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New species group and four new species of *Brueelia* Kéler, 1936 (Phthiraptera: Ischnocera) from African buntings (Passeriformes: Emberizidae)

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Abstract. Four new species of *Brueelia* Kéler, 1936, are described from African emberizids: *Brueelia anomala* sp. nov. from *Emberiza striolata striolata* (Lichtenstein, 1823); *Brueelia kalaharicae* sp. nov. from *Emberiza flaviventris kalaharica* Roberts, 1932; *Brueelia saharae* sp. nov. from *Emberiza sahari* Levaillant, 1850; *Brueelia semicingulata* sp. nov. from *Emberiza tahapisi arabica* (Lorenz von Liburnau & Hellmayr, 1902). All four species belong to a new species group within *Brueelia*, here termed the '*Brueelia anomala* species group', characterized by the presence of a transverse dorsal preantennal suture that does not reach the lateral margins of the head; in three of the four species the gonopore is also modified in a way that is previously unknown within *Brueelia*.

Keywords. Philopteridae, *Brueelia*-complex, *Brueelia*, Africa, new species.

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Introduction

The chewing louse fauna of African birds is poorly known, especially for lice occurring on songbirds (Passeriformes). Lice in the *Brueelia*-complex are commonly associated with these birds, yet Gustafsson *et al.* (2019) noted that only 30 species of *Brueelia* s. str. have been reported from all of Africa since Ledger (1980) summarized the louse fauna of Africa in the south of the Sahara. Since then, only three species of *Brueelia* have been described from African hosts (Gustafsson *et al.* 2022, 2024). These lice probably represent less than 3% of the *Brueelia* spp. that infest African hosts (Gustafsson *et al.* 2019). If other genera of lice in the complex are included, the unknown diversity of lice of the African *Brueelia*-complex is even greater. Several recent publications have included genetic data from lice of the African *Brueelia*-complex (e.g., Bush *et al.* 2016; Light *et al.* 2016; Takano *et al.* 2017, 2019), but the majority of these species have been unidentified (Gustafsson *et al.* 2019).

In addition to the species diversity, the higher-taxonomic levels of the African louse fauna are also largely unknown. Gustafsson & Bush (2015) described a new species group of *Brueelia* Kéler, 1936, endemic to Africa. Of the new genera Gustafsson & Bush (2017) described within the *Brueelia*-complex, eight included species from African hosts. As an example of the undiscovered above-species diversity awaiting discovery in Africa, we here describe four new species of *Brueelia* s. str. parasitizing hosts in the family Emberizidae from Africa and Arabian hosts. All of these species belong to a new species group within *Brueelia*, which is described below.

Material and methods

Previously slide-mounted specimens deposited at the Natural History Museum, London, United Kingdom (NHMUK), or the Price Institute for Parasitology, University of Utah, Salt Lake City, Utah, United States (PIPR), were examined with a Nikon Eclipse E600 (Nikon Corporation, Tokyo, Japan), with a drawing tube attached for making illustrations. Illustrations were drawn by hand, scanned, collated, and edited in GIMP (https://www.gimp.org). Measurements (all in mm) were made from images taken through the same microscope fitted with an Olympus DP25 camera using the digital measuring software (ImageJ ver. 1.48, Wayne Rasband; https://www.imagej.net).

Abbreviations for measurements

AW = abdominal width (at segment V)
HL = head length (along midline)
HW = head width (at temples)
PRW = prothorax width
PTW = pterothorax width
TL = total length (along midline)

Host taxonomy follows Clements *et al.* (2023).

Abbreviations for morphological terms

Terminology for chaetotaxy and other structures of the lice, and the abbreviations thereof, follow Clay (1951), Mey (1994), and Gustafsson & Bush (2017).

ads = anterior dorsal seta
pmes = posterior mesosomal setae
tps = tergal posterior setae
vms = vulval marginal setae
vos = vulval oblique setae
vss = vulval submarginal setae

Results

Taxonomy

Class Insecta Linnaeus, 1758
Order Psocodea Novak, 1890
Parvorder Ischnocera Kellogg, 1896
Family Philopteridae Burmeister, 1838
Brueelia-complex sensu Gustafsson & Bush, 2017

Genus ***Brueelia*** Kéler, 1936

Philopterus Nitzsch, 1818: 288 [in partim].
Nirmus Nitzsch, 1818: 291 [in partim].
Degeeriella Neumann, 1906: 60 [in partim].
Allobrueelia Eichler, 1951: 36 [in partim].
Nigronirmus Złotorzycka, 1964: 248.
Spironirmus Złotorzycka, 1964: 261.
Serinirmus Soler Cruz *et al.*, 1987: 244.
Plesionirmus Mey, 2017: 144.
Neosittiella Mey, 2017: 149.

Type species

Brueelia rossittensis Kéler, 1936: 257 [= *Brueelia brachythorax* (Giebel, 1874: 134)] by original designation.

anomala species group includes:

Brueelia anomala sp. nov.
Brueelia kalaharicae sp. nov.
Brueelia saharae sp. nov.
Brueelia semicingulata sp. nov.

Remarks

The four species described here belong to the genus *Brueelia* s. str., but constitute a distinct species group within this genus, characterised by the presence of a dorsal preantennal suture that reaches the *ads* on each side, but does not reach the lateral margin of the head (Fig. 3). Apart from *Brueelia kalaharicae* sp. nov., all species also have antero-lateral extensions of the gonopore (Fig. 5), which are not found in any other known species of *Brueelia*.

The only previously known species in the genus with a dorsal preantennal suture is *Brueelia phasmasoma* Gustafsson & Bush, 2017, known from the Caribbean bananaquit, *Coereba flaveola luteola* (Cabanis, 1850). This species has a more extensive suture, which reaches both the lateral margins of the head, and the hyaline margin at the frons, thus completely encircling the dorsal preantennal plate (Gustafsson & Bush 2017: fig. 58). There seems to be no reason to assume that these two groups are closely related; it is more likely that the dorsal preantennal suture has evolved twice within *Brueelia*.

The hosts of the three species belong to the African 'brown buntings' (sensu Olsson *et al.* 2013), which constitute a separate radiation within the Old World emberizids (Alström *et al.* 2008). Apart from the species described here, we have examined material at the NHMUK from both *Emberiza capensis* Linnaeus, 1766, and *Emberiza impetuani* Smith, 1836. The specimens from both these host species are all female, and belong to the *anomala* species group. In the absence of males, we do not describe this material further here, but note that based on head shapes, material from each of these two hosts may represent distinct species.

The African 'brown bunting' radiation is closely related to the African 'yellow bunting' radiation (Alström *et al.* 2008). *Brueelia kalaharicae* sp. nov. is described from a host in this radiation. In addition, we have examined a single female from *E. cabanisi orientalis* (Shelley, 1882), which belongs to the *anomala* species group. This specimen was included in the phylogeny of Bush *et al.* (2016: fig. 3e, clade I-2, specimen 55), but its placement near *Brueelia* spp. from fringillid and sylviid hosts was not well supported. Additional samples from emberizid hosts may help to resolve the relationships of these lice within the *Brueelia*-complex. Unfortunately, no male specimens have been seen; consequently, we do not describe this species here.

It is likely that the *anomala* species group occurs throughout the African 'brown and yellow buntings' radiation. The *anomala* species group appears to be a mainly Afro-Arabian radiation within *Brueelia*, and no specimen of *Brueelia* from other emberizids we have examined belongs to this species group. The *anomala* species group thus forms the second species group within *Brueelia* limited to mainly African hosts, the other being the *clara* species group (Gustafsson & Bush 2015).

All species in this species group belong to the subgenus *Br.* (*Brueelia*).

Brueelia* (*Brueelia*) *anomala sp. nov.

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Figs 1–7

Differential diagnosis

Brueelia anomala sp. nov. is most similar to *Brueelia saharae* sp. nov. with which it shares the following characters not found in *Brueelia semicingulata* sp. nov.: antero-lateral extensions of gonopore reach beyond lateral margins of mesosome in *B. anomala* (Fig. 5) and *B. saharae* (Fig. 19), but do not reach lateral margins in *B. semicingulata* (Fig. 12); dark markings of lateral tergopleurites more extensive in *B. anomala* (Figs 1–2) and *B. saharae* (Figs 15–16) than in *B. semicingulata* (Figs 8–9); parameres more elongated in *B. anomala* (Fig. 6) and *B. saharae* (Fig. 20) than in *B. semicingulata* (Fig. 13). *Brueelia anomala* can be separated from *B. saharae* by the following characters: proximal mesosome rounded in *B. anomala* (Fig. 5), but angular and proximally widened in *B. saharae* (Fig. 19); gonopore with flat anterior margin in *B. anomala* (Fig. 5), but medianly pointed anterior margin in *B. saharae* (Fig. 19); male tergopleurite VII with 1 *tps* on each side in *B. anomala* (Fig. 1), but 2 *tps* on each side in *B. saharae* (Fig. 15).

Etymology

The species epithet is derived from the Greek 'anomalia' for 'irregularity', referring to the presence of a dorsal preantennal suture, which is unusual in the genus.

Type material

Holotype (ex *Emberiza striolata striolata*)

"ARABIA" • ♂; locality unknown; Mar. 1948; R. Meinertzhagen leg.; 17490, NHMUK010693762; NHMUK [marked with black dot on slide].

Paratypes (ex *Emberiza striolata striolata*)

"ARABIA" • 3 ♂♂, 8 ♀♀; locality unknown; Mar. 1948; R. Meinertzhagen leg.; 17490, NHMUK010693762; NHMUK.

Type host

Emberiza striolata striolata (Lichtenstein, 1823) – striolated bunting.

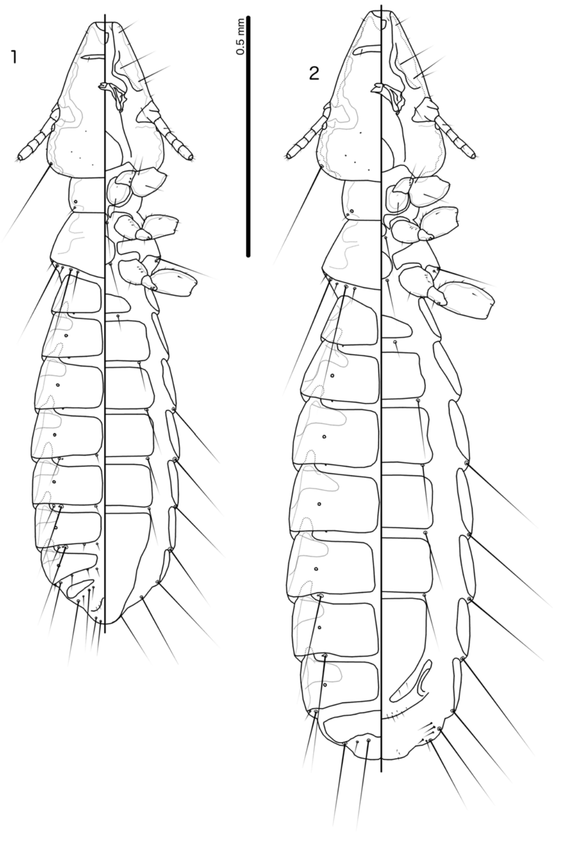
Type locality

"Arabia".

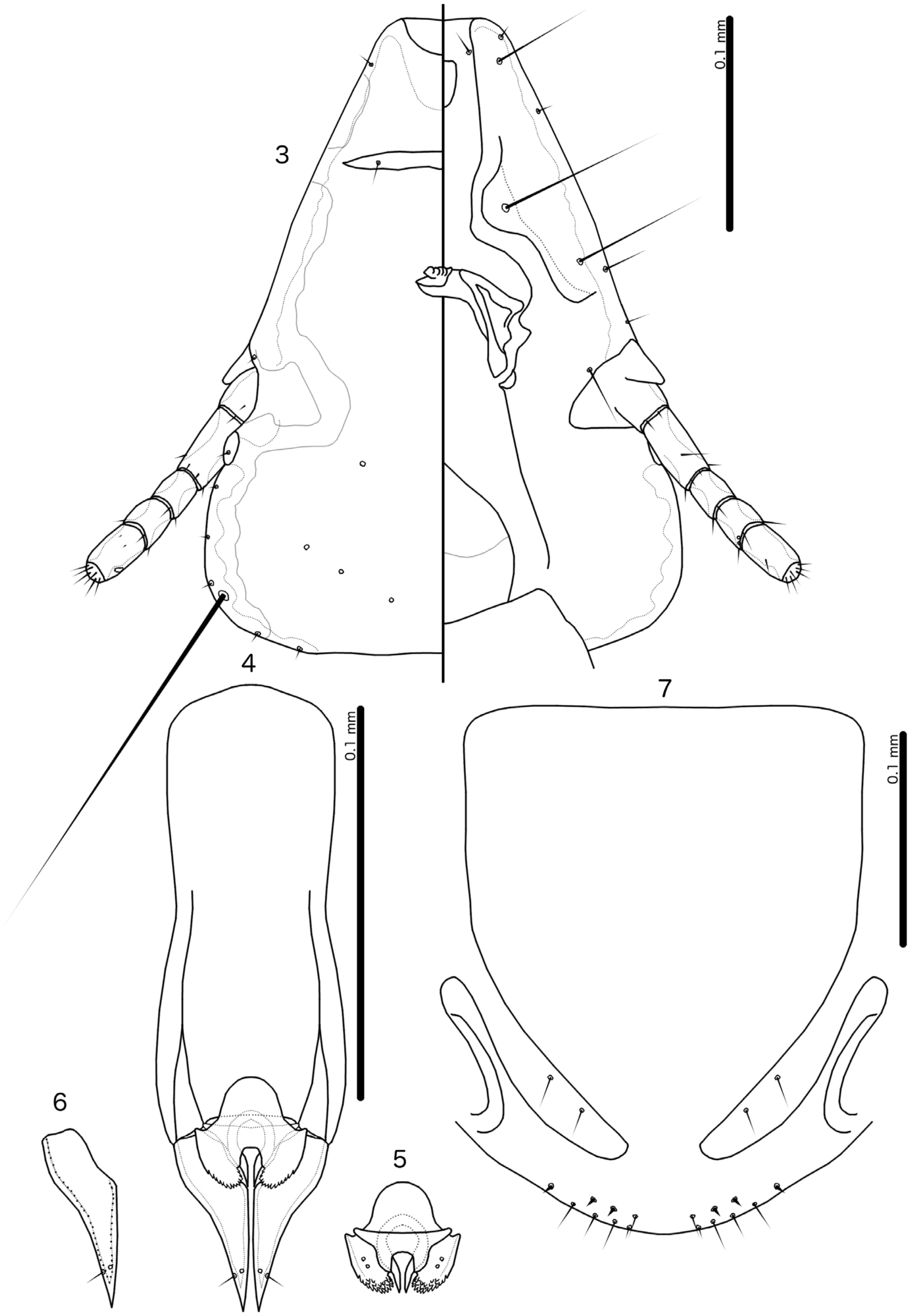
Description

Both sexes

Head narrowly trapezoidal (Fig. 3), lateral margins of preantennal area straight, frons flat to slightly concave. Marginal carina narrow, deeply displaced and much widened at osculum. Ventral anterior plate large, rounded triangular. Head chaetotaxy as in Fig. 3. Preantennal nodi slender, not bulging. Pre-ocular nodi larger than post-ocular nodi. Marginal temporal carina moderate, irregular. Gular plate lanceolate. Thoracic and abdominal segments as in Figs 1–2. Base pigmentation pale yellowish brown; posterior half of marginal carina, margins of antennal sockets, temples, anterior gular plate, proepimera, metepisterna, sternal and subgenital plates, and most of female tergopleurite IX+X medium brown; antero-lateral sections of tergopleurites medium brown as outlined by narrow lines in Figs 1–2.



Figs 1–2. *Brueelia anomala* sp. nov. ex *Emberiza striolata striolata* (Lichtenstein, 1823). **1**. Holotype, ♂ (NHMUK010693762), habitus, dorsal and ventral view. **2**. Paratype, ♀ (NHMUK010693762), habitus, dorsal and ventral view.



Figs 3–7. *Brueelia anomala* sp. nov. ex *Emberiza striolata striolata* (Lichtenstein, 1823). **3**–**5**. Holotype, ♂ (NHMUK010693762). **3**. Head, dorsal and ventral view. **4**. Genitalia, dorsal view. **5**. Mesosome, ventral view. **6**. Paratype, ♂ (NHMUK010693762), paramere, dorsal view. **7**. Paratype, ♀ (NHMUK010693762), subgenital plate and vulval margin, ventral view.

Male

Thoracic and abdominal chaetotaxy as in Fig. 1; tergopleurite VII with 1 *tps* on each side. Basal apodeme slender (Fig. 4), slightly constricted at mid-length. Proximal mesosome gently rounded (Fig. 5). Mesosomal lobes broad, rugose area extensive in distal ends, 2 *pmes* sensilla on each side of gonopore. Gonopore with antero-lateral extensions reaching beyond lateral margins of mesosome, anterior margin flat. Penile arms long, reaching to distal margin of mesosome. Parameres elongated, tapering gently, *pst1–2* as in Fig. 6.

Measurements (n = 4). TL = 1.17–1.23; HL = 0.31–0.32; HW = 0.23–0.24; PRW = 0.15; PTW = 0.21–0.23; AW = 0.31–0.32.

Female

Thoracic and abdominal chaetotaxy as in Fig. 2. Lateral margins of anterior subgenital plate roughly parallel (Fig. 7), with moderate connection to cross-piece. Vulval margin gently rounded (Fig. 7), with 3–4 short, slender *vms* and 3–4 short, thorn-like *vss* on each side; 3–4 short, slender *vos* on each side of subgenital plate; distal 1 *vos* median to *vss*.

Measurements (n = 8). TL = 1.44–1.53; HL = 0.34–0.35; HW = 0.24–0.26; PRW = 0.16–0.17; PTW = 0.24–0.26; AW = 0.26–0.38.

Brueelia* (*Brueelia*) *semicingulata sp. nov.

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Figs 8–14

Differential diagnosis

Brueelia semicingulata sp. nov. can be separated from both *B. anomala* sp. nov. and *B. saharae* sp. nov. by the following characters: antero-lateral extensions of gonopore does not reach lateral margins of mesosome in *B. semicingulata* (Fig. 12), but reaches beyond lateral margins in *B. anomala* (Fig. 5) and *B. saharae* (Fig. 19); anterior margin of proximal mesosome is flat in *B. semicingulata* (Fig. 12), but rounded in *B. anomala* (Fig. 5) and irregular in *B. saharae* (Fig. 19); patches of dark pigmentation on lateral tergopleurites less extensive in *B. semicingulata* (Figs 8–9) than in *B. anomala* (Figs 1–2) and *B. saharae* (Figs 15–16).

Etymology

The species epithet is derived from the Latin '*semi*' for 'half' and '*cingulatus*' for 'belted', referring to the areas of dark pigmentation that reach only half-way across the abdomen.

Type material

Holotype (ex *Emberiza tahapisi arabica*)

"ARABIA" • ♂; locality unknown; Feb. 1948; R. Meinertzhagen leg.; 17428, 17469, NHMUK010693760; NHMUK [marked with black dot on slide].

Paratypes (ex *Emberiza tahapisi arabica*)

"ARABIA" • 1 ♂♂, 5 ♀♀; locality unknown; Feb. 1948; R. Meinertzhagen leg.; 17428, 17469, NHMUK010693760; NHMUK.

Type host

Emberiza tahapisi arabica (Lorenz von Liburnau & Hellmayr, 1902) – cinnamon-breasted bunting.

Type locality

"Arabia".

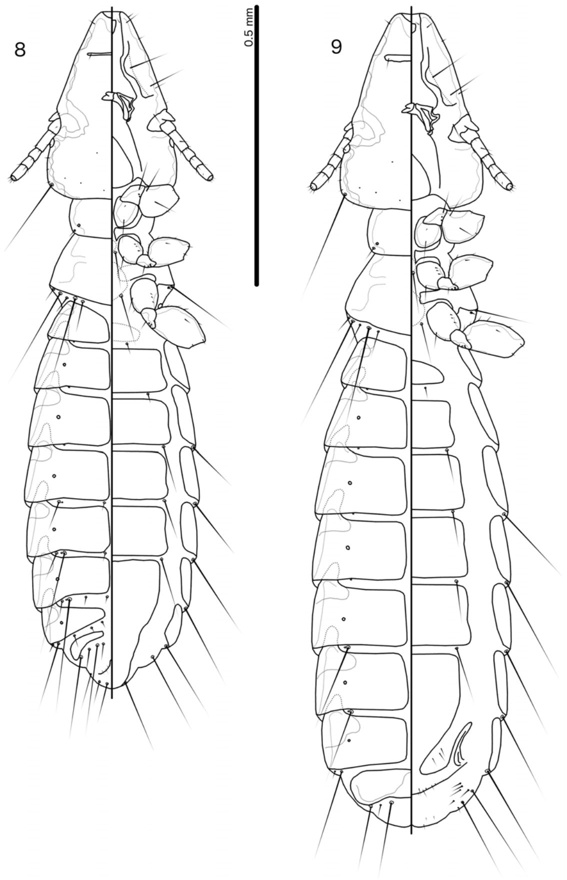
Description

Both sexes

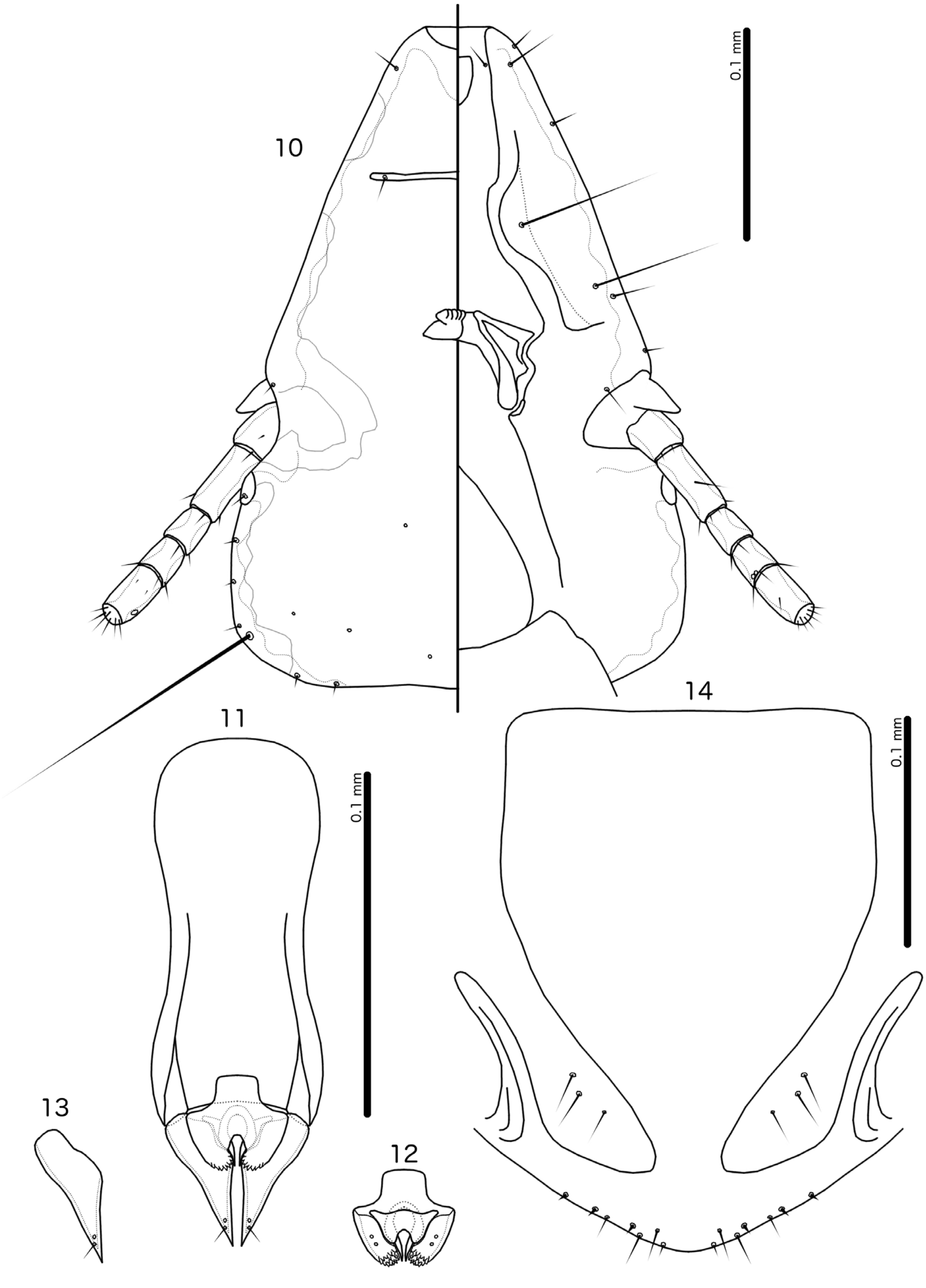
Head slenderly trapezoidal (Fig. 10), lateral margins slightly convex, frons flat to slightly concave. Marginal carina slender, deeply displaced and much widened at osculum. Ventral anterior plate triangular. Head chaetotaxy as in Fig. 10. Preantennal nodi slender, not bulging. Pre-ocular nodi larger than post-ocular nodi. Marginal temporal carinae moderate, irregular. Gular plate lanceolate. Thoracic and abdominal segments as in Figs 8–9. Base pigmentation pale brown; posterior half of marginal carina, margins of antennal sockets, temples, anterior gular plate, proepimera, metepisterna, sternal and subgenital plates, and most of female tergopleurite IX+X medium brown; antero-lateral corners of tergopleurites medium brown as outlined by narrow lines in Figs 8–9.

Male

Thoracic and abdominal chaetotaxy as in Fig. 8; tergopleurite VII with 1 *tps* on each side. Basal apodeme slender (Fig. 11), constricted at mid-length. Proximal mesosome square-shaped (Fig. 12). Mesosomal lobes wide, rugose area limited to distal end, 2 *pmes* sensilla on each side of gonopore. Gonopore with antero-lateral extension not reaching lateral margins of mesosome, anterior margin convex medianly.



Figs 8–9. *Brueelia semicingulata* sp. nov. ex *Emberiza tahapisi arabica* (Lorenz von Liburnau & Hellmayr, 1902). **8**. Holotype, ♂ (NHMUK010693760), habitus, dorsal and ventral view. **9**. Paratype, ♀ (NHMUK010693760), habitus, dorsal and ventral view.



Figs 10–14. *Brueelia semicingulata* sp. nov. ex *Emberiza tahapisi arabica* (Lorenz von Liburnau & Hellmayr, 1902). **10–13**. Holotype, ♂ (NHMUK010693760). **10**. Head, dorsal and ventral view. **11**. Genitalia, dorsal view. **12**. Mesosome, ventral view. **13**. Paramere, dorsal view. **14**. Paratype, ♀ (NHMUK010693760), subgenital plate and vulval margin, ventral view.

Penile arms short, not reaching distal margin of mesosome. Parameres somewhat elongated, tapering gently, *pst1–2* as in Fig. 13.

Measurements (n = 2). TL = 1.14–1.17; HL = 0.31–0.32; HW = 0.22–0.23; PRW = 0.14; PTW = 0.20–0.22; AW = 0.29–0.31.

Female

Thoracic and abdominal chaetotaxy as in Fig. 9. Lateral margins of anterior subgenital plate parallel to slightly convex (Fig. 14), with narrow connection to cross-piece. Vulval margin convergent to blunt median point (Fig. 14), with 3 short, slender *vms* and 3–5 short, thorn-like *vss* on each side; 3–4 short, slender *vos* on each side of subgenital plate; distal 1 *vos* median to *vss*.

Measurements (n = 5). TL = 1.39–1.53; HL = 0.35–0.36; HW = 0.25–0.26; PRW = 0.16–0.17; PTW = 0.23–0.25; AW = 0.33–0.36.

Remarks

Pterothorax and abdominal segment II are obscured by gut content in all examined specimens, and here illustrated approximately.

Brueelia* (*Brueelia*) *saharae sp. nov.

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Figs 15–21

Differential diagnosis

Brueelia saharae sp. nov. is most similar to *B. anomala* sp. nov. with which it shares the following characters not found in *Brueelia semicingulata* sp. nov.: antero-lateral extensions of gonopore reach beyond lateral margins of mesosome in *B. anomala* (Fig. 5) and *B. saharae* (Fig. 19), but do not reach lateral margins in *B. semicingulata* (Fig. 12); dark markings of lateral tergopleurites more extensive in *B. anomala* (Figs 1–2) and *B. saharae* (Figs 15–16) than in *B. semicingulata* (Figs 8–9); parameres more elongated in *B. anomala* (Fig. 6) and *B. saharae* (Fig. 20) than in *B. semicingulata* (Fig. 13). *Brueelia saharae* can be separated from *B. anomala* by the following characters: proximal mesosome angular and proximally widened in *B. saharae* (Fig. 19), but rounded in *B. anomala* (Fig. 5); gonopore with medianly pointed anterior margin in *B. saharae* (Fig. 19), but flat anterior margin in *B. anomala* (Fig. 5); male tergopleurite VII with 1 *tps* on each side in *B. anomala* (Fig. 1), but 2 *tps* on each side in *B. saharae* (Fig. 15).

Etymology

The species epithet is derived from the Sahara Desert, which is the main range of the type host.

Type material

Holotype (ex *Emberiza sahari*)

MOROCCO • ♂; locality unknown; Nov. 1938; R. Meinertzhagen leg.; 12071, NHMUK010693761; NHMUK [marked with black dot on slide].

Paratypes (ex *Emberiza sahari*)

MOROCCO • 11 ♂♂, locality unknown; Nov. 1938; R. Meinertzhagen leg.; 12071, NHMUK010693761; NHMUK • 18 ♀♀; same data as for preceding; 12071, NHMUK010693831; NHMUK

Type host

Emberiza sahari Levaillant, 1850 – house bunting.

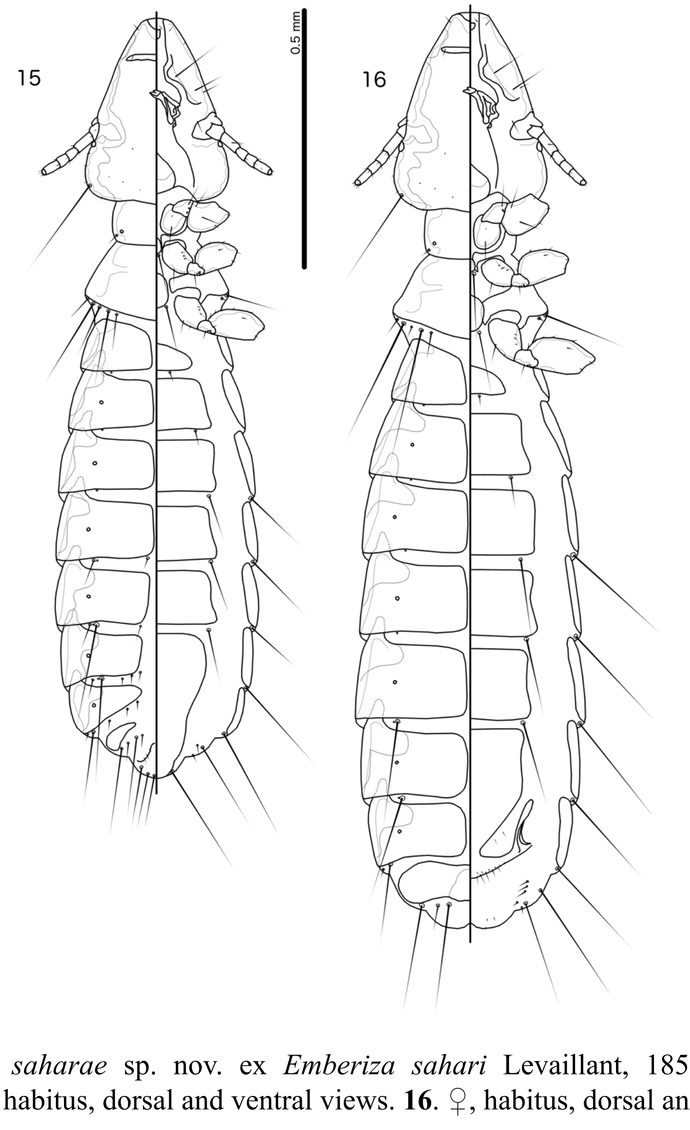
Type locality

Morocco.

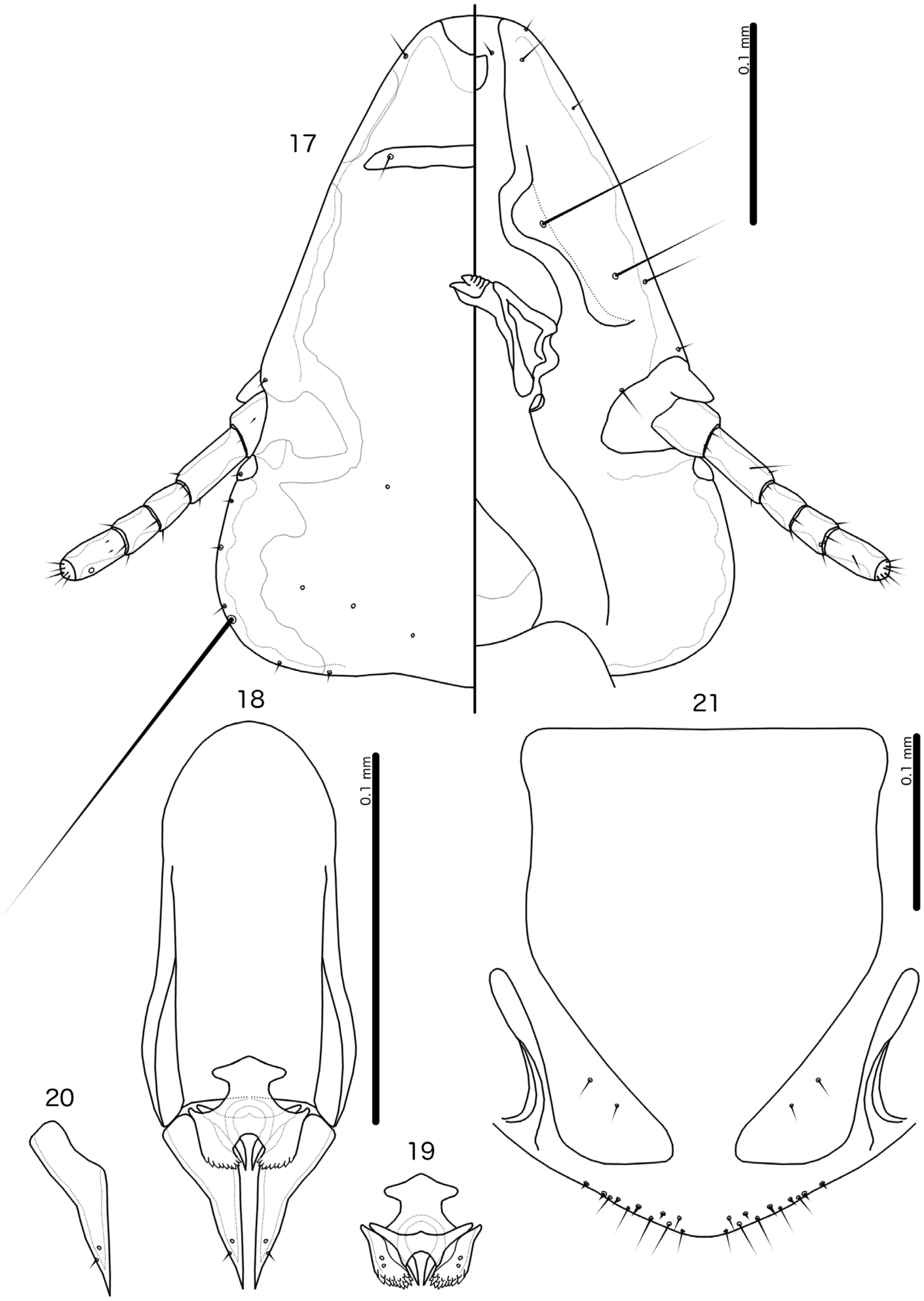
Description

Both sexes

Head slenderly trapezoidal (Fig. 17), lateral margins of preantennal area slightly convex, frons flat to slightly convex. Marginal carina slender, deeply displaced and much widened at osculum. Ventral anterior plate rounded triangular. Head chaetotaxy as in Fig. 17. Preantennal nodi wide but not bulging. Pre-ocular nodi larger than post-ocular nodi. Marginal temporal carina slender, slightly irregular. Gular plate lanceolate. Thoracic and abdominal segments as in Figs 15–16. Base pigmentation pale brown; marginal carina, margins of antennal sockets, temples, anterior gular plate, proepimera, metepisterna, sternal and subgenital plates, and most of female tergopleurite IX+X medium brown; antero-lateral corners of tergopleurites medium brown as outlined by narrow lines in Figs 15–16.



Figs 15–16. *Brueelia saharae* sp. nov. ex *Emberiza sahari* Levaillant, 1850. **15**. Holotype, ♂ (NHMUK010693761), habitus, dorsal and ventral views. **16**. ♀, habitus, dorsal and ventral views.



Figs 17–21. *Brueelia saharae* sp. nov. ex *Emberiza sahari* Levaillant, 1850. **17–20**. Holotype, ♂ (NHMUK010693761). **17**. Head, dorsal and ventral view. **18**. Genitalia, dorsal view. **19**. Mesosome, ventral view. **20**. Paramere, dorsal view. **21**. ♀, subgenital plate and vulval margin, ventral view.

Male

Thoracic and abdominal chaetotaxy as in Fig. 15; tergopleurite VII with 2 *tps* on each side. Basal apodeme short, stout (Fig. 18), slightly constricted at mid-length. Proximal mesosome pointed (Fig. 19), with narrow lateral extensions variable between specimens. Mesosomal lobes broad, rugose area extensive, 2 *pmes* on each side lateral to gonopore. Gonopore with antero-lateral extensions reaching beyond lateral margins of mesosome. Penile arms short, not reaching distal margin of mesosome. Parameres elongated, tapering gently, *pst1–2* as in Fig. 20.

MEASUREMENTS (n = 12 except TL where n = 9). TL = 1.28–1.43; HL = 0.32–0.35 (0.34); HW = 0.25–0.27 (0.26); PRW = 0.16–0.17 (0.16); PTW = 0.24–0.27 (0.26); AW = 0.33–0.39 (0.36).

Female

Thoracic and abdominal chaetotaxy as in Fig. 16. Lateral margins of anterior subgenital plate concave to roughly parallel (Fig. 21), with narrow connection to cross-piece. Vulval margin convergent to rounded median point (Fig. 21), with 3–5 short, slender *vms* and 4–5 short, thorn-like *vss* on each side; 3–4 short, slender *vos* on each side of subgenital plate, distal 1 *vos* median to *vss*.

MEASUREMENTS (n = 18). TL = 1.55–1.75 (1.65); HL = 0.36–0.38 (0.37); HW = 0.27–0.29 (0.28); PRW = 0.17–0.19 (0.18); PTW = 0.27–0.30 (0.29); AW = 0.39–0.44 (0.41).

Brueelia* (*Brueelia*) *kalaharicae sp. nov.

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Figs 22–28

Differential diagnosis

Brueelia kalaharicae sp. nov. can be separated from all other species in the *Br. anomala* species group by the absence of antero-lateral extensions of the gonopore (Fig. 26). Females best separated by the combination of head shape (Fig. 23) and shape of the subgenital plate (Fig. 28).

Etymology

The specific epithet is derived from the subspecific name of the type host species, named after the Kalahari Desert in southern Africa. This name is, in turn, derived from the Tswana words 'kgala' and 'gadi', meaning 'to become thirty' and 'of large size', respectively.

Type material

Holotype (ex *Emberiza flaviventris kalaharica*)
SOUTH AFRICA • ♂; Limpopo, Mopane; 660 m a.s.l.; 16 Sep. 2011; G.A. Voelker leg.; NHMUK.

Paratypes (ex *Emberiza flaviventris kalaharica*)
SOUTH AFRICA • 7 ♂♂, 8 ♀♀; Limpopo, Mopane; 660 m a.s.l.; 16 Sep. 2011; G.A. Voelker leg.; PIPR.

Type host

Emberiza flaviventris kalaharica Roberts, 1932 – golden-breasted bunting.

Type locality

Mopane, Limpopo, South Africa.

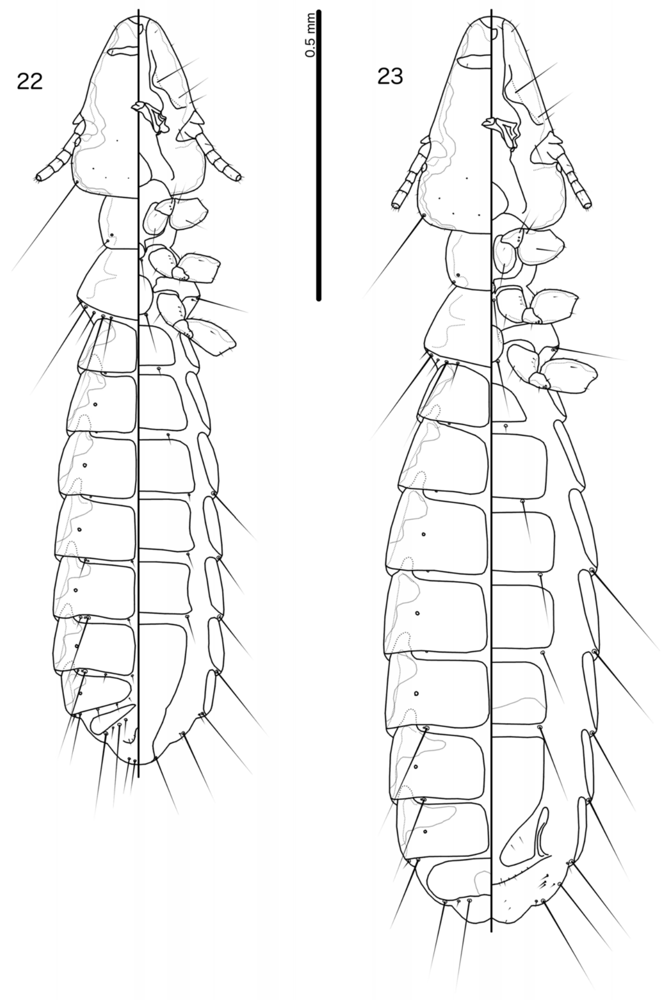
Description

Both sexes

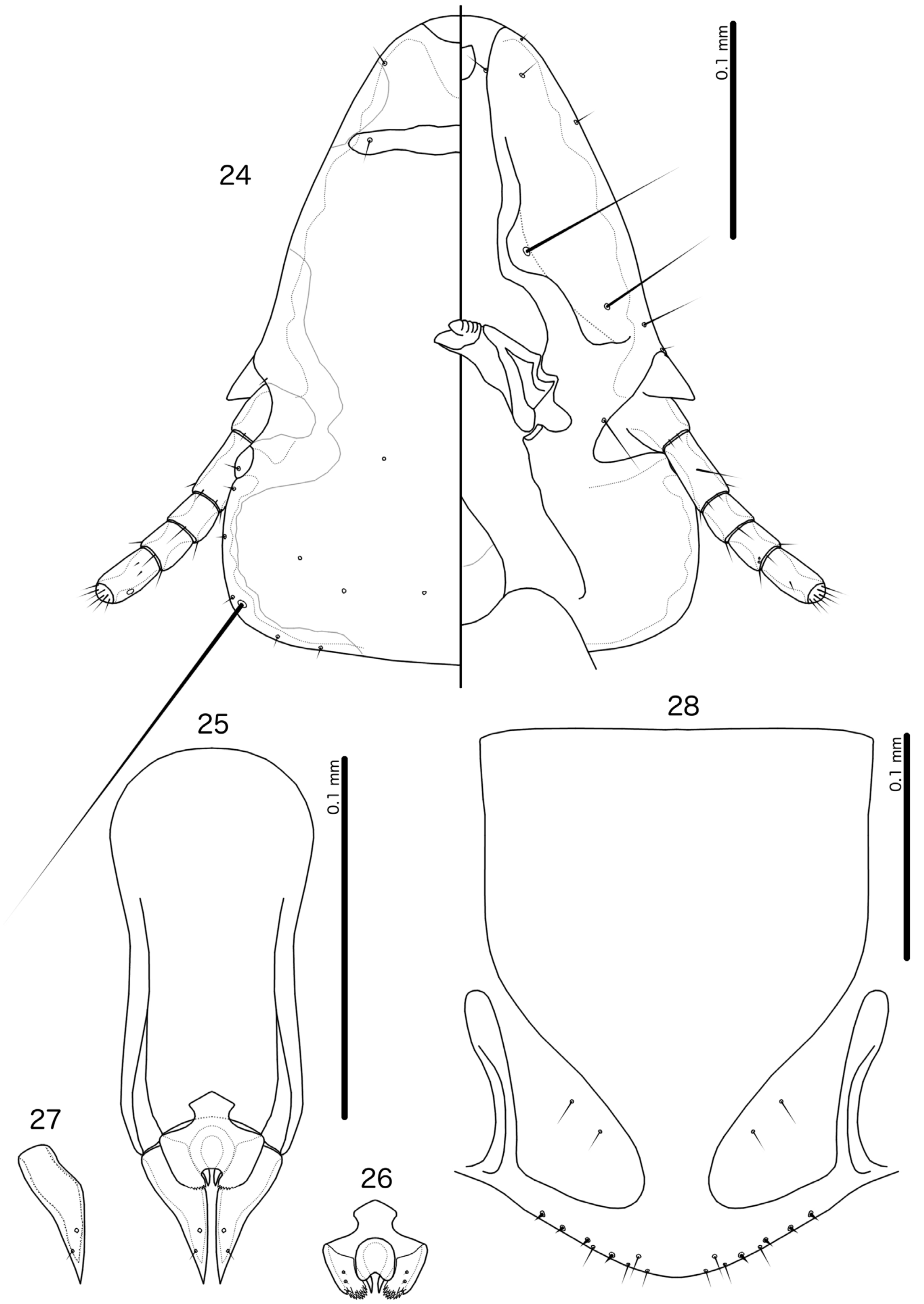
Head slenderly trapezoidal (Fig 24), shape differing between sexes. Frons convex. Marginal carina slender, deeply displaced and much widened at osculum. Ventral anterior plate rounded posteriorly, flattened or slightly concave anteriorly. Head chaetotaxy as in Fig. 24. Preantennal nodi wide, bulging. Pre-ocular nodi much larger than post-ocular nodi. Marginal temporal carina slender, slightly irregular. Gular plate lanceolate. Thoracic and abdominal segments as in Figs 22–23. Base pigmentation translucent; marginal and marginal temporal carinae, margins of antennal sockets, flagellomeres II–III, anterior gular plate, proepimera, metepisterna, and anterior ends of tergopleurites pale to medium brown; sternal plates IV–VI in male and posterior half of sternal plate VI and subgenital plate in female pale brown. Male subgenital plate may by pale brown in anterior end.

Male

Lateral margins of preantennal area slightly convex (Fig. 24). Thoracic and abdominal chaetotaxy as in Fig. 22; tergopleurite VII with 1 *tps* on each side. Basal apodeme moderately wide, lateral margins concave (Fig. 25). Proximal mesosome pointed, lateral margins sinuous (Fig. 26). Mesosomal lobes broad, rugose area more or less limited to distal margin; 2 *pmes* on each side lateral to gonopore.



Figs 22–23. *Brueelia kalaharicae* sp. nov. ex *Emberiza flaviventris kalaharica* Roberts, 1932. **22**. Holotype, ♂, habitus, dorsal and ventral view. **23**. Paratype, ♀, habitus, dorsal and ventral view.



Figs 24–28. *Brueelia kalaharicae* sp. nov. ex *Emberiza flaviventris kalaharica* Roberts, 1932. **24–27**. Holotype, ♂. **24**. Head, dorsal and ventral view. **25**. Genitalia, dorsal view. **26**. Mesosome, ventral view. **27**. Paramere, dorsal view. **28**. Paratype, ♀, subgenital plate and vulval margin, ventral view.

Gonopore rounded anteriorly, without antero-lateral extensions. Penile arms short, not reaching distal margin of mesosome. Parameres stout (Fig. 27), tapering gently; *pst1–2* as in Fig. 27.

Measurements (n = 10). TL = 1.21–1.38 (1.29); HL = 0.32–0.35 (0.33); HW = 0.22–0.25 (0.23); PRW = 0.13–0.16 (0.14); PTW = 0.20–0.23 (0.22); AW = 0.29–0.34 (0.31).

Female

Lateral margins of preantennal area more or less straight, or only slightly convex (Fig. 23). Thoracic and abdominal chaetotaxy as in Fig. 23. Lateral margins of subgenital plate straight or slightly concave (Fig. 28), with narrow connection to cross-piece. Vulval margin bulging but rounded (Fig. 28), with 3–4 short, slender *vms* and 3–4 short, thorn-like *vss* on each side; 3 short, slender *vos* on each side of subgenital plate; distal 1 *vos* median to *vss*.

Measurements (n = 9, except TL n = 6, and PTW n = 8). TL = 1.48–1.64; HL = 0.34–0.39; HW = 0.25–0.27; PRW = 0.14–0.16; PTW = 0.23–0.28; AW = 0.34–0.37.

Discussion

The discovery of a novel species group of lice in the *Brueelia*-complex on African and Arabian hosts is not surprising, given the vast unexplored diversity of lice in Africa. Gustafsson *et al.* (2019) estimated that at least 1100 species of *Brueelia* remain to be discovered in Africa, but the true number may be higher, as that estimate considered host families from which *Brueelia* species are already known. Moreover, their estimate focused on the genus *Brueelia* only; at least 22 genera and subgenera in the *Brueelia*-complex can be expected from African hosts, given their known host associations (Gustafsson & Bush 2017). The number of unknown *Brueelia*-complex species in Africa is difficult to estimate, as some host species are parasitized by more than one species in the complex, and some species of lice occur on more than one host species. However, it seems reasonable to assume that whatever this number is, an extensive survey of African *Brueelia*-complex lice will lead to the discovery of novel species groups, subgenera, and genera.

The host species of the species of *Brueelia* treated here are all closely related (Alström *et al.* 2008). All other specimens belonging to the *Br. anomala* species group we have seen are also from closely related hosts (see above), and all other species of *Brueelia* we have seen from emberizid hosts belong to other species groups. Thus, as far as is known, the *Br. anomala* species group may have a very limited host range, consisting of a monophyletic clade of African and Arabian emberizids that form a sister group to all other emberizids (Alström *et al.* 2008). However, we have only seen material from a small subset of the potential hosts, and many cases are known within *Brueelia* where closely related lice are found on distantly related hosts (e.g., Gustafsson & Bush 2015; Gustafsson *et al.* 2018). It is thus possible that the *anomala* species group is more widely distributed than presently known.

The fact that so few species in the *Brueelia*-complex are known from Africa may be a blessing in disguise. *Brueelia*-complex lice from other parts of the world are often inadequately described and poorly or incompletely illustrated due to unfortunate taxonomic practices in the past (Gustafsson & Najer 2022). As a result, many species are impossible to identify without direct comparisons with type specimens. By contrast, almost all species of *Brueelia* known from Africa have either been described or redescribed in recent decades, in almost all cases with good illustrations (e.g., Sychra *et al.* 2010a, 2010b; Najer *et al.* 2012; Gustafsson & Bush 2015, 2017; Gustafsson *et al.* 2018, 2019, 2022). Future studies of the louse fauna of songbirds may thus be easier in Africa than in many other parts of the world.

This may be significant, given the geographic bias of louse taxonomists perhaps best reflected in the list of louse taxonomists responsible for at least 50 taxa published by Price *et al.* (2003). Of the 24 people listed in this table, 19 are American or European, two are Indian, two South American, and one Japanese. There has never been any significant domestic research program for louse taxonomy in any African country beyond that conducted within the context of European colonialism (e.g., Bedford, Hopkins, Tendeiro). Thus, the kind of 'backyard lice' that have been described by the dozens in Europe have typically never even been collected in Africa or other tropical areas, contributing greatly to the gaps in our knowledge of louse diversity and distribution in the tropics.

Given the ongoing decline in bird abundance, density, and abundance in Africa (e.g., Thiollay 2006; Cresswell *et al.* 2009; Cooper *et al.* 2017; Riegert *et al.* 2021), the discovery and description of the louse fauna associated with African birds is urgent. While some of this discovery can be done based on extant museum collections around the world, the development of domestic programs of surveying and description of avian lice in different parts of Africa would be crucial, not least to determine e.g., prevalence and population trends of lice. We hope that our descriptions of new lice here will aid in the development of such programs and inspire more people to look at lice on African birds. Together with our previous descriptions of an unexpected species group of *Brueelia* in Africa (Gustafsson & Bush 2015), the species group described here show that much remains to be discovered.

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