Filling a gap: First record of the pseudoscorpion *Lamprochernes abditus* (Pseudoscorpiones: Chernetidae) in Slovakia

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Abstract. The cryptic pseudoscorpion species, *Lamprochernes abditus* Christophoryová, Krajčovičová, Šťáhlavský, Španiel & Opatova, 2023, previously confirmed in neighbouring countries, is reported from Slovakia for the first time. Specimens from two localities were analysed and identified based on morphology and their COI sequences. Additionally, the specimens are morphologically described herein and compared with the original description of the species. These findings expand the current knowledge of both, the species' distribution and the pseudoscorpion fauna of Slovakia.

Keywords: Central Europe, chernetid, distribution, diversity, DNA barcoding

Zusammenfassung. Eine Lücke füllen: Erster Nachweis des Pseudoskorpions *Lamprochernes abditus* (Pseudoscorpiones: Chernetidae) in der Slowakei. Die kryptische Pseudoskorpionart *Lamprochernes abditus* Christophoryová, Krajčovičová, Šťáhlavský, Španiel & Opatova, 2023, bekannt aus benachbarten Ländern, wird erstmals aus der Slowakei gemeldet. Exemplare von zwei Fundorten wurden anhand ihrer Morphologie und ihrer COI-Sequenzen identifiziert. Die Exemplare werden zudem in dieser Arbeit morphologisch beschrieben und mit der ursprünglichen Artbeschreibung verglichen. Diese Erkenntnisse erweitern das aktuelle Wissen über die Verbreitung der Art und der Pseudoskorpionfauna der Slowakei.

The genus *Lamprochernes* Tömösváry, 1882 belongs to the cosmopolitan family Chernetidae and the subfamily Lamprochernetinae. Beier (1932) defined Lamprochernetinae by the presence of long, acuminate vestitural setae, long pseudotactile setae on the pedipalpal femur, patella, and chelal hand, and a basally positioned tactile seta on pedal tarsus IV. Later, Harvey (1995) noted that an important feature supporting the monophyly of Lamprochernetinae is the presence of a T-shaped spermatheca. This characteristic is shared by several genera, including *Allochernes* Beier, 1932; *Lamprochernes*; *Lasiochernes* Beier, 1932; *Megachernes* Beier, 1932; *Nudochernes* Beier, 1935; *Pselaphochernes* Beier, 1932; and *Wyochernes* Hoff, 1949 (Harvey 1995). However, *Wyochernes* was later reassigned to Chernetinae due to the absence of a T-shaped spermatheca (Harvey et al. 2012). The spermathecae of *Chiridiochernes* Muchmore, 1972, and *Verrucachernes* Chamberlin, 1947 consist of a single long central tube ending in a large bulb, making them similar to Lamprochernetinae, except for the absence of terminal tubes (Harvey 1995).

Hlebec et al. (2024) used molecular sequence data to demonstrate that Lamprochernetinae includes taxa with a single median spermathecal duct that may end in either a single circular bulb or lead to a pair of long lateral ducts; thus forming a T-shaped system with varying lengths of the lateral arms. Based on these findings, Harvey (2025) examined specimens from the genera *Cacoxylus* Beier, 1965; *Hebridochernes* Beier, 1940; and *Reischekia* Beier, 1948 and concluded that their affinities lie with the Lamprochernetinae rather than with Chernetinae, where they had traditionally been placed. Current evidence supports the view that Lamprochernetinae is a monophyletic group comprising at least 11 genera (Hlebec et al. 2024, Harvey 2025).

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Although the genus *Lamprochernes* is morphologically well defined (Beier 1963), species delimitation remains challenging due to morphological similarities and incomplete descriptions. The genus comprises 10 known species, five of which occur in Europe (WPC 2025). Phoretic dispersal on mobile hosts and anthropogenic spread have facilitated the broad distribution of some species beyond Europe (WPC 2025). *Lamprochernes* species are commonly found in decaying organic matter such as compost or manure, under tree bark, and in bird nests (Beier 1963, Christophoryová et al. 2023).

Christophoryová et al. (2023) applied an integrative approach combining molecular, cytogenetic, and morphological analyses to assess species boundaries among *Lamprochernes chyzeri* (Tömösváry, 1882), *L. nodosus* (Schrank, 1803) and *L. savignyi* (Simon, 1881). Their analysis led to the discovery of a new cryptic species, *Lamprochernes abditus* Christophoryová, Krajčovičová, Šťáhlavský, Španiel & Opatova, 2023, distinguishable only through molecular and cytogenetic differences, or multivariate morphometric analysis including other species. *Lamprochernes abditus* was molecularly confirmed from several European countries, particularly under tree bark.

In Slovakia, *L. chyzeri* and *L. nodosus* have been previously recorded (Červená et al. 2020). In the present study, we targeted chernetid populations under tree bark to investigate the possible presence of *L. abditus* in Slovakia. Our results confirm two new localities for the species. The specimens were analysed using morphological and molecular methods and compared with existing data (Christophoryová et al. 2023).

Abbreviations. Trichobothria of movable chelal finger: *b* – basal, *sb* – subbasal, *st* – subterminal, *t* – terminal; trichobothria of fixed chelal finger: *eb* – exterior basal, *esb* – exterior subbasal, *est* – exterior subterminal, *et* – exterior terminal, *ib* – interior basal, *isb* – interior subbasal, *ist* – interior subterminal, *it* – interior terminal.

Material and methods

Individuals of *L. abditus* were collected individually under tree bark in Bratislava (locality 1) and Malacky (locality 2), SLOVAKIA (Figs 1, 2). Specimens were preserved in 96%

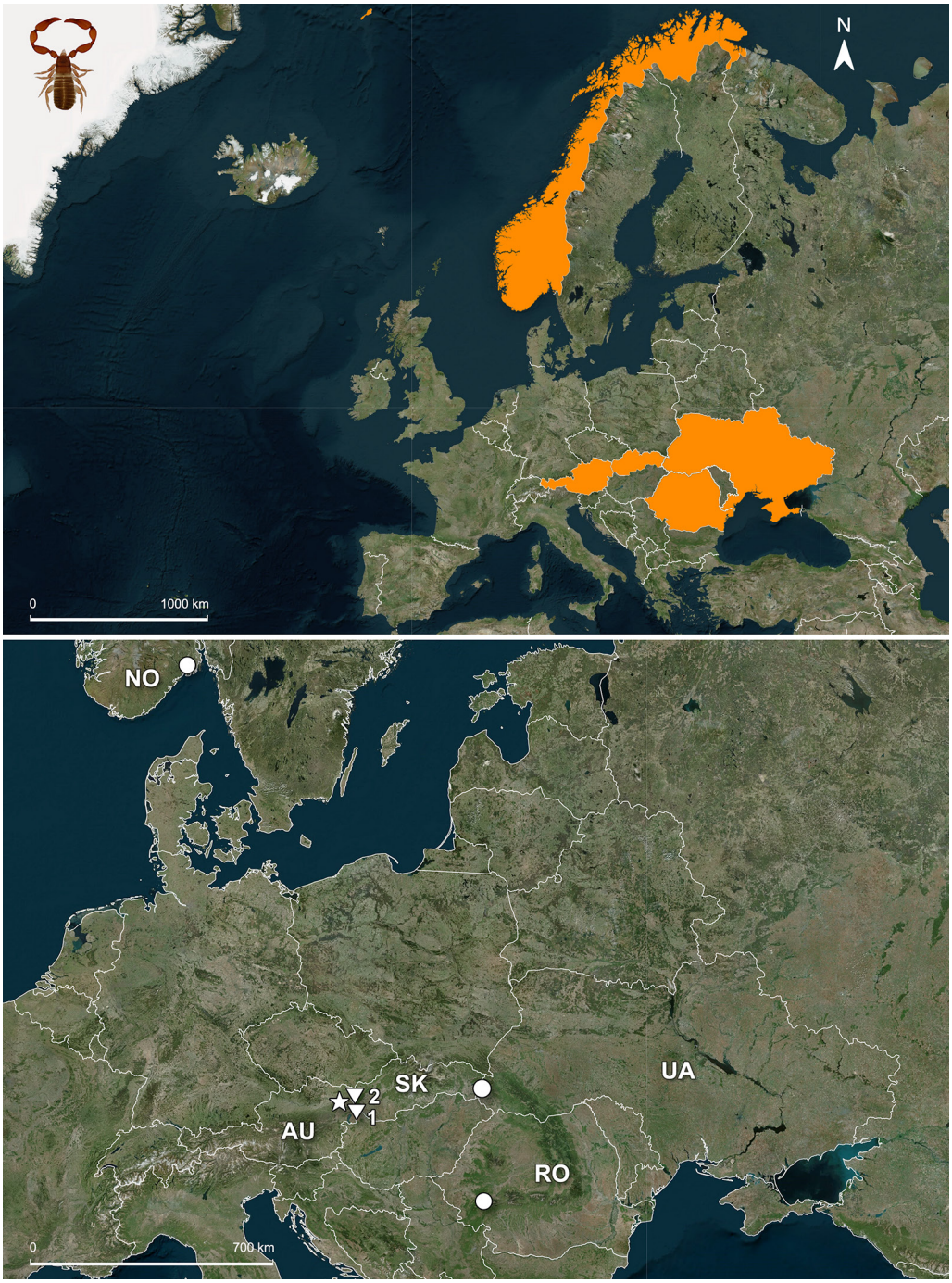

Fig. 1: Distribution of *Lamprochernes abditus*. White triangles indicate newly recorded locations in Slovakia (1 – Bratislava, Rusovce; 2 – Malacky). White circles represent previous known records, and white asterisk marks the localities of the type material (Christophoryová et al. 2023). Country abbreviations: AU – Austria, NO – Norway, RO – Romania, SK – Slovakia, UA – Ukraine

ethanol. Following molecular analyses, they were cleared in lactic acid and examined on temporary slide mounts. After examination, specimens were rinsed in water and returned to ethanol.

All specimens were studied using a Leica DM1000 compound microscope with an ICC50 camera module (LAS EZ v. 3.4.0). Measurements were obtained from digital images using AxioVision 40LE (v. 4.6.3.0). Whole-specimen images were taken with a Canon EOS 5D Mark II camera mounted on a Zeiss Axio Zoom V16 stereomicroscope and pedipalp was taken with a Zeiss Axio Imager.M2 microscope, with Zeiss Axiocam 208 attached. Image stacks were created manually and merged using Zerene Stacker software (v. 1.4). Spatial data used in the map were converted from original coordinates and visualized in QGIS (v. 3.36.2). The figures were edited in Adobe Photoshop CC (v. 25.6.0).

DNA was isolated using the prepGEM Universal isolation kit (MicroGEM). The barcoding region of the mitochondrial gene cytochrome c oxidase subunit 1 (COI) was amplified using primers LCO1490 and HCO2198 (Folmer et al. 1994). PCR parameters followed the protocol described by Kúdelová et al. (2023). PCR products were sequenced by Macrogen Europe (Amsterdam, the Netherlands). The obtained sequence reads were aligned and edited using Geneious R6 (v. 6.1.8) (Kearse et al. 2012). The acquired sequences have been deposited in GenBank (Sayers et al. 2020) under accession numbers PV618338, PV620817, and PV618409.

For phylogenetic analyses, the sequences were incorporated into the alignment from Christophoryová et al. (2023, supplementary material). A sequence of *Chernes hahnii* (C.L. Koch, 1839) (GenBank accession number MW996369, Muster et al. 2021) was used as an outgroup. Maximum Likelihood analysis

was conducted using the IQ-TREE tool (Trifinopoulos et al. 2016) with automatic model selection and parameter settings, and 1000 bootstrap replicates. Bayesian Inference analysis was performed in MrBayes 3.2.7a (Ronquist et al. 2012), using sampling across substitution models and running for 14 million generations. Phylogenetic trees were visualized and edited using FigTree (v. 1.4.4). A haplotype network was constructed using the TCS algorithm (Clement et al. 2002) in the software PopART – Population Analysis with Reticulate Trees software (Leigh & Bryant 2015). The dataset included newly collected Slovak samples, sequences of *L. abditus* from Christophoryová et al. (2023), and two Norwegian specimens (ARTRD430-16 and ARTRD431-16) obtained from the BOLD database – The Barcode of Life Data System (Ratnasingham & Hebert 2007).

The specimens are deposited in the zoological collection of the Department of Zoology, Comenius University in Bratislava.

Results

Chernetidae Menge, 1855
Lamprochernetinae Beier, 1932
Lamprochernes Tömösváry, 1882

Lamprochernes abditus Christophoryová, Krajčovičová, Šťáhlavský, Španiel and Opatova, 2023
Material examined. SLOVAKIA, Bratislava, Rusovce, Sysľovské polia (48.02750 N, 17.10184 E; 132 m a.s.l.), woodland strip; collected individually under the bark of *Ailanthus altissima* (Mill.), 16. Mar. 2025, 2 ♂♂, leg. Daniel Gruľa (PK 38/6 – PV618338, PK 39/6 –PV620817).
SLOVAKIA, Malacky, Zámocký Park (48.43987 N, 17.02728 E; 171 m a.s.l.), park surrounding manor house, collected individually under the bark of fallen *Tilia* L., 2. Apr. 2025, 1 ♂, leg. Lucia Vičanová (PK 37/6 – PV618409).
Distribution. Austria, Norway, Romania, Ukraine (Christophoryová et al. 2023) and Slovakia (present study) (Fig. 1).
Description. Body and pedipalpal setae long, pointed, and finely toothed. Pleural membrane longitudinally striate. **Carapace** (Fig. 3a): 1.22–1.28× longer than broad, almost smooth, lateral margins of carapace granulate; anterior transverse furrow distinct, posterior one indistinct; epistome absent; eyes absent; carapace with 66–68 setae, 31–34 of them on anterior disk, 20–21 on medial disk, posterior margin with 14 setae; carapace with six macrolyrifissures: two pairs situated on anterior disk and one pair located on medial disk, posterior margin with 13–15 microlyrifissures. **Chelicera**: 1.64–1.70× longer than broad, small, slightly sclerotized; hand with five setae and two lyrifissures, one seta on movable finger; movable finger with slender, well-developed branched galea with five terminal rami; serrula exterior with 17 blades; rallum of three blades; small, three largely unsclerotized teeth situated on fixed finger. **Pedipalp** (Fig. 3b): internal margins of pedipalpal trochanter, femur, tibia, and chela moderately granulate; protuberance on pedipalpal trochanter conical and pointed; femur abruptly pedicellate. Trochanter 1.62×, femur 2.29–2.42×, patella 2.21–2.33×, hand with pedicel 1.89–1.96×, chela 3.33–3.36× longer than broad. Chelal fingers with 12 trichobothria (eight on fixed and four on movable finger); fixed finger with trichobothrium *it* closer to *isb* than to tip of fixed finger, *est* slightly distal to *isb*, *esb–ib* and *ist–eb* at about same level. Movable chelal finger with trichobothrium *st* situated slightly closer to *t* than to *sb*, trichobothrium *sb* closer to *b* than to *st*. Venom apparatus developed in movable chelal finger terminating in nodus ramosus close to trichobothrium *sb*; fixed chelal finger with 29–31 and movable chelal finger with 32–34 marginal teeth; fixed chelal finger with five antiaxial and two paraxial accessory teeth and movable chelal finger with four antiaxial and one paraxial tooth. **Coxae**: pedipalpal coxa excluding manducatory process with 19–20 setae, manducatory process with three setae and one microseta; coxal chaetotaxy of legs I–IV: 16–18: 18–23: 19–24: 32–34, all setae acuminate; lyrifissures: none on pedipalpal coxa, one on each pedal coxa I–IV; each pedipalpal coxa with two maxillary lyrifissures. **Opisthosoma**: Tergites I–X divided, XI partly divided (Fig. 3a). Chaetotaxy of tergites I–XI: 17–18 (left hemitergite 9 + right hemitergite 8–9): 16–20 (9–11 + 7–9): 17 (8–9 + 8–9): 18–20 (9–10 + 9–10): 18–20 (9–10 + 9–10): 19–23 (9–11 + 10–12): 19–24 (10–12 + 9–12): 21–23 (10–12 + 11): 18–23 (9–12 + 9–11): 19–20 (10 + 9–10), tergite XI with 10 setae and with a pair of long tactile setae. Sternites IV–X divided, XI partly divided. Chaetotaxy of sternites IV–XI: 18–26 (left hemisternite 9–13 + right hemisternite 9–13): 24–31 (12–15 + 12–16): 26–32 (14–18 + 12–14): 26–33 (14–16 + 12–17): 27–32 (13–16 + 14–16): 23–31 (12–15 + 11–16): 22–25 (10–12 + 12–13), sternite XI with 10 and with a pair of long tactile setae. Spiracles: sternite III with three setae, sternite IV with four setae. Anterior genital operculum with 29–32 setae and two lyrifissures, posterior operculum with 15 setae and two lyrifissures. **Legs**: all claws of legs smooth, arolia simple and shorter than claws. Leg IV with three tactile setae: one distally on femoropatella, one distally on tibia, and one sub-proximally on tarsus (Fig. 3a). Leg I: trochanter 1.20×, femur 1.36–1.45×, patella 2.36–2.55×, tibia 3.25–3.43×, tarsus 4.40–4.60× deeper than broad. Leg IV: trochanter 1.73–1.82×, femoropatella 3.13×, tibia 3.55–3.60×, tarsus 4.00–4.17× deeper than broad.
Measurements (in mm, length/width or, for legs, length/depth). Body length: 2.28–2.37. Carapace: 0.66–0.69/0.54. Chelicera: 0.17–0.18/0.10–0.11, movable finger 0.17. Pedipalps: trochanter 0.34/0.21, femur 0.55–0.58/0.24, patella 0.53–0.56/0.24, chela 0.90–0.94/0.27–0.28, hand with pedicel 0.51–0.55/0.27–0.28, hand without pedicel 0.44–0.48, movable finger 0.44. Leg I: trochanter 0.12/0.10, femur 0.15–0.16/0.11, patella 0.26–0.28/0.11, tibia 0.24–0.26/0.07–0.08, tarsus 0.22–0.23/0.05. Leg IV: trochanter 0.19–0.20/0.11, femoropatella 0.47–0.50/0.15–0.16, tibia 0.36–0.39/0.10–0.11, tarsus 0.25–0.28/0.06–0.07.

Molecular analyses. COI fragment sequences were successfully obtained from three individuals collected in Slovakia. In the phylogenetic analyses, the Slovak sequences consistently clustered within the well-supported *L. abditus* clade (Fig. 4). Two of the sequences correspond to a haplotype previously recorded in Norway, while the third represents a novel haplotype. However, this new haplotype differs by only a single mutation step from a common haplotype known from Austria, Romania and Ukraine (Fig. 5). Based on COI data, the analysed specimens unequivocally match the known molecular characteristics of *L. abditus* and can be confidently assigned to this species.

Fig. 2: Sampling locations of *Lamprochernes abditus* in Slovakia. **a.** Bratislava, Rusovce; **b.** Malacky

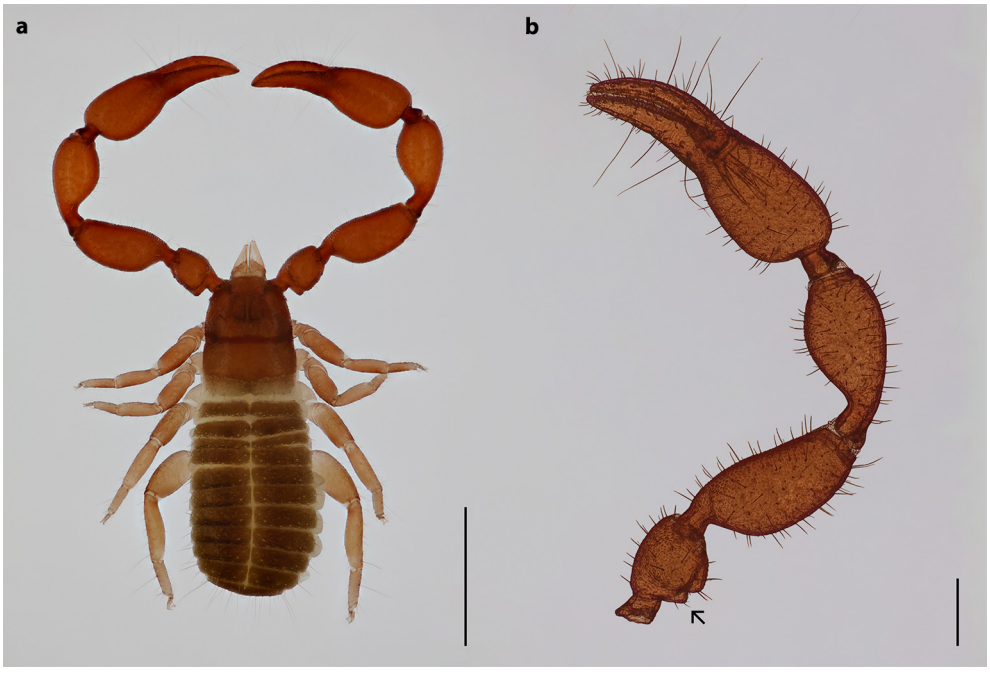

Fig. 3: *Lamprochernes abditus* (PK 38/6 – PV618338). **a.** male habitus; **b.** detail of right pedipalp, dorsal view; arrow indicates the protuberance on the palpal trochanter. Scale bars: a. 1 mm, b. 0.2 mm

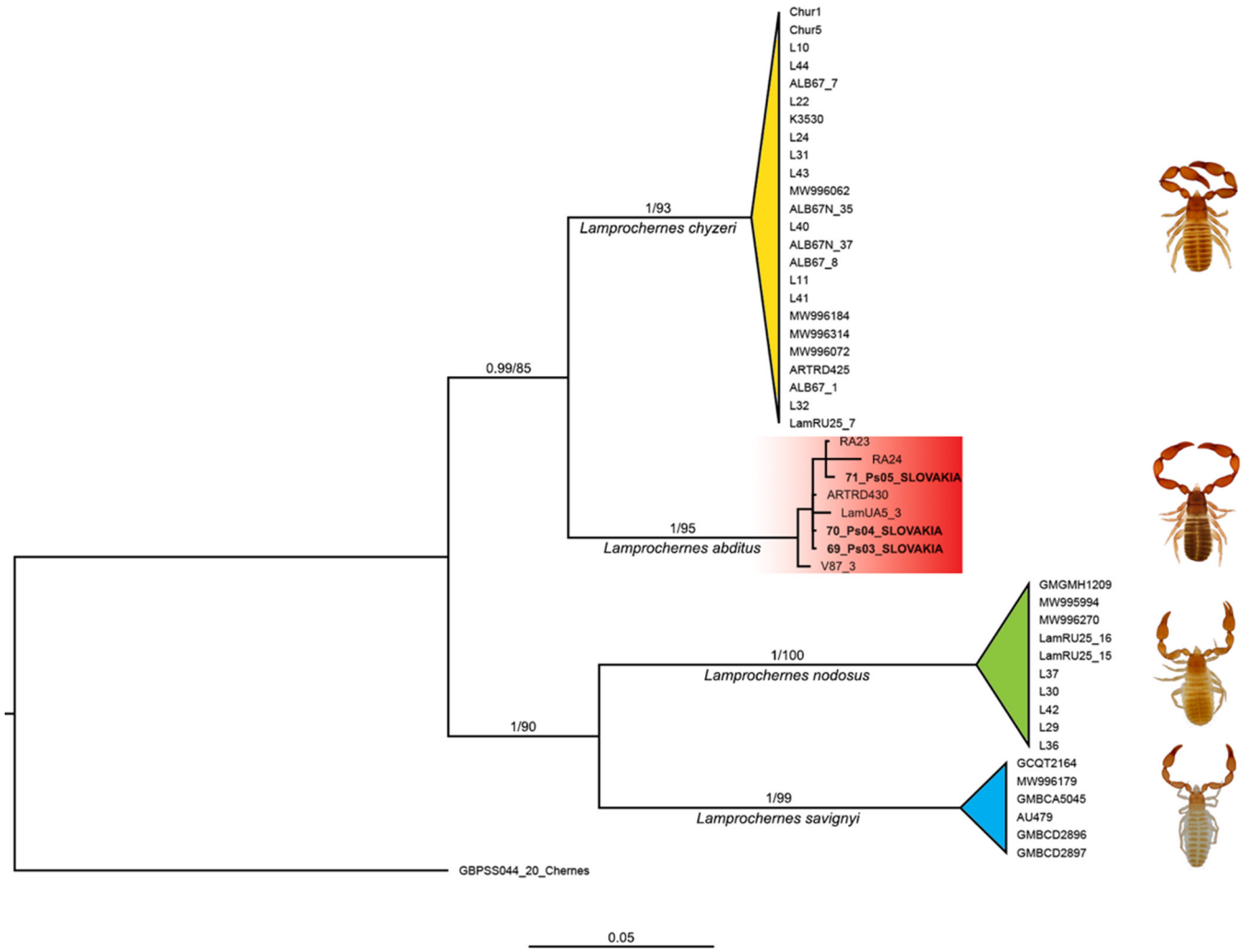

Fig. 4: Phylogenetic tree of *Lamprochernes* species. Values above branches represent Bayesian Inference posterior probability / Maximum Likelihood bootstrap support. Sequences generated in this study are shown in bold

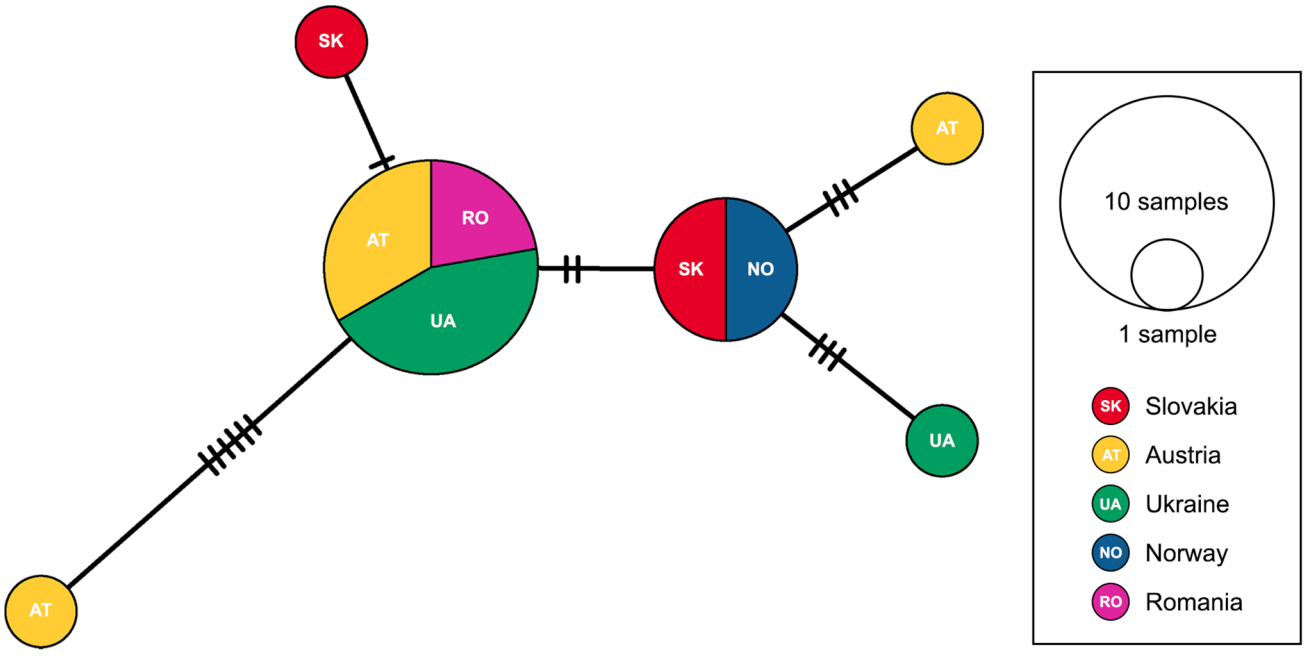

Fig. 5: TCS haplotype network of *Lamprochernes abditus*

Discussion

Lamprochernes abditus can be distinguished from *L. nodosus* by the shape of the palpal trochanter protuberance: conical and pointed in *L. abditus* vs. blunt and rounded in *L. nodosus*. Morphologically, *L. abditus* closely resembles *L. chyzeri*, as both share a conical, pointed trochanter protuberance. However, they can be differentiated by multivariate analyses of several morphologic and morphometric characters in males, such as the number of setae on the anterior and posterior disk of the carapace, the number of setae on tergite VI and sternite X, palpal trochanter width, leg I trochanter length, and leg I patella width and one in females (leg IV tarsus length) (Christophoryová et al. 2023). *Lamprochernes abditus* also differs from both species genetically by unique nucleotide substitutions in the COI DNA barcode sequence and cytogenetically by having more bi-armed than one-armed chromosomes (Christophoryová et al. 2023).

Compared to the original species description (Christophoryová et al. 2023), only minor variation was observed in the number of setae and microlyrifissures on the carapace, the number of teeth on the chelal fingers, and the number of setae on the pedipalpal and pedal coxae, tergites and sternites. All measurements fall within the range reported in the original description (Christophoryová et al. 2023).

Lamprochernes abditus is dendrophilous, living under the bark of various trees, including fallen ones. It does not appear to prefer a specific biotope, having been found at a forest edge, a meadow near the river, a woodland strip, a roadside, and even in a park surrounding a manor house (Christophoryová et al. 2023, present study). In contrast to *L. chyzeri* and *L. nodosus*, it has not yet been found in compost heaps or in phoretic associations.

Although current knowledge of the genetic diversity of *L. abditus* remains limited, available data suggest minimal genetic variation across its range. This pattern may indicate phoretic dispersal (Opatova & Šťáhlavský 2018). Given the species' morphological adaptations and the documented phoresy of its relatives (Christophoryová et al. 2023), it is plausible that phoretic behaviour in *L. abditus* will be confirmed in future studies. Furthermore, it cannot be excluded that some historical records of phoresy attributed to *L. chyzeri* may have involved misidentified specimens of *L. abditus*.

The presence of *L. abditus* in Slovakia was anticipated, given previous records from nearby regions in eastern Austria and western Ukraine (Christophoryová et al. 2023). Based on the currently known distribution, it is likely that the species is more widely spread across Central Europe and may be reported from additional countries in the future, such as Poland or Hungary. Comprehensive research will be essential to fully understand the distribution and biology of this still enigmatic pseudoscorpion.

The most recent version of the checklist of Central European pseudoscorpions included 57 species across 23 genera and eight families (Červená et al. 2020). One year later, *Apocheiridium ferum* (Simon, 1879) from the family Cheiridiidae was recorded as a new species and genus for Slovakia (Christophoryová & Krajčovičová 2021). The most substantial taxonomic revisions occurred within the family Cheliferidae. Muster et al. (2024) applied an integrative taxonomic approach to investigate the polytypic species *Dactylochelifer latreillii* (Leach, 1817). Their molecular analyses revealed three distinct species in Central Europe, distinguishable by differences in female genital morphology and ecological preferences. Consequently, *Dactylochelifer latreillii* specimens from Slovakia have now been reassigned to *Dactylochelifer degeerii* (C.L. Koch, 1835) and *Dactylochelifer ninnii* (Canestrini, 1876) (Muster et al. 2024). In the same year, *Rhacochelifer quadrimaculatus* (Tömösváry, 1882) was recognized as the senior synonym of *Beierochelifer peloponnesiacus* (Beier, 1929), resulting in the new combination *Beierochelifer quadrimaculatus* (Tömösváry, 1882) (Novák 2024). Additionally, *Neobisium inaequale* Chamberlin, 1930, from the family Neobisiidae, was synonymized with *Neobisium sylvaticum* (C.L. Koch, 1835) (Novák 2024).

Taking into account both previously published data and the new record of *Lamprochernes abditus*, a total of 58 pseudoscorpion species, representing 24 genera and eight families, are currently known from Slovakia.

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