basitarsus.

and ZV3), four pairs of poroids (*ivo*, *ivp*), and two pairs of metapodal platelets on the membrane surrounding ventrianal shield, primary metapodal plate 22–24, secondary 9–10 long. Setae ZV1 23–25, ZV3 = JV4 12–13, JV5 70–75, smooth.

Chelicera — (Figure 2B). Movable cheliceral digit 29–32 long, with two teeth; fixed digit 31–35 long, with nine teeth and a *pilus dentilis*.

Spermatheca — (Figure 2C). Calyx bell shaped, 15–18 long and 12–13 wide at apex, atrium visible, minute not bulbous, major duct narrow, tube-like.

Legs — (Figure 2D). Genu II with eight setae; genera III–IV each with seven setae; genera I–III each with a macroseta: 28–31, 28–30, and 35–39 long, respectively; tibiae III without macrosetae; leg IV with three macrosetae: *SgeIV* 68–77, *StiIV* 55–65, *StIV* 76–80, all macrosetae smooth with pointed tip (Figure 2D).

Male (n = 5)

Dorsum — (Figure 3A). Dorsal shield smooth, with few striae laterally, eight pairs of solenostomes, *gd3* present, poroids indistinct, 260–265 long and 190–195 wide. Setae length: *j1* 22–23, *j3* 45–48, *j4* 6–7, *j5* 6–7, *j6* = *J2* 6, *J5* 6–7, *z2* 17–18, *z4* 19–20, *z5* 5–6, *Z1* 12, *Z4* 64–66, *Z5* 115–120, *s4* 62–65, *S2* 10–11, *S4* 10, *S5* 9, *r3* 18–19, *R1* 11–12. All setae smooth, except for *Z4* and *Z5*, finely serrated near tips. Peritreme extending to the level behind *j1*.

Venter — (Figure 3B). Sternogenital shield almost smooth with lateral striae, *st-st5* 113–118, *st2-st2* 60–63. Ventrianal shield entirely with transverse lines/striae, wider than long,

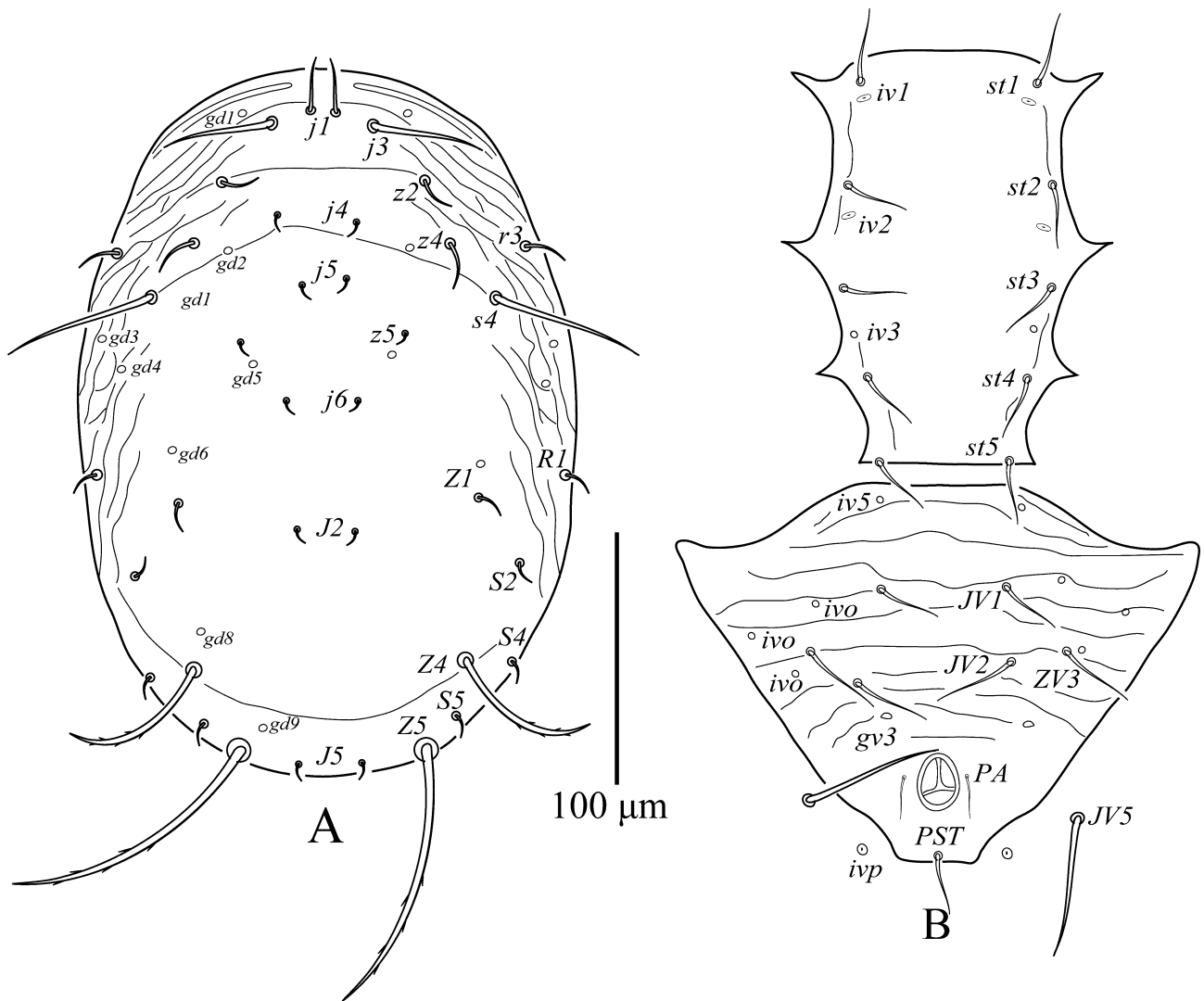


Figure 3 *Amblyseius excelsus* Chaudhri, Akbar & Rasool: Male, A – Dorsum; B – Venter.

114–118 long and 150–155 wide at the anterior corners level; with three pairs of pre-anal setae (*JV1*, *JV2*, and *ZV3*), a pair of solenostomes (*gv3*) posteromesad *JV2*, almost oval in shape, four pairs of poroids (*ivo*); *JV5* 43–45 smooth, a pair of poroids (*ivp*) mesad *JV5*.

Chelicerae — (Figure 4A). Spermatodactyl T-shaped with slightly developed toe, but the axes of shaft and toe make almost right angle, shaft 18–19 long, toe 4–5 long. Movable cheliceral digit 17–19 long, fixed digit 19–21 long.

Legs — (Figure 4B). Three macrosetae on leg IV: *SgeIV* 48–50, *StiIV* 43–45, *StIV* 70–72. One macroseta each on genu of legs I–III: 23–25, 21–24, and 24–28 long, respectively. All macrosetae smooth with pointed tips.

Remarks

Amblyseius excelsus belong to the *duncansonii* species subgroup Chant & McMurtry, 2004 of *americanus* species group Denmark & Muma, 1989 (Chant and McMurtry 2004). This species subgroup includes 14 species worldwide that having spermathecal calyx cup-dish, or bell-shaped. Morphological characters and measurements of the specimens of *A. excelsus* collected in the present study, are similar to its original description (Chaudhri *et al.* 1979),

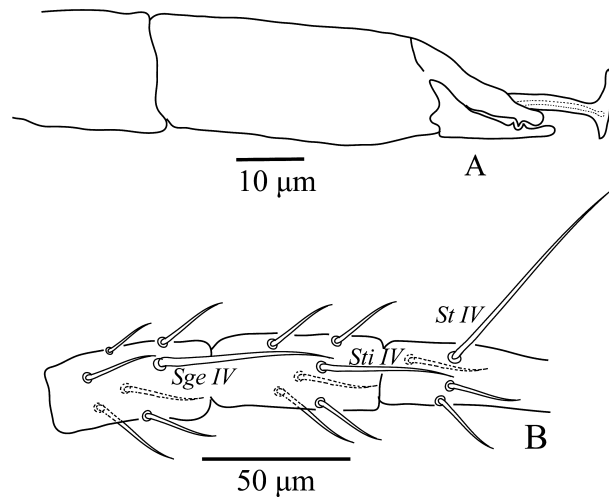


Figure 4 *Amblyseius excelsus* Chaudhri, Akbar & Rasool: Male, A – Spermatodactyl; B – Leg IV, genua, tibia, and basitarsus.

except for small differences in length of some dorsal setae ($z4$ 16–26 vs. 21) and number of teeth on movable and fixed digits of chelicerae (M.D. 2 vs. 4; F.D. 9 vs. 6) in the original description of *A. excelsus*. This might be due to chelicerae in the type specimen were not properly opened as shown in the original illustrations and four teeth were considered on the movable digit that was originally on the fixed digit. Rather (1985) also reported this species from Azad Jammu and Kashmir (India) and provided a brief description without details of teeth on cheliceral digits. However, Denmark and Muma (1989) redescribed *A. excelsus* from type specimens with nine teeth on fixed digit and one tooth on movable digit of chelicerae vs. (F.D 6; M.d. 2) and length of $z4$ (19 vs. 21) in the original description (Chaudhri *et al.* 1979).

Key to the world species of *duncansoni* species subgroup of *americanus* species group of the genus *Amblyseius*

- 1. Setae $Z5 \geq 210$ 2
 — Setae $Z5 \leq 190$ 4
- 2. Setae $Z5$ 260–280 *A. fennicus* Karg & Huhta, 2012
 — Setae $Z5 \leq 230$ 3
- 3. Setae $z4$ 51, $s4$ 70, fixed digit of chelicerae with nine teeth, $gv3$ solenostomes on the ventrianal shield posteroletrad *JV2* *A. williamsi* Schicha, 1983
 — Setae $z4$ 31, $s4$ 106, fixed digit of chelicerae with 13 teeth, $gv3$ solenostomes on the ventrianal shield posteromesad *JV2* *A. duncansoni* Specht & Rasmy, 1970
- 4. Setae $Z5 \geq 150$ 5
 — Setae $Z5 \leq 140$ 8
- 5. Setae $Z4$ 70–72, $s4$ 52 *A. filixis* Karg, 1970
 — Setae $Z4 \geq 90$, $s4 > 75$ 6
- 6. Setae $j3$ 29, $s4$ 98 *A. nayaritensis* De Leon, 1961
 — Setae $j3 > 40$, $s4 < 90$ 8

7. Movable digit of chelicerae with one tooth, without transversely elongate platelet between genital and ventrianal shields; ventrianal shield distinctly wider at *ZVI* than at anus level, *Z4* and *Z5* smooth *A. blosis* Ahmad & Chaudhri, 1989
 — Movable digit of chelicerae with two teeth, with a transversely elongate platelet between genital and ventrianal shields; ventrianal shield slightly wider at *ZVI* than at anus level, *Z4* and *Z5* slightly serrate *A. excelsus* Chaudhri, Akbar & Rasool, 1979
8. Setae *Z4* distinctly longer than *s4* 9
 — Setae *Z4* and *s4* subequal in length 10
9. Setae *Z5* 133, 4.5 times as long as *j3* 28
 *A. collinellus* Athias-Henriot, 1966
 — Setae *Z5* 84, 1.8 times as long as *j3* 47 *A. arbuti* De Leon, 1961
10. Spermathecal calyx long, bell-shaped *A. similoides* Buchelos & Pritchard, 1960
 — Spermathecal calyx small, cup-, cone-, funnelor dish shaped 11
11. Setae *Z5* > 100 12
 — Setae *Z5* < 90 13
12. Setae *j3* 35, *z4* 29–33, movable digit of chelicerae without teeth . . *A. kochi* (Koch, 1839) = replacement name of *A. similis* (Koch, 1839) by Chant and McMurtry 2004
 — Setae *j3* 56, *z4* 46, movable digit of chelicerae with one tooth . . . *A. sinuatus* De Leon, 1961
13. Setae *z4* 23, half the length of *j3* 44, ventrianal shield more wider at anus level than at *ZVI* *A. marunumus* Negm & Gotoh, 2020
 — Setae *z4* and *j3* almost equal in length = 35, ventrianal shield more wider at *ZVI* level than at anus level *A. yadongensis* Wu, 1987

Species group *largoensis* McMurtry & Moraes, 1984

Species subgroup *largoensis* Chant & McMurtry, 2004

Amblyseius adhatodae Muma (Figures 5–6)

Amblyseius adhatodae Muma, 1967: 268; Moraes *et al.* 1989b: 79; Chant and McMurtry 2004: 203; Moraes *et al.* 2004: 12; Gupta 1985: 336; Döker *et al.* 2022: 866.

Material examined

Two females, *Tripidium bengalense* (Retz) (Poaceae), Sargodha, near College of Agriculture, Punjab (32.134294° N, 72.681879° E), 16 Jan. 2016, coll. Muneeb Ur Rehman; one female, *Chrysanthemum* (Asteraceae), Mazar e Qaid, Karachi, 24.87379° N, 67.03901° E, 11 Aug. 2023, coll. A. Hafeez and M. Zeeshan.

Previous record and distribution

Brazil (Lawson-Balagbo *et al.* 2008), India and Pakistan (Muma 1967) and current study, Kenya (Moraes *et al.* 1989), Sri Lanka (Moraes *et al.* 2004), Maldives (Döker *et al.* 2022).

Complementary description of female (n = 3)

Dorsum — (Figure 5A). Dorsal shield smooth, 365–367 long, 221–224 wide at the level of *s4*, and 269–273 wide near *S2*, with seven pairs of solenostomes (*gd1*, *gd2*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*); poroids indistinct. Length of setae: *j1* 34–36, *j3* 46–48, *j4* 5–6, *j5* 5, *j6* 6, *J2* 6–7, *J5* 10–11, *z2* 7–8, *z4* 7–8, *z5* 5, *Z1* 8–9, *Z4* 128–132, *Z5* 248–268, *s4* 110–115, *S2* 11–12, *S4* 11–12,

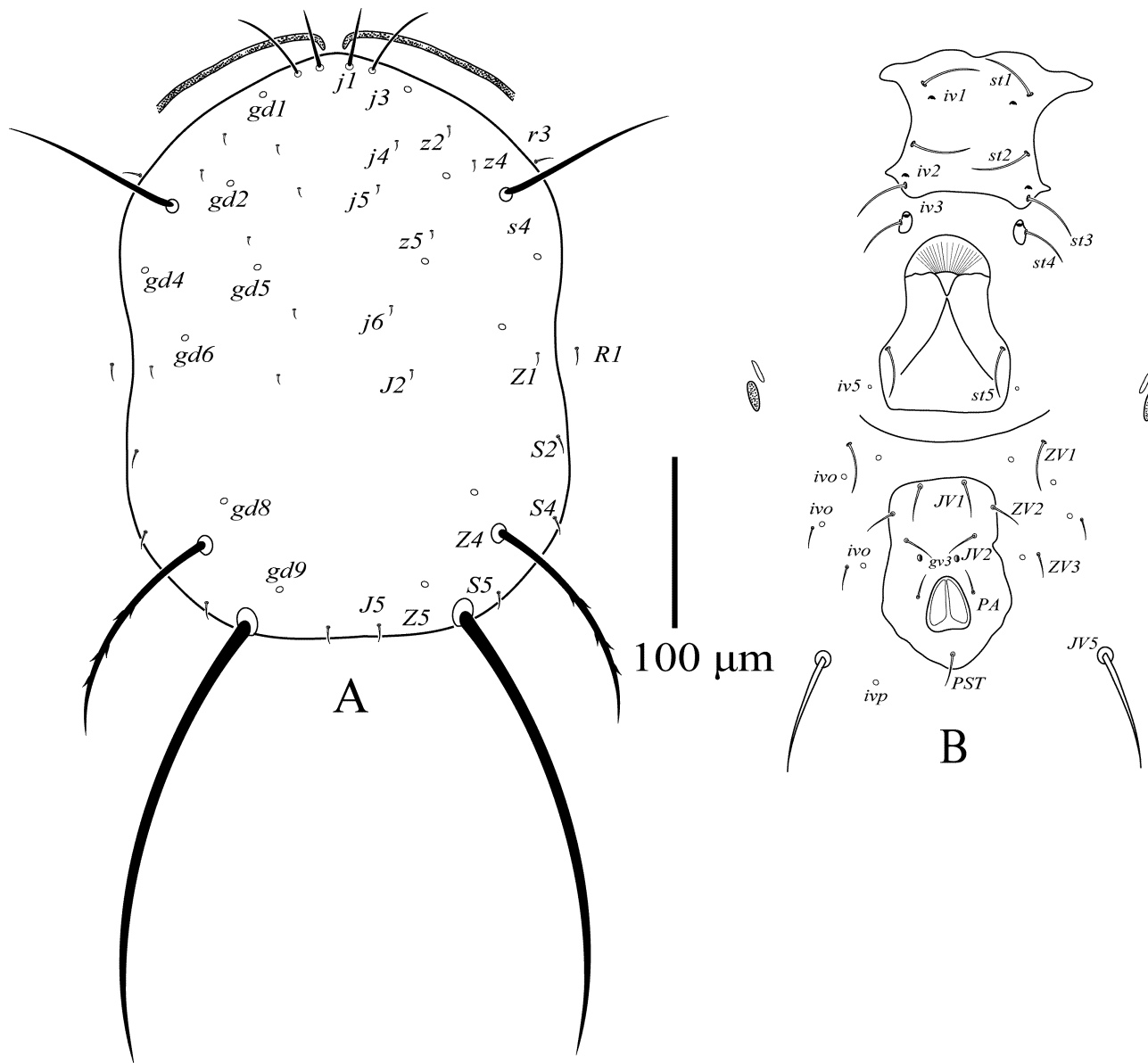


Figure 5 *Amblyseius adhatodae* Muma: Female, A – Dorsum; B – Venter.

S5 10–11, *r3* 11, *R1* 10. All setae smooth, except for *Z4*, finely serrate. Peritreme extending to the level of *j1*.

Venter — (Figure 5B). Sternal shield smooth, slightly concave posteriorly, with three pairs of setae (*st1*–*st3*) and two pairs of poroids (*iv1*, *iv2*); distance *st1*–*st3* 61 (63), *st2*–*st2* 68 (66), *st4* and poroid *iv3* tylochorous; genital shield smooth, distance *st5*–*st5* 73–75; a transversely elongate platelet between genital and ventrianal shields. Ventrianal shield vase-shaped, smooth, 88–90 long, 62–64 wide at *ZV2* level, and 72–74 wide at anus level; with three pairs of pre-anal setae (*JV1*, *JV2*, and *ZV2*) along with para-anal and post-anal setae, a pair of solenostomes (*gv3*), crescentic shape, posteromesad *JV2*; four pairs of setae (*JV4*, *JV5*, *ZV1*, and *ZV3*), four pairs of poroids (*ivo* and *ivp*), and two pairs of metapodal platelets on the membrane surrounding ventrianal shield, primary metapodal platelet 16–18, secondary 8–9 long. Setae *JV5* 63–65, smooth.

Chelicera — (Figure 6A, B). Movable cheliceral digit 31–33 long, with four teeth (three

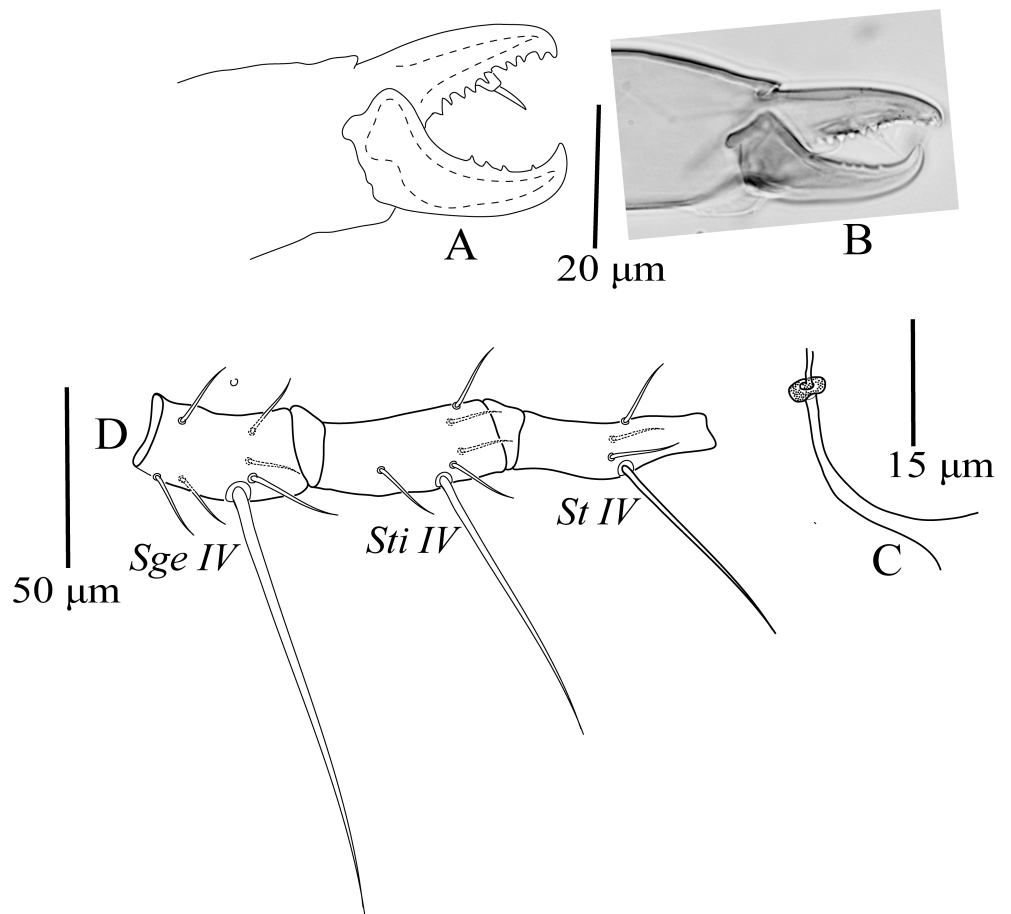


Figure 6 *Amblyseius adhatodae* Muma: Female, A – Chelicera; B – Photograph of chelicera; C – Spermatheca; D – Leg IV genu, tibia, and basitarsus.

teeth in one specimen); fixed digit 34–35 long, with ten teeth and a *pilus dentilis*.

Spermatheca — (Figure 6C). Calyx fundibular tube, 25–27 long and 5 wide at apex, atrium distinct, bulbous, four times as wide as proximal section of calyx, calyx forming long tube, almost 4–5 times longer than the width of atrium.

Legs — (Figure 6D). Genua II–IV each with seven setae, macrosetae on genu I 42–44, genu II 34–36, and genu III 48–50, tibia III 34–36, tibia IV with six setae; leg IV with three macrosetae: *SgeIV* 123–126, *StiIV* 80–86, *StIV* 65–70. All macrosetae smooth with pointed tip.

Remarks

Amblyseius adhatodae belongs to *largoensis* species subgroup of *largoensis* species group of the genus *Amblyseius*. This species subgroup includes 19 species worldwide so far. The morphological characters (shape of spermatheca, length and shape of dorsal setae and chelicerae, and chaetotaxy of body and legs) of specimens of *A. adhatodae* collected in the present study are very similar to that in the original description (Muma 1967) and subsequent/complementary descriptions by Moraes *et al.* (1989b) and Döker *et al.* (2022) except for some variations in length of setae Z4, Z5 and other dorsal setae. Döker *et al.* (2022) reported 11 teeth on fixed digit in *A. adhatodae* compared with ten teeth in the present study as well in holotype specimen described by Moraes *et al.* (1989b) (Table 1).

Key to world species *largoensis* species subgroup of *largoensis* species group of the genus *Amblyseius*

1. Spermathecal calyx comparatively long, forming a long tube and flared distally, neither widened basally nor saccular 9
 — Spermathecal calyx comparatively short, widened saccular or constricted basally forming short tube and flared/widened gradually toward distal end 2
2. Spermathecal calyx almost saccular, not basally constricted 3
 — Spermathecal calyx constricted basally forming short tube and flared/widened gradually toward distal end 6
3. Setae *Z5* 310–336, *SgeIV* 157 *A. duplicisetus* Moraes & McMurtry, 1988
 — Setae *Z5* < 270, *SgeIV* < 100–130 4
4. Movable digit of chelicerae with two teeth
 *A. kokofuensis* Ehara, Okada & Kato in Ehara *et al.* 1994
 — Movable digit of chelicerae with four teeth 5
5. Spermathecal calyx not deeply bifurcate, gradually widened toward distal end
 *A. conulus* Karmakar, Bhowmik & Sherpa, 2017
 — Spermathecal calyx deeply bifurcate, almost equally wide at base and distal end
 *A. sumatrensis* Ehara, 2002
6. Sternal shield posteriorly straight 7
 — Sternal shield posteriorly with median protrusion 8
7. Setae *Z4* 76–96, *s4* 82–96, *Z5* 240–296 *A. fijiensis* McMurtry & Moraes, 1984
 — Setae *Z4*, *Z5* and *s4* comparatively long, *Z4* = *s4* 128–133, *Z5* 76–96, *s4* 82–96, *Z5* 305–348
 *A. nambourensis* Schicha, 1981
8. Setae *StIV* 86, *Z4* 91–125, spermathecal atrium two times as wide as proximal section of calyx *A. eharai* Amitai & Swirski, 1981
 — Setae *StIV* 38–42, *Z4* 59–67, spermathecal atrium more distinct, almost three times as wide as proximal section of calyx *A. herbiculooides* McMurtry & Moraes, 1984
9. Setae *Z5* 110 *A. talpa* Khan & Ashfaq, 2008
 — Setae *Z5* > 200 10
10. Setae *Z4* 59 *A. keni* Shicha, 1987
 — Setae *Z4* > 80 11
11. Spermathecal calyx trumpet shaped 13
 — Spermathecal calyx tubular with parallel sides 12

Table 1 Variation in some morphological characters in *Amblyseius adhatodae* collected from different countries.

	<i>j1</i>	<i>j3</i>	<i>s4</i>	<i>Z4</i>	<i>Z5</i>	<i>SgeIV</i>	<i>StiIV</i>	<i>StIV</i>	<i>JV4</i>	Calyx length	Teeth on F.D/M.D
(Pakistan, India and Kenya) (* Moraes <i>et al.</i> 1989)	36	52	133	142	283–312	152	112	74	71–75	36–41	10/3
Maldives (Döker <i>et al.</i> 2022)	33–38	44–50	99–114	115–125	231–261	104–127	78–82	46–54	63–68	35–38	11/3–4
Pakistan, (Present study)	34–36	46–48	110–115	128–132	248–268	123–126	80–86	65–70	65–70	25–27	10/3–4

12. Setae *Z5* 355–362, *Z4* 158–167, *s4* 140–148 *A. neolargoensis* Van der Merwe, 1965
 — Setae *Z5* 206, *Z4* 96, *s4* 94 *A. largoensis* (Muma, 1955)
13. Cheliceral fixed digit with six teeth *A. diverto* Khan, Ashfaq & Hassan, 2010
 — Cheliceral fixed digit with \geq nine teeth 14
14. Movable digit of chelicerae with two teeth *A. melicardus* Khan & Ashfaq, 2005
 — Movable digit of chelicerae with 3–4 teeth 15
15. Spermathecal atrium almost two times as wide as proximal section of calyx, calyx forming short tube, the tube two times as long as the width of atrium, gradually widening toward distal end *A. herbicolus* (Chant, 1959)
 — Spermathecal atrium more bulbous, four times as wide as proximal section of calyx, calyx forming long tube, almost 3–5 times longer than the width of atrium
 *A. adhatodae* Muma, 1967,
A. impactus Chaudhri, 1968, *A. fletcheri* Schicha, 1981, *A. phillipsi* McMurtry & Schicha, 1987*

The morphological features of *A. impactus* Chaudhri, 1968, *A. fletcheri* Schicha, 1981, and *A. phillipsi* McMurtry & Schicha, 1987 are very similar to *A. adhatodae* (Table 1). So we could not separate these species in the diagnostic key from *A. adhatodae*. Further research is required to confirm if these species are either distinct species or junior synonyms of *A. adhatodae*.

Species group *obtusus* Chant, 1959

Species subgroup *obtusus* Chant & McMurtry, 2004

Amblyseius isuki Chant & Hansell (Figures 7–9)

Amblyseius isuki Chant & Hansell, 1971:714.

Amblyseius bajulus Chaudhri, Akbar & Rasool, 1979: 70. (Synonymy by Denmark and Muma 1989: 7)

Material Examined

Three females, grasses (Poaceae), Hadoot, Muzaffarabad (34.327106° N, 73.473219° E), 16 July 2023, three females, grasses, Kiran, Neelam Valley, A. J. Kashmir (34.6318277° N, 73.9191069° E), 18 July 2023, one female, grasses (Poaceae), Dam Gala, Mansehra, KPK (34.4062372° N, 73.3375557° E), 20 July 2023, coll. M. Kamran.

Previous record and distribution

British Columbia, Canada (Chant and Hansell 1971); Kalam, Abotabad, Pakistan (Chaudhri *et al.* 1979).

Complementary description of female (n = 7)

Dorsum — (Figure 7A). Dorsal shield smooth, 400–410 long and 270–277 wide at the level of *s4*; with eight pairs of solenostomes (*gd1*, *gd2*, *gd3*, *gd4*, *gd5*, *gd6*, *gd8*, *gd9*). Setae length: *j1* 18–21, *j3* 29–35, *j4* 4, *j5* 4–5, *j6* 4–5, *J2* 6–7, *J5* 7–8, *z2* = *z4* 4–5, *z5* 4–5, *Z1* 6–7, *Z4* 136–142, *Z5* 260–269, *s4* 82–89, *S2* 14–15, *S4* 9–10, *S5* 9–10, *r3* 11–12, *R1* 9–10. All setae smooth, except for *Z4* and *Z5*, finely serrated near tips. Peritreme extending to the level of *j1*.

Venter — (Figure 7B). Sternal shield smooth, slightly concave slightly, with three pairs of setae (*st1-st3*) and two pairs of poroids (*iv1*, *iv2*); distance *st1-st3* 62–66, *st2-st2* 68–73, *st4* and poroid *iv3* tylochorous; genital shield smooth, distance *st5-st5* 69–75; a transversely elongate platelet between genital and ventrianal shields. Ventrianal shield almost pentagonal in shape, wider anteriorly at the level of *JVI*, with transverse striated pattern, 108–115 long, 103–109

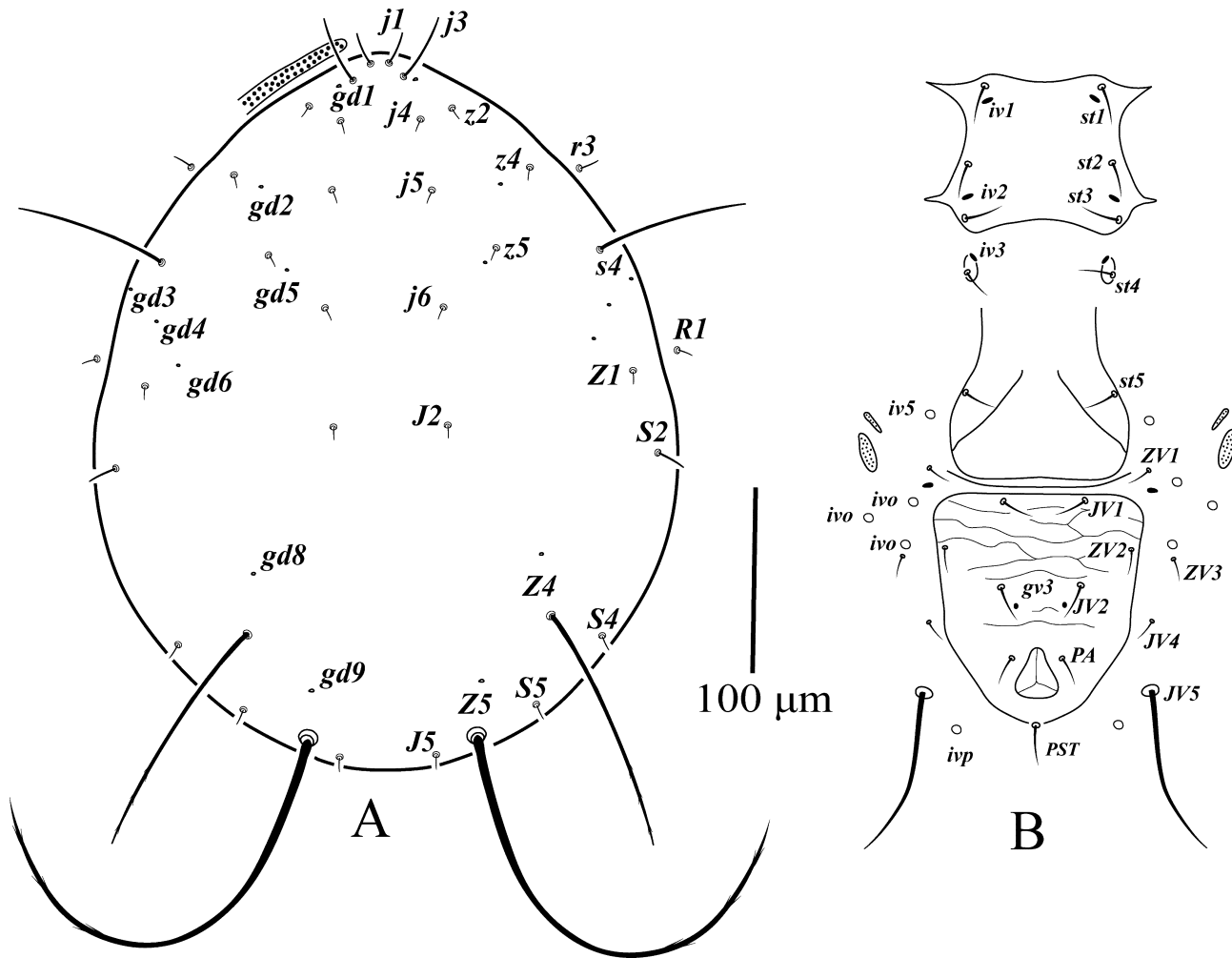


Figure 7 *Amblyseius isuki* Chant & Hansell: Female, A – Dorsum; B – Venter.

wide at anterior corners, and 73 wide at anus level; with three pairs of pre-anal setae (*JV1*, *JV2*, and *ZV2*) along with para-anal and post-anal setae, a pair of solenostomes (*gv3*), round shape, posteriomesad *JV2*; four pairs of setae (*JV4*, *JV5*, *ZV1*, and *ZV3*), four pairs of poroids (*ivo* and *ivp*), and two pairs of metapodal platelets on the membrane surrounding ventrianal shield, primary metapodal platelet 20–22, secondary 12–13 long. Setae *JV5* 75–80 smooth.

Chelicerae — (Figure 8A). Movable cheliceral digit 28–32 long, with three teeth; fixed digit 30–35 long, with nine teeth and a *pilus dentilis*.

Spermatheca — (Figures 9A, B). Calyx dish-shaped, 13–14 wide, with a divided granulated stalk, 9 long; atrium distinct, not adjacent to the calyx; minor duct visible (Figures 9A, B).

Legs — (Figure 8B). Genua II–IV each with seven setae, macrosetae on genu I 35–38, genu II 39–42, genu III 60–63, and tibia III 44–47; tibia IV with six setae; leg IV with three macrosetae: *SgeIV* 98–107, *StiIV* 84–89, *StIV* 61–66. All macrosetae smooth with pointed tip.

Remarks

Amblyseius bajulus, a species described from Pakistan considered as a junior synonym of *A. obtusus* based on the original descriptions and illustrations without observing its type specimens by Denmark and Muma (1989). While, Chant and McMurtry (2004) considered *A. bajulus* as uncertain species because of the brief description of spermatheca. The type

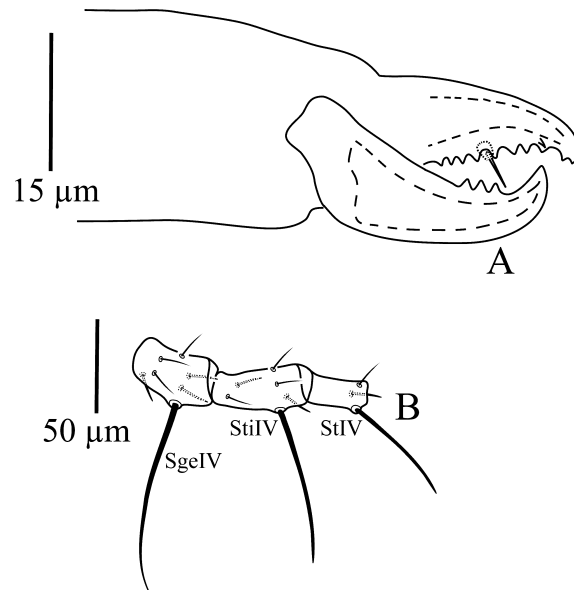


Figure 8 *Amblyseius isuki* Chant & Hansell: Female, A – Chelicera; B – Leg IV, genu, tibia, and basitarsus.

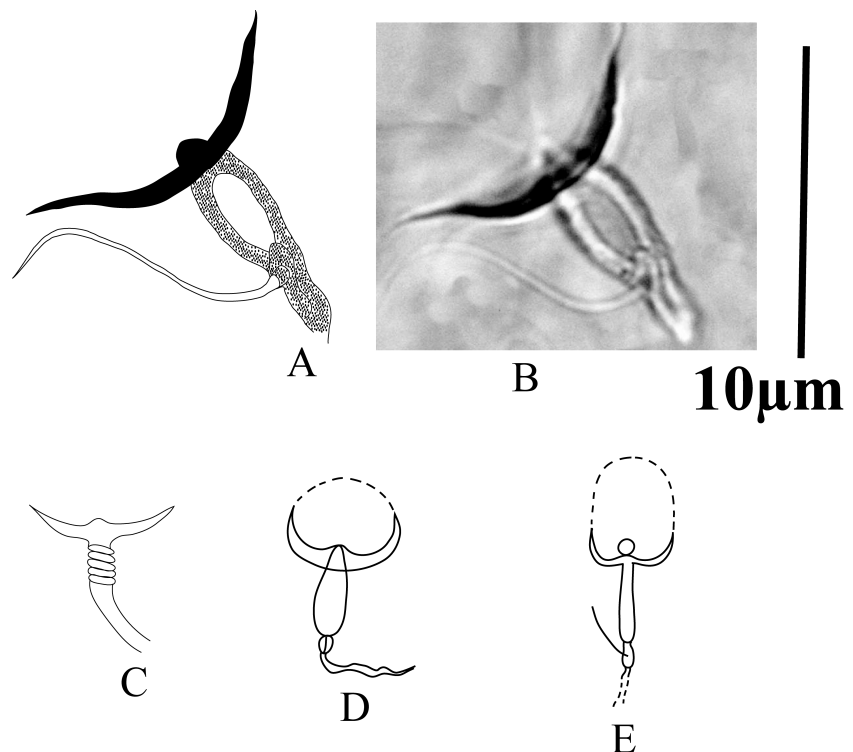


Figure 9 Different spermataecae: A – *Amblyseius isuki* Chant & Hansell, B – Photograph of *Amblyseius isuki* Chant & Hansell (current study); C – *Amblyseius bajulus* from Chaudhri *et al.* 1979; D – *Amblyseius isuki* from Chant and Hansell 1971; E – *Amblyseius obtusus* (Koch) from Denmark and Muma 1989.

specimens of *A. bajulus* were deposited at Acarology Laboratory, University of Agriculture, Faisalabad (AL, UAF). The senior author of the current study contacted AL, UAF and was informed that type specimens of *A. bajulus* had been lost. The senior author collected a few mite specimens of genus *Amblyseius* from the northern Pakistan near type locality of *A. bajulus*. The morphological characteristics (shape of spermatheca, length and shape of dorsal setae and chelicerae, and chaetotaxy of body and legs) of *Amblyseius* specimens collected in the present study are very similar to the original descriptions of both *A. bajulus* and *A. isuki*. Based on description and illustrations, we found that spermatheca of *A. bajulus* is similar to that of *A. isuki* where the spermathecal calyx stalk shorter than its width distally in both species (Figures 9C, D), as opposed to *A. obtusus*, which has a longer stalk of spermathecal calyx than its width distally (Figure 9E). As a result, *A. bajulus* would be considered as junior synonym of *A. isuki*, rather than *A. obtusus*.

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ORCID

Muhammad Kamran  <https://orcid.org/0000-0001-6084-203X>

Fahad Jaber Alatawi  <https://orcid.org/0000-0002-6824-2650>

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