

Systematics of the moth larval-feeding genus *Kundakimuka* Cassis (Hemiptera: Heteroptera: Miridae: Deraeocorinae: Termatophylini)

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Abstract

Two new species of the termatophylinae genus *Kundakimuka* Cassis, 1995 (Heteroptera: Miridae) are described from the Eastern Hemisphere: *K. ribesi* n. sp. from Australia and *K. sudanensis* n. sp. from the Sudan. *Kundakimuka queenslandica* Cassis is recorded from Papua New Guinea for the first time. The distribution range of *Kundakimuka* is greatly extended to include the Afrotropical biogeographic region. A key to species of *Kundakimuka* is given.

Key words: Heteroptera, Miridae, Termatophylini, *Kundakimuka*, new species, Australia, Sudan.

Resumen

Sistemática del género *Kundakimuka* Cassis, comedor de larvas de polillas (Hemiptera: Heteroptera: Miridae: Deraeocorinae: Termatophylini)

Se describen, del Hemisferio Oriental, dos nuevas especies del género termatofilino *Kundakimuka* Cassis, 1995 (Heteroptera: Miridae): *K. ribesi* n. sp., de Australia, y *K. sudanensis* n. sp., de Sudán. Se cita *Kundakimuka queenslandica* Cassis de Papúa Nueva Guinea por primera vez. Se amplía notablemente el área de distribución de *Kundakimuka*, incluyendo la región biogeográfica Afrotropical. Se presenta una clave de las especies de *Kundakimuka*.

Palabras clave: Heteroptera, Miridae, Termatophylini, *Kundakimuka*, especies nuevas, Australia, Sudán.

Laburpena

***Kundakimuka* Cassis genero sits-larben jalearen sistematika (Hemiptera: Heteroptera: Miridae: Deraeocorinae: Termatophylini)**

Kundakimuka Cassis, 1995 genero termatofilinoaren (Heteroptera: Miridae) Ekialde Hemisferioko bi espezie berri deskribatzen dira: *K. ribesi* n. sp., Australiakoa, eta *K. sudanensis* n. sp., Sudanekoa. *Kundakimuka queenslandica* Cassis lehenengo aldiz aipatzen da Papua Ginea Berritik. *Kundakimuka*aren banaketa-eremua nabarmen zabaltzen da, eskualde biogeografiko Afrotropikala ere hartuz, hain zuzen. *Kundakimuka* espezieen klabea aurkezten da.

Gako-hitzak: Heteroptera, Miridae, Termatophylini, *Kundakimuka*, espezie berriak, Australia, Sudan.

Introduction

The plant bug tribe Termatophylini (Heteroptera: Miridae: Deraeocorinae) is a little studied taxon and

prior to this study comprised 10 genera and 34 species worldwide (Cassis, 1995; Cassis and Eyles, 2006). They are noteworthy because of their autapomorphic morphology and specialised biology, with a number

of species recorded as cryptozoic predators in microhabitats such as shed eucalypt bark and moth larval galleries (Cassis, 1995).

The phylogenetic relationships of the Termatophylini requires assessment as they are unlikely members of the Deraeocorinae, where they are currently placed. Cassis (1995) suggested that their male genitalia and metathoracic gland morphology infer a closer relationship with the Bryocorinae: Dicyphini, than with deraeocorines. This reanalysis is beyond the scope of this work.

In a previous work, one of us (Cassis, 1995) described a new genus of termatophylines, *Kundakimuka*, from the Eastern Hemisphere, from Australia, with the inclusion of *K. pallipes* (Miyamoto, 1965) from Japan. The genus was recognised in part by the greatly enlarged male hind femora. Previous to the current study, three species are recognised in the genus (Cassis, 1995; Kerzhner and Josifov, 1999). In this work, we are describing two new species of *Kundakimuka* from Australia and the Sudan.

The Australian species is described in honour of the Spanish heteropterist, Jordi Ribes. Jordi is a prolific heteropterist who has greatly increased our understanding of true bugs of the Mediterranean Region. This patronymic is a recognition of his dedication and contributions to advancing knowledge of true bugs.

Material and methods

Specimens:

This study was based on an examination of specimens from the Australian Museum (AM), the American Museum of Natural History (AMNH), BP Bishop Museum (BPBM), the British Museum of Natural History (BMNH), the Queensland Museum (QM) and the University of New South Wales (UNSW).

Microscopy:

Specimens were examined using Leica MZ16 and Leica DMB microscopes. Illustrations were prepared using a camera lucida attached to the microscopes. Habitus photographs were taken using a Visionary Digital macrophotography system. Scanning electron micrographs were taken using an Hitachi TM3000 desktop microscope.

Taxonomy

Kundakimuka Cassis, 1995

Kundakimuka Cassis, 1995: 301 (gen. nov.); Kerzhner and Josifov, 1999: 30 (catalogue).

Type species:

Kundakimuka carvalhoi Cassis, 1995, by original designation.

Diagnosis:

Kundakimuka is recognised by the following combination of characters: flat pronotum; apically flattened parempodia; enlarged metafemora with subapical spine or processes; R+M shorter than median flexion line.

Distribution and diversity:

Kundakimuka comprises five species from the paleotropics. Species are now recorded from Sudan, Japan, Papua New Guinea and Australia.

Remarks:

Kundakimuka is closely related to *Seychellesius* Carvalho, 1988, and an examination of the type of the latter genus may result in the synonymy of these two genera in the future; they both have apically flattened parempodia and enlarged male metafemora. Cassis and Eyles (2006), in their revised key to the genera of the Termatophylini, maintained the two genera as distinct, on the basis of the R+M and median flexion line being subequal in *Seychellesius*. In our new species, *K. ribesi* n. sp., the median flexion line is only a little longer than the R+M and it can only be deduced by a close examination of the specimens. In this work, we maintain these two genera as valid pending examination of *Seychellesius*.

In our new species, *K. sudanensis* n. sp., the median flexion line is longer than the punctate R+M. This character state is not like any other species of *Kundakimuka* as originally defined by Cassis (1995), and fits more the definition of *Termatophylum* Reuter, 1884. However, we are confident in the generic placement of *K. sudanensis* n. sp., because of the greatly enlarged male metafemora, and the impunctate posterior margin of the pronotal collar (cf. punctate margin in *Termatophylum*). Its inclusion in *Kundakimuka* requires a redefinition of the genus based on the hemelytral characters, which means that the generic keys in Cassis (1995) and Cassis and Eyles (2006) would not work for this species.

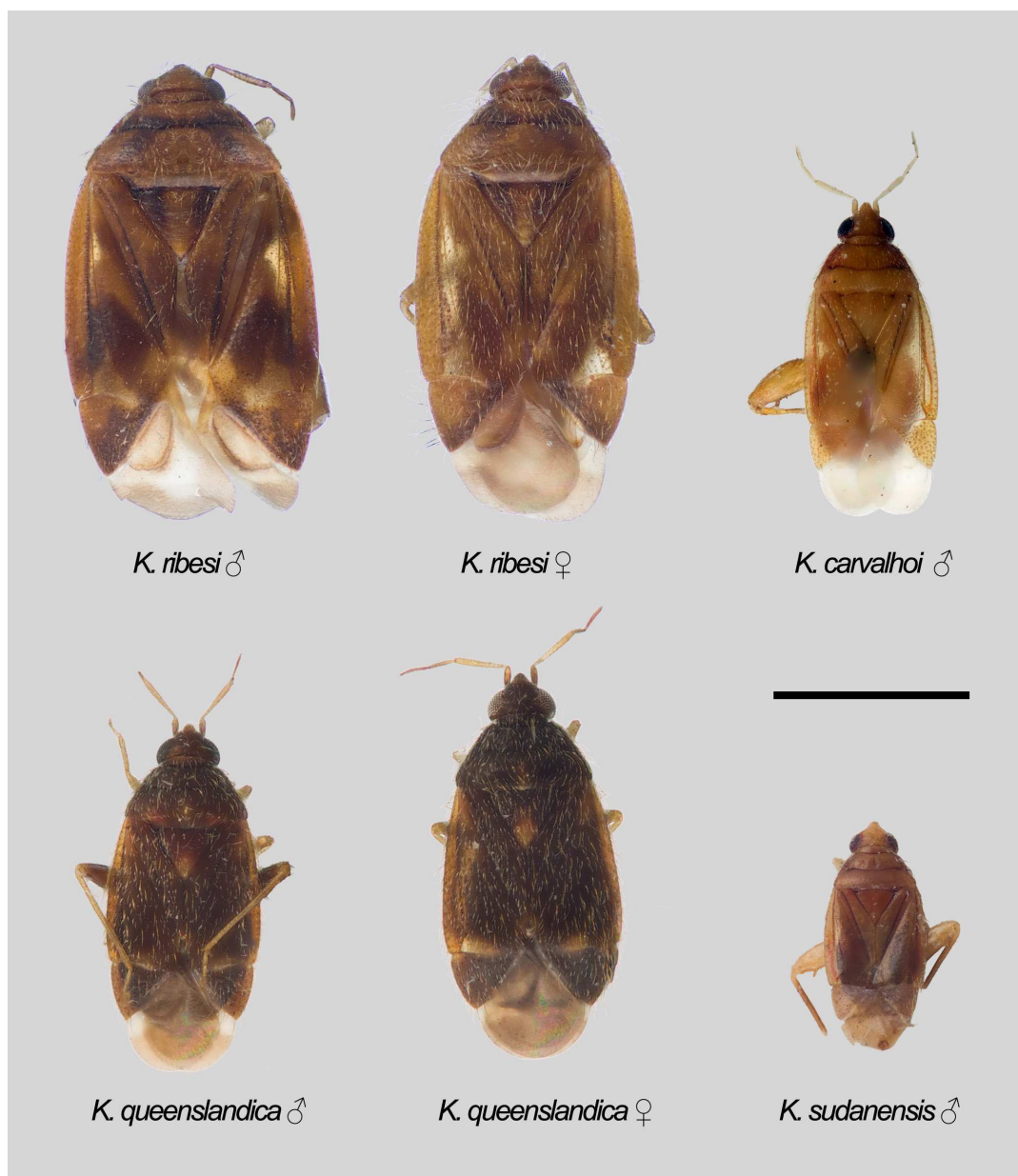


FIGURE 1. Habitus photographs of *Kundakimuka* species, including *K. ribesi* n. sp. and *K. sudanensis* n. sp. (Scale bar = 2 mm).

Checklist of species of *Kundakimuka*:

<i>K. carvalhoi</i> Cassis, 1995	Australia (Northern Territory)
<i>K. queenslandica</i> Cassis, 1995	Australia (Queensland)
<i>K. pallipes</i> (Miyamoto, 1965)	Japan (Kyushu)
<i>K. ribesi</i> Cassis, Tatarnic & Symonds n. sp.	Australia (New South Wales)
<i>K. sudanensis</i> Cassis, Tatarnic & Symonds n. sp.	Sudan

Key to species of *Kundakimuka*

- (1) Median flexion line longer than R+M vein (Fig. 1); minute species, male body length 1.75 mm; AIV red; male metafemora with subapical spine (Fig. 1) (Sudan) ***K. sudanensis* n. sp.**
 – Median flexion line shorter than or subequal to R+M vein; species small to large, male body length > 2 mm; AIV pale; male metafemora with either subapical spine or subapical flange 2
- (2) Midline of callar region of pronotum punctate; cuneus dark brown, contrasting with paler colouration of corium (Japan) ***K. pallipes*** (Miyamoto)
 – Midline of callar region usually not demarcated, at most with impressed, impunctate line; cuneus concolorous with corium 3
- (3) Embolium with prominent red stripe; male metafemora with enlarged subapical flange (Australia)
 ***K. carvalhoi*** (Cassis)
 – Hemelytral membrane with white spot distal to cuneus; embolium yellow-brown to dark brown, without red stripe; male metafemora with subapical enlarged spine or rows of minute teeth 4
- (4) Large species, male body length 3.57 mm, female body length 3.56 mm; dorsum yellowish-brown with male metafemora with large subapical spine on ventral surface (Fig. 1); male metatibiae arcuate (Figs. 2c, 3c) (Australia) ***K. ribesi* n. sp.**
 – Small species, male body length 2.33–2.82 mm, female body length 2.79–3.03 mm; dorsum dark brown with yellowish markings on corium and apex of scutellum; male metafemora with rows of minute teeth (Fig. 2e) (Australia) ***K. queenslandica*** Cassis

***Kundakimuka carvalhoi* Cassis, 1995**

Figs.: 1 (habitus), 2d (female metafemora).

Kundakimuka carvalhoi Cassis, 1995: 303 (n. sp.); Kerzhner and Josifov, 1999: 30 (type species); Cassis and Eyles, 2006: 47 (checklist).

Material examined:

AUSTRALIA: Queensland, 19.3 km S Tully, Murri- gal, Bruce Highway, 23 August 1993, L.M. Brown, NQA1193043.P014, «adult ?feeds on *Acacia ?flaves- cen.*», MC93/442 (QM).

Biology:

The new material of this species extends its distribu- tional range to Queensland, from an *Acacia* species of uncertain determination.

Remarks:

Cassis (1995) described *K. carvalhoi* from a single male specimen from Darwin. The new record for this

species extends the range of this species from the Northern Territory to the wet tropics of Queensland. The female metafemora are not expanded (Fig. 2d), as in the male (see Cassis, 1995: Fig. 2).

***Kundakimuka pallipes* (Miyamoto, 1965)**

Teratophylum pallipes Miyamoto, 1965: 275 (n. sp.).

Kundakimuka pallipes: Cassis, 1995: 279 (new combination); Kerzhner and Josifov, 1999: 30 (catalogue); Yasunaga *et al.*, 2001: 204 (diagnosis).

Remarks:

Miyamoto (1965) described *K. pallipes* from Kyushu, Japan, placing it in *Teratophyloides* Carvalho, 1955, the latter a monotypic genus from Guatemala. Cassis (1995), in erecting the genus *Kundakimuka*, transferred the Japanese species to it on the basis of head struc- ture. In so doing, he commented that the pronotal callar region has the midline punctate, as indicated in

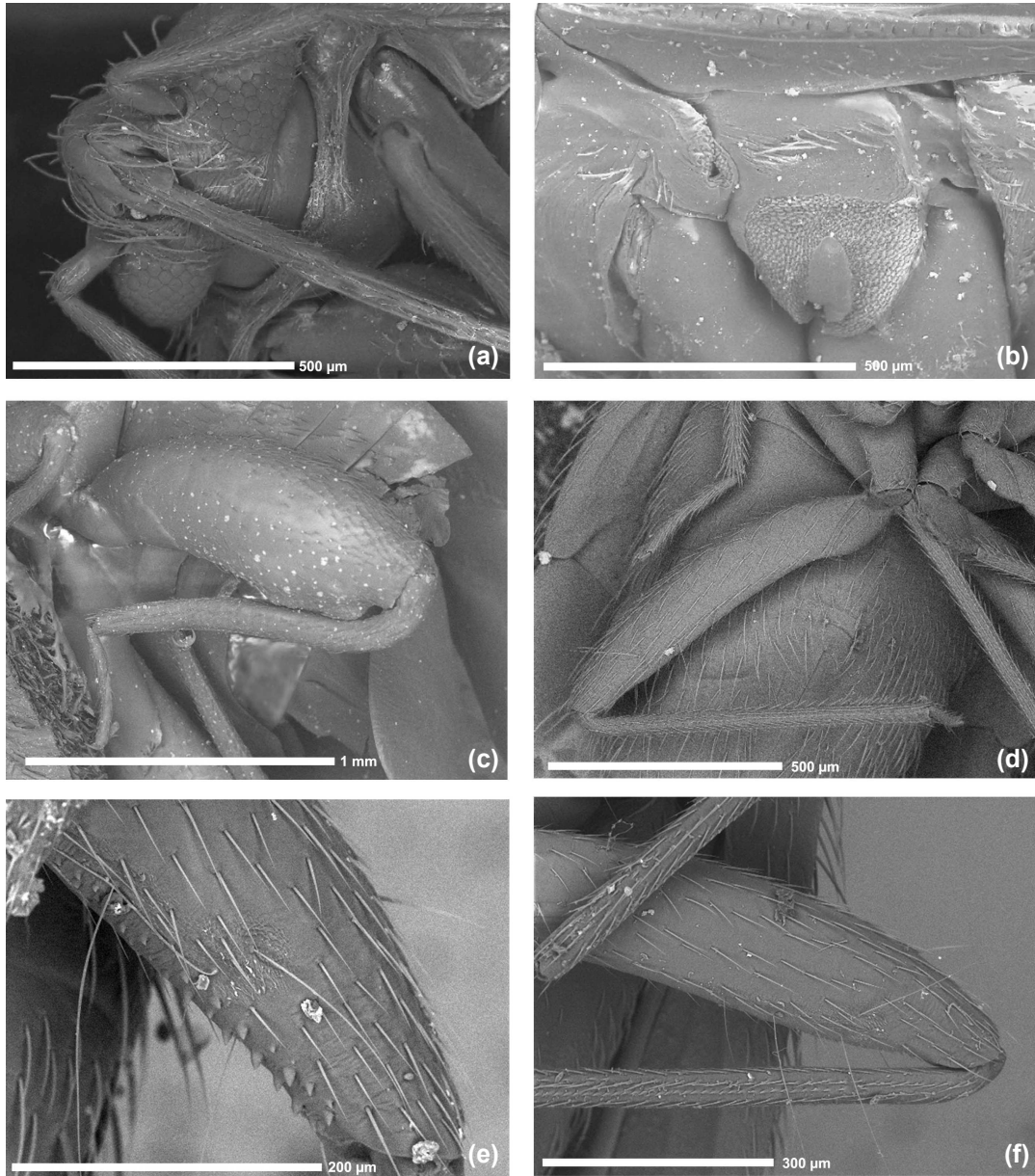


FIGURE 2. Scanning electron micrographs of *Kundakimuka* spp.: (a) *K. ribesi* n. sp. male head ventral; (b) *K. ribesi* n. sp., male meta-thoracic gland, external efferent system; (c) *K. ribesi* n. sp., male metafemora, anterior view; (d) *K. carvalhoi*, female metafemora, anterior view; (e) *K. queenslandica*, male metafemora, anterior view; (f) *K. queenslandica*, female metafemora, anterior view.

Miyamoto's (1965) illustration. Yasunaga *et al.* (2001) supported its placement in *Kundakimuka*. Like *S. niger*, the R+M and median flexion lines are subequal in length. *K. pallipes* is only known from the female

holotype. We predict, as with all other *Kundakimuka* spp., that the male will possess exaggerated and armed metafemora.

***Kundakimuka queenslandica* Cassis, 1995**

Figs.: 1 (habitus), 2e-f (male and female metafemora).

Kundakimuka queenslandica Cassis, 1995: 304 (n. sp.); Cassis and Eyles, 2006: 47 (checklist).

Material examined:

AUSTRALIA: 2 ♀♀, Queensland, 5.3 km SSW Brisbane Long Pocket, St Lucia, 27:30.70S 152:58.81E, May 2002 B Brown ABCL, *Poliopaschia* lab colony, «Miridae infesting laboratory culture of *Poliopaschia litbochlora* (Lepidoptera: Pyralidae)» (UNSW). 1 ♀, James Cook University, ABC lab, 3 April 1994, S Russell, NQPLN95018.P033, «Miridae collected from *Planchonia careya* (F.Muell.) R.Knuth» (QM).

PAPUA NEW GUINEA: 1 ♂, 2 ♀♀, Morobe Province, Wau, Namie Road, 1240 m, 23 June 1984, pyrethrin (synergized) fog of *Castanopsis acuminatissima* (Bl.) A.D.C. [Fagaceae] canopy, W.C. Gagne & UREP session III colls., sample #14, tree #3314. 2 ♂♂, 2 ♀♀, NE Bulolo, 550 m, 29-XI-1976 (BPBM; UNSW).

Biology:

The new material from Queensland provides new information on the biology of this species. It was found in laboratory cultures of the pyralid, *Poliopaschia litbochlora* (Lower). It was also collected from a canopy fog of the fagaceous genus *Castanopsis*, in the Wau district of northeast Papua New Guinea. In addition, it was collected on Cockatoo apple, *Planchonia careya* (family Lecythidaceae) in North Queensland.

Remarks:

Cassis (1995) described *K. queenslandica* from Queensland. In this work we extend the range of this species to New Guinea. In addition, we have examined specimens from the Hawaiian Islands (Oahu) and the Solomon Islands that may be conspecific with *K. queenslandica*. The colouration and leg morphology of these specimens are similar, but the Hawaiian and Solomon Island specimens are smaller in size. At this stage, we have refrained from identifying them as *K. queenslandica*, pending more exhaustive examination of the material. Nonetheless, it is possible that *K. queenslandica* is an adventive species in the Pacific Basin.

The male metafemora are weakly swollen and armed with rows of minute teeth distally (Fig. 2e) and the female metafemora are not expanded (Fig. 2f).

***Kundakimuka ribesi* Cassis, Tatarnic & Symonds n. sp.**

Figs.: 1 (habitus), 2a-c, 3 (external characters), 4 (male genitalia).

Etymology:

This species is named in honour of Jordi Ribes for his lifelong work on the Heteroptera.

Type material:

HOLOTYPE: ♂, AUSTRALIA, New South Wales, Brotherony, 33°06'S 146°39'E, between Lake Cargelligo and Condobolin, ex *Eucalyptus populnea* subsp. *bimbil* L.A.S. Johnson & K.D. Hill, isolated paddock tree (AM). PARATYPE: ♀, same data as holotype (AM).

Diagnosis:

Kundakimuka ribesi n. sp. is recognised by the following characters: dorsum yellowish-brown, with fuscous patterning on pronotum and hemelytra (Fig. 1); metafemora of male with a large subapical flange (Figs. 2c, 3c); male metatibiae arcuate (Figs. 2c, 3c); left paramere with elongate, narrow apophysis; and male endosoma saclike with two short spicules, more distal spicule with armature.

Description:

Elongate-ovoid; macropterous; male body length 3.57 mm, body width 1.75; female body length 3.56 mm, body width 1.86. COLOURATION (Fig. 1). Head mostly yellowish-brown, in female with obscure darker enbrowment on vertex. Antennae and labium uniformly yellowish-brown. Pronotum mostly yellowish-brown, with posterior ½ of callar region fuscous, contiguous with subquadrate, radiating fuscous markings on disc. Scutellum narrowly yellowish-brown medially, laterally fuscous. Hemelytra yellow-brown ground colour, with extensive fuscous and yellowish markings; clavus proximally mostly yellowish-brown, graduating distally to fuscous, with anal vein fuscous; embolium mostly yellowish-brown, apex with darker brown infusion; endocorium mostly yellowish-brown proximally, graduating to fuscous areas distally intermixed with two yellowish markings; cuneus narrowly yellow proximally, with remainder yellowish-brown; membrane bicoloured, mostly fumose, with translucent yellow marking adjacent to veins; veins dark brown. Legs: forelegs yellowish-brown; meso- and metafemora darker brown. Ventral surface of body darker brown than dorsum, reddish-brown on lateral regions of abdominal venter. VESTITURE. Dorsum

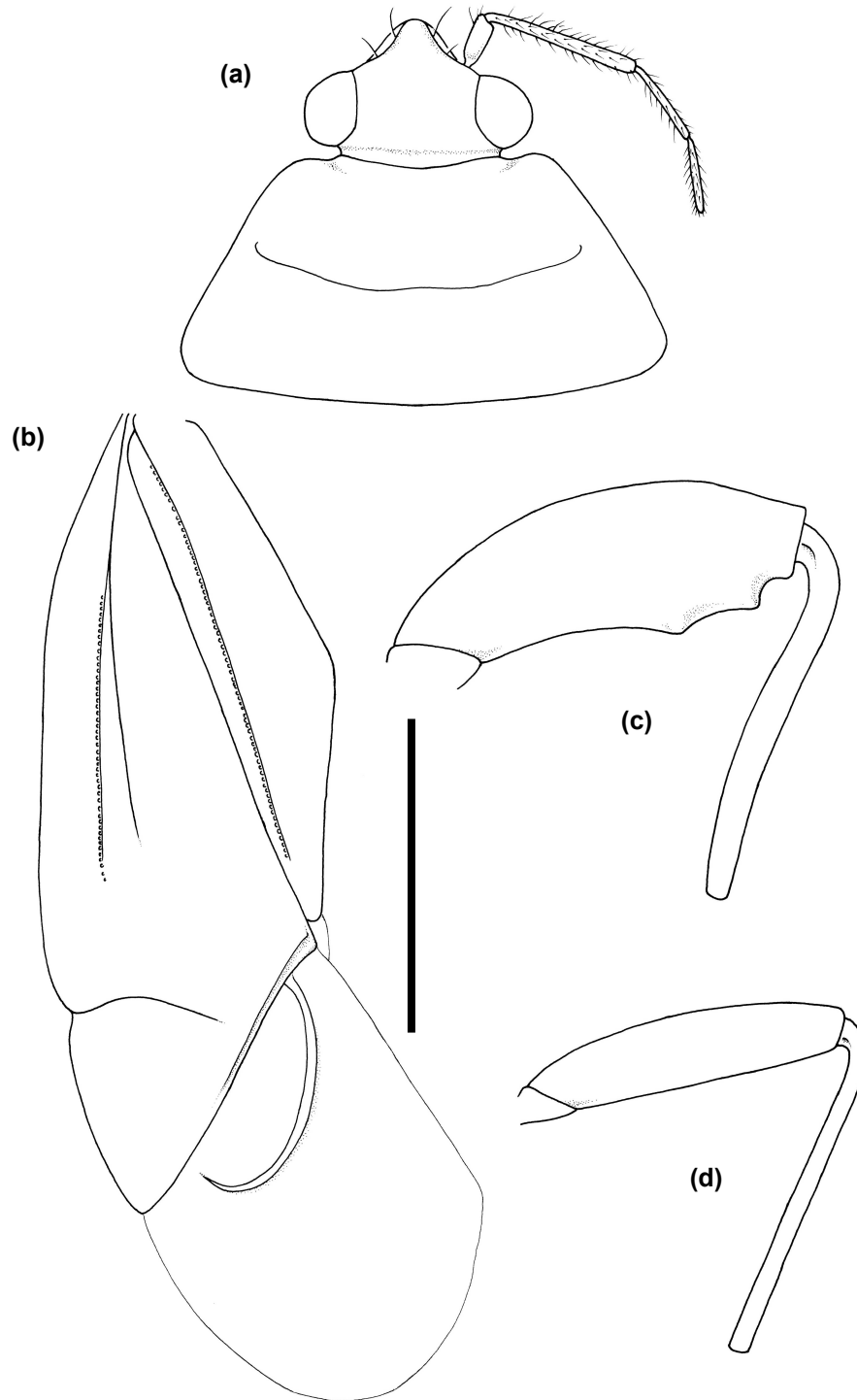


FIGURE 3. *Kundakimuka ribesi* n. sp., external characters: (a) Head and pronotum, dorsal view; (b) Left hemelytra, dorsal view; (c) Hind femur male; (d) Hind femur female (Scale bar = 1 mm).

with dense distribution of elongate, decumbent, pale setae, extremely long on anterolateral regions of pronotum. Abdominal venter with greatly elongate, erect setae on lateral margins, moreso caudally. STRUCTURE. *Head*: triangular, moderately produced in front of eyes (Fig. 3a); first labial segment subequal in length to bucculae (Fig. 2a). *Antennae*: AII>AIII>AIV>AI. *Labium*: short, reaching posterior margin of forecoxae. *Eyes*: enlarged, contiguous with pronotum. *Pronotum*: broad, subtrapezoidal, lateral margins strongly divergent posteriorly (Fig. 3a); posterior carina of collar impunctate; posterior margin of pronotum rectilinear. *Scutellum*: mesoscutellum exposed; scutellum large, weakly convex; flat. *Metathoracic glands*: moderately sized, peritreme tongue-shaped, rectilinear, projected laterally (Fig. 2b). *Hemelytra* (Fig. 3b): embolium broad, ca. 1 eye width; R+M punctate, subequal to median flexion line; costal fracture small; cuneus large; single membrane vein. *Legs*: male metafemora greatly enlarged with a large subapical flange (Figs. 2c, 3c); female metafemora not enlarged (Fig. 3d). *Male genitalia*: pygophore capsulelike (Fig. 4a); genital opening twisted to right hand side (Fig. 4a); parameres greatly asymmetrical, left paramere largest, C-shaped, sensory lobe weakly expanded, with robust setae, apophysis narrow evenly arcuate, with apex weakly flanged (Fig. 4c); right paramere minute, columnar (Fig. 4b); aedeagus simple, endosoma saclike, with two small triangular spicules, distal-most with small teeth, ductus seminis obscure (Figs. 4d-e).

Biology:

Kundakimuka ribesi n. sp. was collected on *Eucalyptus populnea bimbil*, commonly known as bimbil box. It was found on isolated paddock trees.

Remarks:

Kundakimuka ribesi n. sp. is the largest species of the genus, with the male 3.57 mm in length. Its overall facies is similar to that of *K. carnalboi*, however, aside from size differences, it differs from it by the colour patterning, the vastly different shape of the apex of the male metafemora (Figs. 2c, 3c), and the arcuate male metatibiae (Figs. 2c, 3c). The R+M is only a little longer than the median flexion line, which approaches the condition in *Seychellesius niger* Distant, 1913 where they are subequal in length. Like *K. queenslandica*, the dorsum has distinctive colour patterning (Fig. 1), but in *K. ribesi* n. sp. the patterning of the endocorium is unique, with two yellow patches distally.

Kundakimuka sudanensis Cassis, Tatarnic & Symonds n. sp.

Figs.: 1 (habitus).

Etymology:

This species is named for its collection in the Sudan.

Type material:

HOLOTYPE: ♂, SUDAN: Bahr el Ghazal, Khor Kyom, 18 February 1963, R. Linnavuori (AMNH).

Diagnosis:

Kundakimuka sudanensis n. sp. is recognised by the following characters: dorsum mostly yellowish-brown, ventral surface mostly fuscous (Fig. 1); AIV red, remainder of antennae yellowish-brown (Fig. 1); median flexion line longer than punctate R+M; medial margin of embolium red (Fig. 1).

Description:

Elongate-ovoid; macropterous; small species, male body length 1.75 mm, body width 0.69 mm. COLORATION (Fig. 1). Body mostly yellowish-brown; AIV and medial margin of embolium with reddish tinge; medial region of pronotal collar with obscure red marking; thoracic pleura and sterna, and abdominal venter mostly fuscous; punctate carinae and veins on dorsum darker brown; legs uniformly yellowish-brown. VESTITURE. Body with moderate distribution of decumbent, simple, pale setae; abdominal venter with moderate distribution of adpressed, simple, pale setae. STRUCTURE. *Head*: triangular, strongly produced in front. *Antennae*: AII>AIII>AIV>AI. *Labium*: short, reaching posterior margin of forecoxae. *Eyes*: enlarged, contiguous with pronotum. *Pronotum*: broad, subtrapezoidal, lateral margins strongly divergent posteriorly; posterior carina of collar impunctate; posterior margin of pronotum rectilinear. *Scutellum*: mesoscutellum narrowly exposed; scutellum large; flat. *Hemelytra*: embolium broad, ca. ¾ eye width; R+M punctate, short, shorter than apex of claval commissure; median flexion line little longer than R+M vein; costal fracture deep; cuneus large; single membrane vein. *Legs*: metafemora greatly enlarged with a large distal, outwardly directed spine (Fig. 1), with numerous minute spines.

Biology:

Unknown.

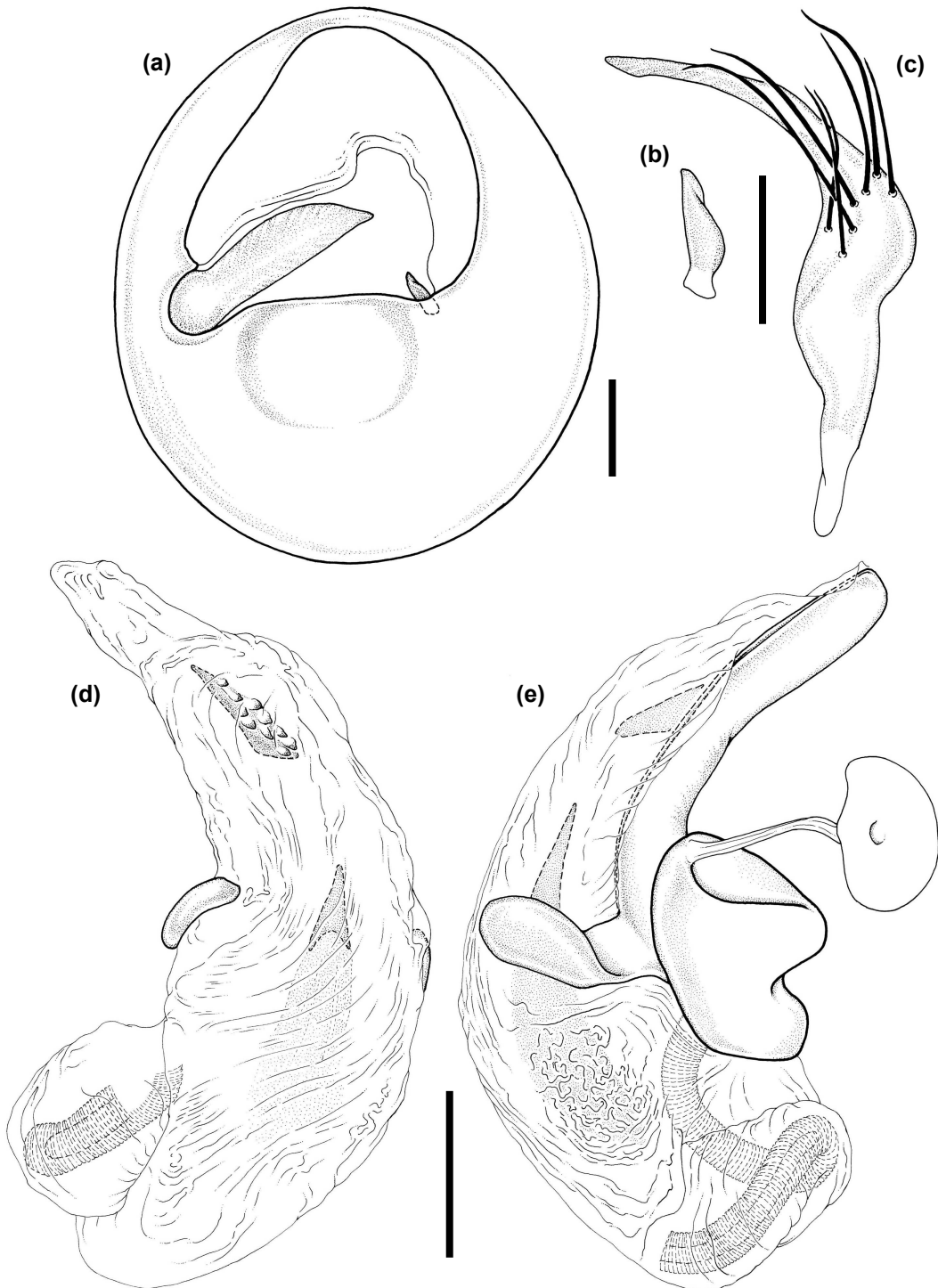


FIGURE 4. *Kundakimuka ribesi* n. sp., male genitalia: (a) Pygophore, posterior view; (b) Right paramere, dorsal view; (c) Left paramere, dorsal view; (d) Aedeagus, ventral view; (e) Aedeagus, left lateral view (Scale bars = 0.1 mm).

Remarks:

Kundakimuka sudanensis n. sp. is only known from the type locality. It is the smallest of all the described species of *Kundakimuka*. See the generic remarks section for discussion of its systematic placement. *K. sudanensis* n. sp. has a similar male metafemoral configuration to *K. carvalhoi*, with both possessing a large subdistal spine (Fig. 1). These species are separated by the great difference in size and colour differences, with *K. sudanensis* n. sp. having a red AIV, in comparison to *K. carvalhoi* which has yellowish-brown unicolorous antennae.

The male genitalia were not investigated because the species is only known from the holotype.

Discussion

Secondary sexual characters:

Kundakimuka displays distinctive sexual dimorphism of the metafemora in all species where both sexes are known. This is now shown to be the case in *K. carvalhoi*, *K. queenslandica* and *K. ribesi* n. sp. In *K. sudanensis* n. sp. only the male is known, and it has greatly enlarged metafemora. In all these species the male metafemora are greatly enlarged in comparison to females, and always possess armature, either as a large subdistal spine (sometimes with apical teeth) as in *K. carvalhoi* and *K. sudanensis* n. sp., large subapical flange (*K. ribesi* n. sp.), or with robust, minute teeth (*K. queenslandica*). The females of most of the species do not have armed metafemora (on the other hand, *S. niger* has rows of teeth as in the male of *K. queenslandica*). The modified hind legs of these males are strikingly similar to those of many leaf-footed bugs (Coreidae), which have been shown to function in male-male combat (Mitchell, 1980; Miyatake, 1997). Wheeler (2001) provided a summary of existing knowledge of plant bug mating, and courtship behaviour, however there is no mention of male combat behaviour. Although sexual dimorphism is well-known in the Miridae, including for example wing dimorphism (Schwartz *et al.*, 2008; Cassis and Wall, 2010), we are unaware of any example where male conflict has been evoked as the evolutionary driver for such secondary sexual characteristics. Based on our examination of this genus, we believe that further studies of *Kundakimuka* will reveal a mating system characterized by male-male combat, similar to that seen in coreids

(*e.g.* Mitchell, 1980; Miyatake, 1997; Eberhard, 1998) and rhyparochromids (Rodríguez, 2000).

Food preferences:

The food preferences of *Kundakimuka* species are little known. However, for *K. queenslandica* there is sufficient evidence to suggest that it is a facultative predator of lepidopterous larvae. Cassis (1995) reported this species from the oecophorid species, *Xylocyrtia luteodactella*. This moth species is an Australian native that is known to be a pest of ornamental Proteaceae (Wallace, 1974). In this work, we examined material that had been collected from laboratory cultures of the pyralid moth *Poliopaschia lithochlora*, which was being tested as a potential biological control agent of *Melaleuca quinquenervia* (Cav.) S. T. Blake in Florida (Galway and Purcell, 2005). The label data indicated that *K. queenslandica* were in large abundances, characterized as an infestation.

Acknowledgements

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