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A new species of the genus *Centrochthonius* Beier, 1931 (Pseudoscorpiones: Pseudotyrannochthoniidae) from Kyrgyzstan

Новый вид рода *Centrochthonius* Beier, 1931 (Pseudoscorpiones: Pseudotyrannochthoniidae) из Кыргызстана

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KEY WORDS: morphology, taxonomy, arachnid, relict species, lyrifissures.

КЛЮЧЕВЫЕ СЛОВА: морфология, таксономия, арахниды, реликтовый вид, лировидный орган.

ABSTRACT. A new species of pseudotyrannochthoniid pseudoscorpion is described from Kyrgyzstan, including a detailed diagnosis and illustrations: *Centrochthonius dashdamirovi* sp.n. (Arachnida, Pseudotyrannochthoniidae), represents the fifth valid species of this genus from Asia. Diagnostic, biogeographic and ecological features of this new species are presented and discussed, as well as compared to the related congeners, both extinct and extant. The species description also includes details of the cheliceral and chelal lyrifissures, as this may be important for diagnosing the interspecies and intergeneric variations within Pseudotyrannochthoniidae.

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РЕЗЮМЕ. Описан новый вид псевдотираннохтониевых ложноскорпионов из Кыргызстана с подробным диагнозом и иллюстрациями: *Centrochthonius dashdamirovi* sp.n. (Arachnida, Pseudotyrannochthoniidae), это пятый валидный вид этого рода из Азии. Приводятся и обсуждаются диагностические, биогеографические и экологические особенности этого нового вида, а также его сравнение с вымершими и современными видами этого рода. Описания видов псевдотираннохтониевых ложноскорпионов должны также отражать вооружение хелицеральных и хелальных лировидных органов, так как это может быть важно для межвидовой и межродовой диагностики внутри Pseudotyrannochthoniidae.

Introduction

The family Pseudotyrannochthoniidae Beier, 1932 is currently represented by 80 valid species, both extant and extinct, which are grouped into six genera [WPC, 2022]. The genus *Centrochthonius* Beier, 1931 includes five species (Fig. 1): four extant from Central Asia — *C. anatonus* Harvey et Harms, 2022 from Nepal, *C. cheni* (Gao, Zhang et Zhang, 2016) from Guizhou Province, China, *C. kozlovi* (Redikorzev, 1918) from Qinghai Province, China, *C. schnitnikovi* (Redikorzev, 1934) from Kyrgyzstan; and one extinct from Europe — and *C. bitterfeldicus* Schwarze, Harms, Hammel et Kotthoff, 2022 from Eocene Bitterfeld amber, Germany [Redikorzev, 1918, 1934; Schawaller, 1991; Gao *et al*., 2016; Harvey, Harms, 2022; Schwarze *et al.,* 2022].

Among the recent pseudoscorpions, the Pseudotyrannochthoniidae, together with the sister family Chthoniidae Daday, 1889, forms the basal-most group, i.e. the superfamily Chthonioidea Daday, 1889, belonging to the suborder Heterosphyronida Chamberlin, 1929,

of possibly Carboniferous or even Devonian origins [Benavides *et al*., 2019]. The mosaic worldwide distribution of Pseudotyrannochthoniidae [WPC, 2022], as well as the time of divergence of the suborder Heterosphyronida [Benavides *et al*., 2019] suggests the origin of this family within the supercontinent Pangea [Kolesnikov *et al*., 2022a]. Biogeographically, the genus *Centrochthonius* belongs to the ancient Laurasian radiation event of pseudotyrannochthoniids which show 16 setae on the carapace. The morphologically most similar relatives occur either in the warm temperate forests of western North America (the genus "*Pseudotyrannochthonius*" Beier, 1930 with three species) or live exclusively in caves of East Asia (the genus *Spelaeochthonius* Morikawa, 1954 with eleven species) [Harvey, Harms 2022, see fig. 1; You *et al.,* 2022].

After reviewing and defining the generic limits for both *Spelaeochthonius* [You *et al*., 2022] and *Centrochthonius* [Harvey, Harms, 2022], the importance of the structure of coxal blades, as well as the number and position of carapaceal setae (e.g. the loss of seta *Mm*, including that also in the related North American "*Pseudotyrannochthonius*", which in fact seems to be an independent, still undescribed genus) has been emphasized. It seems noteworthy that the sets of lyrifissures in pseudotyrannochthoniids have almost never been studied, in contrast to chthonioid pseudoscorpions [Zaragoza, 2017], where these structures have long been shown to be of taxonomic importance for the separation of species and genera.

Given the genus *Centrochthonius* is amongst the rarest to be found in museum collections, and that all of its species are known from single specimens/types series, the description of a new congener from Kyrgyzstan (Fig. 1) is certainly of considerable interest. The present paper is based only on the detailed study of morphological characters. Below we compare the new species with other congeners and provide a key to all presently known species of *Centrochthonius*. We recommend that future species descriptions should focus on/include more details on the arrangement of the cheliceral and chelal lyrifissures, as these may be of importance for interspecies and intergeneric diagnostics within Pseudotyrannochthoniidae. This, in turn, makes it possible to distinguish closely related species similar in a number of morphological characters. In addition, data on the ecology of *Centrochthonius* are supplemented, confirm its status as a relict psychrophilic high-mountainous Central Asian genus.

Material and methods

For morphological examination using light microscopy, pseudoscorpions were cleared in 100% lactic acid and temporarily mounted on slide preparations in glycerol. Animals were examined and dissected using a Biomed MC-2 binocular stereo microscope and measured using an ocular micrometer installed on a Biomed 6 (variant 3) microscope. All studied specimens were dissected for a more detailed study of the chelicerae, pedipalps and leg IV. Morphological drawings were processed by means a computer monitor using Adobe Photoshop CS6 (ver. 13.0.1.3) based on the images of these structures obtained using an Euromex Color HD-Ultra (5MPs) digital microscope camera connected to a Bioptic C-400 microscope. After examination, each specimen including its dissected body parts was preserved in a vial with 96% ethanol.

The distribution map (Fig. 1) was generated using ArcGIS 10.8 software, and the final processing of the map was performed in Inkscape v.1.0.1.

All specimens are deposited at the Zoological Museum of the Moscow University, Russia (ZMMU).

Both terminology and measurements largely follow Chamberlin [1931] with the exception of the nomenclature of the pedipalps, legs and with some minor modifications to terminology of the trichobothria [Harvey, 1992], chelicerae [Harvey, Edward, 2007; Judson, 2007] and legs [Harvey *et al*., 2012]. The nomenclature of setae on the carapace is adopted from the terminology initially proposed by Gabbutt & Vachon [1963], Heurtault-Rossi [1963], Vachon [1963] and modified by Harvey & Harms [2022]. The nomenclature of the cheliceral and chelal lyrifissures are adopted from Zaragoza [2017] with the addition of a new notation for antiaxial chelal hand lyrifissure (*ha*).

Abbreviations used in text and figures: *af* and *am* — spot sensilla; *Al* — anterolateral seta of carapace; *Am* — anteromedial seta of carapace; *Ao* — anterial ocular seta of carapace; *b*, *eb*, *esb*, *est*, *et*, *ib*, *isb*, *ist*, *it*, *sb*, *st*, *t* — chelal trichobotria; *dx* — double sensilla of fixed chelal finger; *fa* – antiaxial lyrifissure of fixed chelal finger; *fb* — basal lyrifissures of fixed chelal finger; *fd* — dorsal lyrifissures of the fixed chelal finger; *gl*, *db*, *dst*, *dt*, *vb* and *vt* — cheliceral setae; *ha* — antiaxial lyrifissure of chelal hand; *hd* — distal lyrifissure of chelal hand; *hp* — proximal lyrifissure of chelal hand; *ldb*, *ldt* — lyrifissures associated with cheliceral setae *db*, *dt*, respectively; ma_1, ma_2 — antiaxial lyrifissures of movable chelal finger; *Ml* — medialateral seta of carapace; *Il* — intermedialateral seta of carapace; *Ol* — lateral ocular seta of carapace; *Om* — medial ocular seta of carapace; *pc* — coupled sensilla of movable chelal finger; *Pl* — posterolateral seta of carapace; *Pm* — posteromedial seta of carapace.

Results

Class Arachnida Lamarck, 1801
Order Pseudoscorpiones de Geer, 1778
Family Pseudotyrannochthoniidae Beier, 1932

Genus *Centrochthonius* Beier, 1931

Centrochthonius dashdamirovi **sp.n.**
Figs 2–5.

HOLOTYPE ♀ (ZMMU TI-105), Kyrgyzstan, Pamir-Alay Mountain System, Kichik Alay Mt. Range, gorge of Kyrgyz-Ata River, near Kara-Koy Village, 2800–3200 m a.s.l., 40°06′N 72°37′E, under stones, 22.V.1993, S. Dashdamirov leg.

PARATYPES: 2 ♀♀ (ZMMU TI-106), together with holotype.

ETYMOLOGY. Named in honour of our arachnologist colleague, specialist in pseudoscorpion taxonomy, Dr Selvin Dashdamirov (Azerbaijan / Germany); the collector of the new species.

DIAGNOSIS (♀, ♂ unknown). Medium-sized, chela 1.16–1.17 mm long, chelal hand 0.23–0.24 (4.88–5.04×) wide. Chelicera with 16 small teeth (distal 8 teeth noticeably

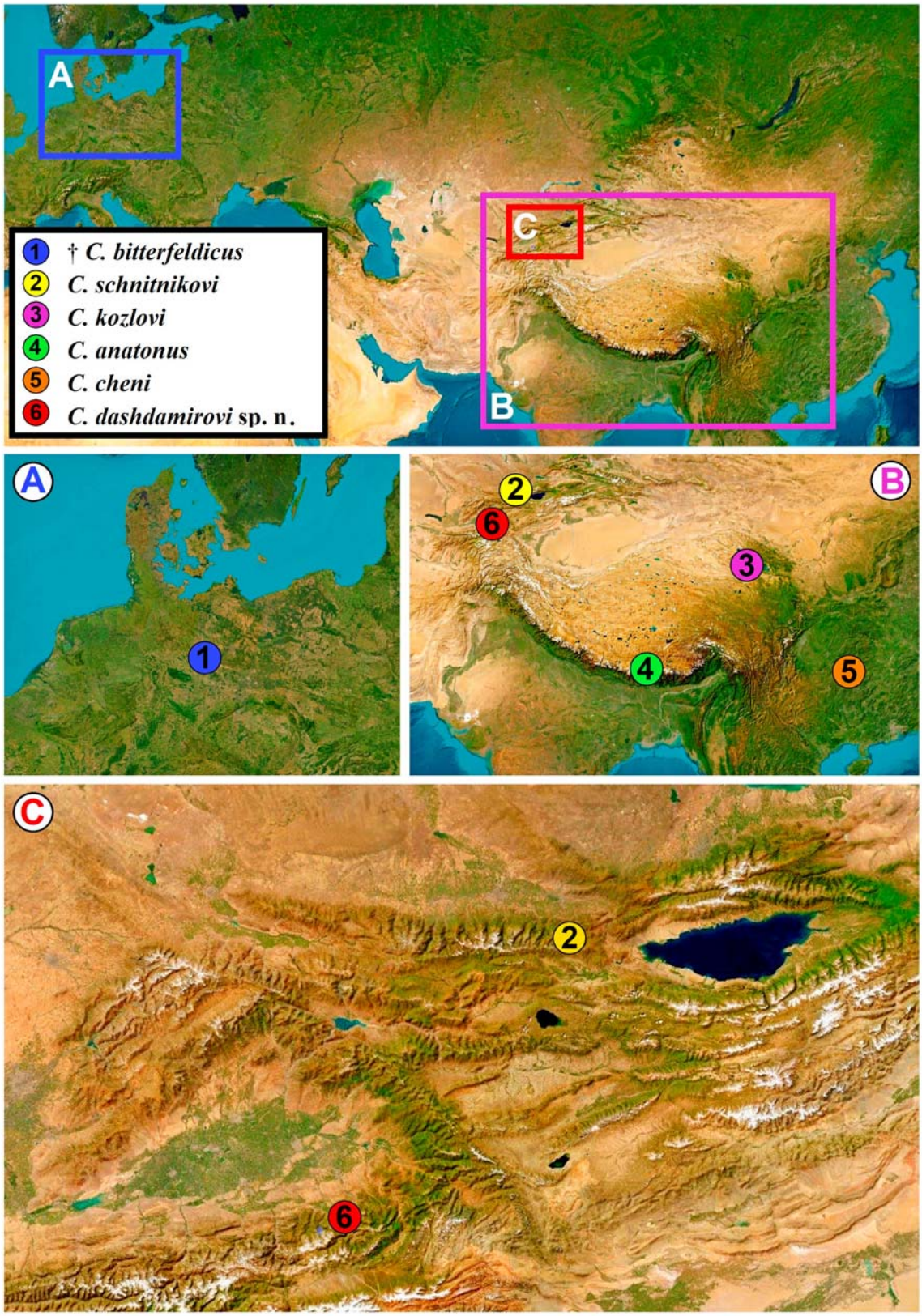

Fig. 1. Distribution maps of extant and extinct species of the genus *Centrochthonius*: A — Central Europa, Germany; B — Central Asia; C — Kyrgyzstan.

Рис. 1. Карты распространения современных и вымерших видов рода *Centrochthonius*: А — Центральная Европа, Германия; Б — Центральная Азия; С — Кыргызстан.

Fig. 2. Habitus of *Centrochthonius dashdamirovi* sp.n., ♀ paratype: A — dorsal view; B — ventral view. Scale bar 0.5 mm.
Рис. 2. Общий вид *Centrochthonius dashdamirovi* sp.n., паратип ♀: A — вид сверху; B — вид снизу. Масштаб: 0,5 мм.

smaller than basal ones, their apices being directed slightly forward) on movable finger. Trichobothrium *ist* distal to or level with *esb*; *sb–b>b–t*. Distal part of chelal hand gradually tapering towards base of fixed finger viewed from outside (dorsal view). Fixed chelal finger with 21–22 teeth, movable finger with 20 teeth, dentition of movable finger extending beyond *st* by 1–2 teeth. Tergite I with 4 setae.

DESCRIPTION. Adults (♀, ♂ unknown).

Color: uniformly light yellow (Fig. 2). Integument: marked hispid granulations on lateral surfaces of carapace, on cheliceral hand and at base of chelal fingers.

Chelicera (Figs 3B, 5E): hand with 6 acuminate setae; movable finger with 1 medial seta; fixed finger with ca. 9 teeth, distalmost teeth the largest and becoming progressively smaller basally, a small triangular tooth present at base of a large tooth, movable finger with 16 small teeth (distal 8 teeth noticeably smaller than basal ones, their apices being directed slightly forward); with 2 lyrifissures: *ldt* and *ldb*; galea represented by very low swelling; rallum consisting of 11 blades with fine barbules except for the posterior one which is shorter than others (Fig. 3C). Serrula exterior with 15 lamellae; serrula interior with 17 lamellae.

Carapace (Fig. 3A): equal to or slightly shorter than broad, weakly constricted posteriorly; with 4 corneate eyes; epistome low, but distinctly serrate (Figs 5A, B); with 16 setae arranged 6:4:2:2:2; furrows absent; setae *Ao* and *Ol* about half the length of other setae in anterior row (Fig. 5C); 2 anterior and 1 pair of posterior lyrifissures present.

Chaetotaxy of coxae: 2+3:6–7(6):5:5:5(5–6); manducatory process with 2 acuminate distal setae, lateral seta about half as long as medial seta; pedipalpal coxa with another 3 setae arranged in a triangle; coxae I with 6–7 (5) coxal blades (Fig. 3G) on each side, set in a transverse row near anterior coxal margin, blades tripartite with central lobe only slightly longer than lateral lobes; an intercoxal tubercle present, small, with 2 setae.

Abdomen: tergites and sternites undivided; setae acuminate and arranged in irregular uniseriate rows, except for sternite II, on which they are arranged in 2 triangles. Tergal chaetotaxy of holotype 2:6:6:7:7:9:8:8:7:7:4:0, of paratype 2:6:6:7:7:7:8:7:7:6:4:0. Sternal chaetotaxy of holotype: 6:(2)9(2):(2)9(2):11:12:12:11:9:4:–:2, of paratype 5:(2)9(2):(2)9(2):11:11:12:11:9:4:–:2.

Genitalia: not visible.

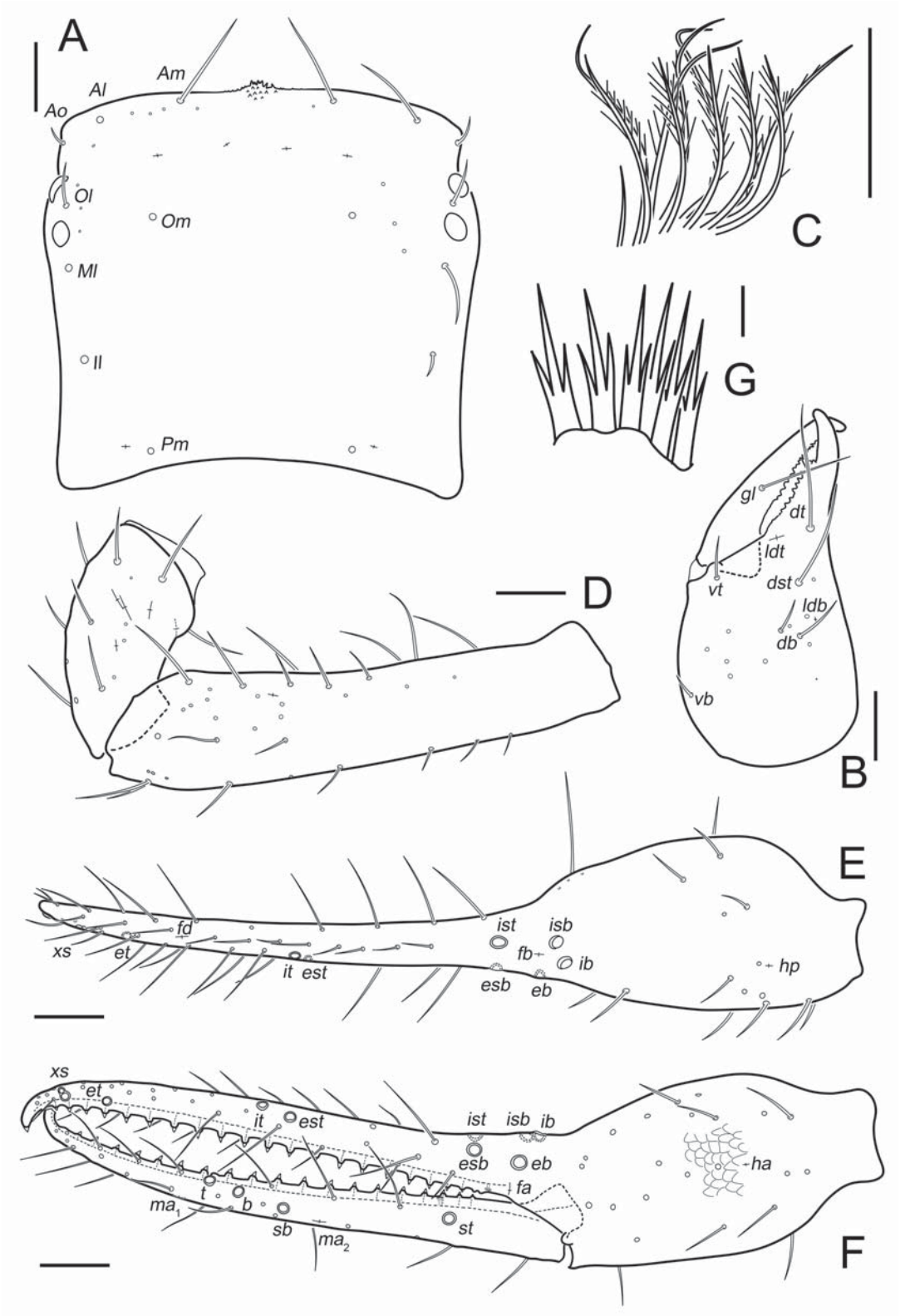

Fig. 3. *Centrochthonius dashdamirovi* sp.n., ♀ holotype: A — carapace, dorsal view; B — left chelicera, dorsal view; C — rallum; D — left femur and patella of pedipalp, dorsal view; E — left chela, dorsal view; F — left chela, lateral view; G — coxal blades. Scale bars: 0.1 mm (A–F), 0.01 mm (G).

Рис. 3. *Centrochthonius dashdamirovi* sp.n., голотип ♀: A — карапакс, вид сверху; B — левая хелицера, вид сверху; C — раллум; D — левые фемур и пателла педипальпы, вид сверху; E — левая хела, вид сверху; F — левая хела, вид сбоку; G — коксальные лопасти. Масштаб: 0,1 мм (A–F), 0,01 мм (G).

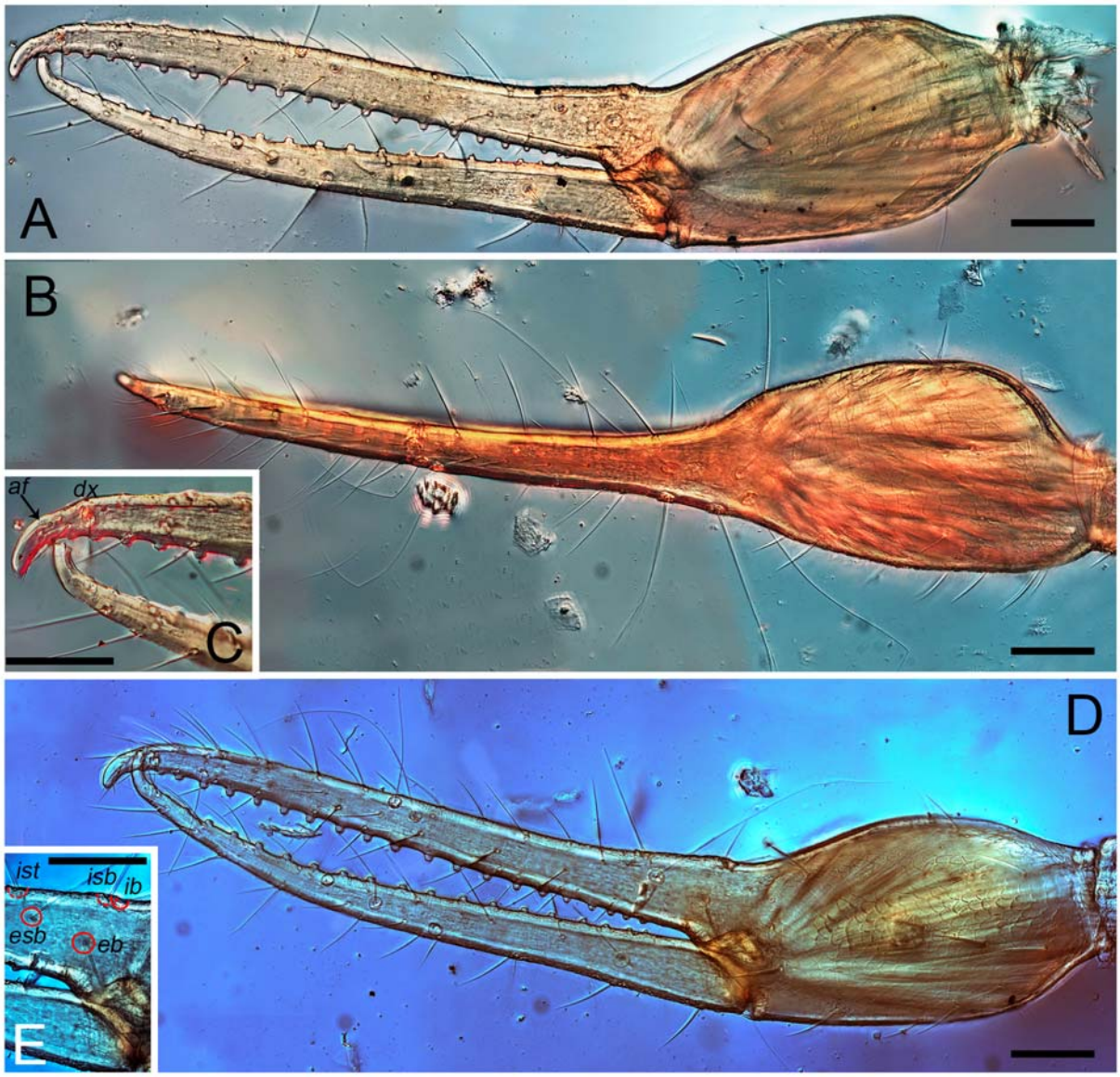

Fig. 4. *Centrochthonius dashdamirovi* sp.n., ♀ holotype (A–C) and ♀ paratype (D, E), light microscope images (DIC): A, D — left chela, lateral view; B — left chela, dorsal view; C — distal part of chelal fingers, lateral view; E — basal part of chelal fingers, lateral view. Scale bars: 0.1 mm. Trichobothria are marked in red in the Fig. 4E.

Рис. 4. *Centrochthonius dashdamirovi* sp.n., голотип ♀ (A–C) и паратип ♀ (D, E), изображения светового микроскопа (DIC): A, D — левая хела, вид сбоку; B — левая хела, вид сверху; C — дистальная часть хелицеральных пальцев, вид сбоку; E — базальная часть хелицеральных пальцев, вид сбоку. Масштаб: 0,1 мм. На рис. 4E трихоботрии отмечены красным цветом.

Pedipalp (Figs 3E, F, 4A, B, D): all setae acuminate; femur with 3:6:3:7:1 setae and one lyrifissure (Fig. 3D); patella with 5 lyrifissures: 2 large contiguous, 2 small dorsal and 1 ventral (Figs 3D, 4D). Fixed chelal finger and hand with 8 trichobothria plus a duplex trichobothrium (*xs*), movable chelal finger with 4 trichobothria: *ib* and *isb* situated close together sub-distally on dorsal side of chelal hand (Fig. 4E); *eb*, *esb* and *ist* in a row sub-laterally at base of fixed chelal finger, with *ist* situated slightly distad to or level with *esb* (not basal) (Fig. 4E); *it* and *est* situated sub-distally about halfway between *et* and *ist*, and about 2 areolar diameters apart; *et* located distally, closer to *xs* than to *it* (Fig. 4C); *xs* situated distal to *et*, each seta shorter than those of other trichobothria (Fig. 4C); neither dorsal side of chelal hand nor fixed finger with a patch of lanceolate setae; trichobothrium *st* of movable finger placed sub-basally; *sb*, *b* and *t* situated sub-distally, *sb*-*b*>*b*-*t* in 1.4–1.6×. Chelal teeth homodentate and diastemodentate, fixed finger with 20 triangular and terminally acuted teeth with dental canals and 1–2 teeth without canals at base of finger; dentition reaching *esb*; central teeth of fixed finger 0.3–0.4× as long as wide; movable finger with 20 acuminate teeth (1–2 distal teeth shorter than others), dentition extending beyond *st* by 1–2 teeth. Chelal hand with 1 dorsal (*hd*) and 1 antiaxial (*ha*) lyrifissure; fixed finger with 2 basal (*fb* and *fa*) and 1 distal (*fd*) lyrifissure; movable finger with 2 antiaxial (*ma*) lyrifissures, both slightly displaced ventrally; ventral lyrifissures on movable finger absent. Distally, each finger with a pair of apical

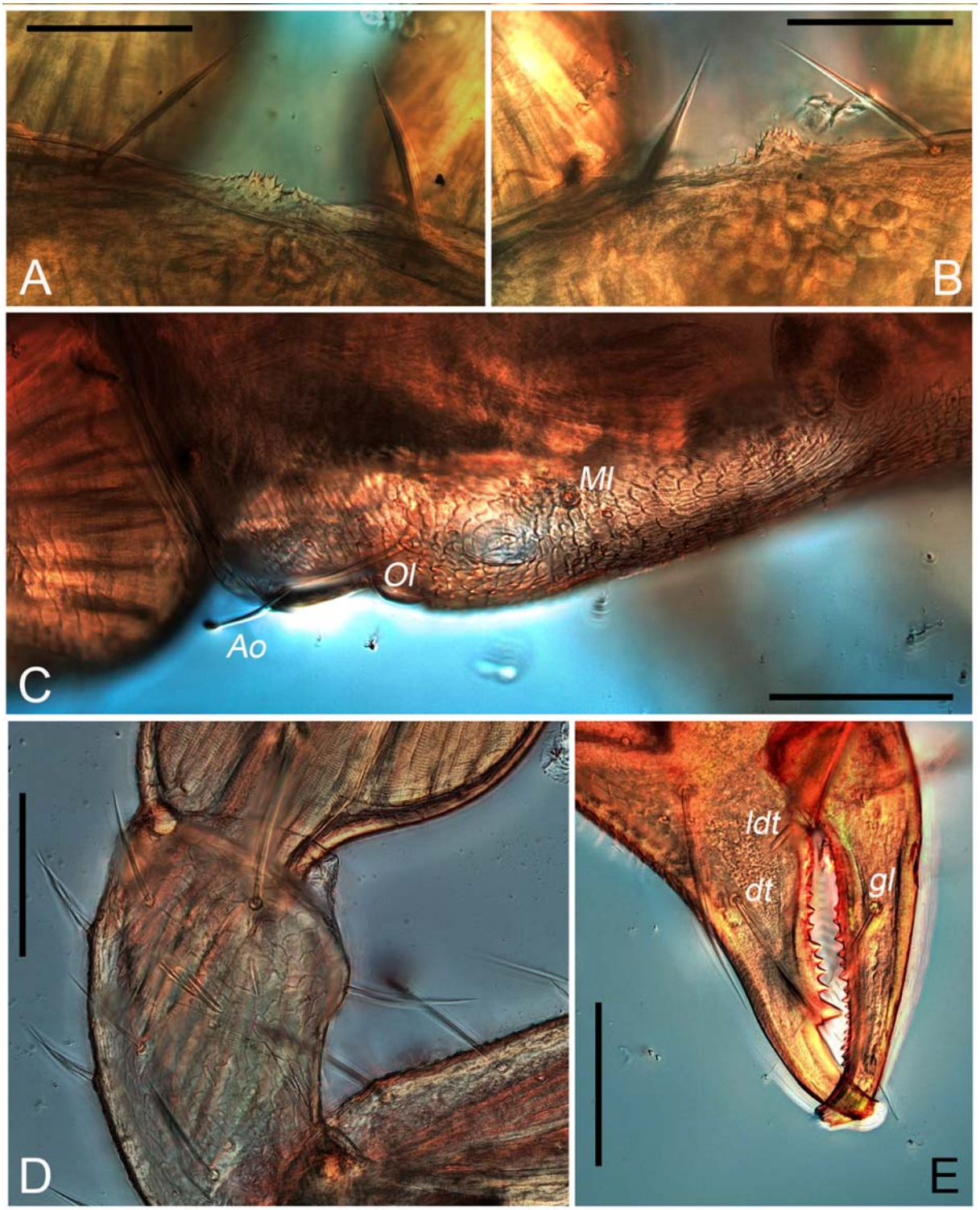

Fig. 5. *Centrochthonius dashdamirovi* sp.n., ♀ holotype (A, C–E) and ♀ paratype (B), light microscope images (DIC): A, B — epistome, dorsal view; C — left eyes area, dorsal view; D — left pedipalpal patella, dorsal view; E — left cheliceral fingers, dorsal view. Scale bars: 0.1 mm.

Рис. 5. *Centrochthonius dashdamirovi* sp.n., голотип ♀ (A, C–E) и паратип ♀ (B), изображения светового микроскопа (DIC): A, B — эпистом, вид сверху; C — область левых глаз, вид сверху; D — левая педипальпальная пателла, вид сверху; E — левые хелицеральные пальцы, вид сверху. Масштаб: 0,1 мм.

sensilla: *af* and *am* (sensory organs according to You *et al.* 2022). A coupled sensilla (*pc*) absent, but a small pore present at base of both fingers (between teeth), a similar pore present at distal end of palpal femur.

Legs: typical of the family. Tarsus I without long tactile seta, tarsus IV with a long tactile seta (TS = 0.35). Arolium shorter than claws, incised; claws simple and with faint striations.

Measurements (length/breadth or depth in mm, ratios in parentheses). Holotype (♀): body length 2.3; carapace 0.53 × 0.58 (0.91); chelicera 0.50 × 0.23 (2.17); cheliceral movable finger 0.26; palpal femur 0.70 × 0.15 (4.6); patella 0.32 × 0.16 (2.0); chela 1.17 × 0.24 (4.88); hand of chela 0.45 × 0.25 (1.8); movable finger length 0.76 (1.68× hand); leg I femur 0.40 × 0.08 (5.00); leg I patella 0.25 × 0.07 (3.57); leg I tibia 0.32 × 0.06 (5.33); leg I tarsus 0.42 × 0.05 (8.4); leg IV femur + patella 0.80 × 0.19 (4.21); leg IV tibia 0.52 × 0.8 (6.5); leg IV metatarsus 0.20 × 0.07 (2.85); leg IV tarsus 0.45 × 0.06 (7.5).

Paratype (♀): body length 2.1; carapace 0.53 × 0.58 (0.91); carapace 0.53 × 0.58 (0.91); chelicera 0.50 × 0.22 (2.27); cheliceral movable finger 0.25; palpal femur 0.72 × 0.15 (4.8); patella 0.33 × 0.16 (2.06); chela 1.16 × 0.23 (5.04); hand of chela 0.44 × 0.24 (1.83); movable finger length 0.75 (1.70× hand); leg I femur 0.40 × 0.08 (5.00); leg I patella 0.25 × 0.07 (3.57); leg I tibia 0.32 × 0.07 (4.57); leg I tarsus 0.42 × 0.05 (8.4); leg IV femur + patella 0.81 × 0.21 (3.88); leg IV tibia 0.52 × 0.8 (6.5); leg IV metatarsus 0.20 × 0.07 (2.85); leg IV tarsus 0.46 × 0.06 (7.6).

DISTRIBUTION. Currently known only from the type locality.

TAXONOMIC REMARKS. The described species of the genus *Centrochthonius* are all very similar in morphology and differ primarily in size and the number of chelal teeth and coxal spines [Harvey, Harms, 2022]. The new species seems to be especially similar in proportions to *C. cheni* (chela 1.16–1.17 mm length in *C. dashdamirovi*, *vs.* 1.21 in *C. cheni*), yet differing in the number of teeth on the movable finger of the chela (20 in the new species, *vs.* 16 in *C. cheni*); the dentition of the movable finger in the new species extends beyond *st* by 1–2 teeth (*vs.* does not extend beyond *st* in *C. cheni*), *sb–b>b–t* in the new species (*vs. sb–b=b–t* in *C. cheni*), *ist* distal to or level with *esb* in the new species (*vs. ist* more basal than *esb* in *C. cheni*), the distal part of the chelal hand gradually tapers towards the base of the fixed finger when viewed from outside (dorsal view) in the new species (*vs.* the hand sharply narrows towards the base of the fixed finger in dorsal view in *C. cheni*), the carapace is slightly narrowed caudad in the new species (*vs.* strongly narrowed in *C. cheni*), the basal teeth of the movable cheliceral finger are larger than the distal ones (*vs.* all teeth of the movable finger are subequal in size in *C. cheni*). The new species also differs from *C. cheni* in the presence of 6 setae on the cheliceral hand (*vs.* 5 setae in *C. cheni*), and of 2 lyrifissures (*vs.* 5 lyrifissures in *C. cheni*). However, the presence of the sixth setae is likely to be variable within species [Harvey, Harms, 2022], and the taxonomic significance of the composition of cheliceral lyrifissures within the family has not yet been clarified.

The new species differs markedly from *C. schnitnikovi*, another species from Kyrgyzstan, in its larger size (chela 1.16–1.17 mm length in *C. dashdamirovi*, *vs.* 1.01 in *C. schnitnikovi*) and the presence of teeth on the movable finger of the chelicerae (*vs.* absence in *C. schnitnikovi* — this is confirmed by our re-examination the type).

The main differences of the new species from congeners are given in the key below.

KEY TO EXTANT AND EXTINCT SPECIES OF THE GENUS *CENTROCHTHONIUS*

1. Tergite I with 2 setae 2
– Tergite I with 4 setae 3
2. Movable chelal finger with 15 teeth ..... †*C. bitterfeldicus* Schwarze, Harms, Hammel et Kotthoff, 2022
– Movable chelal finger with 22 teeth .... *C. anatonus* Harvey et Harms, 2022
3. Movable cheliceral finger without teeth; chela 1.01 mm long ..... *C. schnitnikovi* (Redikorzev, 1934)
– Movable cheliceral finger with teeth; chela longer than 1.01 mm 4
4. Large-sized, chela 1.64–1.71 mm long .... *C. kozlovi* (Redikorzev, 1918)
– Medium-sized, chela 1.16–1.21 mm long 5
5. Movable chelal finger with 20 teeth, dentition of movable finger extending beyond *st* by 1–2 teeth; trichobothria *ist* distal to or level with *esb*; distal part chelal hand gradually tapering towards base of fixed finger when viewed from outside (dorsal view) .... *C. dashdamirovi* sp.n.
– Movable chelal finger with 16 teeth, dentition of movable finger not extending beyond *st*; trichobothria *ist* basal to *esb*; hand sharply narrowing towards base of fixed finger when viewed from outside (dorsal view) .... *C. cheni* (Gao, Zhang et Zhang, 2016)

Discussion

NOTES ON THE TAXONOMIC SIGNIFICANCE OF LYRIFISSURES. Unfortunately, most species of the family Pseudotyrannochthoniidae have been described but fragmentarily [Harvey, Harms, 2022]. In particular, information about the set of lyrifissures is practically not mentioned, especially on the chela. Only in a few cases, individual lyrifissures on the chela, the patella of the palp and/or the chelicera have been considered, albeit almost always without specifying their nomenclature: Harvey & Harms [2022] indicate the number and location of lyrifissures on the patella of the palp and the chelicera, without lyrifissures on the chela in *Centrochthonius*; Harms & Harvey [2013] and Harms [2013] indicate the number and location of lyrifissures on the chela (only basal lyrifissure on fixed finger — obviously *fb*), chelicera, coxae and sternites in *Pseudotyrannochthonius*; You *et al*. [2022] pointed out the presence of *fb* on the chela in *Spelaeochthonius*. On the other hand, the arrangement of lyrifissures on the carapace has been described for many species, but it is virtually constant there. Thus, Li [2023] used the presence of lyrifissures on the carapace as a diagnostic feature to distinguish *C. cheni* from *C. kozlovi*, referring to the report by Harvey & Harms [2022] that "lyrifissures are not visible" in *C. kozlovi*. However, because Harvey & Harms [2022] used the very old museum/type material for their revision, which was imperfectly preserved, they were not able to see lyrifis-

sures although they would have been present in the living animals. Moreover, they actually depicted the posterior parts of the anterior lyrifissures in their fig. 11. In some species, such as *C. dashdamirovi* sp.n., the lyrifissures on the carapace are very small, and are difficult to discern even in well-preserved specimens (Fig. 3A). This is why the species diagnostics concerning lyrifissures on the carapace may well be controversial in many descriptions, and those in Li [2023] are certainly unrelibale.

Zaragoza [2017] has detailed, designated and analyzed the taxonomic significance of the arrangement of lyrifissures on the chela and chelicerae of various species of Chthoniidae. He concluded that they provided important taxonomic value for separating species and genera, in contrast to the set of lyrifissures on the patella of the palp that showed no such significance. Given the sister group relationship between Chthoniidae and Pseudotyrannochthoniidae within the same superfamily Chthonioidea [Benavides *et al*., 2019], we can well suggest that the arrangement of the lyrifissures on the chela and chelicera in the latter family may also be of taxonomic importance.

As regards the chela in the genus *Centrochthonius*, its species seem to show all of the main groups of lyrifissures as revealed by Zaragoza [2017] in Chthoniidae: (1) dorsal face of chelal hand (*hp* present, but *hd* absent); (2) base of fixed finger (*fa* and *fp* present); (3) antiaxial face of fixed finger (*fb* present); (4) dorsal face of fixed finger (one *fd* present); (5) ventral face of movable finger (*mv* absent); (6) antiaxial face of movable finger (two *ma* present, both shifted towards the ventral side). At the same time, the Chthoniidae is characterized by the absence of a lyrifissure on the antiaxial side of the chelal hand, while *Centrochthonius*/Pseudotyrannochthoniidae and some other families, e.g., Neobisiidae Chamberlin, 1930 and Syarinidae Chamberlin, 1930 (e.g., Turbanov, Kolesnikov [2020]; Kolesnikov *et al*. [2022b]), show a small lyrifissure at the base of the hand in that place. We take the opportunity to designate it herewith as an antiaxial hand lyrifissure (*ha*).

At the moment, it is too difficult to compare the arrangement of chelal lyrifissures within the genus *Centrochthonius* and across the family Pseudotyrannochthoniidae, since the species have mostly been described without any reference to this character. Fragmentary information, such as the location of *fb* among the neighboring trichobothria in *Spelaeochthonius* (see You *et al*. [2022]), shows certain variability in this character in some pseudotyrannochthoniid genera (in *Spelaeochthonius*, lyrifissure *fb* is distal to both trichobothria *esb* and *ist*, *vs.* basal in *Centrochthonius*).

The arrangement of cheliceral lyrifissures in *Centrochthonius* is described here in full detail. Thus, one lyrifissure is found at the base of the fixed finger (apparently *ldt*) in *C. cheni*; two (dorsal and ventral, presumably *ldt* being ventral and *ldb* or *ldst* being dorsal) in *C. anatonus*; also two, *ldt* and *ldb*, in *C. dashdamirovi* sp.n.; three (one ventral, presumably *ldt*, and two dorsal, presumably *ldb* and *lds*) in *C. schnitnikovi*; but in *C. kozlovi* and *C. bitterfeldicus*, no cheliceral lyrifissures are visible. Interestingly, *lvb* and *lvt* are missing in *Centrochthonius* and *Pseudotyrannochthonius*, both being almost always found in Chthoniidae, as well as *lvt* being clearly present in *Allochthonius* and other families, e.g., Neobisiidae and Syarinidae. The presence or absence of *ldb* is known as an interspecific character in the genera *Ephippiochthonius* Beier, 1930 and *Occidenchthonius* Zaragoza, 2017 [Zaragoza, 2017].

According to Zaragoza [2017], certain species can vary in the number of some lyrifissures, i.e., teratological specimens sometimes show duplicate or triplicate lyrifissures on only one chela within samples with normal sets of lyrifissures. For example, one of the paratypes of *C. dashdamirovi* sp.n. has *hp* missing on one chela, but present on the second. However, such variations are always easy to establish, especially when several specimens are available in the series.

Thus, the arrangement of cheliceral and chelal lyrifissures seems to represent an interspecific or even intergeneric character within Pseudotyrannochthoniidae, and should not be neglected when describing the constituent taxa. In the least, this can help in distinguishing morphologically similar species.

Zaragoza [2017], following Chamberlin [1931], indicated the absence of the taxonomic value in the arrangement of lyrifissures on the pedipalpal femur and patella in Chthoniidae. Meanwhile, Harvey & Harms [2022] showed differences in the arrangement of pedipalpal patella lyrifissures for different *Centrochthonius*: 1 mediodorsal lyrifissure in *C. kozlovi*; 1 large and 1 small mediodorsal lyrifissure in *C. anatonus* and *C. schnitnikovi* (but, according to the figures [Harvey, Harms, 2022], their mutual arrangement is notably different). Lyrifissures on the patella are not mentioned in *C. cheni*, but based on the photograph [see Gao *et al.,* 2016, fig. 3C], one or two closely placed, large, mediodorsal lyrifissures can be distinguished; these are not known only in *C. bitterfeldicus*. As regards *C. dashdamirovi* sp.n., it clearly has 5 lyrifissures on the patella: 2 large contiguous mediodorsals, 2 small on both sides of the previous ones, and 1 ventral, i.e, a set typical of Chthoniidae. To understand the taxonomic significance of this character, the arrangement of lyrifissures on the pedipalpal patella in Pseudotyrannochthoniidae should be studied in detail.

NOTES ON THE ECOLOGY, DISTRIBUTION AND BIOGEOGRAPHY OF *CENTROCHTHONIUS*. The ecology of *Centrochthonius* has been studied extremely poorly, due to its rarity in museum collections and the scarcity of available data on habitats [Harvey, Harms, 2022]. *Centrochthonius* is a psychrophilic genus inhabiting the alpine and subalpine zones with probable seasonal vertical migrations from deep soil layers [Harvey, Harms, 2022]. *C. anatonus* from Nepal was collected in May in mixed forest with *Betula* and

Rhododendron at 3,550–3,650 m a.s.l. [Schawaller, 1991; Harvey, Harms, 2022]; *C. cheni* from Guizhou Province, China in October from under fallen wet bamboo leaves at 2,214 m a.s.l. [Gao *et al*., 2016]; *C. schnitnikovi* from Kyrgyzstan in July in moss under a *Juniperus* bush at ~2,100 m a.s.l. [Redikorzev, 1934; Harvey, Harms, 2022]; *C. kozlovi* from Qinghai Province, China in August at 3,350 m a.s.l., without indication of a biotope [Redikorzev, 1918]. *C. dashdamirovi* sp.n. was found in May under stones at 2,800–3,200 m a.s.l. [this study]. At the same time, it is obvious that *C. dashdamirovi* sp.n. does not deviate from the ecological model known for extant species of the genus. Similar patterns have been recorded for other Pseudotyrannochthoniidae [Harvey, Harms, 2022, see discussion). However, the fact that extinct *C. bitterfeldicus* lived in the Eocene forests of Europe with a warm and temperate climate with diverse communities of mesophytic conifers (Cupressaceae, Pinaceae and Geinitziaceae) and angiosperms, in particular the very diverse Fagaceae [Sadowski *et al*., 2017, 2020], remains highly surprising [Schwarze *et al*., 2022]. Thus, there was a biogeographic connection between the Eocene forests of Europe and the highlands of Central Asia, with a probable change in habitat confinement between the Eocene extinct and present-day/Holocene faunas of *Centrochthonius*. As an alternative, the extinct species of this genus could have been distributed more widely in a variety of habitats [Harvey, Harms, 2022], followed by extinctions and the preservation of relict species in the mountains of Central Asia.

The two species that inhabit Kyrgyzstan, *C. schnitnikovi* and *C. dashdamirovi* sp.n., probably have allopatric distributions. Each occurs in isolated large mountain systems of Asia, i.e., *C. schnitnikovi* in the Tian Shan Mountains, and *C. dashdamirovi* sp.n. in the Pamir-Alay Mountains (see Fig. 1). There can be little doubt that in the future we may expect an increase in *Centrochthonius* species diversity in Central Asia due to the description of new taxa. At the same time, the distribution of a particular species can be limited not only to large mountain systems, but also to individual high-mountain valleys, mountain ranges, caves or karst massifs, etc., as this has been found in numerous insect taxa [Kryzhanovsky, 1965; Faille *et al*., 2015; Weng *et al*., 2020]. This is partly confirmed by recent genetic and morphological studies on other pseudotyrannochthoniid pseudoscorpions [Harms, 2013, 2018; Harms, Harvey, 2013; Harms *et al.,* 2019; Viana, Ferreira, 2021; Prado *et al*., 2022; You *et al*., 2022; Gao *et al*., 2023; Li, 2023]. Thus, the genus *Centrochthonius* is rather a relict with a possible refugium in the mountains of Central Asia.

Compliance with ethical standards

CONFLICT OF INTEREST: The authors declare that they have no conflict of interest.

Ethical approval: No ethical issues were raised during our research.

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