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The genus *Grzegorzekia* Edwards (Diptera: Mycetophilidae) revisited: molecular phylogeny and description of four new species

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Abstract. The genus *Grzegorzekia* Edwards, 1941 (Diptera: Mycetophilidae: Gnoriinae) is revised based on newly assembled material from Europe, the Nearctic, and the Oriental region, complemented by molecular data (COI, 16S, 28S). Four new species are described and illustrated: *Grzegorzekia pseudocollaris* Kurina, Ševčík & Kjaerandsen sp. nov. (Czech Republic, Slovakia, Italy), *G. bruneiensis* Kurina & Ševčík sp. nov. (Brunei Darussalam), *G. taiwanica* Kurina & Ševčík sp. nov. (Taiwan), and *G. canadensis* Kurina & Kjaerandsen sp. nov. (Canada: British Columbia, Alberta). All previously known European species are re-illustrated for comparison, and a revised key to the world species is provided. Diagnostic characters of the genus are confirmed, including the secondary loss of the male gonostylus and the presence of complex, bipartite gonocoxites bearing posterior combs of spines. Molecular data largely corroborate morphospecies boundaries, although *G. canadensis* comprises two COI BINs with low divergence (2.12%), and *G. taiwanica* shows pronounced COI divergence despite minimal variation in 16S and 28S. With these additions, *Grzegorzekia* now comprises nine described species distributed across the Holarctic and Oriental regions. New country records are provided for *G. hungarica* Papp & Ševčík, 2007 and *G. bushyae* Chandler, 2015.

Keywords. Sciaroidea, Mycetophilidae, *Grzegorzekia*, male terminalia, DNA barcoding, key to species.

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Introduction

The genus *Grzegorzekia* Edwards, 1941 (Diptera: Mycetophilidae: Gnoristinae) has attracted renewed attention in recent years. For nearly two centuries, it was represented by a single Holarctic species, *G. collaris* (Meigen, 1818), originally described in *Sciophila* Meigen, 1818. Over the past two decades, four additional species have been described: two European species, *G. hungarica* Papp & Ševčík, 2007 and *G. bushyae* Chandler, 2015, and two Nearctic species, *G. quercus* Fitzgerald, 2019 and *G. kerri* Fitzgerald, 2019. The generic concept was redefined by Chandler (1999), based on the single European species, and further elaborated by Fitzgerald (2019) based on a new Nearctic species; Fitzgerald (2019) also provided a key to all five species known at the time.

Species of *Grzegorzekia* are characteristic, rather large and stout fungus gnats (Fig. 1), blackish in colour and with distinct thick wing venation where $Rs+R_{2+3}$ forms a tiny cell. All known species lack a male gonostylus, a diagnostic feature first noted by Söli (1997) and otherwise known only in the monotypic genus *Phoenikiella* Chandler, 1999. The sole species of that genus, *P. phoenix* (Väisänen, 1984), was originally described as *Grzegorzekia phoenix* before being transferred to *Phoenikiella* by Chandler (1999).

During examination of newly collected fungus gnat material from Slovakia and re-examination of all available specimens of *Grzegorzekia*, we discovered one new European species. In addition, we describe two new species from the Oriental Region and one new species from the Nearctic Region.



Fig. 1. Habitus of a male *Grzegorzekia collaris* (Meigen, 1818) photographed on 21 Jun. 2013 in Slovakia. Both hind legs missing beyond coxae. Photo by Jan Ševčík.

Material and methods

Morphological study

Most species-specific diagnostic characters in Mycetophilidae Newman, 1834 are found in the male terminalia, which are often highly complex and require detailed examination. Accordingly, the terminalia of the studied specimens of *Grzegorzekia* were removed and macerated in hot 10% KOH, neutralized with acetic acid, and thoroughly rinsed in distilled water. The cleared terminalia were transferred to glycerine for detailed study and illustration. Dissected parts were preserved as glycerine preparations attached to the corresponding specimens. Photographs of the general habitus and terminalia were taken using a Leica K5C camera mounted on a Leica M205 C stereo microscope. Image stacks were combined in Leica's LAS X (ver. 5.3.0) or Helicon Focus (ver. 8.3.11), sharpened using Topaz Sharpen AI (ver. 4.1.0), and the resulting images were edited and assembled into plates in Adobe Photoshop CS5 (see also Kjærandsen *et al.* 2022).

Male terminalia were illustrated from four perspectives: ventral, dorsal, lateral, and posterior. In addition, the aedeagal apparatus was detached from the gonocoxites and illustrated in ventral, dorsal, and lateral views, while the cerci, together with the hypoproct and epiproct, were illustrated in ventral and lateral views. Descriptions of the new species follow the format adopted from Fitzgerald (2019). Morphological terminology largely follows Söli (2017), and interpretation of the terminalia follows Chandler (1999), supplemented by observations from Fitzgerald (2019). However, the third section of the gonocoxite as interpreted by Fitzgerald (2019) is here treated as the posterior projection of the gonocoxal apodeme (see Discussion). Diagnoses of the new species are based exclusively on characters of the male terminalia.

Studied material is deposited in the following collections:

CBG-BIOUG	=	Centre for Biodiversity Genomics, University of Guelph, Canada
IZBE	=	Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences, Tartu, Estonia
JSL-OUC	=	Jan Ševčík Lab, University of Ostrava, Ostrava, Czech Republic
NMNS	=	National Museum of Natural Science, Taichung, Taiwan
NMPC	=	National Museum, Prague, Czech Republic
RBINS	=	Royal Belgian Institute of Natural Sciences, Brussels, Belgium
SMOC	=	Silesian Museum, Opava, Czech Republic
TMU	=	The Arctic University Museum of Norway, Tromsø, Norway
UBDM	=	University Brunei Darussalam Museum, Brunei Darussalam
ZMHB	=	Museum für Naturkunde, Berlin, Germany

Morphological abbreviations

a	=	anterior setae on tibiae
aed	=	aedeagus
cer	=	cercus
d	=	dorsal setae on tibiae
ej ap	=	ejaculatory apodeme
epi	=	epiproct
gap	=	gonocoxal apodeme
gc I, II	=	gonocoxite sections 1, 2
hyp	=	hypoproct
lb gc I	=	lobe of gonocoxal section 1
lb gc II	=	lobe of gonocoxal section 2
p	=	posterior setae on tibiae

Table 1. List of specimens used for the phylogenetic analyses, with GenBank or BOLD accession numbers.

Species	Voucher code	Sampling locality (year)	16S	28S	COI
<i>Boletina trivittata</i> (Meigen, 1818)	GS46	Slovakia (2016)	MH114181	MH114261	MH114430
<i>Coelosia flava</i> (Staeger, 1840)	GS19	Slovakia (2013)	MH114160	MH114240	MH114411
<i>Gnoriste bilineata</i> Zetterstedt, 1852	GS4	Czech Republic (2009)	KP288713	KP288794	KT316839
<i>Speolepta leptogaster</i> (Winnertz, 1864)	GS5	Slovakia (2013)	MH114183	MH114263	MH114432
<i>Grzegorzekia bruneiensis</i> Kurina & Ševčík sp. nov.	GS38	Brunei (2015)	PX931722	PX924906	PX924812
<i>G. bushyae</i> Chandler, 2015	GS40	Great Britain (2011)	PX931723	PX924907	PX924813
<i>G. canadensis</i> Kurina & Kjaerandsen sp. nov.	BOLD	Canada	n/a	n/a	KR242043
	BOLD	Canada	n/a	n/a	KM959291
<i>G. collaris</i> (Meigen, 1818)	GS17	Slovakia (2013)	MH114158	MH114238	MH114410
<i>G. hungarica</i> Papp & Ševčík, 2007	GS35	Slovakia (2013)	MH114173	MH114253	MH114424
<i>G. kerri</i> Fitzgerald, 2019	BA427	USA (2012)	PX931721	PX924905	PX924811
<i>G. pseudocollaris</i> Kurina, Ševčík & Kjaerandsen sp. nov.	BA413a	Slovakia (2016)	PX931720	PX924904	PX924810
<i>G. taiwanica</i> Kurina & Ševčík sp. nov.	TW50	Taiwan (2023)	PX931726	PX924910	PX924816
	TW60	Taiwan (2017)	PX931727	PX924911	PX924817
<i>Grzegorzekia</i> sp. 1	BOLD	Malaysia	n/a	n/a	BOLD:ACQ7838

par	=	paramere
par ap	=	parameral apodeme
pp gap	=	posterior projection of gonocoxal apodeme
pv	=	posteroventral setae on tibiae
st	=	sternite
tg	=	tergite

ChatGPT ver. 5.2. (OpenAI) was used to assist with language editing and stylistic improvements; all scientific content, interpretations, and conclusions were generated, verified, and approved by the authors.

Molecular study

DNA was extracted using NucleoSpin Tissue Kit (Macherey-Nagel, Düren, Germany). The primers used for PCR amplification (total volume 20 µl) are listed in Ševčík *et al.* (2023). The PCR products were purified using Gel/PCR DNA Fragments Extraction Kit (Geneaid, New Taipei City, Taiwan) and subsequently, sequenced by Eurofins Genomics (Germany) or Macrogen Europe (Netherlands). The sequences were assembled and edited in Sequencher ver. 5.0 (Gene Codes Corporation, Ann Arbor, MI, USA) or SeqTrace ver. 0.9.0 (Stucky 2012). GenBank accession numbers for all the sequences are listed in Table 1.

Alignments of all genes were created using MAFFT ver. 7 on the MAFFT server (<http://mafft.cbrc.jp/alignment/server/>). Resulting alignments were visually inspected in BioEdit ver. 7.2.5 (Hall 1999). Unreliably aligned regions of rRNA genes were removed in ClipKIT ver. 2.2.2 (Steenwyk *et al.* 2020) using the -gappy option with a threshold of 0.7. The alignments were concatenated using FASconCAT ver. 1.0 (Kück & Longo 2014). The final data matrix consisted of 1951 characters: 16S – 344 bp, 28S – 949 bp and COI – 658 bp.

The final concatenated dataset was partitioned by gene and codon position and subsequently analysed using the Maximum likelihood (ML) method. Analyses were conducted using IQtree (Nguyen *et al.* 2015). Best-fitting substitution models were chosen automatically by the IQ-TREE software: K3Pu+F+G4:16S; HKY+F+I:28S; HKY+F+G4:COI_1, TNe+G4:COI_2, HKY+F:COI_3; without free-rate heterogeneity. Branch supports were evaluated using 1000 ultrafast bootstrap (Hoang *et al.* 2017). All other settings were left as default. The node support values are given in the form of ultrafast bootstrap (= ufboot). The resulting phylogenetic tree (consensus tree) was visualized using Interactive Tree Of Life (iTOL ver. 7.0; Letunic & Bork 2024).

Results

Four new species are described. In addition, all three previously known European species are illustrated to provide broader comparative context. Given that a substantial portion of the genus is covered here, we provide a revised key to the world's species.

Key to the world species of *Grzegorzekia* (males) (updated and modified from Fitzgerald 2019)

1. Mid-tibial organ present (Fitzgerald 2019: fig. 6); (Nearctic) 2
 - Mid-tibial organ absent; (Palearctic, Nearctic, Holarctic, Oriental) 3
2. Male cerci without a strong, black, spine-like seta; gonocoxal comb of black spine-like setae visible in dorsal view (Fitzgerald 2019: fig. 5; com); gonocoxal lobe slender, elongate with apical setae (Fitzgerald 2019: figs 3–4; gc lb) ***G. kerri*** Fitzgerald, 2019 (western Nearctic)
 - Male cerci each with a single, strong, black spine-like seta; gonocoxal comb of black spine-like setae not visible in dorsal view; gonocoxal lobe short, cow-horn-like, without apical setae (Fitzgerald 2019: figs 7–9; gc lb) ***G. quercus*** Fitzgerald, 2019 (western Nearctic)

3. In lateral view, section II of the gonocoxite simple, without additional lobes or outgrowths along ventral and posteroventral margin; a single comb along posteroventral margin consists of 13–15 stout spines; additional 1–2 spines situated at posteroventral corner (Fig. 6C–D)
..... *G. bushyae* Chandler, 2015 (Europe: England, France, Belgium, Italy)
- In lateral view, section II of the gonocoxite complex, with posteroventral corner drawn out to a lobe; posterior comb consists at most of 10 spines; additional 1–2 separate spines may be present (Figs 3C, 8C, 11C, 15C, 17C)4 (Palaeartic, Holarctic, Nearctic, Oriental)
4. Section II of the gonocoxite with two spines at posterior margin and with a comb of spines posterointernally (Figs 15C, 17C); gonocoxal synsclerite with medioventral outgrowth (Fig. 19; gc l mv); posterior projection of the gonocoxal apodeme beak-shaped5 (Oriental)
- Section II of the gonocoxite with only a single comb of spines along posterior margin (Figs 3C, 8C, 11C); gonocoxal synsclerite without medioventral outgrowth (Fig. 13); posterior projection of the gonocoxal apodeme digitate and curved or hook-shaped6 (Palaeartic, Nearctic, Holarctic)
5. Posteroventral outgrowth of the gonocoxite section II large, wider than long (Fig. 15C); in ventral view medioventral outgrowth of the gonocoxal synsclerite bifurcate (Fig. 19A)
..... *G. bruneiensis* Kurina & Ševčík sp. nov. (Oriental: Brunei)
- Posteroventral outgrowth of the gonocoxite section II narrow, longer than wide (Fig. 17C); in ventral view medioventral outgrowth of the gonocoxal synsclerite deltoid (Fig. 19B)
..... *G. taiwanica* Kurina & Ševčík sp. nov. (Oriental: Taiwan)
6. Aedeagus apically not divided 7
- Aedeagus apically bifurcate (Figs 3A, 21A) 8
7. Aedeagus slender, nearly parallel-sided, elongate, extending beyond apex of gonocoxites (Fig. 11A)
..... *G. hungarica* Papp & Ševčík, 2007 (Europe: Hungary, Slovakia, Estonia, Sweden, Norway)
- Aedeagus triangular, shorter, not reaching apex of gonocoxites (Fig. 8A)
..... *G. collaris* (Meigen, 1818) (Holarctic)
8. Section II of the gonocoxite with posterodorsal corner drawn out to a clearly outlined hump well discernible in lateral view (Fig. 3C); aedeagus apically bifurcate, with deep and wide medial concavity; posterior projection of gonocoxal apodeme tapering, very long, curved dorsad
..... *G. pseudocollaris* Kurina, Ševčík & Kjaerandsen sp. nov. (Europe: Slovakia, Czech Republic, Italy)
- Section II of the gonocoxite with posterodorsal corner without hump (Fig. 21C); aedeagus apically bifurcate, with deep and narrow medial concavity; posterior projection of gonocoxal apodeme tapering, considerably short, curved dorsad
..... *G. canadensis* Kurina & Kjaerandsen sp. nov. (Nearctic)

Taxonomy

Phylum Arthropoda Latreille, 1829
Class Insecta Linnaeus, 1758
Order Diptera Linnaeus, 1758
Infraorder Bibionomorpha Hennig, 1954
Superfamily Sciaroidea Billberg, 1820
Family Mycetophilidae Newman, 1834
Subfamily Gnoristinae Edwards, 1925
Genus *Grzegorzekia* Edwards, 1941

European species

Grzegorzekia pseudocollaris Kurina, Ševčík & Kjaerandsen sp. nov.
urn:lsid:zoobank.org:act:59C83D15-70D8-424C-83C3-5711DAD7D142
Figs 2–5, 13C

Differential diagnosis

Most readily distinguished by the stout, apically bifurcate aedeagus with widely separated prongs (Fig. 3A, D), in combination with a very long, tapering posterior projection of the gonocoxal apodeme (pp gap) curved dorsad and clearly surpassing section II posteriorly (Fig. 3C). Section II of the gonocoxite bears a comb of 8–9 spines at the posteroventral corner and a thin, hooked, apically setose gonocoxal lobe (lb gc II) projecting posteriad to about one-fifth of section II height. It comes closest to *G. canadensis* sp. nov. and *G. collaris* but differs from *G. canadensis* by the longer, stouter pp gap and the presence of a posterodorsal hump on section II (Fig. 3C), and from *G. collaris* by the broader, more widely bifurcate aedeagus and stouter pp gap.

Etymology

The specific epithet ‘*pseudocollaris*’ is a compound formed from the Greek prefix ‘pseudo-’ (‘false, deceptive, resembling’) and ‘*collaris*’ (the name of the widespread Holarctic congener). It means ‘false *collaris*’ or ‘resembling *collaris*’, referring to the close similarity of the new species to *Grzegorzekia collaris* and its prior confusion with that species. The epithet is an adjectival compound of the third Latin declension.

Type material

Holotype

SLOVAKIA • ♂, dry-mounted from ethanol, terminalia in glycerine; Muránska planina National Park, Maretkiná; 48.771° N, 20.029° E; 26 May 2009; O. Kurina leg.; sweep net; IZBE, IZBE0222462; this specimen was misidentified and published as *G. collaris* by Ševčík & Kurina (2011: 103).

Paratypes

CZECH REPUBLIC • 1 ♂, in ethanol; Krkonoše Mts, Velká Kotelní jáma, glacial cirque; 6 Jun.–14 Jul. 2025; J. Ševčík and K. Sopuch leg.; Malaise trap; NMPC, JSBA672 • 1 ♂, in ethanol; same data as for preceding; SMOČ, JSBA672B • 2 ♂♂, in ethanol; same data as for preceding; JSL-OUC, JSBA672D, JSBA672E • 1 ♀, in ethanol; same data as for preceding; JSL-OUC, JSBA672C.

SLOVAKIA • 2 ♂♂, in ethanol; Muránska planina National Park, Havrania dolina National Nature Reserve; 12 May–16 Jun. 2016; J. Roháček and J. Ševčík leg.; Malaise trap; JSL-OUC, JSBA413, JSBA413A • 1 ♀, in ethanol; same data as for preceding; JSL-OUC, JSBA413AA.

Other material examined

ITALY • 1 ♂, in ethanol; Abruzzo, L'Aquila, Pescasseroli, Bosco della Difesa; 41.761° N, 13.777° E; 1423 m a.s.l.; 15 May–3 Jun. 2024; F. Paone leg.; Malaise trap in beech forest; Compound tube ID: 4077003684; ZMHB, IMY0001265 • 1 ♂, in ethanol; Lazio, Frosinone, Campoli Appennino, Vallone Carbonara; 41.789° N, 13.723° E; 1474 m a.s.l.; 3–22 Jun. 2024; F. Paone leg.; Malaise trap in beech forest; compound tube ID: 4077002498; ZMHB, IMY0000199.

Description

Male (Fig. 2A)

MEASUREMENTS. Body length 5.7–6.0 mm (n = 2).

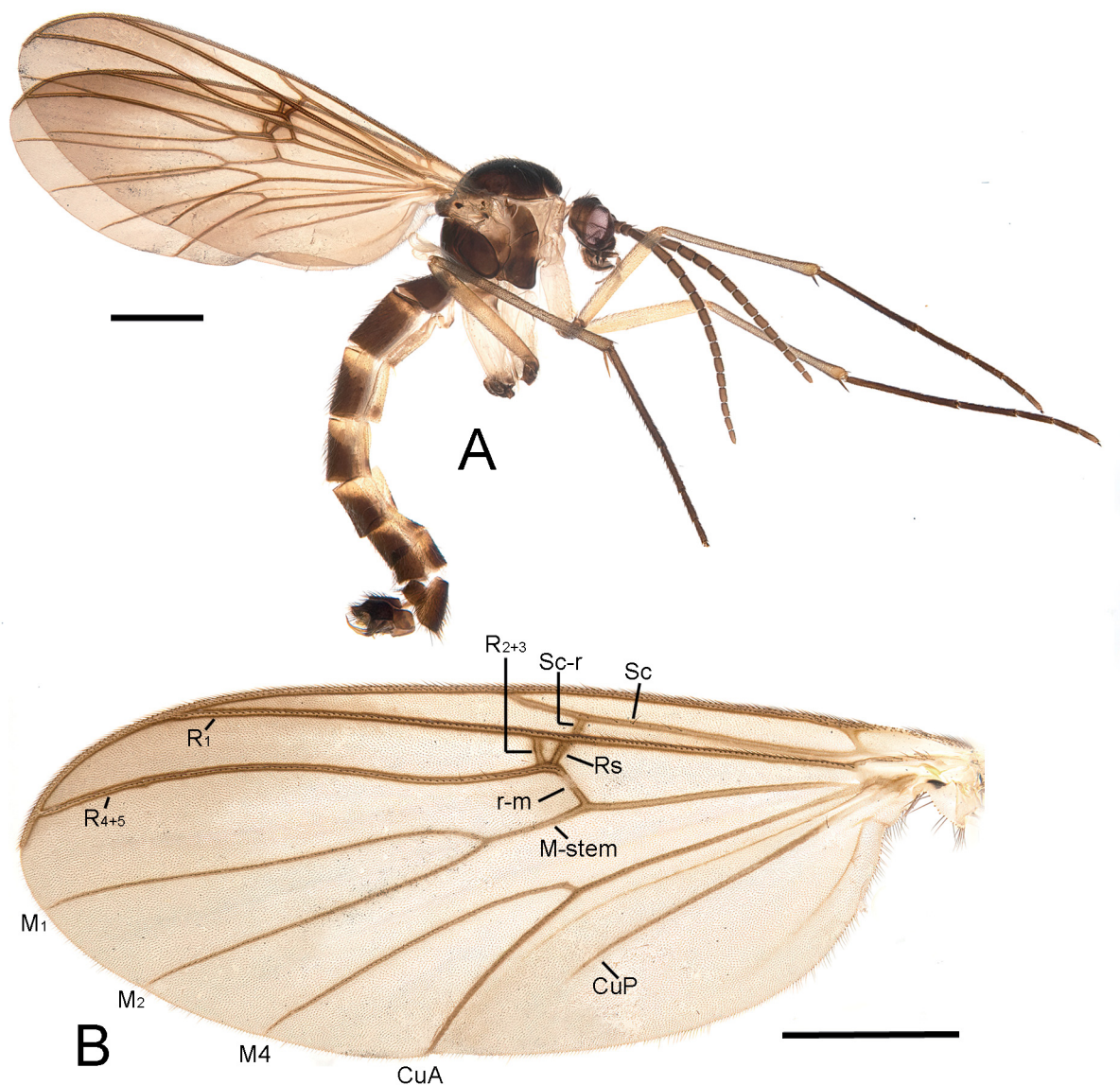


Fig. 2. *Grzegorzekia pseudocollaris* Kurina, Ševčík & Kjaerandsen sp. nov., paratype, ♂ (JSBA413, JSL-OUC). **A.** Habitus, lateral view. **B.** Wing, dorsal view. Scale bars = 1 mm.

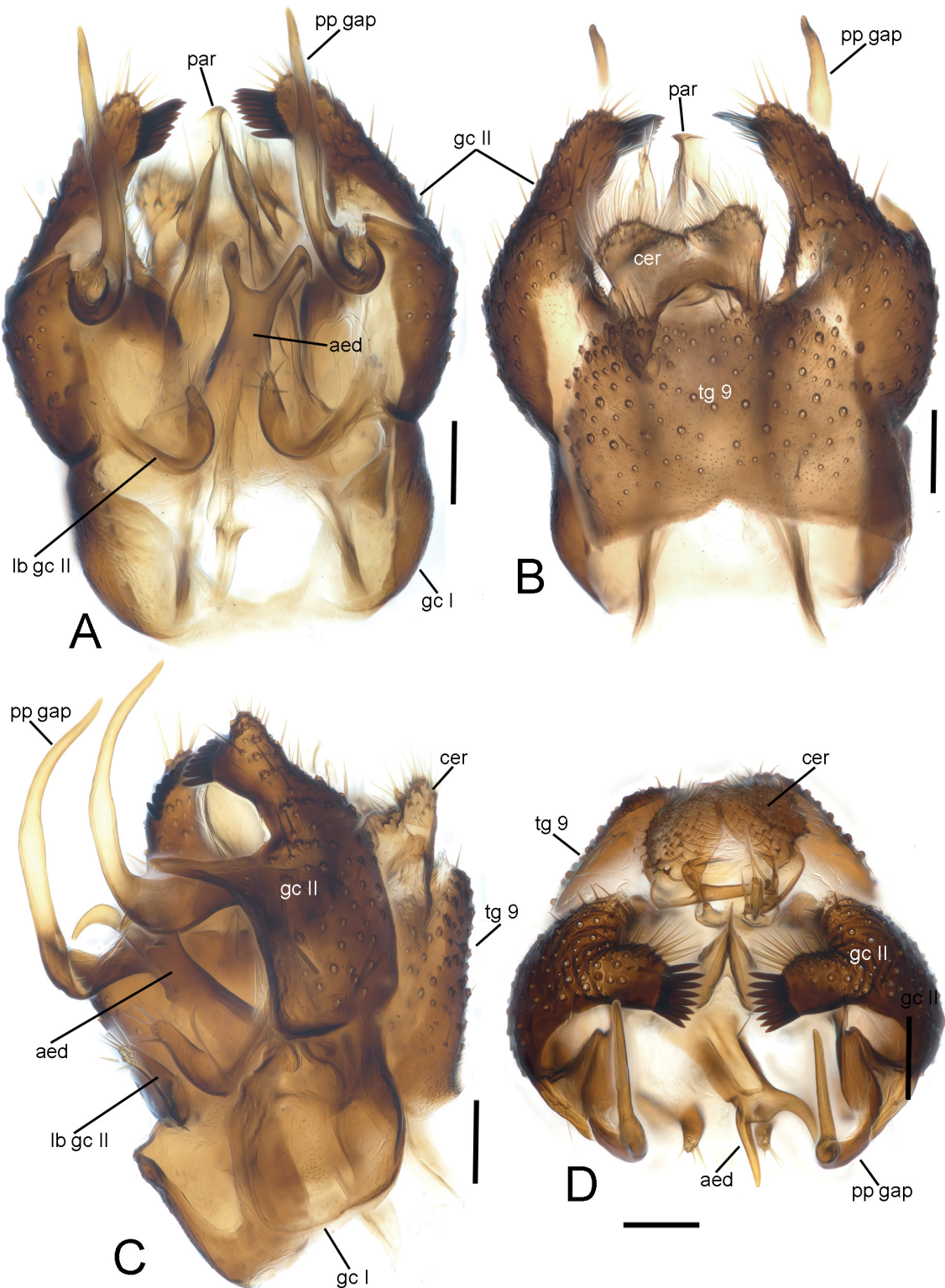


Fig. 3. *Grzegorzekia pseudocollaris* Kurina, Ševčík & Kjaerandsen sp. nov., holotype, ♂ (IZBE0222462, IZBE), terminalia. **A.** Ventral view. **B.** Dorsal view. **C.** Lateral view. **D.** Posterior view. Abbreviations: aed = aedeagus; cer = cercus; gc I, II = gonocoxite sections 1, 2; lb gc II = lobe of gonocoxal section 2; par = paramere; pp gap = posterior projection of gonocoxal apodeme; tg 9 = tergite 9. Scale bars = 0.1 mm.

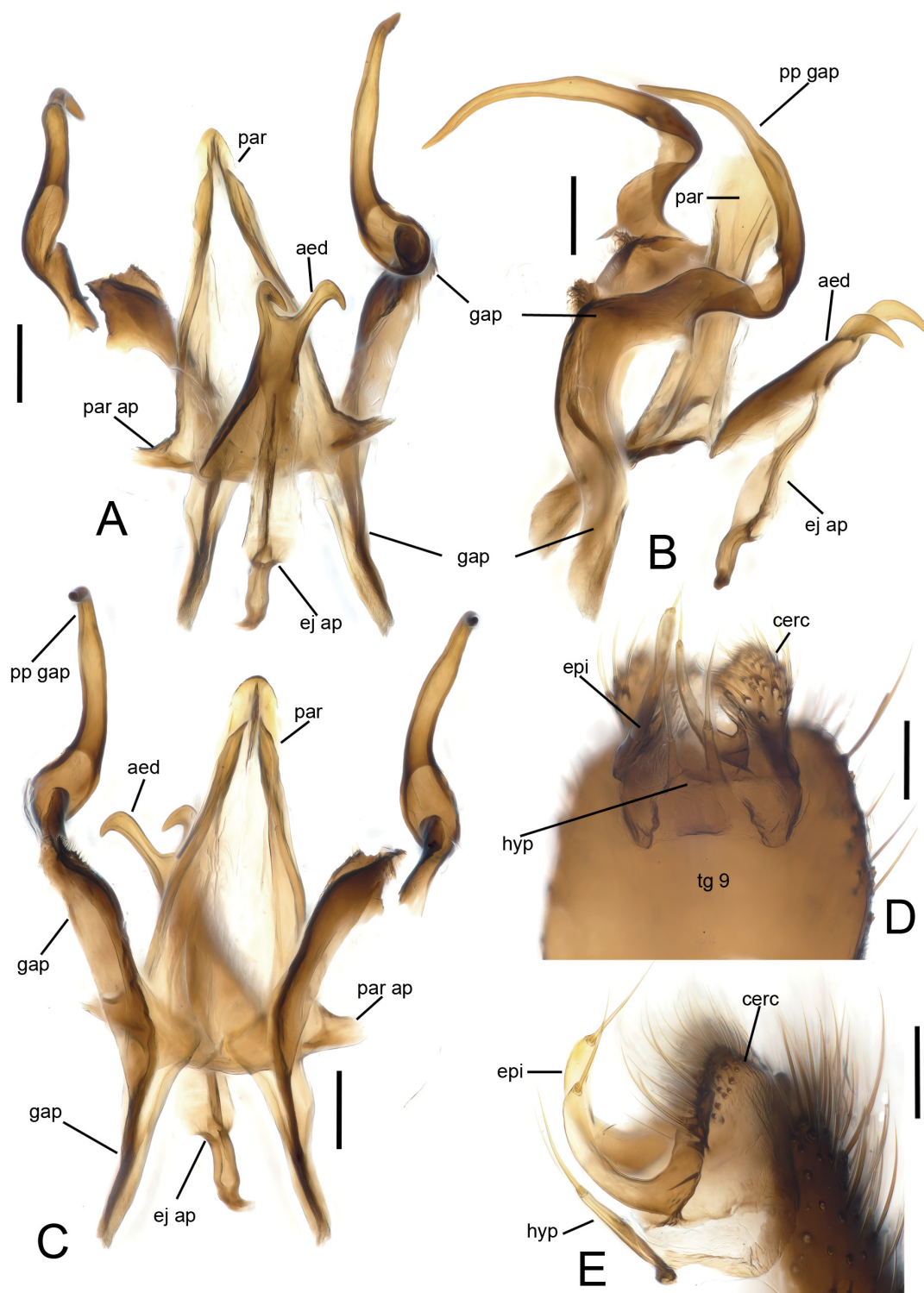


Fig. 4. *Grzegorzekia pseudocollaris* Kurina, Ševčík & Kjaerandsen sp. nov., paratype, ♂ (JSBA413, JSL-OUC). A. Aedeagal complex, ventral view. B. Aedeagal complex, lateral view. C. Aedeagal complex, dorsal view. D. Proctiger, ventral view. E. Proctiger, lateral view. One pp gap is broken but photographed alongside. Abbreviations: aed = aedeagus; cerc = cercus; ej ap = ejaculatory apodeme; epi = epiproct; gap = gonocoxal apodeme; hyp = hypoproct; par = paramere; par ap = parameral apodeme; pp gap = posterior projection of gonocoxal apodeme; tg = tergite. Scale bars = 0.1 mm.

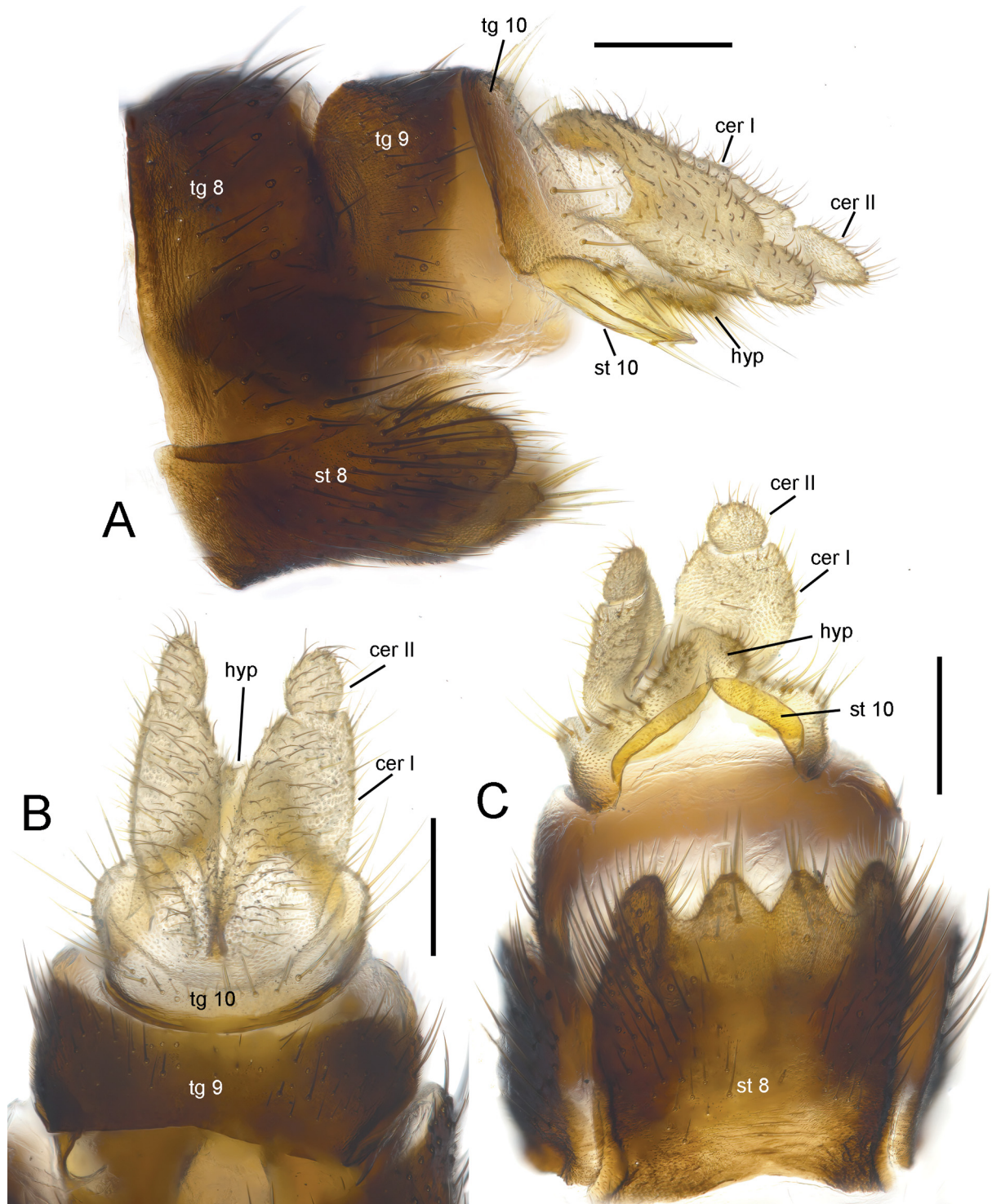


Fig. 5. *Grzegorzekia pseudocollaris* Kurina, Ševčík & Kjaerandsen sp. nov., paratype, ♀ (JSBA413, JSL-OUC), terminalia. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. Abbreviations: cer = cercus; hyp = hypoproct; st = sternite; tg = tergite. Scale bars = 0.2 mm.

HEAD. Brown with short brown setae. Three ocelli, lateral ocelli equal to their diameter distant from the eye margin. Antennae ~1.3 times as long as head+thorax. Scape and pedicel short, thick and brown; scape somewhat conical, ~1.2 times as long as pedicel. Fourteen elongate, brown flagellomeres shortening distally, basal flagellomere ~3.2 times as long as wide.

THORAX. Mesonotum dark brown, with marginal areas lighter laterally; scutellum, mediotergite and laterotergite dark brown; anepisternum, anepimeron and katepisternum somewhat lighter; antepronotum and proepisternum pale yellow. Mesonotum with short pale setosity; well-delimited lines of acrostichal and dorsocentral setae present. Scutellum with marginal setae not arranged into pairs. Antepronotum and proepisternum with setae, rest of the thorax bare.

LEGS. Coxae pale yellow, trochanters brown, femora and tibiae yellow, tarsi brown. Mid tibia parallel-sided, without sensory area along dorsal surface. Fore tibia without setae; mid tibia with 5–6a, 5d, 5–6p and 2–3pv; hind tibia with 8a, 10–11d, 5p. Tibial spurs 1:2:2. Tarsal claw with a basal tooth, empodia undeveloped.

WINGS (Fig. 2B). 5.4–5.8 mm ($n = 2$). Hyaline without distinct markings but somewhat infuscated apically and around crossvein r–m. Veins brown, all with dorsal setae except: Rs, R_{2+3} , r–m, base and stem of M. Sc ending beyond R_{2+3} , sc–r ending before base of Rs and slightly before the level of the posterior fork. Radial cell trapezoid, both Rs and R_{2+3} oblique. Stem M more than twice as long as r–m. Posterior fork beginning basal to level of medial fork, arising at level of Rs. CuP ending at level of posterior fork. Both stem and knob of halter yellow.

ABDOMEN. Brown, with tergites II–VI yellowish anteriorly.

TERMINALIA (Figs 3A–D, 4A–E, 13C). Tergite 9 broader than long with broad V-shaped emargination on anterior edge and shallow concavity on posterior edge (Fig. 3B). Gonocoxite consists of two sections, well exposed in ventral and lateral views. In lateral view: (1) gonocoxite section I sub-quadrangular, bare; (2) gonocoxite section II elongated, setose, anterior two-thirds about twice as wide as posterior one-third, with medial ventrally projecting and tapering outgrowth, posterior third slightly bent ventrad, and with a comb of 8–9 spines at posteroventral corner. Posterior projection of the gonocoxal apodeme shaped as a curved, digitate, bare lobe, projecting well beyond section II posteriorly, associated anteriorly with the gonocoxal apodeme. Gonocoxal section II anteriorly with thin, hooked, apically setose gonocoxal lobe projecting posteriad to level of ca one-fifth section II height; apical setae approximately equal to lobe width apically. Gonostylus absent. Aedeagus bifurcate, with both apical prongs hooked ventrad. Parameres exposed dorsad from aedeagus, with lateral lobes, fused apically; in ventral view triangular, with more sclerotized lateral sections. Cerci posteriorly rounded, somewhat extended medially, anteriorly fused, with U-shaped anterior margin. Hypoproct membranous, with a pair of small digitate lobes bearing apical seta. Epiproct membranous, with a pair of digitate, apical seta-bearing lobes, about twice the size of the similar lobes on hypoproct.

Female

Similar to male, except body length 7.1 mm ($n = 1$), wing length 6.8 mm ($n = 1$). Basal segment of cerci elongated, about four times as long as the second segment, which is sub-rounded, slightly longer than wide. Sternite 8 in lateral view posteriorly rounded; in ventral view, posterior margin four-lobed, with setose lateral and medial lobes. Setae on medial lobes somewhat thicker than those on lateral lobes (Fig. 5).

Distribution

Known from Central and southern Europe: Czech and Slovak Republics and Italy.

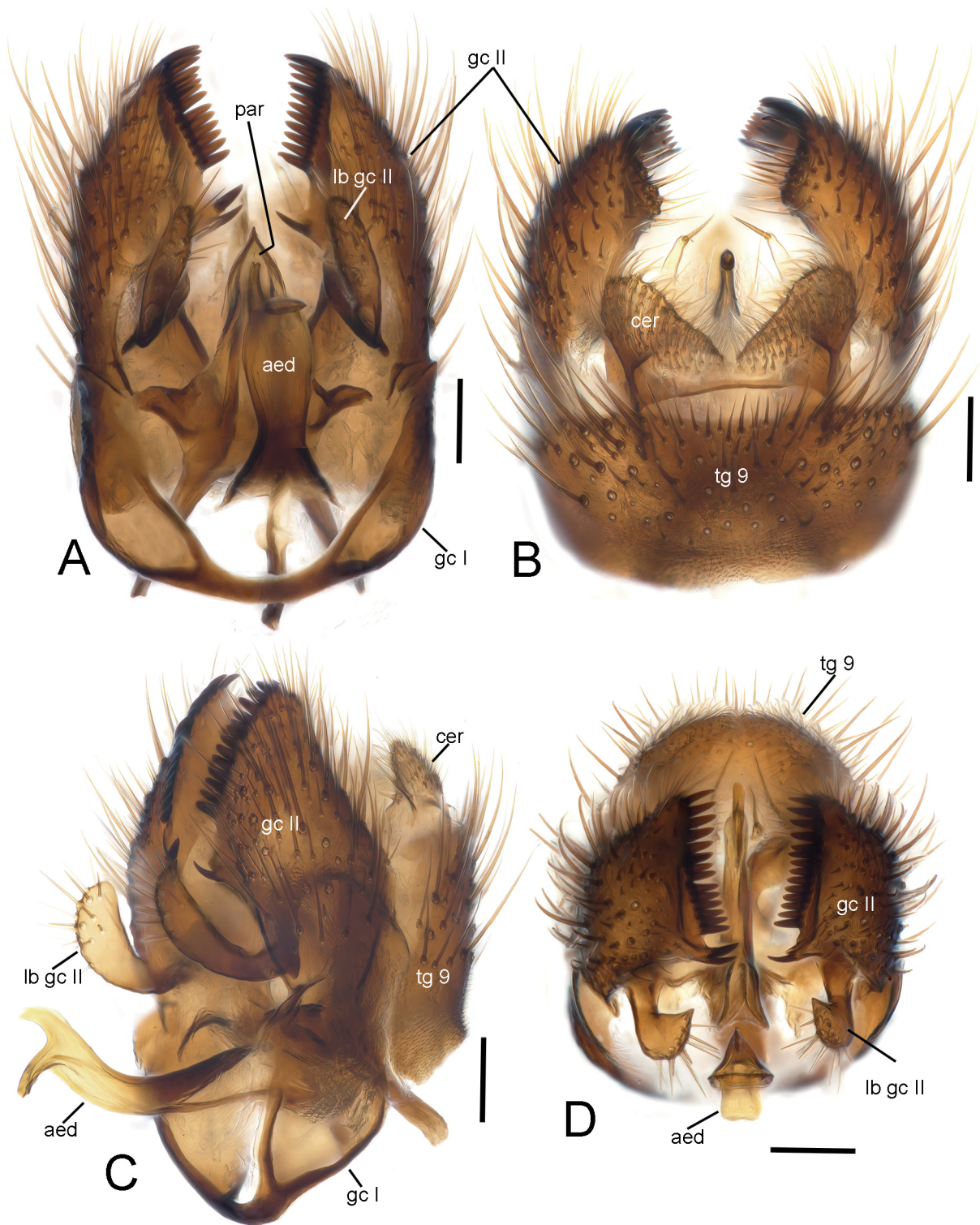


Fig. 6. *Grzegorzekia bushyae* Chandler, 2015, ♂ (RBINS), terminalia. A. Ventral view. B. Dorsal view. C. Lateral view. D. Posterior view. Abbreviations: see Fig. 3. Scale bars = 0.1 mm.

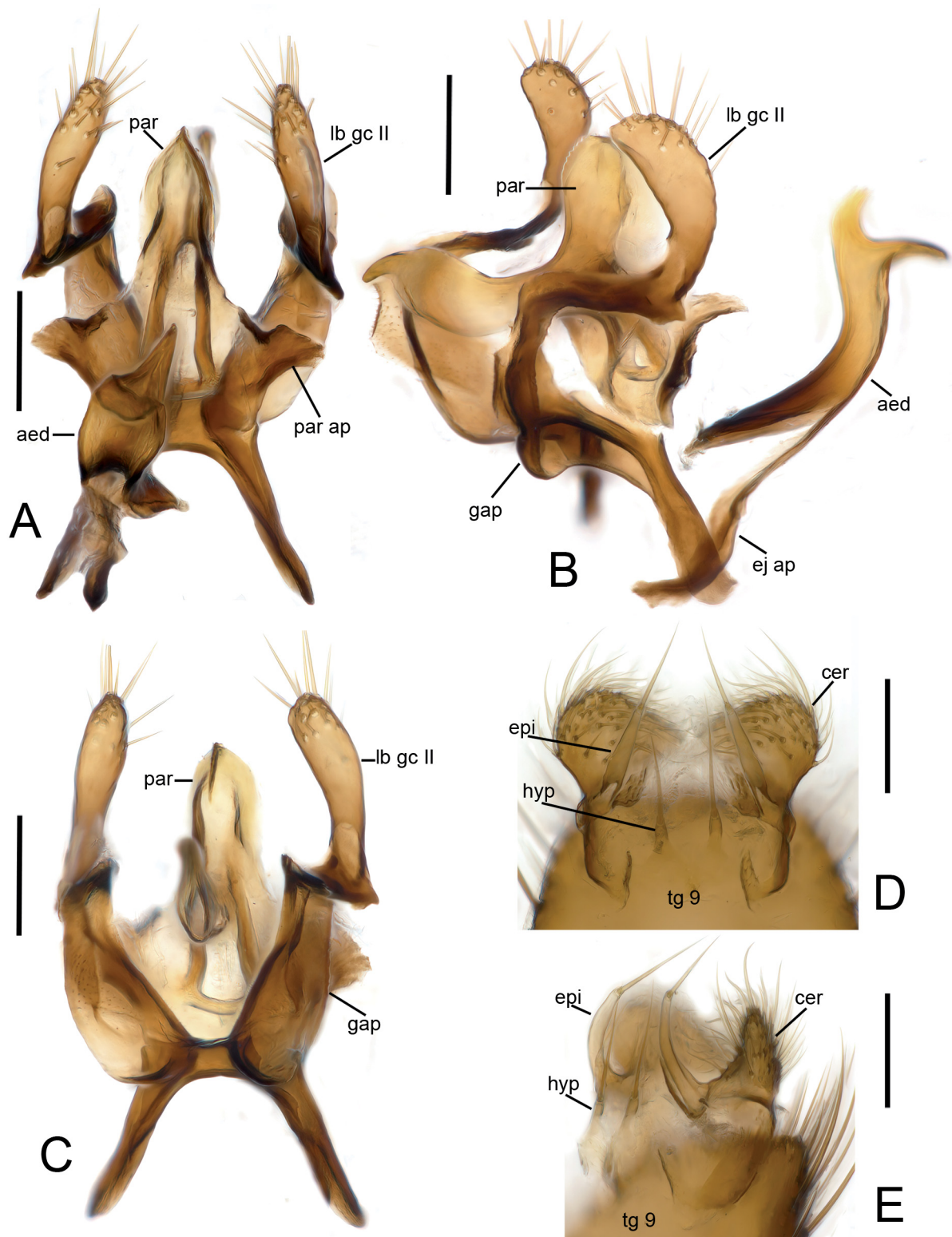


Fig. 7. *Grzegorzekia bushyae* Chandler, 2015, ♂ (RBINS). **A.** Aedeagal complex, ventral view. **B.** Aedeagal complex, lateral view. **C.** Aedeagal complex, dorsal view. **D.** Proctiger, ventral view. **E.** Proctiger, lateral view. Abbreviations: see Fig. 4. Scale bars = 0.1 mm.

Grzegorzekia bushyae Chandler, 2015
Figs 6–7, 13D

Differential diagnosis

Readily recognized by the simple ventral/posteroventral margin of section II of the gonocoxite, which bears a broad comb of 13–15 stout dentate spines with an additional 1–2 separate spines at the posteroventral corner (Fig. 13D). The aedeagus is uniquely shaped, with a down-curved subapical projection (Fig. 6C). The gonocoxal synsclerite lacks any medioventral outgrowth. This combination separates *G. bushyae* from all congeners with more complex posteroventral lobes and smaller combs on section II.

Type material

Paratype

GREAT BRITAIN • 1 ♂, in ethanol; Bushy Park, Waterhouse Plantation; 13 Aug. 2011; P.J. Chandler leg.; JSL-OUC, JSGS40; published by Chandler (2015).

Other material examined

BELGIUM • 1 ♂, in ethanol; Brussels, Botanical Garden Jean Massart; 50.814° N, 4.439° E; 23 Jun.–1 Jul. 2016; P. Grootaert *et al.* leg.; Malaise trap 3; RBINS; published by Kurina & Grootaert (2023: 48) • 1 ♂, in ethanol; same data as for preceding; 50.814° N, 4.435° E; 7–21 Sep. 2017; Malaise trap 6; RBINS; published by Kurina & Grootaert (2023: 48).

ITALY • 1 ♂, in ethanol; CZ, Taverna, Central Calabria, Sila National Park, Gariglione Reserve, “A6”; 39.133° N, 16.641° E; 1693 m a.s.l.; 2–14 Oct. 2024; G. Scrivano leg.; Malaise trap in mixed beech forest; Compound tube ID: 4076952053; ZMHB, IMY0005998 • 1 ♂, in ethanol; same data as for preceding, except “B3”; 39.147° N, 16.645° E; 1468 m a.s.l.; 15 May–3 Jun. 2024; G. Scrivano leg.; Malaise trap in mixed beech forest; Compound tube ID: 4076996837; ZMHB, IMY0002099 • 1 ♂, in ethanol; KR, Petilia Policastro, Central Calabria, Sila National Park, Gariglione Reserve, “A8”; 39.149° N, 16.675° E; 1507 m a.s.l.; 4–14 Oct. 2024; G. Scrivano leg.; Malaise trap in mixed beech forest; Compound tube ID: 4076973820; ZMHB, IMY0003518.

Remarks

This European species was described only recently and has so far been recorded from south-eastern France, Britain (Chandler 2015, 2020) and Belgium (Kurina & Grootaert 2023). The first two British specimens were collected in Bushy Park, on the outskirts of London, after which the species was named (Chandler 2015). Further specimens were obtained in 2019 from ancient woodland in Gloucestershire, west of London (Chandler 2020). Its biology is presumed to resemble that of *G. collaris*, with a reliance on damp, decayed wood (Chandler 2015). Given the few known localities, the species may be either genuinely rare or overlooked due to its specialized habitat requirements. Like *G. collaris*, it may be saproxylic, depending on fungal decay processes in fallen or standing dead timber. New country record for Italy.

Grzegorzekia collaris (Meigen, 1818)
Figs 8–10, 13A

Differential diagnosis

Most readily distinguished by the relatively short, triangular aedeagus with a down-curved tip and only moderate apical splitting (Fig. 8A, C), together with slender, tapering posterior projections of the gonocoxal apodeme and the absence of a medioventral outgrowth on the gonocoxal synsclerite (Fig. 13A). It is closest to *G. pseudocollaris* sp. nov. and *G. canadensis* sp. nov. but differs from

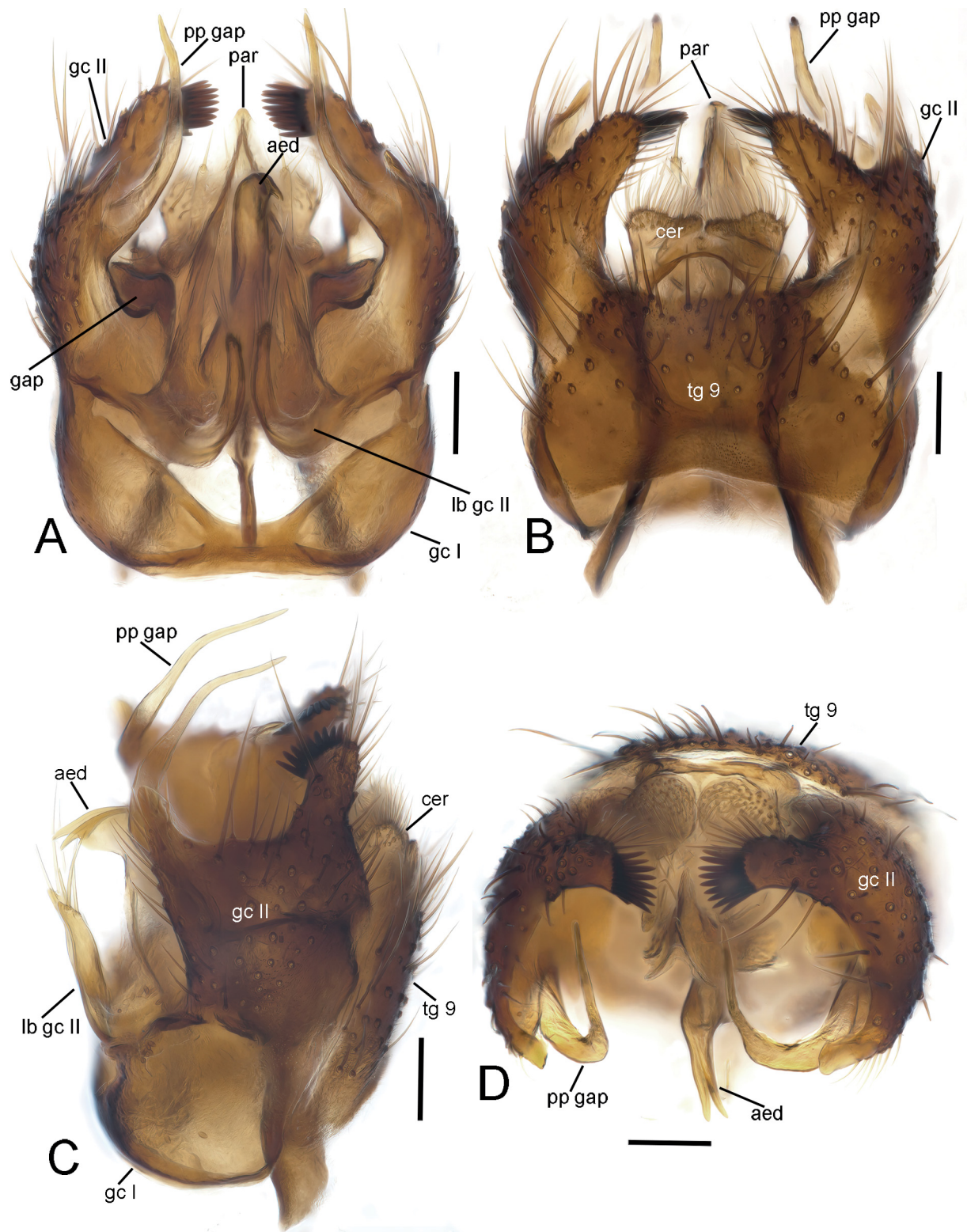


Fig. 8. *Grzegorzekia collaris* (Meigen, 1818), ♂ (IZBE0222463, IZBE), terminalia. **A.** Ventral view. **B.** Dorsal view. **C.** Lateral view. **D.** Posterior view. Abbreviations: see Fig. 3. Scale bars = 0.1 mm.

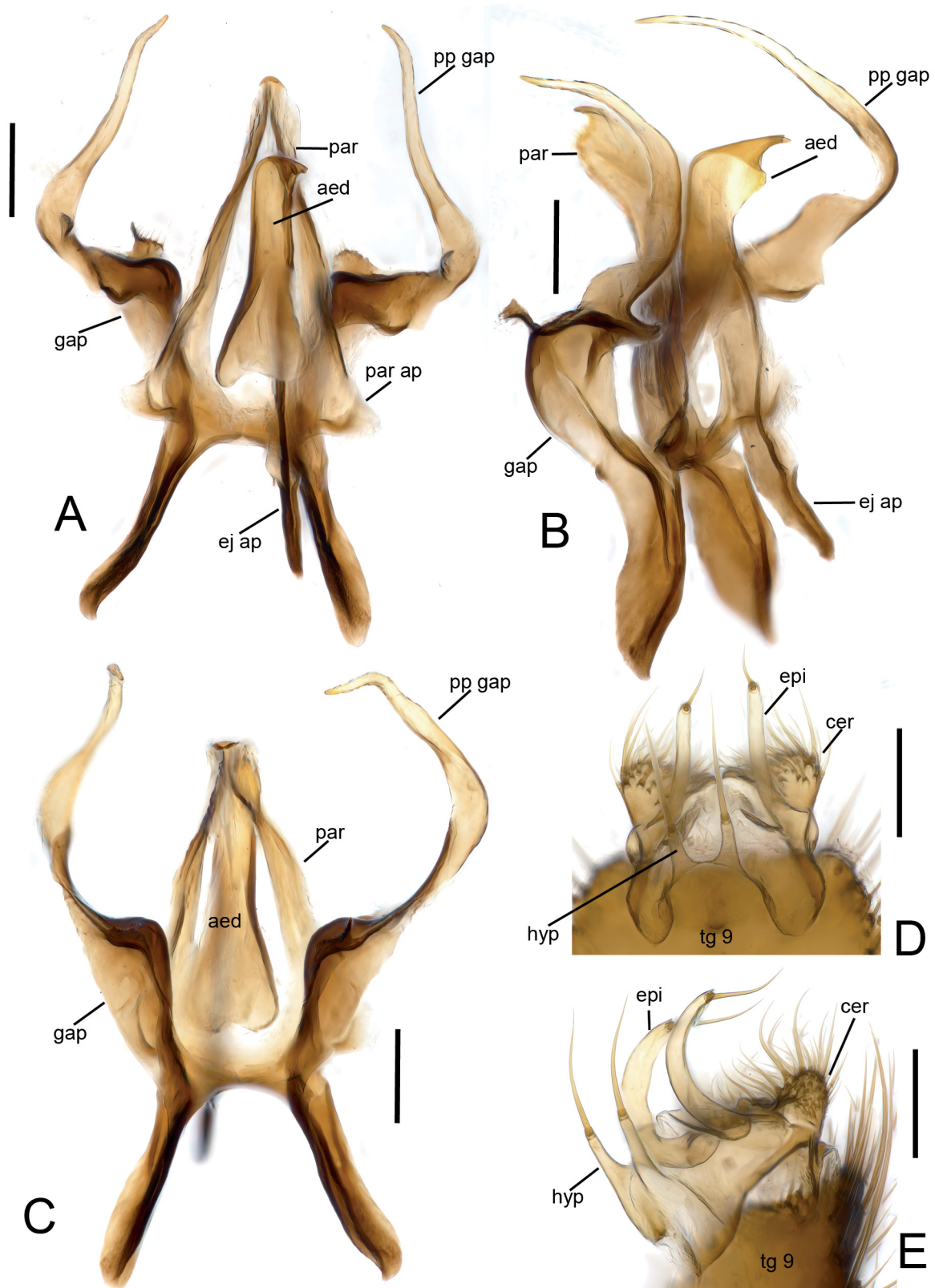


Fig. 9. *Grzegorzekia collaris* (Meigen, 1818), ♂ (IZBE0222463, IZBE). A. Aedeagal complex, ventral view. B. Aedeagal complex, lateral view. C. Aedeagal complex, dorsal view. D. Proctiger, ventral view. E. Proctiger, lateral view. Abbreviations: see Fig. 4. Scale bars = 0.1 mm.

G. pseudocollaris by the less widely bifurcate aedeagus and much more slender pp gap, and from *G. canadensis* by the more tapered pp gap and subtle differences in the shape of section II.

Material examined

CZECH REPUBLIC • 1 ♀; Podyjí National Park, 9 mlýnů; 21 Jul.– 3 Sep. 2025; K. Sopuch and J. Ševčík leg.; Malaise trap; JSL-OUC, JSBA698.

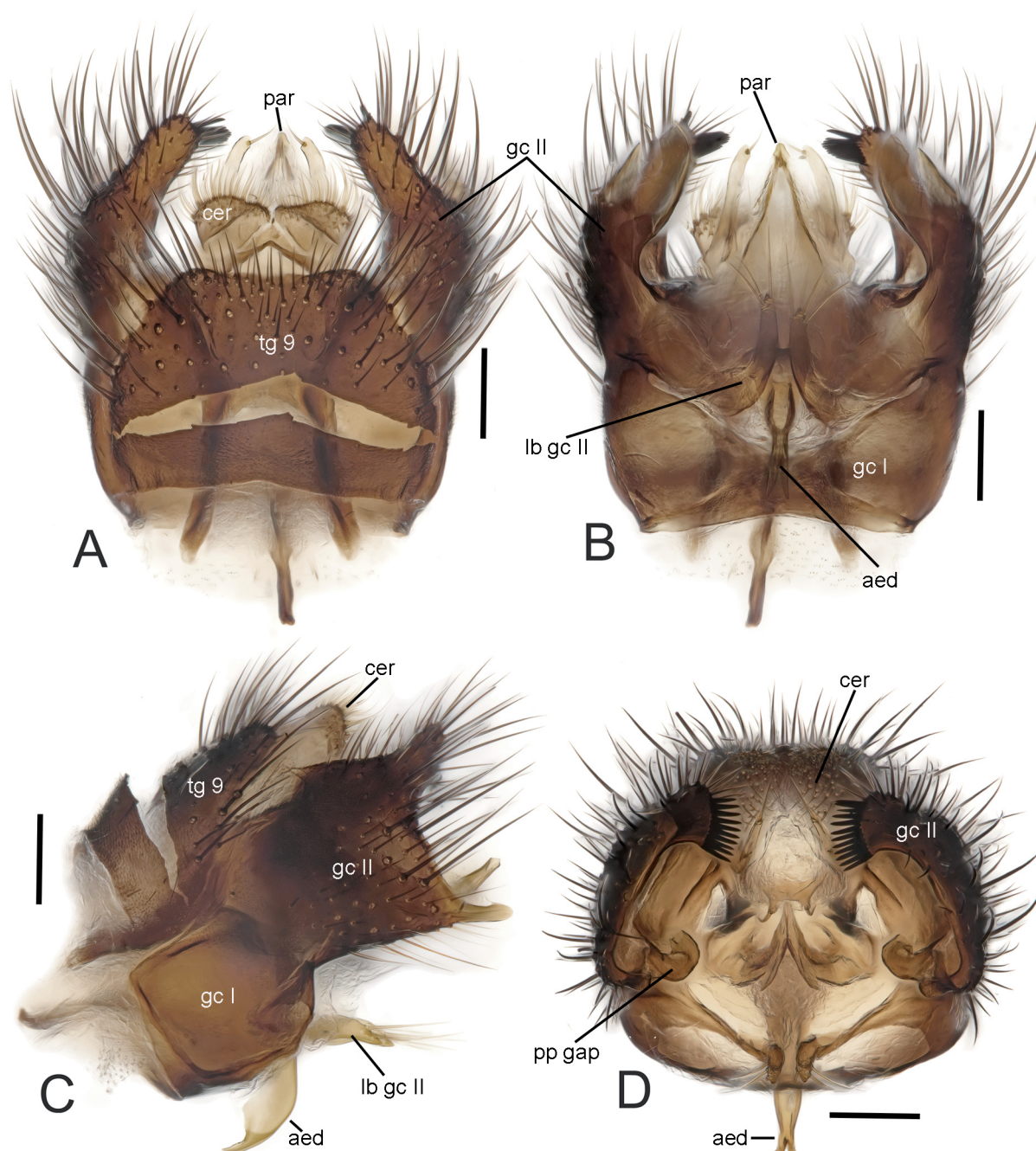


Fig. 10. *Grzegorzekia collaris* (Meigen, 1818), ♂ (TSZDJKJ116235), maldeveloped terminalia. A. Dorsal view. B. Ventral view. C. Lateral view. D. Posterior view. Abbreviations: see Fig. 3. Scale bars = 0.1 mm.

ESTONIA • 1 ♂, glued on card point with terminalia in glycerine; Endla NR, Tooma village; 58.875° N, 26.267° E; 4–11 Jun. 1995; K. Kimmel leg.; light trap; IZBE, IZBE0222463 • 2 ♂♂, in ethanol with terminalia in glycerine; Haanja NP; 57.735° N, 27.064° E; 23 Jul.–23 Aug. 2017; I. Süda leg.; trunk window trap; IZBE, IZBE0250770, IZBE0254101.

FINLAND • 2 ♂♂; Li, Utsjoki, Kevo SNR, Tsieskuljärvi at road entrance to KBI; 69.724° N, 27.043° E; 4–17 Jul. 2014; J. Kjørandsen leg.; site 4, interception trap + red pan trap; TMU, TSZD-JKJ-100850, TSZD-JKJ-100134.

GEORGIA • 1 ♂, in ethanol; Samegrelo-Zemo Svanethi, S of Lakhushdi, meadow; 42.999° N, 42.651° E; 1270 m a.s.l.; 13–14 Jun. 2019; X. Mengual leg.; Malaise trap; IZBE, IZBE0254102; published by Kurina (2021: 104) • 1 ♂, in ethanol; Imereti, Marelisi; 41.947° N, 43.284° E; 450 m a.s.l.; 20 May 2012; O. Kurina leg.; sweeping; IZBE, IZBE0254103, published by Kurina (2021: 104) • 1 ♂, in ethanol; Shida-Kartli, W of Surami; 42.026° N, 43.498° E; 940 m a.s.l.; 18 May 2012; O. Kurina leg.; sweeping; IZBE, IZBE0254104; published by Kurina (2021: 104).

NORWAY • 1 ♂, 1 ♀; Rogaland (RY), Sokndal, Kvam; 58.342° N, 6.271° E; 50 m a.s.l.; 14 May–3 Jun. 2023; J. Birkeland leg.; Malaise trap; TMU, TSZD-JKJ-116235, TSZD-JKJ-116236 • 4 ♂♂, 3 ♀♀; Vestland (HOY), Sveio, Førde, Dalen; 59.611° N, 5.478° E; 20 m a.s.l.; 1 Jan–17 Aug 2023; J. Kjørandsen leg.; TMU, TSZD-JKJ-116580, TSZD-JKJ-116581 • 1 ♂; Troms (TRY), Tromsø, Oldervik, Innernebbba; 69.738° N, 19.700° E; 40 m a.s.l.; 23 Jun.–1 Sep. 2019; J. Kjørandsen leg.; Malaise trap; TMU, TSZD-JKJ-107704.

SLOVAKIA • 1 ♂, in ethanol; Muránska planina National Park, Poľudnica National Nature Reserve; 24 May–21 Jun. 2013; J. Roháček and J. Ševčík leg.; Malaise trap; JSL-OUC, JSBA413C • 1 ♂, in ethanol; Muránska planina National Park, Poľudnica National Nature Reserve; 21 Jun. 2013; J. Ševčík leg.; sweep netting; JSL-OUC, JSGS17 (living specimen photographed, see Fig. 1); used in the phylogenetic analysis by Kaspřák *et al.* (2019) • 1 ♂, in ethanol; Muránska planina National Park, Šarkanica National Nature Reserve; 11 Jul.–9 Aug. 2017; J. Roháček and J. Ševčík leg.; Malaise trap; JSL-OUC, JSBA413B • 1 ♂, in ethanol; Prešov district, Lažany village; 49.037° N, 21.096° E; 16–23 Jun. 2023; P. Manko and J. Oboňa leg.; Malaise trap; IZBE, IZBE0254105; published by Kurina *et al.* (2024: 201).

SWEDEN • 1 ♂, 1 ♀; HA, Halmstads k.n., Skällås; 11 May–15 Jul. 2011; M. Lindström leg.; Malaise trap; TMU, TSZD-JKJ-260173, TSZD-JKJ-260174 • 3 ♂♂; LU, Jokkmokk, Kaltisbäcken 1 km NNE of Messaure; 66.691° N, 20.377° E; 250 m a.s.l.; 12 Jul.–17 Aug. 2004; J. Kjørandsen and K. Hedmark leg.; Malaise trap; TMU, TSZD-JKJ-233366.

Remarks

This is a widespread but rather uncommon species, recorded widely across Europe and also known from the Eastern Palaearctic (Fauna Europaea data downloaded in 2021; De Jong *et al.* 2014) and the Nearctic Regions (Fitzgerald 2019). One examined male specimen (TSZD-JKJ-116235) from Norway shows terminalia that deviate somewhat from those of other specimens and are likely malformed, with the pp gap particularly shortened and deformed (Fig. 10A–D). However, COI sequence data place this specimen unambiguously with *G. collaris*, showing 100% sequence identity.

Grzegorzekia hungarica Papp & Ševčík, 2007

Figs 11–12, 13B

Differential diagnosis

Distinguished by the smoothly ‘pig-tail’ curved posterior projections of the gonocoxal apodeme, in combination with a long, rod-shaped aedeagus that is nearly parallel-sided in ventral view and distinctly

club-shaped in lateral view (Fig. 11B–C). The aedeagus extends beyond the apex of the gonocoxites. The gonocoxal synsclerite lacks any medioventral outgrowth. This set of characters separates *G. hungarica* from all other species.

Material examined

ESTONIA • 1 ♂, double pinned with terminalia in glycerine; Tartu, Tähtvere dendropark; 58.394° N, 26.694° E; 9–16 Sep. 2020; T. Tammaru leg.; bait trap; IZBE, IZBE0222464 • 1 ♂, in ethanol with terminalia in glycerine; Matsalu NP, Lopi near Puise; 58.794° N, 23.523° E; 11 Jul.–14 Aug. 2009; I. Süda leg.; trunk window trap; IZBE, IZBE0250417.

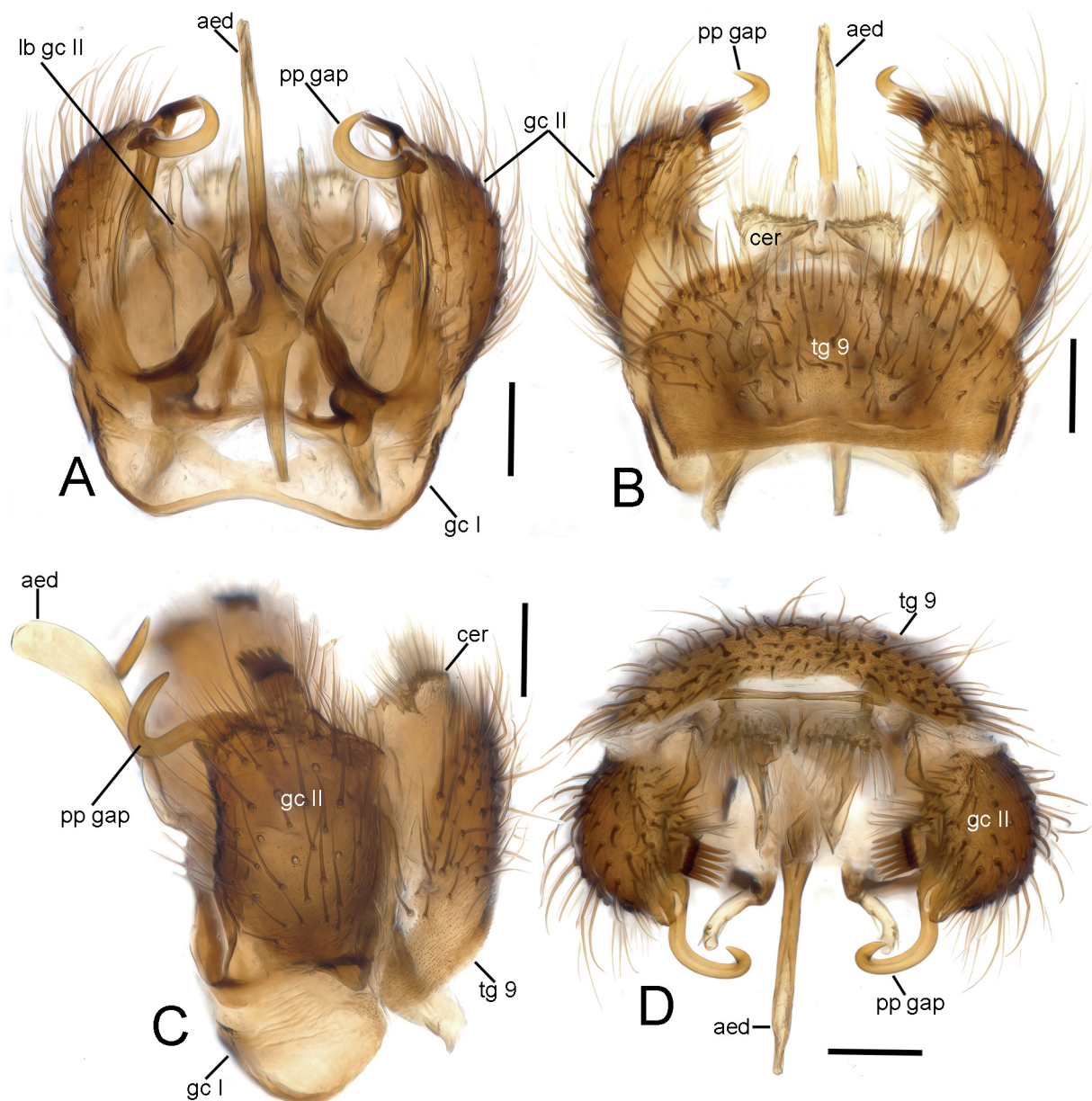


Fig. 11. *Grzegorzekia hungarica* Papp & Ševčík, 2007, ♂ (IZBE0250417, IZBE), terminalia. A. Ventral view. B. Dorsal view. C. Lateral view. D. Posterior view. Abbreviations: see Fig. 3. Scale bars = 0.1 mm.

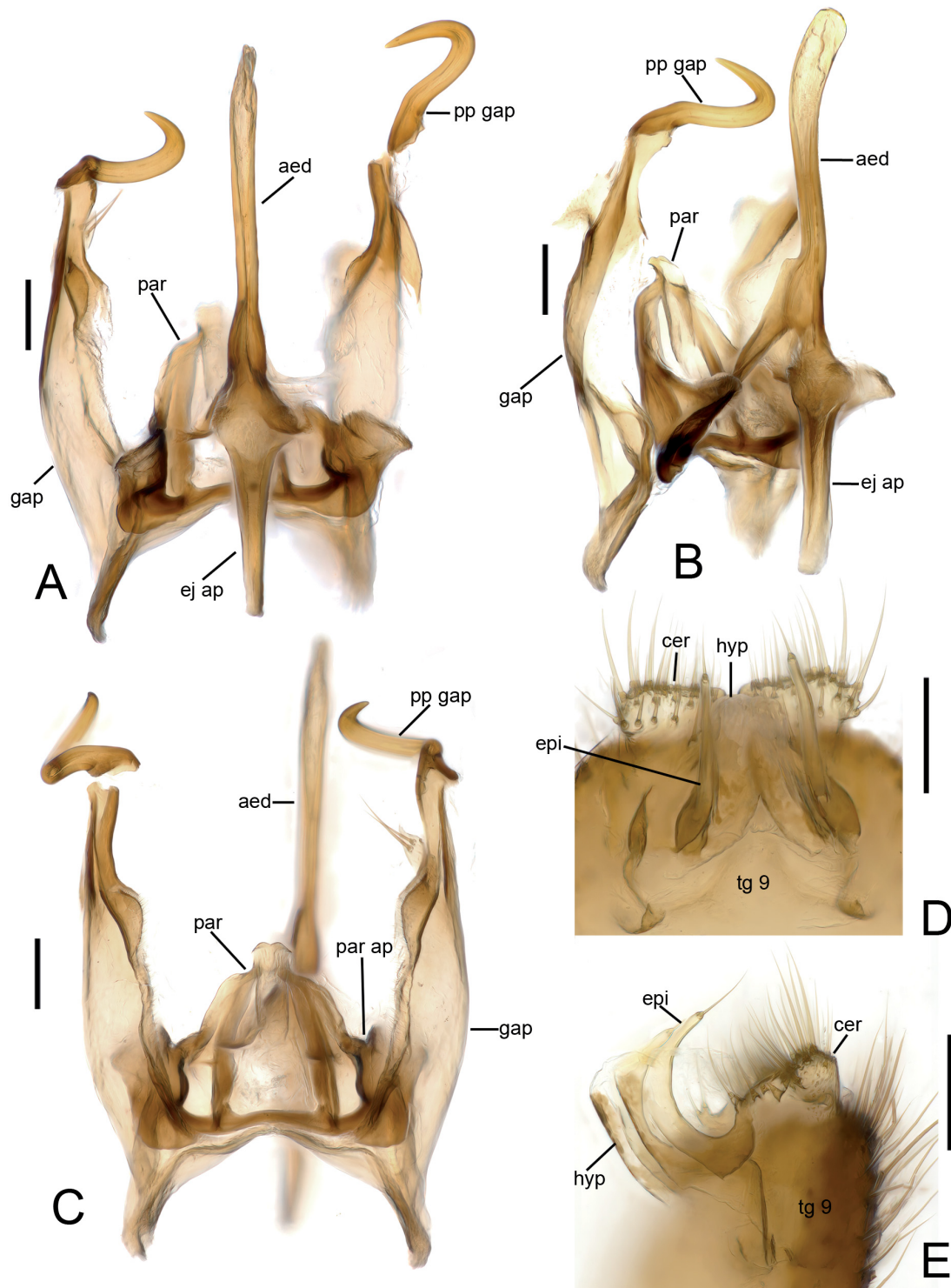


Fig. 12. *Grzegorzekia hungarica* Papp & Ševčík, 2007, ♂ (IZBE0250417, IZBE). **A.** Aedeagal complex, ventral view. **B.** Aedeagal complex, lateral view. **C.** Aedeagal complex, dorsal view. **D.** Proctiger, ventral view. **E.** Proctiger, lateral view. One pp gap is broken but photographed alongside. Abbreviations: see Fig. 4. Scale bars = 0.1 mm.

SLOVAKIA • 1 ♂; Muránska planina National Park, Šiance; 5 Sep. 2012; J. Ševčík leg.; sweep netting; JSL-OUC, JSGS35; published by Mantič *et al.* (2015) and used in the phylogenetic analysis by Kaspřák *et al.* (2019).

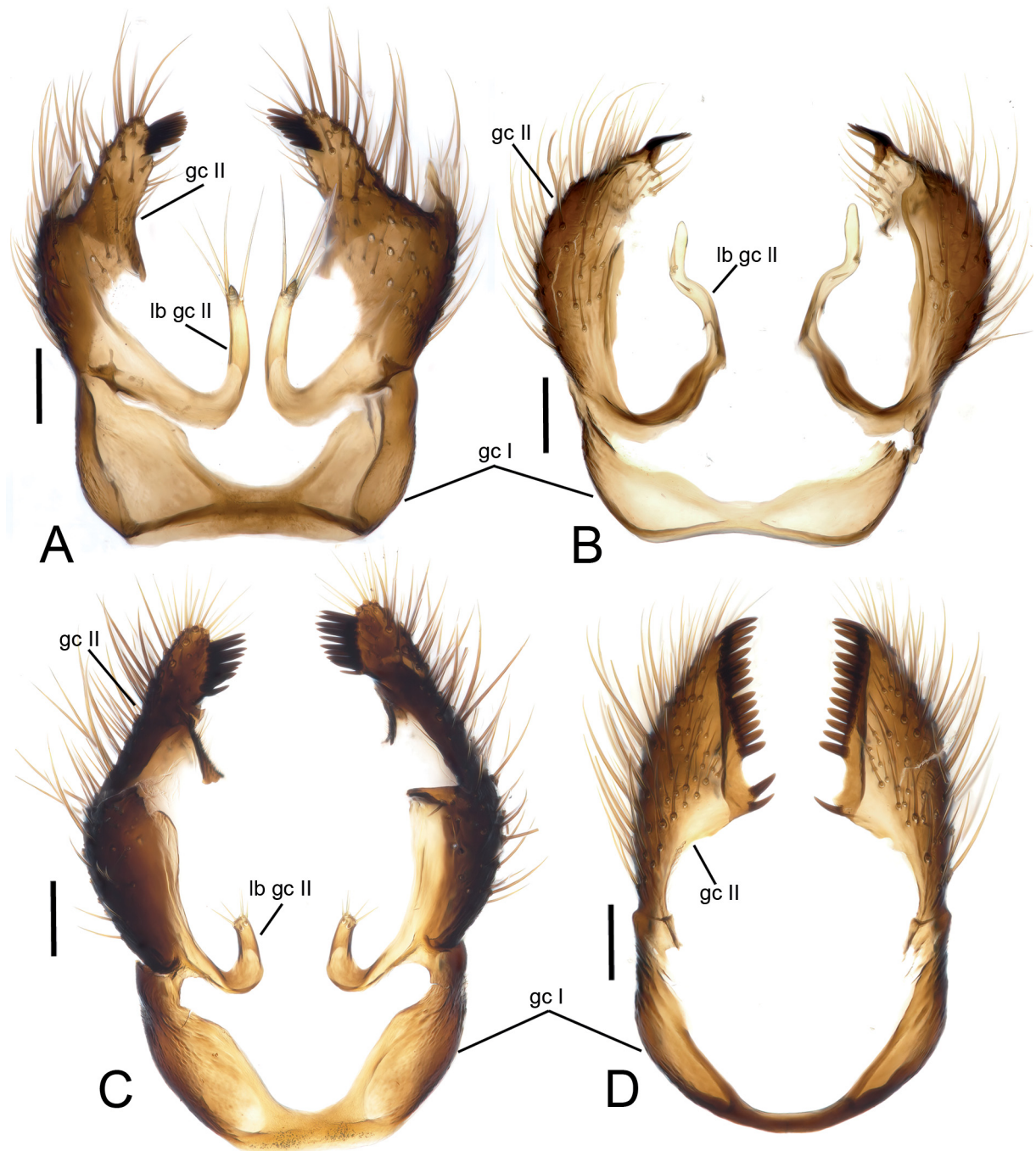


Fig. 13. European species of *Grzegorzekia* Edwards, 1941, ventral view of male terminalia with aedeagal complex and tergite IX removed. **A.** *G. collaris* (Meigen, 1818), ♂ (IZBE0222463, IZBE). **B.** *G. hungarica* Papp & Ševčík, 2007, ♂ (IZBE0250417, IZBE). **C.** *G. pseudocollaris* Kurina, Ševčík & Kjaerandsen sp. nov., holotype, ♂ (IZBE0222462, IZBE). **D.** *G. bushyae* Chandler, 2015, ♂ (RBINS). Abbreviations: see Fig. 3. Scale bars = 0.1 mm.

SWEDEN • 1 ♂; Älvkarleby, Batfors, pine forest with blueberry; 60.461° N, 17.318° E; 5 Aug. 2003; Malaise trap; Swedish Malaise Trap Project; NHRS, borrowed and DNA barcoded by TMU under TSZD-JKJ-112871.

Remarks

New country records for Estonia, Sweden, and Norway. The Norwegian record is based solely on three metabarcoding reads obtained during the National Insect Monitoring Programme in Norway from a Malaise trap in Viken, Drammen, Krokstad (59.7639° N, 9.9848° E): one read from the sample collected during 12–26 Jul. 2024 and two reads from the sample collected during 5–17 Oct. 2024 (Åström & Davey 2025).

Oriental species

Grzegorzekia bruneiensis Kurina & Ševčík sp. nov.

urn:lsid:zoobank.org:act:E58F6868-D2F8-4E3F-9BF7-6C36D77D1D43

Figs 14A, 15–16, 19A

Differential diagnosis

Shares with *G. taiwanica* sp. nov. the unique posterior armature on section II of the gonocoxite split into two free apical, pointed spines plus a separate, more internal comb of five dentate spines (Figs 15D, 19). It differs from *G. taiwanica* by having large, subquadrate ventral lobes of section II (gc II) (Fig. 15C), a bifurcate medioventral outgrowth on the gonocoxal synsclerite (Fig. 19A), and a beak-shaped pp gap.

Etymology

The specific epithet ‘*bruneiensis*’ is a Latinized toponym formed from Brunei (Brunei Darussalam) + the Latin suffix ‘-ensis’ (‘from, belonging to’), meaning ‘from Brunei’. It refers to the origin of the type material from Brunei and acknowledges the country’s biodiversity and conservation significance. The epithet is treated as an adjective.

Type material

Holotype

BRUNEI DARUSSALAM • ♂, in ethanol; Ulu Temburong National Park, Kuala Belalong Field Study Centre; 26 Jan.–15 Jun. 2015; D. Kaspřák and M. Mantič leg.; Malaise trap ID1; UBDM, JSOR13.

Paratype

BRUNEI DARUSSALAM • 1 ♂, in ethanol; same data as for holotype; JSL-OUC, JSGS38.

Description

Male (Fig. 14A)

MEASUREMENTS. Body length 3.4–3.6 mm (n = 2).

HEAD. Brown with short brown setae. Three ocelli, lateral ocelli equal to their diameter distant from the eye margin. Antennae about two times as long as head+thorax. Scape and pedicel yellow; scape cylindrical, about as long as wide; pedicel longitudinally compressed, about two times as wide as long. Fourteen flagellomeres; first flagellomere yellow; second flagellomere yellow basally; other flagellomeres dark brown, with two apical flagellomeres lighter. Basal flagellomere about 3.5 times as long as wide; second flagellomere about two times as long as wide; flagellomeres 3–11 about 1.3 times as long as wide; flagellomeres 12–14 narrowing gradually.

THORAX. Mesonotum, scutellum, mediotergite, laterotergite, anepisternum, anepimeron and katepisternum dark brown; antepronotum and proepisternum pale yellow. Mesonotum with pale setosity; lines of acrostichal and dorsocentral setae not discernible; lateral prealar setae dark. Scutellum with marginal setae not arranged into pairs. Antepronotum and proepisternum with setae, rest of the thorax bare.

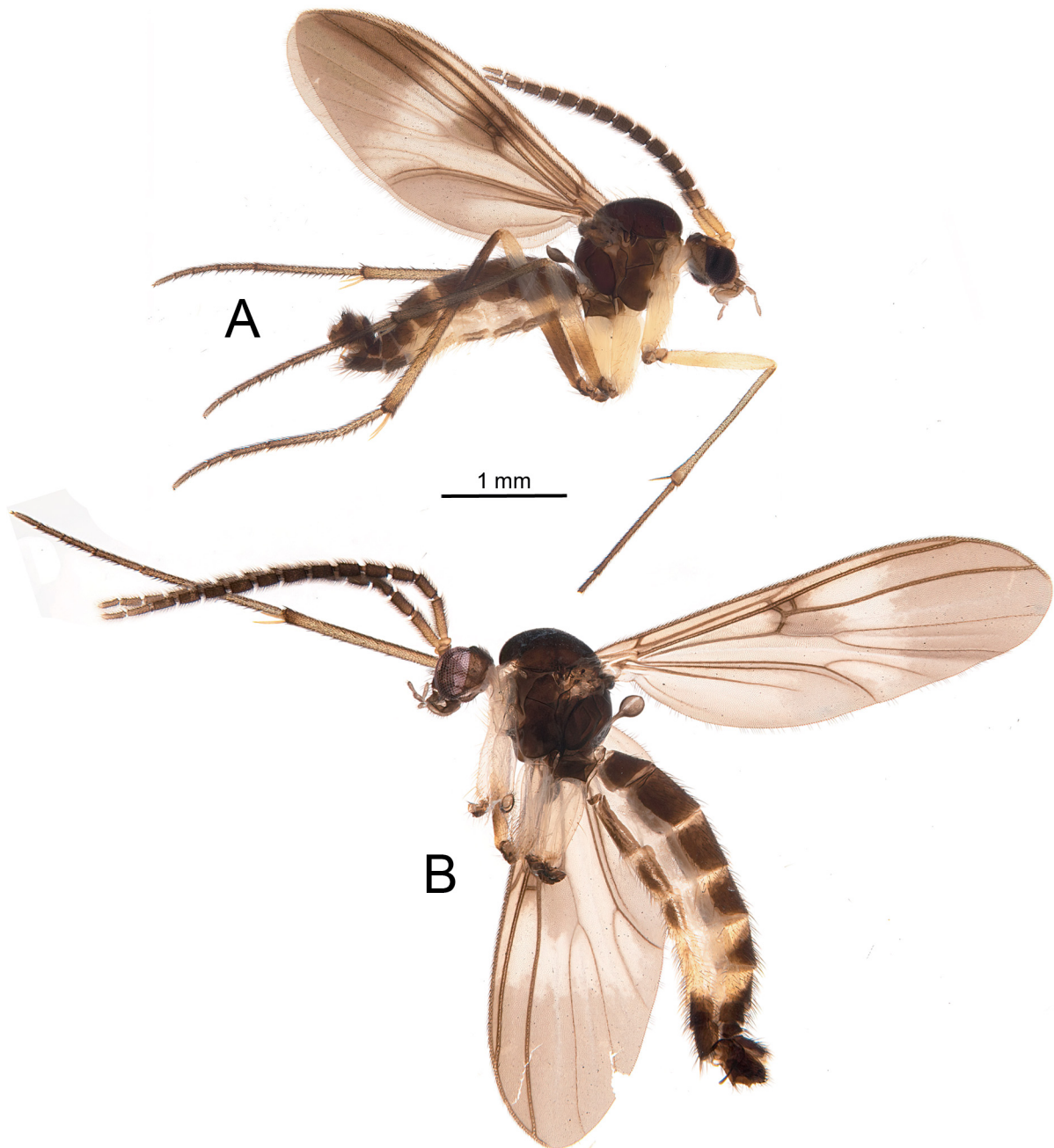


Fig. 14. Oriental species of *Grzegorzekia* Edwards, 1941, lateral view of habitus. **A.** *G. bruneiensis* Kurina & Ševčík sp. nov., holotype, ♂ (JSOR13, UBDM). **B.** *G. taiwanica* Kurina & Ševčík sp. nov. holotype, ♂ (JSTW60, NMNS). Scale bar = 1 mm.

LEGS. Coxae pale yellow; trochanters brown; fore femur yellow; basal half of mid- and hind femora brown, apical half yellow; tibiae and tarsi yellow, except basal third of hind tibia brown; all tibiae and tarsi appear brown because of dense brown setosity. Mid tibia parallel-sided, without sensory area along

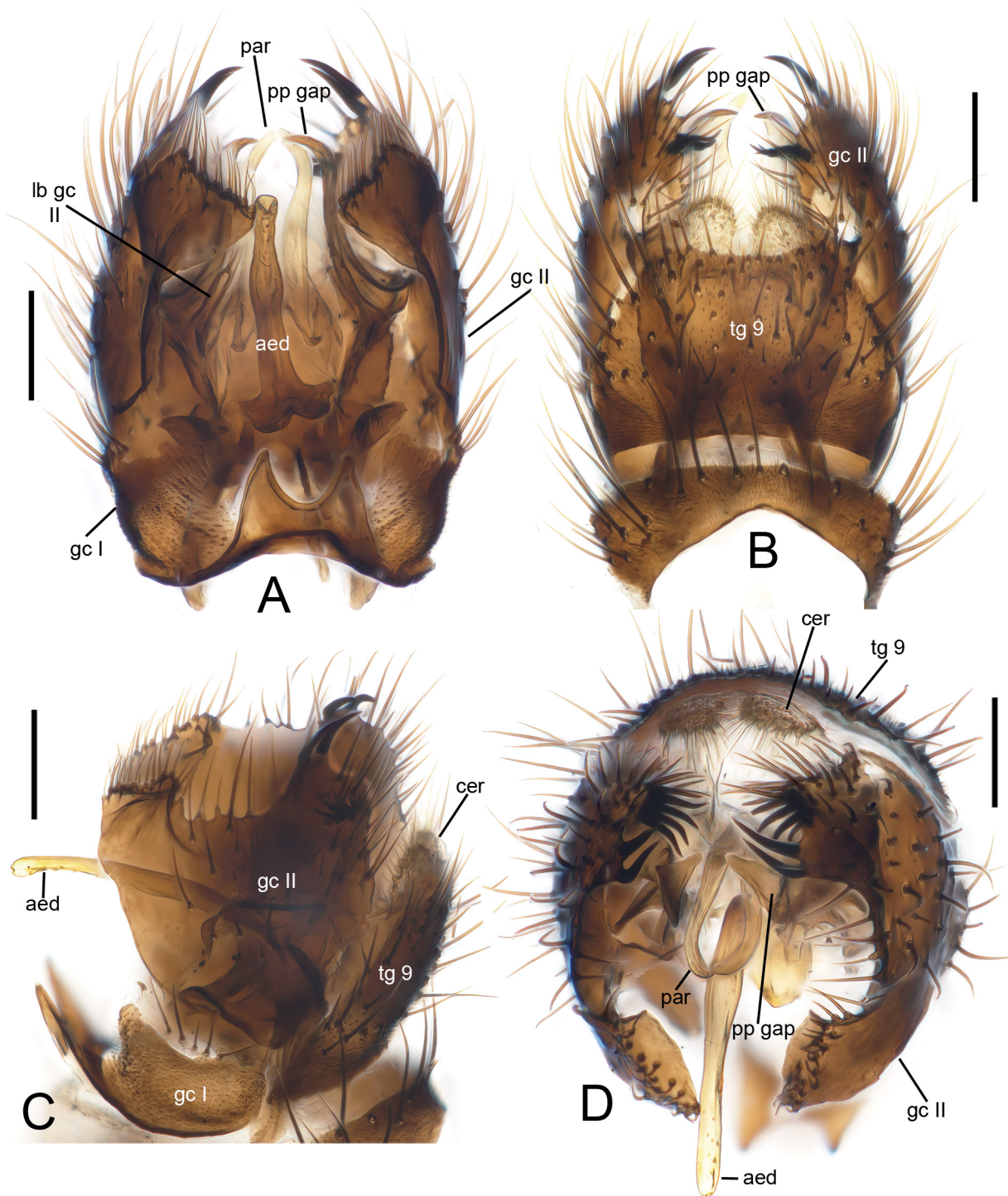


Fig. 15. *Grzegorzekia bruneiensis* Kurina & Ševčík sp. nov., holotype, ♂ (JSOR13, UBDM), terminalia. A. Ventral view. B. Dorsal view. C. Lateral view. D. Posterior view. Abbreviations: see Fig. 3; lb gc I = lobe of gonocoxal section 1. Scale bars = 0.1 mm.

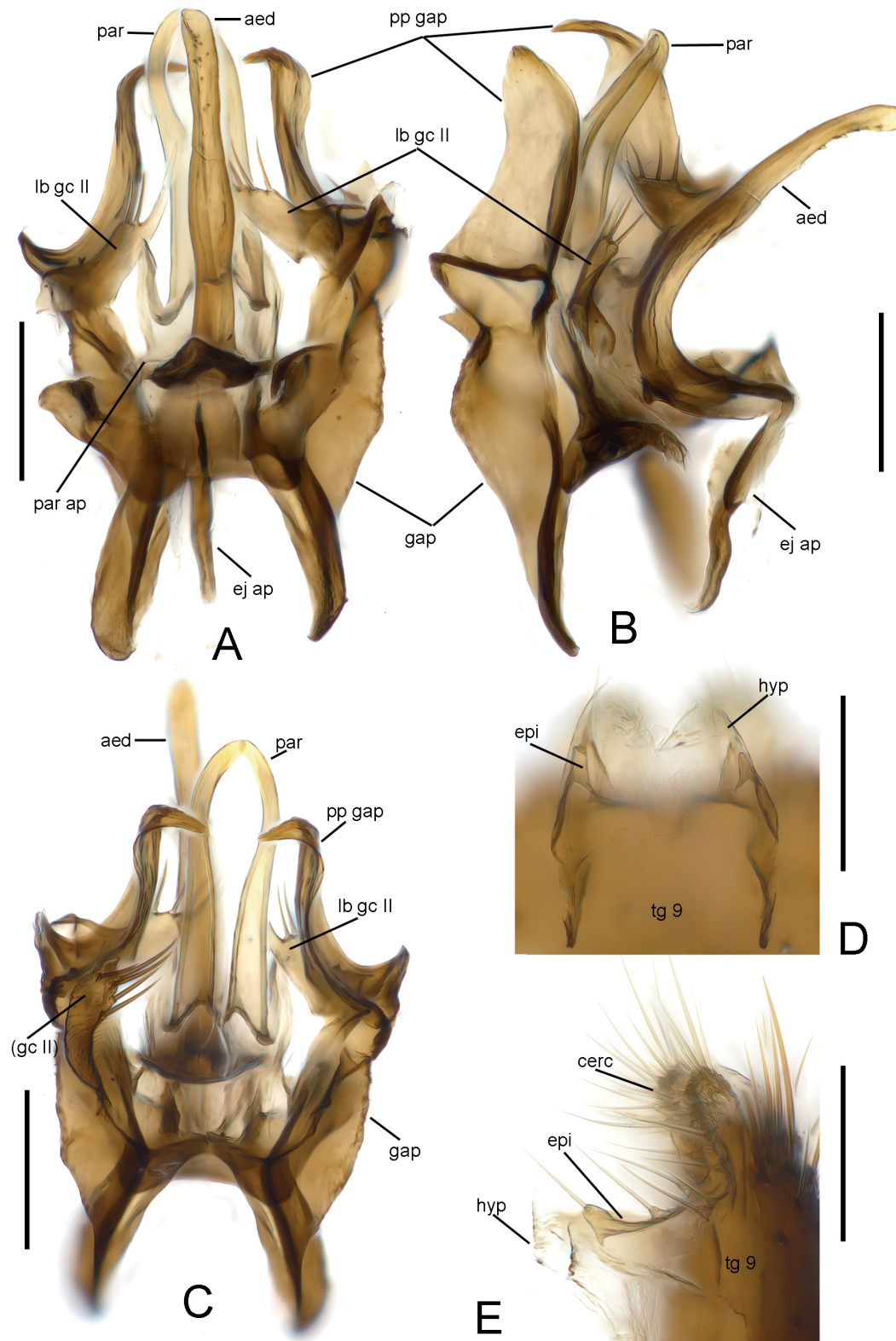


Fig. 16. *Grzegorzekia bruneiensis* Kurina & Ševčík sp. nov., holotype, ♂ (JSOR13, UBDM). **A.** Aedeagal complex, ventral view. **B.** Aedeagal complex, lateral view. **C.** Aedeagal complex, dorsal view. **D.** Proctiger, ventral view. **E.** Proctiger, lateral view. Abbreviations: see Fig. 4; gc II = broken edge of gonocoxal section 2. Scale bars = 0.1 mm.

dorsal surface. Fore tibia without setae; mid tibia with 1–2a, 5d, 7–8p and 3pv; hind tibia with 6–8a, 5–6d, 2p. Tibial spurs 1:2:2. Tarsal claw with a basal tooth; empodia undeveloped.

WING (Fig. 14A). 3.1 mm ($n = 2$). Hyaline with apical third darkened, and with darkened areas around radial cell, above M-stem and beneath apical third of CuA. Veins brown with dorsal setae on R_1 , R_{4+5} , CuA and CuP; M_1 , M_2 and M_4 with few setae apically; other veins bare. Sc ending at level of R_{2+3} , slightly before level of posterior fork; sc-r ending at base of Rs. Radial cell square-shaped; Rs oblique; R_{2+3} transversal. R_{2+3} missing in one wing of paratype. M more than two times as long as r-m. Posterior fork beginning somewhat basal to level of medial fork. CuP ending at level of sc-r. Halter with basal two-thirds of stem yellow, and apical one-third of stem and knob brown.

ABDOMEN. Brown, with tergites IV–VI yellowish areas anteriorly.

TERMINALIA (Figs 15–16, 19A). Tergite 9 broader than long with broad emargination on anterior edge and shallow concavity on posterior edge (Fig. 15B). Gonocoxite consists of two sections, well exposed in ventral and lateral views. In lateral view: (1) gonocoxite section I polygonal, posteriorly concave, with a row of five strong setae, otherwise bare; anteroventral corner drawn ventrally out to a tapering lobe; (2) gonocoxite section II polygonal, posteroventrally drawn out to a rectangular lobe with a row of setae along the posterior margin; posterodorsally projecting with two pointed spines at the apical margin, and a comb of five spines internally. An additional lobe (Fig. 15A, D), with basal half about twice as wide as the tapering apical half and with 3–4 setae lateromedially, arises from the internal surface. Posterior projection of the gonocoxal apodeme bare, posteriorly beak-shaped, anteriorly attached to gc II and gap, not projecting over gc II posteriorly. In ventral view, first gonocoxal sections anteriorly bridged to form a bifurcate outgrowth. Aedeagus digitate, bent ventrad, with 3–4 small warts subapically, basally hook-like, well discernible in lateral view (Fig. 16B). Parameres exposed dorsad from aedeagus, subapically bent mediad, with additional lateral short lobe basally about a quarter of the paramere length. Cerci apically rounded, setose. Hypoproct membranous, hardly discernible, without outgrowths. Epiproct membranous, with a pair of small digitate, apical seta-bearing lobes.

Female

Unknown.

Distribution

Known only from the Oriental Region (Brunei Darussalam).

Grzegorzekia taiwanica Kurina & Ševčík sp. nov.

urn:lsid:zoobank.org:act:2CB755F7-63D5-4E5C-9C2F-33426D7107E6

Figs 14B, 17–18, 19B

Differential diagnosis

Shares with *G. bruneiensis* sp. nov. the unique posterior armature on section II of the gonocoxite split into two free apical, pointed spines plus a separate, more internal comb of 3–4 dentate spines (Fig. 19). It differs from *G. bruneiensis* by having narrow, rectangular ventral lobes of section II (gc II) (Fig. 17C) and a deltoid medioventral outgrowth on the gonocoxal synsclerite (Fig. 19B). Additional diagnostic features include a hook-shaped, apically pointed setose process arising from the internal surface of section II, and a distinctive digitate, upward-curved bare lobe on the posteroventral part of section I (lb gc I) unique to this species (Figs 17A, 19B).

Etymology

The specific epithet '*taiwanica*' is a Latinized adjectival toponym formed from Taiwan + the Latin suffix '-icus' (adjectival), here in the feminine form '-ica' to agree with the feminine gender of *Grzegorzekia*. It means 'of Taiwan' and refers to the origin of the type material. The epithet is treated as an adjective.

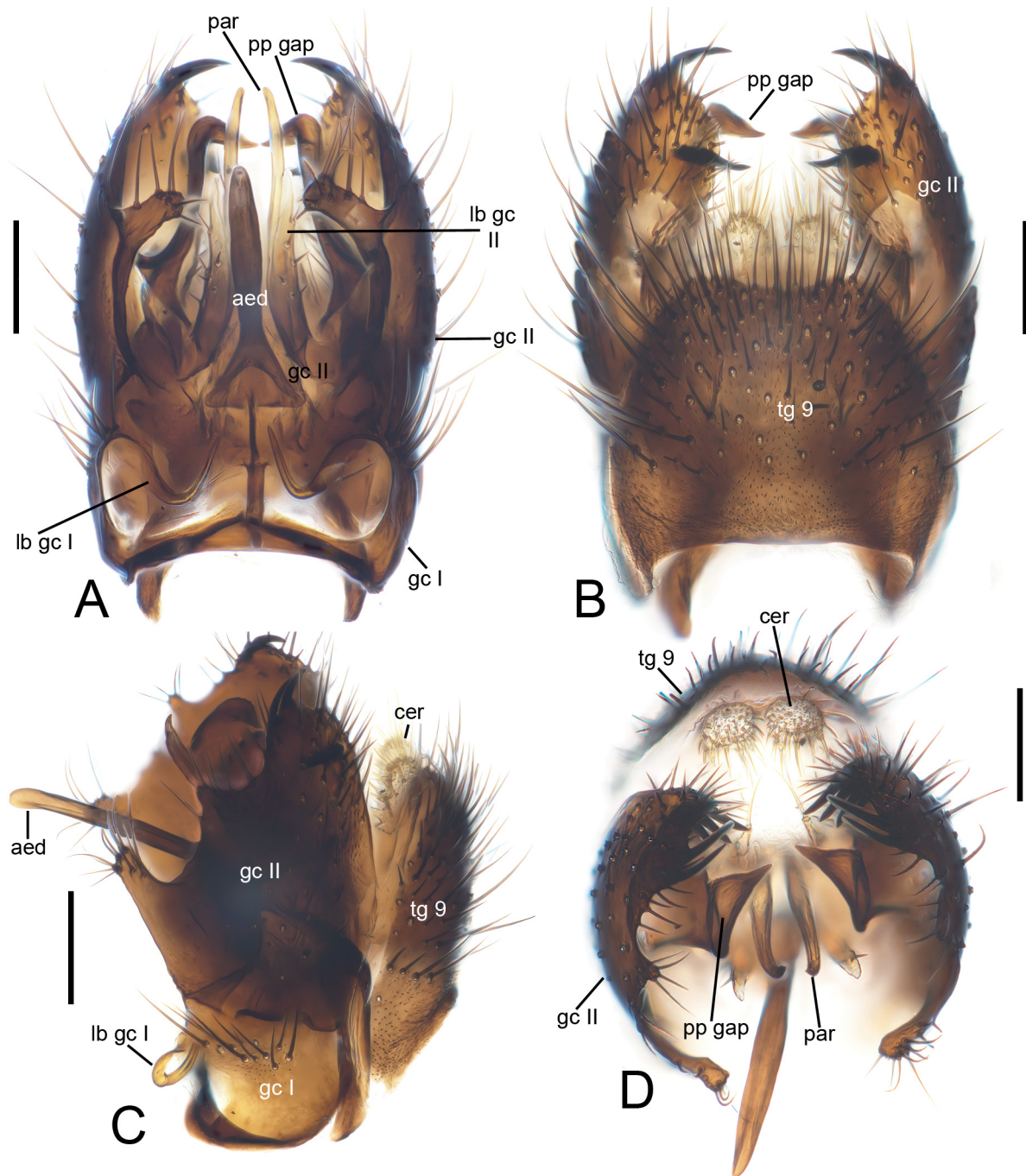


Fig. 17. *Grzegorzekia taiwanica* Kurina & Ševčík sp. nov., holotype, ♂ (JSTW60, NMNS), terminalia. A. Ventral view. B. Dorsal view. C. Lateral view. D. Posterior view. Abbreviations: see Fig. 3. Scale bars = 0.1 mm.

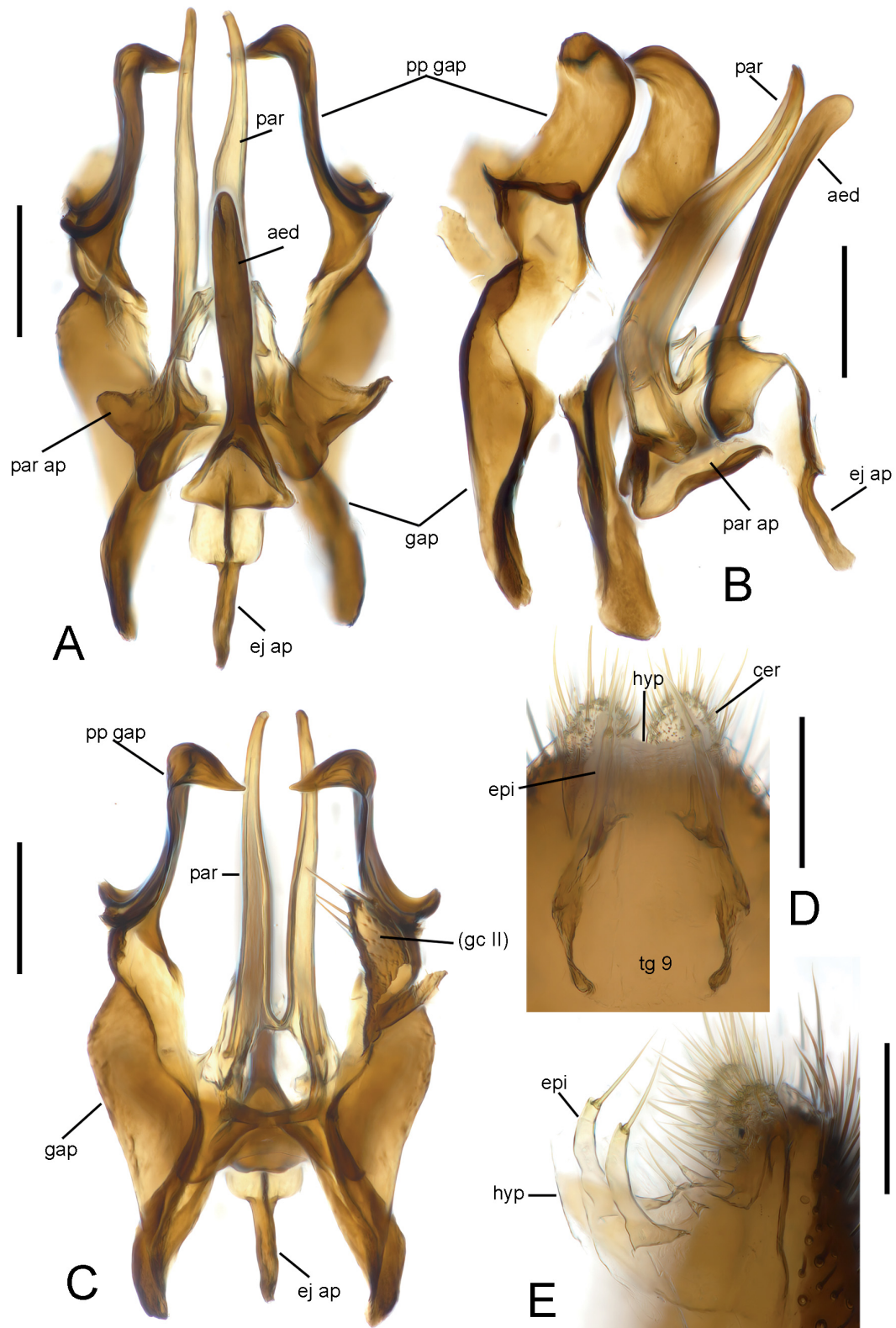


Fig. 18. *Grzegorzekia taiwanica* Kurina & Ševčík sp. nov., holotype, ♂ (JSTW60, NMNS). **A.** Aedeagal complex, ventral view. **B.** Aedeagal complex, lateral view. **C.** Aedeagal complex, dorsal view. **D.** Proctiger, ventral view. **E.** Proctiger, lateral view. Abbreviations: see Fig. 4; gc II = broken edge of gonocoxal section 2. Scale bars = 0.1 mm.

Type material

Holotype

TAIWAN • ♂, in ethanol; Nantou, Pingtung Co., Dahan forest road; Aug.–11 Oct. 2017; Malaise trap; NMNS, JSTW60.

Paratype

TAIWAN • 1 ♂, in ethanol; Nantou, Taroko National Park, Bilu; Oct. 2023; Malaise trap; S.-F. Lin leg.; JSL-OUC, JSTW50.

Description

Male (Fig. 14B)

MEASUREMENTS. Body length 4.1 mm.

HEAD. Light brown with short brown setae. Three ocelli, lateral ocelli less than their diameter distant from the eye margin. Antennae ~2.4 times as long as head+thorax. Scape and pedicel short, thick and yellow; scape cylindrical; pedicel spherical, subequal to scape length. Fourteen elongate flagellomeres; basal flagellomere yellowish, ~3.5 times as long as wide; other flagellomeres of equal length, ~2.5 times as long as wide; flagellomeres 2–12 brown; flagellomeres 13–14 yellowish.

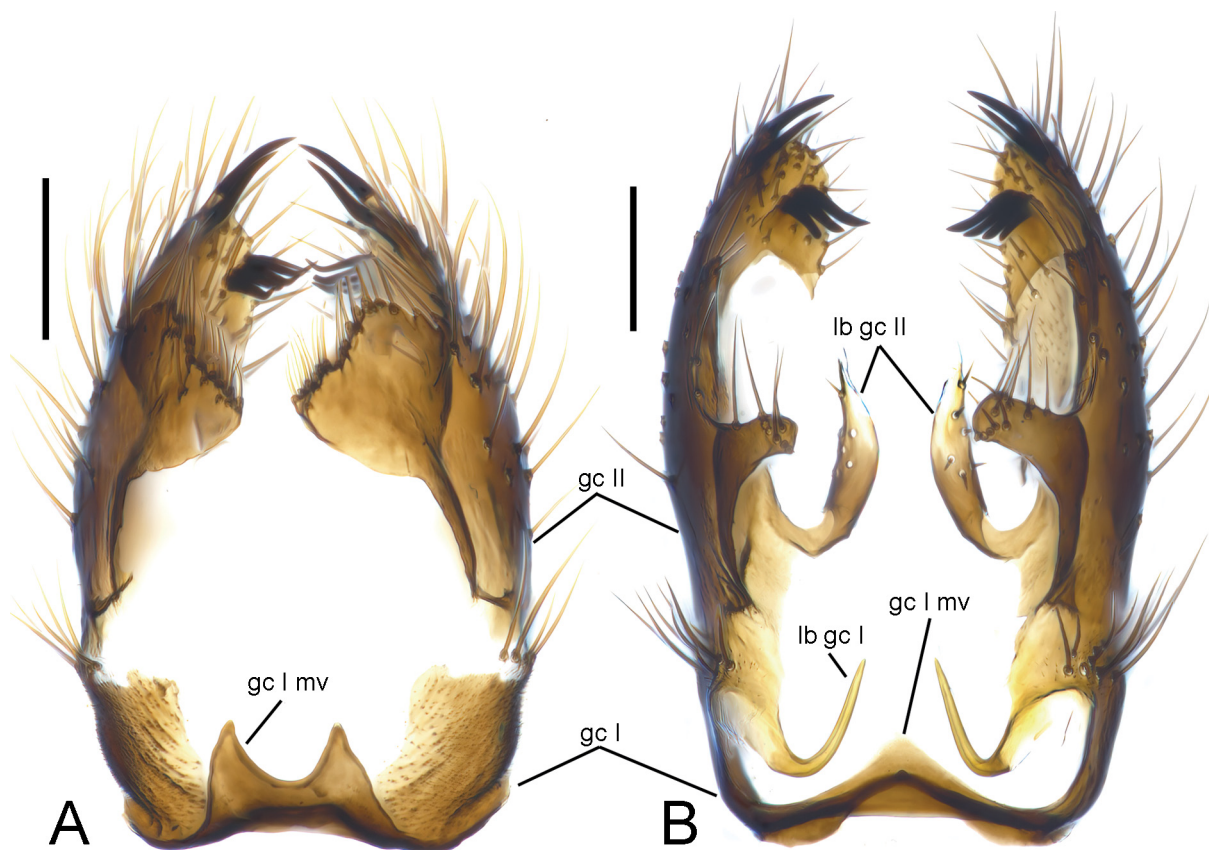


Fig. 19. Oriental species of *Grzegorzekia* Edwards, 1941, ventral view of male terminalia with aedeagal complex and tergite IX removed. **A.** *G. bruneiensis* Kurina & Ševčík sp. nov., holotype, ♂ (JSOR13, UBDM). **B.** *G. taiwanica* Kurina & Ševčík sp. nov., holotype, ♂ (JSTW60, NMNS). Abbreviations: see Fig. 3. Scale bars = 0.1 mm.

THORAX. Mesonotum, scutellum, mediotergite, laterotergite, anepisternum, anepimeron and katapisternum dark brown; antepronotum and proepisternum pale yellow. Setae on mesonotum and scutellum broken; antepronotum and proepisternum with few setae; rest of the thorax bare.

LEGS. Coxae pale yellow, trochanters brown. Legs beyond trochanters missing in holotype, except one mid leg. Proximal half of mid femur brownish; distal half pale yellow. Mid tibia and tarsus brownish. Mid tibia parallel-sided, without sensory area along dorsal surface. Mid tibia with 4a, 5d, 8p and with 2 tibial spurs. Tarsal claw with a basal tooth; empodia undeveloped.

WING (Fig. 14B). 3.9 mm. Hyaline with apical third darkened, and with darkened areas around radial cell, above M-stem and beneath apical third of CuA. Veins brown with dorsal setae on R_1 , R_{4+5} , M_1 , M_2 and CuA; other veins bare. Sc ending beyond R_{2+3} , approximately at the level of the posterior fork; sc-r ending at the base of Rs. Radial cell square-shaped; Rs oblique; R_{2+3} transversal. Stem M about three times as long as r-m. Posterior fork beginning basal to level of medial fork. CuP ending at level of sc-r. Halter with basal two-thirds of stem yellow, and apical one-third of stem and knob brown.

ABDOMEN. Brown, with tergites IV–VI bearing yellowish areas anteriorly.

TERMINALIA (Figs 17–18, 19B). Tergite 9 broader than long with broad emargination on anterior edge and shallow concavity on posterior edge (Fig. 17B). Gonocoxite consists of two sections, well exposed in ventral and lateral views. In lateral view: (1) gonocoxite section I polygonal, bare except for a patch of setae posteriorly; anteroventral corner drawn ventrally out; posteroventral corner drawn out to a digitate, curved bare process; (2) gonocoxite section II elongated, polygonal, setose, anteriorly twice as wide as posteriorly; with a comb of four spines posterointernally; medioventral margin oblique, with (a) anterior corner drawn out to a rectangular, apically setose small lobe, (b) medial convexity, and (c) two pointed spines posteriorly. A hook-shaped, apically pointed setose process arises from the internal surface. Posterior projection of the gonocoxal apodeme bare, posteriorly beak-shaped, anteriorly attached to gc II and gap, not projecting over gc II posteriorly. In ventral view, first gonocoxal sections anteriorly bridged to form a deltoid outgrowth. Aedeagus digitate, apically rounded, slightly bent ventrad, basally wide and angular (Fig. 18B). Parameres exposed dorsad from aedeagus, with an additional lateral short lobe basally about one-fifth of the paramere length. Cerci apically rounded, setose. Hypoproct membranous, hardly discernible, without outgrowths. Epiproct membranous, with a pair of digitate, apical seta-bearing lobes.

Female

Unknown.

Distribution

Known only from Taiwan in the Oriental Region.

Remarks

The COI sequences of the two studied specimens differ by approximately 5%. However, the 16S gene shows 99% similarity (differing in only six nucleotides), and the 28S gene shows 100% similarity. No morphological differences were observed between the specimens; therefore, we treat them as a single species.

Nearctic species

Grzegorzekia canadensis Kurina & Kjaerandsen sp. nov.

urn:lsid:zoobank.org:act:02A906B1-FCEB-413B-9C44-4331D8BF2D5D

Figs 20–22

Differential diagnosis

Distinguished by an apically bifurcate aedeagus with a deep, narrow medial concavity and moderately separated prongs, both hooked ventrad (Fig. 21A), together with a short, tapering posterior projection of the gonocoxal apodeme curved dorsad (basally swollen) and the absence of any posterodorsal hump on section II (Fig. 21C). Section II bears a comb of 11–12 spines at the posteroventral corner and an anteriorly anchored, hooked, apically setose gonocoxal lobe (lb gc II) with apical setae about twice the lobe width. It is closest to *G. pseudocollaris* sp. nov. and *G. collaris* but differs from *G. pseudocollaris* by the shorter, weaker pp gap and lack of a posterodorsal hump, and from *G. collaris* by the more distinctly bifurcate aedeagus.

Etymology

The specific epithet ‘*canadensis*’ is a Latinized toponym formed from Canada + the Latin adjectival suffix ‘-ensis’ (‘from, belonging to’), meaning ‘from Canada’. It refers to the origin of the type material. The epithet is treated as an adjective; masculine and feminine are *canadensis* (neuter: *canadense*).

Type material

Holotype

CANADA • ♂; British Columbia, Crooked River, CR3; 54.642° N, 122.743° W; 663 m a.s.l.; 2 Jul. 2015; D. Erasmus, D. Huber and C. Shrimpton leg.; Malaise trap; Process ID: RBCA7035-24; BIOUG, CBG-A29446-A05.

Paratype

CANADA • 1 ♂; Alberta, Jasper National Park, Miette Hotsprings; 53.124° N, 117.775° W; 1439 m a.s.l.; 21 Jul. 2012; BIOBus 2012 leg.; Malaise trap; Process ID: SSJAD033-13; GenBank Accession: KM959291; BIOUG, 06187-H09.

Other material examined

CANADA • 1 ♂; Quebec, Forillon National Park, trail of park compound (operation centre); 48.857° N, 64.376° W; 135 m a.s.l.; 15 Jul. 2013; F. Tremblay leg.; Sequence ID: CNFNR3067-14.COI-5P; GenBank Accession: KR237465; BIOUG, 11912-F07 • 1 ♂; same data as for preceding; Sequence ID: CNFNR3026-14.COI-5P; GenBank Accession: KR257560; BIOUG, 11912-C02 • 1 ♂; same data as for preceding; 5 Jul. 2013; Sequence ID: CNFNE246-14.COI-5P; GenBank Accession: KR242043; BIOUG, 10178-G07 • 1 ♀; Quebec, Mingan Archipelago National Park Reserve, Quarry Island; 50.214° N, 63.798° W; 20 Aug. 2013; Park staff leg.; Sequence ID: CNMIH1177-14.COI-5P; GenBank Accession: KR252728; BIOUG, 12638-B03.

Comments on material

All four specimens from Quebec are in very poor condition, with legs missing or detached; antennae predominantly missing; wings missing, broken or detached.

Description

Male (Fig. 20A)

MEASUREMENTS. Body length 7.0–7.5 mm.

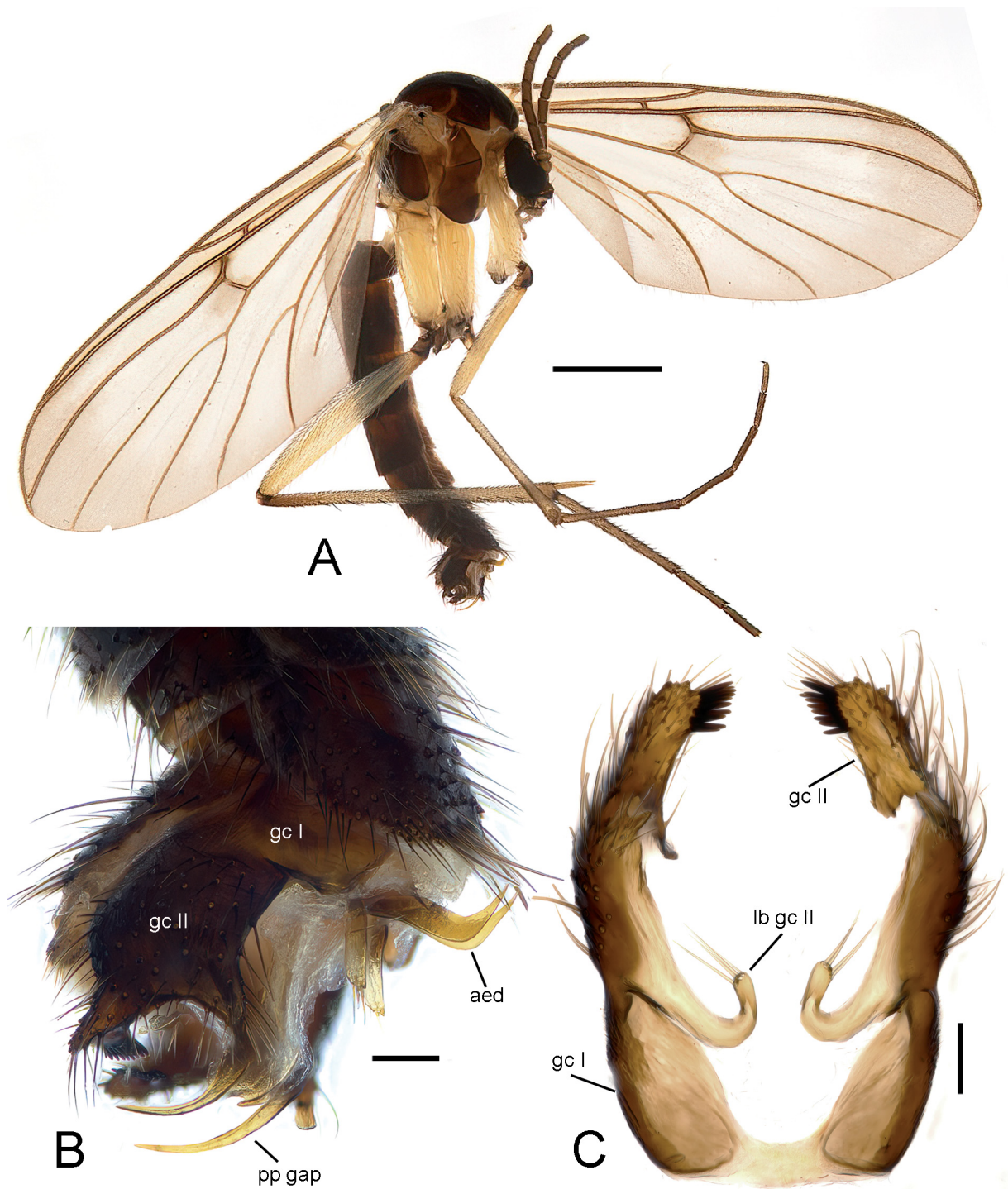


Fig. 20. *Grzegorzekia canadensis* Kurina & Kjaerandsen sp. nov. **A–B.** Holotype, ♂ (BIOUG CBG-A29446-A05). **C.** ♂ (BIOUG 11912-C02). **A.** Lateral view of habitus. **B.** Closer view of terminalia. **C.** Ventral view of male terminalia with aedeagal complex and tergite IX removed. Abbreviations: see Fig. 3. Scale bars: A = 1 mm; B–C = 0.1 mm.

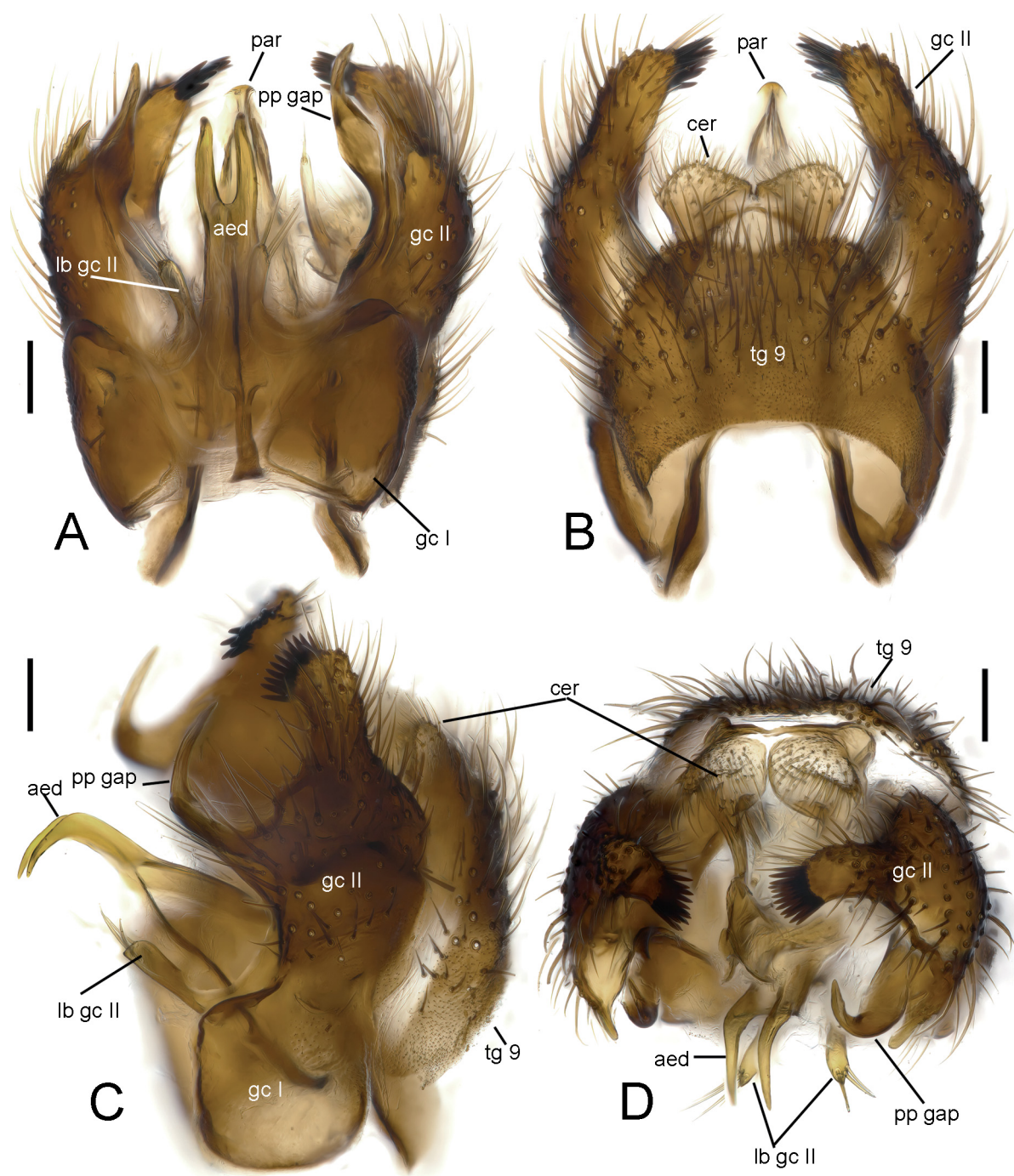


Fig. 21. *Grzegorzekia canadensis* Kurina & Kjaerandsen sp. nov., ♂ (BIOUG 11912-C02), terminalia. A. Ventral view. B. Dorsal view. C. Lateral view. D. Posterior view. Abbreviations: see Fig. 3. Scale bars = 0.1 mm.

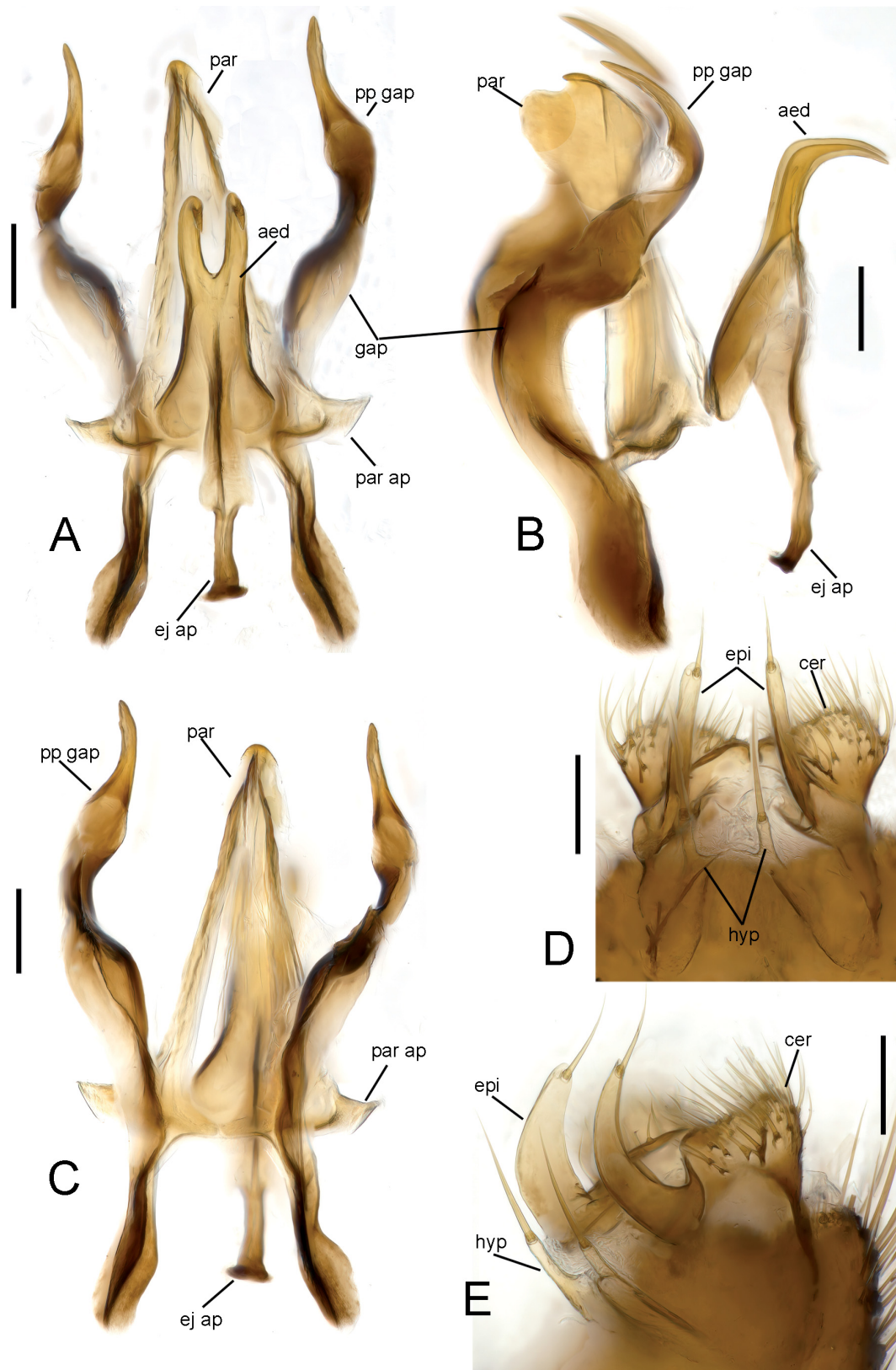


Fig. 22. *Grzegorzekia canadensis* Kurina & Kjaerandsen sp. nov., ♂ (BIOUG 11912-C02). **A.** Aedeagal complex, ventral view. **B.** Aedeagal complex, lateral view. **C.** Aedeagal complex, dorsal view. **D.** Proctiger, ventral view. **E.** Proctiger, lateral view. Abbreviations: see Fig. 4. Scale bars = 0.1 mm.

HEAD. Brown to blackish with short brown setae. Three ocelli, lateral ocelli about their diameter distant from the eye margin. Antennae broken beyond 6th flagellomere in both type specimens. Scape and pedicel short, thick, light brown; scape cylindrical; pedicel spherical, shorter than scape. Flagellomeres elongate; basal flagellomere light brown, ~2.4 times as long as wide; other flagellomeres of equal length, ~2.0 times as long as wide.

THORAX. Mesonotum, scutellum, mediotergite, laterotergite, anepisternum and katepisternum brown to dark brown; anepimeron light brown; anteprenotum and proepisternum yellow. Setae on mesonotum and scutellum pale, partly broken; anteprenotum and proepisternum with few setae; rest of the thorax bare.

LEGS. Coxae pale yellow to yellow, trochanters brown, femora and tibiae yellow, tarsi brown. Tibiae appear brownish because of dense setae. Mid tibia parallel-sided, without sensory area along dorsal surface. Fore tibia with 4d and 2p; mid tibia with 8a, 8d, 3–4p; hind tibia with 7a, 3d. Tibial spurs 1:2:2. Tarsal claw with a basal tooth; empodia undeveloped.

WING (Fig. 20A). 5.8–6.0 mm. Hyaline with apical fourth darkened, and with darkened areas around Rs, r-m and beneath apical half of CuA. Sc ending at level of R_{2+3} ; sc-r ending at level of posterior fork. Radial cell square-shaped; Rs oblique; R_{2+3} transversal. Vein R_{2+3} absent in paratype. Stem M about two times as long as r-m. Posterior fork beginning basal to level of medial fork. CuP ending at level of sc-r. Halter with stem and knob pale yellow.

ABDOMEN. Light brown to brown, with tergites II–IV narrowly yellowish anteriorly, and sternites I–V yellowish.

TERMINALIA (Figs 20B–C, 21–22). Tergite 9 broader than long with broad emargination on anterior edge and shallow concavity on posterior edge (Fig. 21B). Gonocoxite consists of two sections, well exposed in ventral and lateral views. In lateral view: (1) gonocoxite section I subquadrate, bare; (2) gonocoxite section II elongated, setose, anterior two-thirds about twice as wide as posterior one-third; with medial ventrally projecting and tapering outgrowth; posterior third slightly bent ventrad; and with a comb of 11–12 spines at the posteroventral corner. Posterior projection of gonocoxal apodeme considerably short, tapering, curved dorsad, basally swollen. Gonocoxal section II anteriorly with hooked, apically setose gonocoxal lobe projecting posteriad to level of ca one-fifth section II height; apical setae approximately twice as long as lobe width apically. Aedeagus apically bifurcate, with deep and narrow medial sclerotized lateral sections. Cerci posteriorly rounded, somewhat extended medially, anteriorly fused, with U-shaped anterior margin. Hypoproct membranous, with a pair of small digitate lobes bearing apical seta. Epiproct membranous, with a pair of digitate, apical seta-bearing lobes, about twice the size of the similar lobes on hypoproct.

Female

Unknown.

Distribution

Known only from Canada in the Nearctic Region.

Remarks

The studied material is assigned to two BINs in BOLD. The first (BOLD:AGA7611) comprises two male specimens from western Canada (Alberta and British Columbia), while the second (BOLD:ACI4320) comprises three male and one female specimens collected in eastern Canada (Quebec). Although the genetic divergence between these two BINs is 2.12%, no reliable morphological characters were found to support their delimitation as a separate species. We describe *G. canadensis* sp. nov. based on the two

specimens from Alberta and British Columbia because all four specimens from Quebec are in very poor condition and do not allow adequate description of a new species. These four specimens from Quebec are listed above as Other material examined.

Discussion

Including the four new species described above, the genus *Grzegorzekia* now comprises nine species: one with a Holarctic distribution (*G. collaris*), three occurring in Europe (*G. hungarica*, *G. bushyae*, *G. pseudocollaris* sp. nov.), three in the Nearctic (*G. quercus*, *G. kerri*, *G. canadensis* sp. nov.), and two from the Oriental Region (*G. bruneiensis* sp. nov., *G. taiwanica* sp. nov.). All species can be identified by the similar structure of the male terminalia, characterized by a comb of fine spines on the posterior margin of the gonocoxites and, notably, the absence of a gonostylus. The latter represents a synapomorphic character state shared only by *Grzegorzekia* and the monotypic *Phoenikiella*. Two Nearctic species – *G. kerri* and *G. quercus* – are distinguished by the presence of a mid-tibial sensory organ (Fitzgerald 2019), which is absent in the remaining species, including the third Nearctic species *G. canadensis* described above. Chandler (1980) and Fitzgerald (2019) discussed the taxonomic value of the presence or absence of the mid-tibial organ (sensory pit) and concluded that it is not of generic significance. In addition to *Grzegorzekia*, the occurrence of this organ is also variable within species of, for example, *Synapha* Meigen, 1818.

Interpretation and naming details of the male terminalia sclerites have varied between earlier authors (Søli 1997; Chandler 1999; Fitzgerald 2019). Hereafter, we compare the male terminalia of studied species and briefly discuss the terminology. According to Søli (1997) the gonocoxite consists of three sections, of which the first two are explicitly discernible in ventral and lateral views also in our material.

The first section of the gonocoxite (gc I), which constitutes the basal part of the gonocoxite, is devoid of setae, except in two Oriental species, where a row or patch of setae is present along the posterior margin and is well discernible in lateral view (e.g., Fig. 17C). The first sections of both sides are fused ventrally, forming a narrow synsclerite. This synsclerite is deeply concave in European species but forms a ventromedial bifurcate or deltoid process in Oriental species (Fig. 19, gc I mv). In *G. taiwanica* sp. nov., the posteroventral part of gc I is drawn out into a digitate, upward-curved, bare lobe (e.g., 17A, lb gc I), which is absent in all other species.

The second section of the gonocoxite (gc II), positioned posteriorly to gc I, is setose and structurally complex, with a multipartite ventromedial margin (except in *G. bushyae*). It features a comb of spines along the posterior margin or on the internal surface sub-marginally. In three species (*G. bushyae*, *G. bruneiensis* sp. nov., and *G. taiwanica* sp. nov.), an additional 1–2 separate spines are present. The gonocoxal lobe (lb gc II), which is turned upward, either digitate or club-shaped and always setose, is anchored to gc II anteriorly (*G. collaris*, *G. pseudocollaris* sp. nov., *G. hungarica*) or medially (*G. bruneiensis*, *G. taiwanica*). Because the gonocoxal lobe is setose in all studied species, we consider that the setose lobe posteriorly from the gonocoxal apodeme, which was dissected together with the aedeagal apparatus in *G. bushyae* (Fig. 7A–C), is homologous to lb gc II in other species. In the case of *G. bruneiensis*, lb gc II was dissected together with the aedeagal apparatus and gonocoxal apodeme, and therefore is absent on Fig. 19A but indicated on Fig. 16 A–B.

In interpreting the structure referred to as the “third section of the gonocoxite” by Fitzgerald (2019: figs 3, 8; gc III), we follow Chandler (1999: fig. 14; gap) and consider it a posterior projection of the gonocoxal apodeme (pp gap). We have carefully studied the concept of the third section of the gonocoxite (gc III) as described and illustrated by Søli (1997: fig. 26) and later adopted by Fitzgerald (2019), and found it to be more steadily anchored to gc II, either anteriorly (*Phthinia* spp., *Polylepta* spp.) or posteriorly (*Synapha* spp., *Boletina* spp.). In the seven species of *Grzegorzekia* studied, the digitate

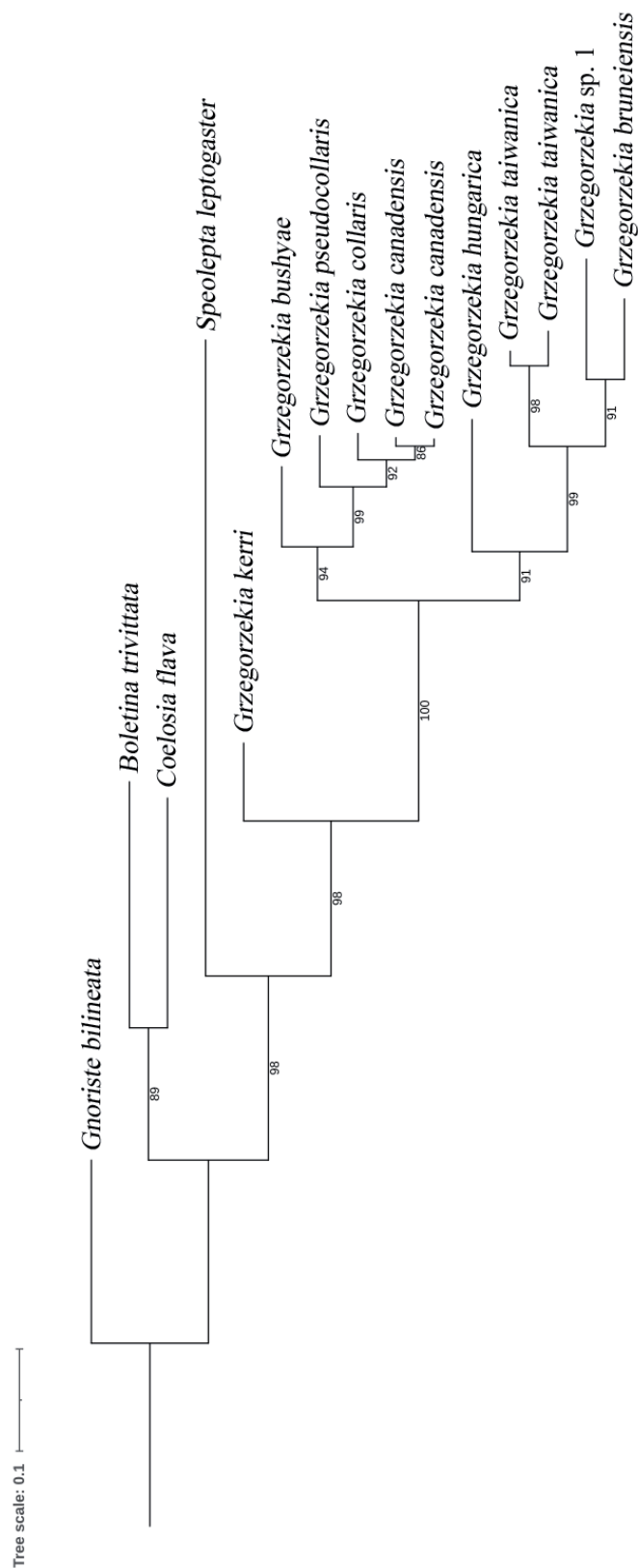


Fig. 23. Maximum likelihood hypothesis for relationships among species of *Grzegorzekia* Edwards, 1941 based on DNA sequence data (COI, 16S, 28S). Above node number = ultrafast bootstrap values (ufboot).

process is clearly discernible as a posterior continuation of the gonocoxal apodeme (gap), but it is weakly fixated also to the posteroventral corner of gc II. The close association of the process with the gonocoxal apodeme is clearly stated also for *G. kerri* but not so in the case of *G. quercus* (cf. Fitzgerald 2019: 165, 168, as gc III). In dissecting the aedeagal apparatus together with the gonocoxal apodeme from the rest of the male terminalia, pp gap usually remains connected to the basal part of the gap rather than to gc II (see Fig. 9A). However, in some cases, the pp gap can break away from both gc II and gap (see Fig. 4A). In Oriental species, the pp gap is beak-shaped and more firmly attached to gap.

The secondary reduction of the gonostylus, already noted by Söli (1997), is remarkable among fungus gnats. Indeed, the absence of the gonostylus is obvious in most of the species. However, in *G. bruneiensis* sp. nov., an additional lobe similar to a simple one-lobed gonostylus in other genera is discernible medially from gc II (Fig. 16A–C). That lobe was dissected from gc II together with the aedeagal apparatus, gap and pp gap. After detailed study, we are convinced this lobe is originally anchored to the folded margin of gc II and is homologous to lb gc II of the second Oriental species – *G. taiwanica* sp. nov.

As already noted by Chandler (1999), *Grzegorzekia*, together with *Phoenikiella* and *Creagdhubhia* Chandler, 1999, appears to represent a distinct lineage within the Gnoristinae and could arguably be treated as subgenera. However, a comprehensive phylogenetic assessment of the relationships among these genera was beyond the scope of the present study, which focuses on species-level taxonomy within *Grzegorzekia*. Progress in this direction is further constrained by the extreme rarity of *Phoenikiella* and *Creagdhubhia*, both of which remain monotypic and are known from very limited material.

Molecular discussion

Relationships among the species of *Grzegorzekia* included in this study are shown in Fig. 23. All the species of *Grzegorzekia* form a monophyletic group with a relatively strong support (ufboot = 98) and with *Speolepta leptogaster* (Winnertz, 1864) as a sister taxon, in agreement with Kaspřák *et al.* (2019). Within this clade, *G. kerri* forms the sister lineage to all remaining species of the genus, which is consistent with morphological evidence, as *G. kerri* and *G. quercus* (not sequenced here) differ markedly from all other species by the presence of a mid-tibial organ.

The clade comprising the remaining species of *Grzegorzekia* is strongly supported (ufboot = 100) and splits into two subclades. The first subclade (ufboot = 94), which includes the type species *G. collaris*, also contains *G. pseudocollaris* sp. nov., *G. canadensis* sp. nov., and *G. bushyae*. The second subclade (ufboot = 91) includes *G. hungarica*, which forms the sister lineage to a well-supported clade (ufboot = 99) comprising *G. bruneiensis* sp. nov., *G. taiwanica* sp. nov., and an undescribed species from Malaysia. The barcode sequence of the undescribed Malaysian species was obtained from the BOLD database (<https://portal.boldsystems.org/record/GMMGN1189-14>). The specimen was not available for detailed morphological study and, according to the habitus photograph available in BOLD, is too damaged to allow formal description. Nevertheless, its placement in the phylogeny indicates the presence of additional, undescribed diversity of *Grzegorzekia* in the Oriental region.

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We are greatly indebted to the late Peter Chandler (1944–2026) and Scott J. Fitzgerald (Corvallis, USA) for their detailed descriptions and discussions of species of *Grzegorzekia* in earlier publications (cf. Chandler 1999, 2015; Fitzgerald 2019) as well as for providing specimens for DNA extraction. Access to systematic and in-depth information on previously described species greatly facilitated both the description of new species and the preparation of a revision of the group. We are grateful to Valerie Levesque-Beaudin (Guelph, Canada) for the loan of Nearctic specimens. We are grateful to the Institute for Biodiversity and Environmental Research, University Brunei Darussalam, for allowing us to work in Kuala Belalong Field Studies Centre (KBSFC), and to the Biodiversity and Research Innovation Centre

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Data availability

DNA barcode sequences have been deposited in GenBank (accession numbers listed in Table 1) and are also partially available through the Barcode of Life Data Systems (BOLD) under the process IDs provided in the manuscript. All other data supporting the findings of this study are included in the manuscript.

Author contribution

Conceptualization: OK, JŠ. Data curation: OK, NB, JK. Formal analysis: OK, NB, DK, JK. Funding acquisition: OK, JŠ. Investigation & Validation: OK, JK, JŠ. Methodology: OK, NB, DK, JŠ. Project administration: OK, JŠ. Supervision: OK, JŠ. Visualization: OK, NB, JK. Writing – original draft: OK. Writing – review and editing: OK, NB, DK, JK, JŠ.

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