Improphantes parallelus sp. nov., a new linyphiid species close to *Improphantes geniculatus* from Bulgaria (Araneae: Linyphiidae)

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Abstract. A new species of *Improphantes* Saaristo & Tanasevitch, 1996, *Improphantes parallelus* **sp. nov.**, is described from an open, xerothermic slope located in a low mountain summit area in Western Bulgaria, close to the Serbian border. Illustrations are provided and its morphological separation from its closest related species *Improphantes geniculatus* (Kulczyński, 1898) is defined.

Keywords: grassland, new species, spider

Zusammenfassung. *Improphantes parallelus* sp. nov., eine neue Art der Baldachinspinnen mit Ähnlichkeit zu *Improphantes geniculatus* aus Bulgarien (Araneae: Linyphiidae). Es wird eine neue *Improphantes*-Art Saaristo & Tanasevitch, 1996, *Improphantes parallelus* **sp. nov.** von einem offenen, xerothermen Hang eines niedrigen Gebirges in Westbulgarien nahe der serbischen Grenze beschrieben. Die Art wird illustriert und von der nächstähnlichen Art *Improphantes geniculatus* (Kulczyński, 1898) morphologisch abgegrenzt.

Резюме. *Improphantes parallelus* sp. nov., нов вид паяк от сем. Linyphiidae от България, сходен с *Improphantes geniculatus* (Araneae: Linyphiidae). *Improphantes parallelus* **sp. nov.**, нов вид от род *Improphantes* Saaristo & Tanasevitch, 1996, е описан от открит, ксеротермен хабитат около нископланинско било в Западна България, близо до границата със Сърбия. Представени са илюстрации и морфологичните му разлики с много подобния вид *Improphantes geniculatus* (Kulczyński, 1898) са дефинирани.

The genus *Improphantes* Saaristo & Tanasevitch, 1996 currently contains 20 described species (World Spider Catalog 2024), of which two have been reported from Bulgaria (Deltshev & Blagoev 2001). It was separated based on characters of the male embolus by Saaristo & Tanasevitch (1996) from the genus *Lepthyphantes* in the broad sense. The species closest to the type species *Improphantes improbulus* (Simon, 1929) feature a more or less elongated and pointed lamella characteristica and a strongly protruding epigyne (Heimer & Nentwig 1991, key from Nentwig et al. 2024). One of these species, *Improphantes geniculatus* (Kulczyński, 1898), features a dentate terminal apophysis, a prolaterally situated rectangular cymbial outgrowth and a paracymbium with a powerful and blunt tooth at the base of the distal branch, from which a slender and pointed "secondary tooth" emerges (von Broen 1965). This species is found in steppe and other dry grassland habitats in Central Europe eastwards to the Urals (Miller & Valešová 1964, von Broen 1965, Esyunin & Efimik 1999, Rozwałka & Łysiak 2011) and its distribution does not include Bulgaria according to the current data (Deltshev & Blagoev 2001). For this reason it was probable that a very similar, possibly vicariant, and morphologically distinct undescribed species might be found in similar habitats in Western Bulgaria – this is described herein.

Materials and methods

The spiders were collected by hand under stones and preserved in 75% ethanol. Epigyne and palp were separated using syringe needles and the epigyne was cleared at room temperature in lactic acid. The material was examined under a Bresser Advance ICD stereomicroscope and a Levenhuk 50L Plus monocular microscope. Photographs of genitalia were taken using a Samsung Galaxy A54 attached to the monocular microscope's eyepiece and stacked using Picolay (Cypionka 2024). Photographs of the habitus were taken through the eyepiece of the Bresser stereomicroscope. The holotype, one male paratype and two female paratypes will be deposited at the National Museum of Natural History Sofia. The remaining paratypes will be deposited in the author's collection until they are also transferred to other institutional collections in the future.

The terminology of male copulatory organs mainly follows that of Saaristo & Tanasevitch (1996).

Abbreviations. Legs: Fe, femur; Pt, patella; Ti, tibia; Mt, metatarsus; Ta, tarsus. Genital morphology: BPS, basal part of scapus; CPO, cymbial posterodorsal outgrowth; DPS, distal part of scapus; E, embolus; EP, embolus proper; LC, lamella characteristica; LW lateral wall of epigyne; MP, median plate; MPS, middle part of scapus; R, radix; SA, suprategular apophysis; Str, stretcher; TA, terminal apophysis.

Results

Linyphiidae Blackwall, 1859
Improphantes Saaristo & Tanasevitch, 1996
Improphantes parallelus sp. nov. (Figs 1-4)

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Material examined. BULGARIA: Holotype: male ♂, West Stara planina, Chepan Mountain, Chepan ecoalley below Petrovski Krast Peak (42.94811°N, 22.95246°E), dry grassland, under stone, 13. Nov. 2023; Paratypes, 3 ♂♂, 3 ♀♀, same data as holotype; 1 ♀, same location, 26. Mar. 2022; 1 ♂, 2 ♀♀, same location, 14. Mar. 2023.

Etymology. The name *parallelus* refers to the nearly parallel lamella characteristica and terminal apophysis in the male palp that are also equally long.

Diagnosis. The species is very closely related to *Improphantes geniculatus* (Kulczyński, 1898), with the two likely having a sister-species relationship. The two species are virtually identical in most elements of the copulatory organs, having the same male palpal patella, prolateral cymbial outgrowth,

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paracymbium, suprategular apophysis, and also external female genitalia. The only established differences are in the shape of the lamella characteristica and the terminal apophysis in the male palp, with *Improphantes geniculatus* having a short sigmoid lamella characteristica and a short and thick terminal apophysis with multiple fine denticles at the tip (fig. 4 in von Broen, 1965), and *Improphantes parallelus* **sp. nov.** having a long and straight lamella characteristica reaching the edge of the bulbus (Figs 1a-c, Fig. 2a), and an equally long and two to three times narrower terminal apophysis with few teeth at the very tip (Figs 1a-b, 2a). The embolus is also shorter in *Improphantes parallelus* **sp. nov.**, not reaching the upper edge of the tegulum (Fig. 1a-c, Fig. 2a-c). In the female, the few established differences are in the shape of the median plate which is medially incised in *Improphantes parallelus* **sp. nov.**, while it is straight in *Improphantes geniculatus* (Figs 1e, 3d vs. fig. 6 in von Broen, 1966). Also, the spermathecae seem to be longer in *Improphantes parallelus* **sp. nov.**, with their apex reaching the connection of the copulatory ducts after the turn [U-shaped vs. J-shaped in *Improphantes geniculatus*, Figs 1e-f, 3c-d vs. fig. 7a in von Broen (1966) and fig. 14 in Esyunin & Efimik (1999)]. The length of the epigyne from the epigastral fold to the base of the scapus is also higher in *Improphantes parallelus* **sp. nov.**, being twice the length of the basal part of the scapus, versus about as long as the basal part of the scapus in *Improphantes geniculatus* [Figs 1e-f, 3c-d vs. fig. 4a in von Broen (1966) and fig. 13 in Esyunin & Efimik (1999)].

Description

Both sexes

Habitus. Carapace and legs brown, legs with faint darkening at the joints. Opisthosoma monochromatic black to dark grey (Fig. 4). No noticeable sexual dimorphism observed other than somewhat longer legs in the male (Fig. 4a).

Leg spines. Fe I: 1 prolateral; Fe II–IV spineless. Pt I–IV: 1 dorsal. Ti I: 2 dorsal, 1 prolateral, 1 retrolateral. Ti II: 2 dorsal, 1 retrolateral. Ti III–IV: 2 dorsal. Mt I–IV: 1 dorsal.

Male

Measurements. (in mm, N = 4): Total length 2.27–2.88. Carapace length 0.96–1.12. Leg measurements (holotype male with carapace length 1.1): Fe I 1.3; Pt I 0.35; Ti I 1.3; Mt I 1.17; Ta I 0.85. Fe II 1.26; Pt II 0.32; Ti I 1.17; Mt I 1.1; Ta I 0.77. Fe III 1.0; Pt III 0.27; Ti III 0.9; Mt III 0.9; Ta III 0. 7. Fe IV 1.2; Pt IV 0.3; Ti IV 1.27; Mt IV 1.2; Ta IV 0.77.

Pedipalp. Femur unmodified. Patella short, with a small conical protrusion bearing a tapering macroseta (Fig. 1a, 2a-b). Tibia bell-shaped (Figs 1a, 2a-b). Cymbium with a postero-dorsal, somewhat prolateral rectangular outgrowth (Figs 1a,

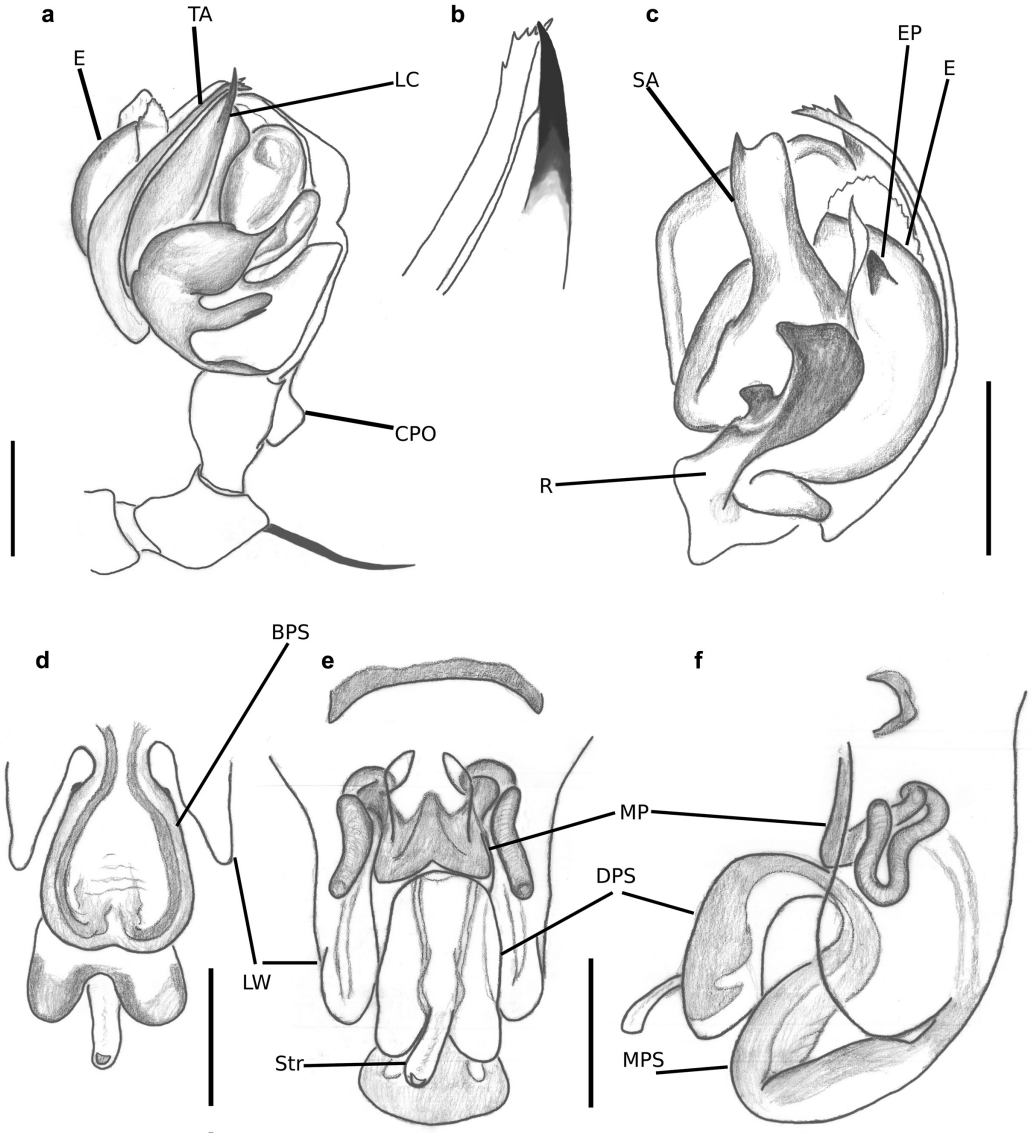

Fig. 1: *Improphantes parallelus* **sp. nov.**, copulatory organs, drawings. **a.** male palp, retrolateral view (holotype); **b.** tip of lamella characteristica and terminal apophysis, close-up; **c.** male bulbus, prolateral view, embolus in normal position (paratype); **d.** epigyne, cleared, ventral view, showing basal part of scapus; **e.** epigyne and vulva, dorsal view; **f.** ditto, lateral view (right side). Scale bar 0.2 mm throughout, e and f to same scale

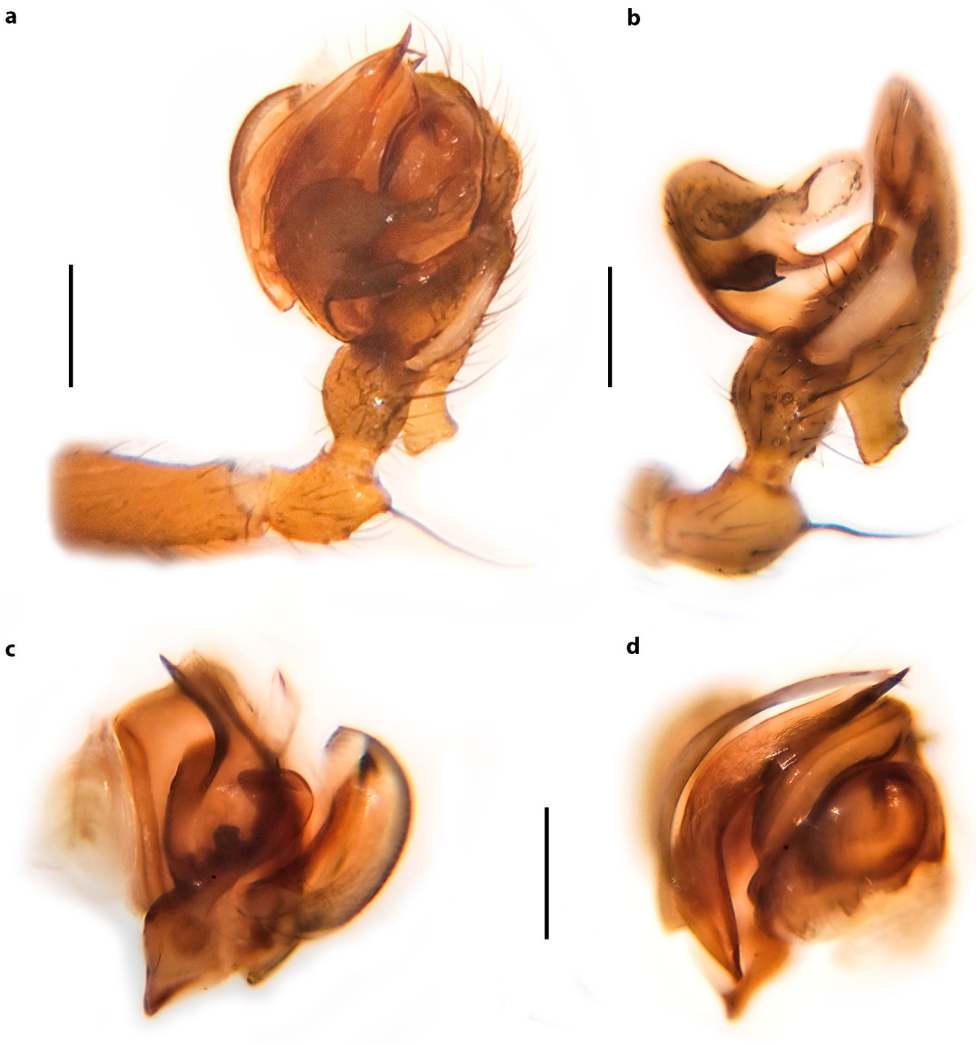

Fig. 2: *Improphantes parallelus* **sp. nov.**, male pedipalp. **a.** intact pedipalp, retrolateral view (holotype); **b.** cymbium and paracymbium, retrolateral view (paratype); **c.** detached bulbus, prolateral view, embolus somewhat extended (paratype); **d.** ditto, retrolateral view. Scale bars 0.2 mm

2a-b). Paracymbium conspicuous, with a thick double tooth at the base of the distal branch (Fig. 2b). Distal branch of paracymbium ending with a broad, subcircular tip, exhibiting some variability in the sclerotization of the distal margin (Fig. 2b). Lamella characteristica straight, its broadest part mid -length, with a heavily sclerotized and tapering tip; the convex and somewhat translucent prolateral edge of the lamella characteristica ends at some distance before the tip (Figs 1a-b, 2a, d). Terminal apophysis unusually long and thin, as long as the lamella characteristica, crossing behind the lamella characteristica, with 4–5 somewhat variable denticles at the tip. One of the denticles is often situated somewhat lower than the rest, on the prolateral edge (Figs 1a-b, 2a, d). Suprategular apophysis broad, weakly bifid, with one rounded membranous tip and one pointed, sclerotized pit hook (Fig. 2c). Radix identical with that of *Improphantes geniculatus*. Embolus nearly identical to that of *Improphantes geniculatus* but shorter, with a prolaterally situated, sclerotized, short and thick embolus proper which is situated subapically, a serrate ventral side and a dorsally situated thumb (cf. Saaristo & Tanasevitch 1996) which is hard to see unless one mechanically stretches the embolic division.

Female

Measurements. (in mm, N = 3): Total length 2.27–2.54. Carapace length 0.96–1.00. Leg measurements (paratype female with carapace length 0.97): Fe I 1.09; Pt I 0.31; Ti I 1.09; Mt I 1.0; Ta I 0.78. Fe II 1.02; Pt II 0.29; Ti I 0.96; Mt I 0.92; Ta I 0.72. Fe III 0.91; Pt III 0.2; Ti III 0.72; Mt III 0.83; Ta III 0. 58. Fe IV 1.03; Pt IV 0.24; Ti IV 1.08; Mt IV 1.0; Ta IV 0.67.

Epigyne. Heavily protruding. Scapus sigmoid, all its parts, basal middle and distal, well-developed (Fig. 3). Basal part of scapus nearly trapezoidal, somewhat rounded distally (Fig. 3a-b). Lateral walls rounded in lateral view (Figs 1f, 3c). Median plate medially incised, with a second sclerotized bar situated in front of it (Figs 1e, 3d). Stretcher relatively short, slender. Spermathecae elongated, U-shaped (Fig. 3c)

Natural history. The new species has so far been only observed near the highest part of Chepan Mountain Ridge, West Stara Planina (1206 m at its highest part), in dry grassland on limestone (Fig. 5), and has been collected under stones. The specimens were collected in November and March, suggesting activity of the adults from late autumn till early spring. The same observations were made by Rozwałka & Łysiak (2011) for *Improphantes geniculatus*.

Discussion

The new species is a potentially vicariant sibling species of *Improphantes geniculatus* and thus another member of the genus close to *Improphantes improbulus*. As the genus *Improphantes* was described based on one relatively conservative element of the male morphology and Saaristo & Tanasevitch (1996) could not find any morphological synapomorphy for

Fig. 3: *Improphantes parallelus* **sp. nov.**, epigyne and vulva. **a.** epigyne, ventral view; **b.** ditto, macerated, different specimen; **c.** ditto, lateral view (right side); **d.** ditto, dorsal view. Scale bar for each row 0.2 mm

Fig. 4: *Improphantes parallelus* **sp. nov.**, habitus. **a.** male; **b.** female. Scale bar 1 mm

the females, it is possible the genus might require further revisions according to these authors. In any case, the new species will likely remain in core *Improphantes* as long as the genus remains valid. However, an integrative revision of the currently known species of this genus is beyond the scope of this paper. Another important aspect of this new finding is the limited known area of distribution and the special habitat where the new species was found. While open xerothermic habitats, possibly secondary in nature after historical felling of the forests once present there (Boev 2022), are widespread on the northern side of the Sofia Basin, the species has not been found in any of them yet, neither north of the village of Balsha nor on the mountain of Tri Ushi, for example (pers. obs.). Even on Chepan Mountain, the species has not been found in the lower parts. The higher parts of the mountain are open, with nearly no trees and bushes, with grasses and other herbaceous vegetation growing on limestone. It is possible that a combination of climatic, vegetational and soil factors limit the

Fig. 5: Photo of the summit area of Chepan Mountain, view towards Petrovski Krast Peak, on 13. Nov. 2023

available habitat for the species. Given that its likely sister-species *Improphantes geniculatus* is distributed in more northern areas, it is possible that *Improphantes parallelus* **sp. nov.** originates from southern relict populations of a common ancestor preferring more temperate conditions, which are now limited to certain mountainous areas in Bulgaria. While its occurrence in other parts of Bulgaria, in neighboring Serbia and perhaps North Macedonia and Romania is highly likely, provided there are similar open, dry habitats, it is possible that the populations are fragmented. Further research, both in the Sofia Basin and in other areas of the Balkans, is necessary in order to map its complete distribution and habitat preferences.

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