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Review of the genus *Sanganus* Distant, 1909 including the description of a new species, *S. quadrangularis* spec. nov.

(Hemiptera, Heteroptera, Tessaratomidae)

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The Oriental genus *Sanganus* Distant, 1909 is reviewed and redescribed. Also a new species, *Sanganus quadrangularis* spec. nov. is described so that the genus now comprises three species which are illustrated together with their distinctive morphological characteristics. Morphometric analyses of the highly variable species *Sanganus westwoodii* (Vollenhoven, 1866) and *Sanganus jenseni* Distant, 1909 are provided. A partly revised key to discriminate between the closely related genera *Sanganus* and *Pseudopycanum* Bergroth, 1891 and a key to the *Sanganus* species are presented.

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Introduction

The Oriental tessaratomid genus *Sanganus* Distant, 1909 has so far contained only two little known species, *Sanganus westwoodii* (Vollenhoven, 1866) and *S. jenseni* Distant, 1909. In 1866, the Dutch entomologist Snellen van Vollenhoven described the first species, *D. westwoodii*, accommodating it in the genus *Dalcantha* Amyot & Serville, 1843. His description appears to have been based on a single female specimen from Sumatra (Vollenhoven 1866). Two years later Vollenhoven (1868) transferred the species to *Pycanum* Amyot & Serville, 1843, whereas Stål (1870) considered the species more likely to belong to the newly established genus *Oxylobus* Stål, 1870. Bergroth (1891) revealed that this name was preoccupied by the coleopteran *Oxylobus* Chaudoir, 1855 and introduced *Pseudopycanum* which currently includes one species, *P. nigromarginatum* (Stål, 1863), as a substitute for *Oxylobus*. Hence, Kirkaldy (1909) catalogued the species as *Pseudopycanum westwoodi* (sic). While describing the second species, *Sanganus jenseni*, Distant (1909) created the new genus *Sanganus* based on at least one male and one female specimen from East Borneo. Unaware of, or ignoring Bergroth (1891), Distant stated that "This genus is allied to *Oxylobus*, Stål, and apparently includes the *Pycanum westwoodii*, Voll., a species only known to me by its figure […] allied to *S. westwoodii*, Voll., …" which suggests transferring *P. westwoodii* to the new genus *Sanganus*. Blöte (1945) followed the classification proposed by Distant (1909) and catalogued Vollenhoven's holotype in the RMNH as *Sanganus westwoodii* without further comment. Both Vollenhoven's and Distant's descriptions are insufficient for an accurate determination of the species. No detailed morphological studies on the two *Sanganus* species have been published, apart

from Kumar & Ghauri (1970) who illustrated the aedeagus, paramere, and spermatheca of *S. jenseni* and included *Sanganus* in their key to the genera of Tessaratominae – Eusthenini. It seems, however, that this key was solely based on *S. jenseni*, since certain characteristics do not apply to *S. westwoodii*. In our review of the genus *Sanganus*, we therefore redescribe the genus consulting the type specimens of these rare species. Whilst examining the material collected, we found a specimen in the Bavarian State Collection of Zoology (Munich) labelled '*Pseudopycanum quadrangularis*' which we identify and describe as a new *Sanganus* species.

Material and methods

Specimens studied. Material for this study was provided by the following institutions and private collections (abbreviations of depositories and curators who arranged the loans):

BMNH Museum of Natural History, London, United Kingdom (M. Webb)
cHGK Helmut G. Kallenborn collection, Saarbrücken, Germany
cJPM Jean-Philippe Maurel collection, Ramonville-Saint-Agne, France
cPHM Philippe Magnien collection, Paris, France
MNHN Muséum Nationale d'Histoire Naturelle, Paris, France (D. Pluot-Sigwalt)
NHMW Naturhistorisches Museum, Vienna, Austria (H. Zettel)
RMNH Nationaal Natuurhistorisch Museum (now Naturalis), Leiden, The Netherlands (R. de Vries)
ZMUA Zoölogisch Museum, University of Amsterdam, The Netherlands (W. Hogenes; the collection was recently transferred to RMNH)
ZSM Zoologische Staatssammlung, Munich, Germany (T. Kothe).

Data are presented in quotation marks, as they appear on the label, and separated by slashes. The first label is closest to the specimen. Remarks are given in brackets.

Material used for comparison. *Pseudopycanum nigromarginatum* (Stål, 1863). 1 ♂ (NHMW): "Malaca [handwritten] Coll. Signoret [printed] / nigromarg. [handwritten] det. Signoret [printed]". Left antenna and segments 3–4 of right antenna missing. Remarks: This specimen is probably the holotype (P. Kment, personal communication). Rolston et al. (1993) erroneously recorded *P. nigromarginatum* as a Mollucan species (i.e. from Maluku Islands, an Indonesian archipelago east of Sulawesi) – a confusion with Malacca, as becomes clear from the type locality Tringany Malaccae (Stål 1863) [Malaysia, Peninsular Malaysia, Terengganu State, Tringano (see Fig. 17)].

Preparation of genitalia. Aedeagus and spermatheca were prepared by boiling the genital segment and the apex of the abdomen in 10 % potassium hydroxide solution and subsequently rinsed in distilled water. The aedeagus was then inflated using a water-filled microsyringe.

Microscopy. Observations were made using a Wild M3C stereomicroscope and a Leica DM RB compound microscope. Photographs and illustrations of morphological features were made using a Jenoptic ProgRes C10 digital camera mounted on the microscopes and rendered in Adobe Photoshop 5.0 software.

Statistics. In order to determine the characteristics that were most helpful in discriminating between *S. westwoodii* and *S. jenseni*, 15 morphometric measurements from both sexes were analysed by means of linear discriminant analysis performed using Systat 10 software. The input variables were total body length, maximal width across abdomen, maximal and median length of pronotum, width across pronotum, distal width between anterior lateral projections of pronotum, humeral angles, scutellar length, width of scutellum at base, head width across eyes, interocellar width, width across mandibular plates at level of the visible tip of the tylus, length of antennal segments, and length of rostral segments. Furthermore, 11 morphometric measurements of the gonocoxites VIII and paratergites IX were tested in order to discriminate between the females: proximal, distal and median width of paratergites IX, interior, exterior and median length of paratergites IX, both diagonals of paratergites IX, latero-posterior angles of paratergites IX, and width and length of gonocoxites VIII. F-to-remove statistics were used to determine the relative importance of variables included in the model. Cross-validation was performed using a Jackknifed classification matrix.

Taxonomy

The phylogeny of the family is not yet fully resolved (resumed by Kment & Vilímová 2010). We follow the most recent classification provided by Schuh & Slater (1995) and Grazia et al. (2008), who recognized three subfamilies, Natalicolinae, Oncomerinae, and Tessaratominae, the latter including the tribes Prionogastrini, Sepinini, Eusthenini, Tessaratomini, and Platytatini.

Family Tessaratomidae Stål, 1864
Subfamily Tessaratominae Stål, 1870
Tribe Eusthenini Stål, 1870

Genus *Sanganus* Distant, 1909

Sanganus Distant, 1909: 389 (gen. nov., description). Type species: *Sanganus jenseni* Distant, 1909, by original designation.
Sanganus: Kirkaldy (1909): 366 (catalogue).

Fig. 1. Habitus of **A.** *Sanganus westwoodii* (Vollenhoven, 1866) ♀, **B.** *S. jenseni* Distant, 1909 ♀, **C.** *S. quadrangularis* spec. nov., ♀ holotype, and **D.** *Pseudopycanum nigromarginatum* (Stål, 1863) ♂. Specimens are shown in dorsal and ventral views.

Sanganus: Kumar & Ghauri (1970): 19–20, 30 (key, genitalia).
Sanganus: Rolston et al. (1993): 75 (catalogue).

Diagnosis. *Sanganus* shares the characteristics of the tribe Eusthenini as mentioned by Horváth (1900): Pronotum posteriorly not produced; scutellum subequilateral, frenum extended towards apex; lateral margins of connexiva not bifurcated; antennae 4-segmented, male genital segment without particular characteristics; tarsi 3-segmented.

The genus is distinguished from other members of the tribe by a combination of the following characteristics: Maximum width of pronotum larger than or equal to combined median length of head, pronotum, and scutellum; margins of fourth abdominal segment not ampliated laterally; mandibular plates meet in the middle; metasternal carina no more than half the width of hind coxae, only slightly elevated; posterior tibiae not noticeably curved; postero-lateral margins of seventh abdominal segment only slightly produced into pointed structures. The characteristic "anterior margin of pronotum slightly wider than posterior margin" mentioned in the key of Kumar & Ghauri (1970) only applies to *S. jenseni*. Although *Sanganus* is certainly closely related to *Pseudopycanum*, they differ in the characteristics given in the following identification step which may partly amend the key of Kumar & Ghauri (1970, p. 16, step 6):

6. Body size 20 mm (Fig. 1D). Lateral margins of abdomen distally more or less evenly diverging; 7th abdominal segments posteriorly produced into long, diverging and distally pointed processes thus forming the broadest part of the body; dorsal and ventral laterotergites VII of the same size (Fig. 10D). Evaporatorium of the scent efferent system not extending on mesopleuron (Kment & Vilímová 2010 and own observations). Femora ventro-distally with reduced knobs. .... *Pseudopycanum* Bergroth, 1891

– Body size larger than 23 mm (Fig. 1A–C). Lateral margins of abdomen sinuate; ventral laterotergites VII distally moderately produced, distinctly larger than dorsal laterotergites VII. Evaporatorium of the scent efferent system extending on mesopleuron (Fig. 8A–C). Femora ventro-distally with two large spines. .... *Sanganus* Distant, 1909

Redescription

Colouration. Dried specimens ochreous to saddle brown.

Head. Eyes distinctly protruding outwards; ocelli situated proximally to an imaginary line between posterior edges of the eyes; distance between ocelli about half the distance between the inner margins of the eyes. Mandibular plates longer than tylus, medially contiguous in front of the tylus (Fig. 2). Antennae 4-segmented; first segment smallest, slightly surpassing apex of head; second and third segments subequal in length, third segment distally slightly thickened; fourth segment longest; antennifer visible from above and nearly straight (Fig. 3). Bucculae short and parallel-sided; rostrum 4-segmented, not reaching beyond metacoxae; first labial segment surpassing posterior terminations of bucculae; second segment longest; third and fourth segments subequal in length.

Pronotum (Fig. 4). Humeral angles explanate and produced antero-laterad, apices rounded; anterior angles dentate; posteriorly hardly produced; with fine and coarse punctures; calli almost impunctate and separated from each other. Maximum width of pronotum greater than or equal to combined median length of head, pronotum, and scutellum.

Scutellum (Fig. 5). Subisosceles, apically spatulate and rounded; moderately dense punctate except apex.

Hemelytra. Membrane distally semicircular; with four to six basal cells, mesially quadrangular to hexangular, the lateral cell subtriangular and distally extended (Fig. 6).

Sternum. Mesosternal carina medially sulcate. Metasternal xyphus not produced anteriorly; metasternal carina width not exceeding half the width of metacoxae, taxonomically diagnostic (Fig. 7).

Metathoracic scent efferent system (Fig. 8; terminology adopted from Kment & Vilímová, 2010). Ostiole close to metacoxal cavity, slit-shaped, peritremal lobes nearly parallel to each other. Metathoracic spiracle rather small, hardly visible, located laterally of an imaginary median line of metapleuron. Metapleural evaporatorium developed along ostiolar groove, reaching laterad beyond spiracle. Mesopleural evaporatorium located between mesopleural suture and lustrous median area of posterior margin of mesopleuron.

Legs. Femora and metatibia straight; pro- and mesotibia slightly curved inwards. Femora ventro-distally with smaller inner spine and larger outer spine; these spines larger on meso- and metafemora (Fig. 9). Tibiae longitudinally sulcate. Tarsi 3-segmented.

Abdomen. Connexivum laterally curved. Distal angles of ventral laterotergites II–VI slightly protruding. Ventral laterotergites VII latero-distally distinctly acuminate and considerably larger than dorsal laterotergites, meaning that the suture is visible from above (Fig. 10). Ribes et al. (2006) introduced the term 'connexival groove' for this suture and discussed its taxonomic value.

Male genitalia. Pygophore subtriangular in ventral view, lateral margins diverging distally, distal margin wave-like with medial notch (Fig. 11). Parameres blade-shaped, apophysis regularly curved inwards, sensory lobe with long, densely arranged setae; apophysis at the base with a long seta with approximately apophysis length (Fig. 12). Aedeagus with two pairs of membranous and sclerotized conjunctival appendages, respectively (Fig. 13). The male of *S. quadrangularis* spec. nov. was not traceable.

Female genitalia. Gonocoxites VIII nearly flat, sutural margins juxtaposed, posterior margins slightly convex. Visible parts of laterotergites VIII elongated and triangular, spiracles exposed. Laterotergites IX subquadrangular or rhomboid, sutural margins diverging distally (Fig. 14). Spermatheca (terminology adopted from Kocorek & Danielczok-Demska 2002). Typically pentatomoid, but lacking the sclerotized rod characteristic of the Pentatomidae (Rider 2006). Spermatheca differentiated into three distinct regions (Fig. 15): apical seminal receptacle developed as spherical bulb, connected by a basal neck-like region; intermediate pumping region delimitated by strongly sclerotized flanges with proximal flange flat and distal flange cup-like; spermathecal duct with a median bulbous dilatation, distal duct narrow, proximal duct wider and lined with annular thickenings.

Biology. Unknown, most likely arboricolous and phytophagous species.

Etymology. The genus name 'Sanganus' is most likely the latinized form of the type locality Sangasanga located on Borneo Island. The gender is masculine.

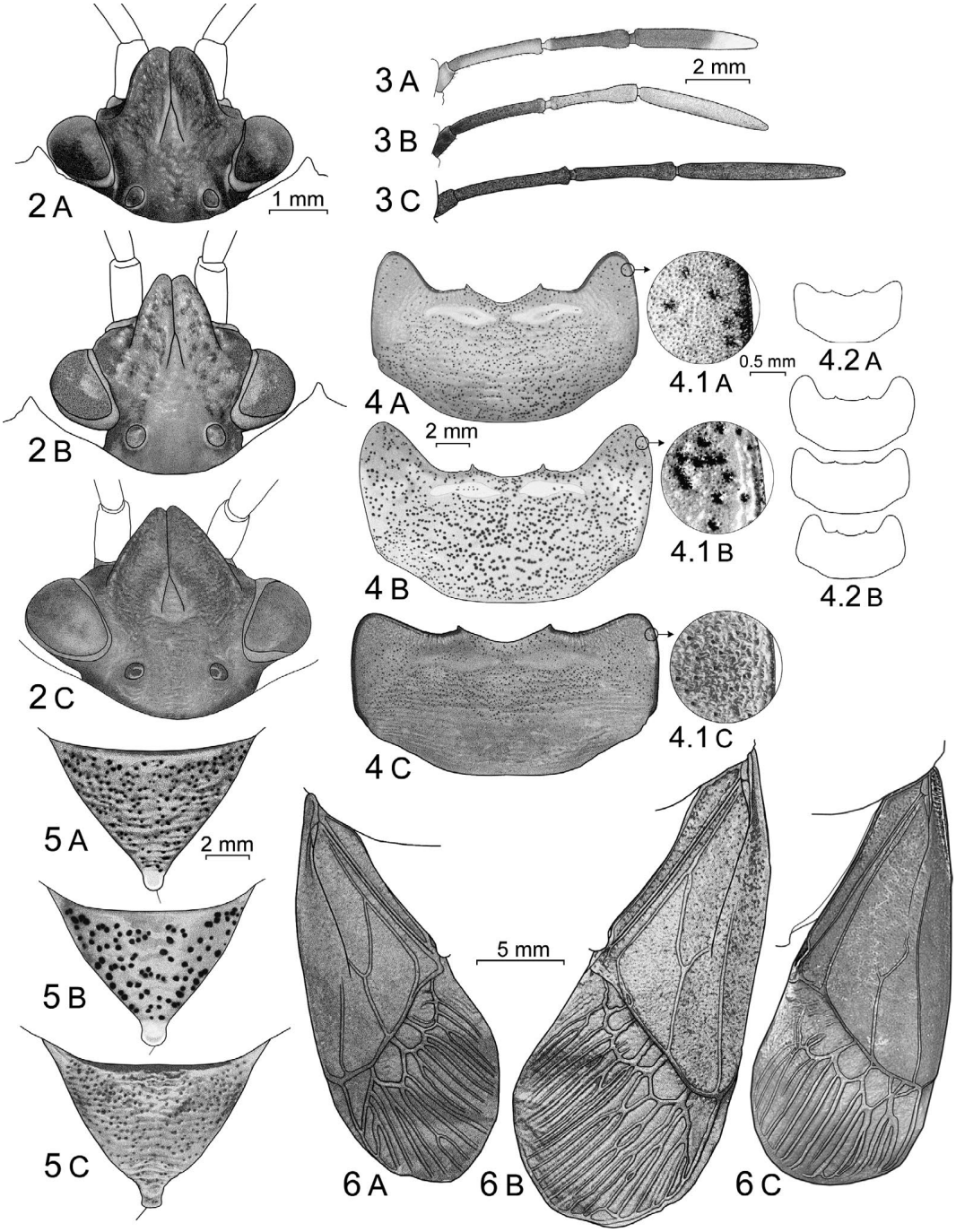
Distribution (Fig. 17)**.** *Sanganus* is a tropical genus distributed in the Oriental region ranging from Malaysia and Western Indonesia to the Philippines.

Sanganus westwoodii (Vollenhoven, 1866)
Fig. 1A

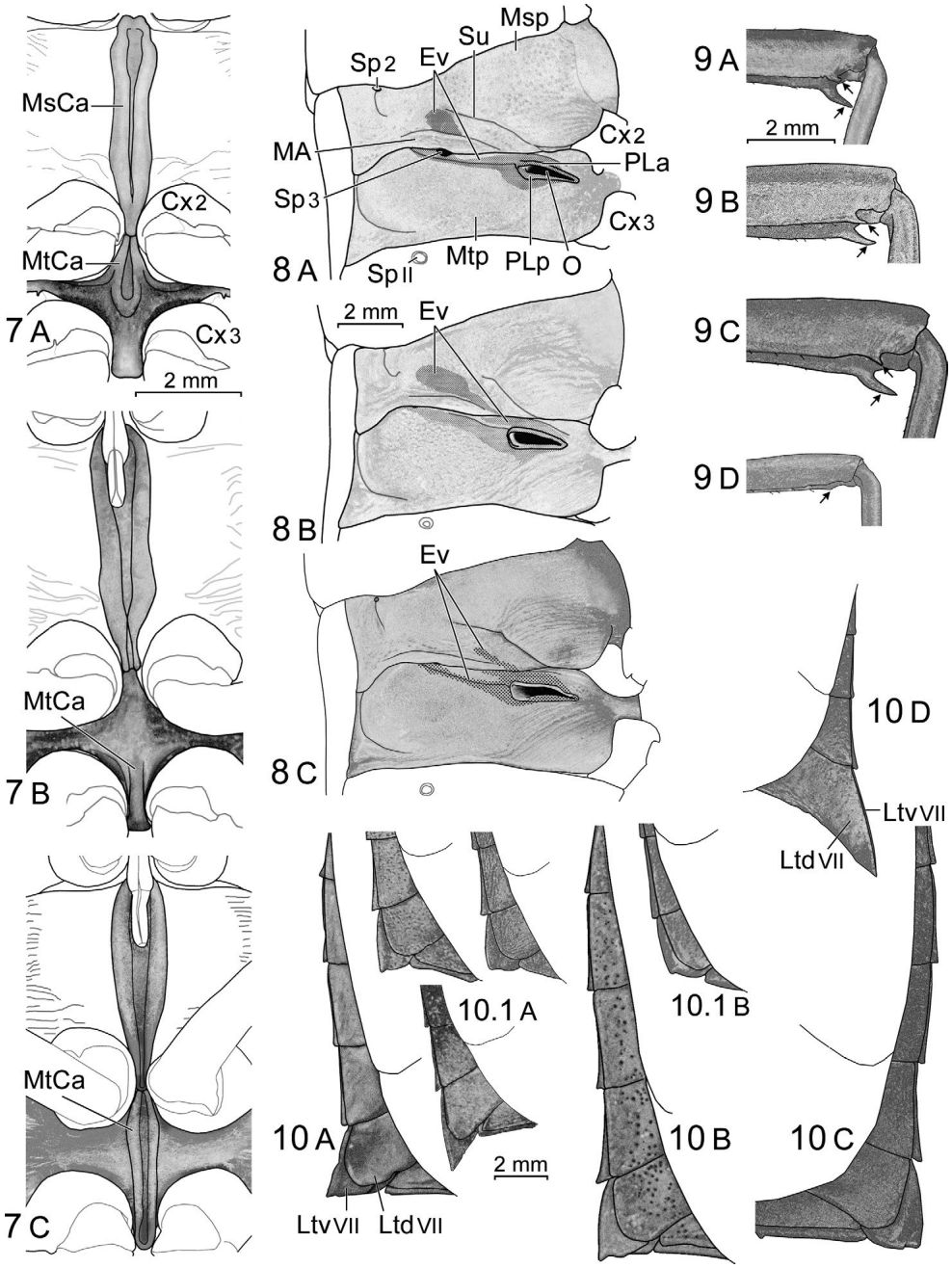
Dalcantha Westwoodii Vollenhoven, 1866: 217–218, pl. 11, fig. 5 (spec. nov., description).
Pycanum westwoodii: Vollenhoven (1868): 33–34, pl. 3, fig. 7 (description).
Pycanum Westwoodii: Walker (1868): 471 (listed).
Oxylobus Westwoodii: Stål (1870): 76 (listed).
Oxylobus westwoodii: Walker (1873): 27 (listed).
Oxylobus Westwoodi: Lethierry & Severin (1893): 232 (catalogue).
Oxylobus westwoodii: Schouteden (1907): 37 (taxonomic status).
Sanganus westwoodii: Distant (1909): 390 (cf. *Sanganus jenseni*; taxonomic status).
Pseudopycanum westwoodi: Kirkaldy (1909): 357 (catalogue).
Sanganus westwoodii: Blöte (1945): 307 (listed, distribution).
Pseudopycanum westwoodii: Krikken et al. (1981): 250 (type material).
Sanganus westwoodii: Rolston et al. (1993): 75 (catalogue).

Type material examined. Holotype ♀ (RMNH): "Muller [printed], Sumatra [printed in italic] / Holotypus [printed, blue label] / Museum Leiden [printed], Sanganus westwoodii v. Voll. [handwritten], Det: [printed]" [Indonesia, Sumatra; undated, but before 1866]. Fourth segment of left antenna, last two segments of fore tarsi, and right hind leg missing. Needle pinned through base of scutellum and metasternal xyphus, thus obscuring metasternum. Remark: This specimen definitely belongs to Vollenhoven's collection. The original description (Vollenhoven 1866) does not mention any numbers but indicates that he had only one female specimen at his disposition (measurements given as single values, not as a range). Since Vollenhoven did not label his types as such (Krikken et al. 1981), it is assumed that the holotypus label was added at a later date (most probably by Blöte).

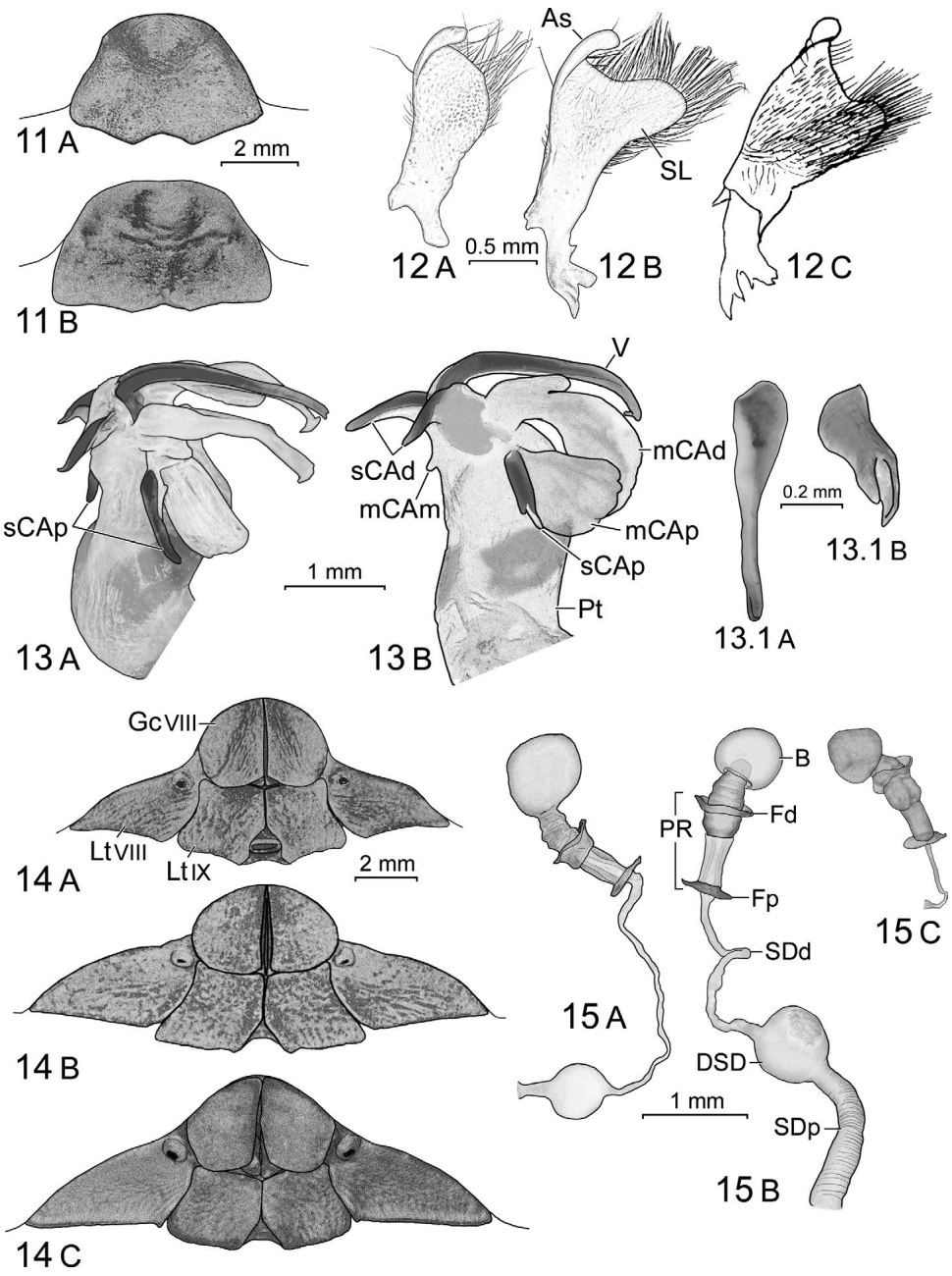
Additional material examined. 4♂♂: BMNH (1 ex.): "Selangor 7. M.S., Ulu Langat, Nov: 1916? [handwritten]" [Malaysia, Peninsular Malaysia, Selangor State, Hulu Langat District]. – NHMW (1 ex.): "Frič. 1882 [Antonín Frič] / Ambal? [handwritten]" [Indonesia, Java, Kebumen Regency, Ambal?]. – ZSM (2 ex.): "Sumatra, Holzweg 2A, 1100–1200m, 14.VI.1987, leg. E. Diehl [printed] / Sanganus westwoodii (Voll. 1866) ♂ [handwritten], det. Arnold 2007 [printed] / yellow confetti / Zoologische Staatssammlung München [printed]". – "Sumatra, Holzweg 2, 1050m, Simalungun, 03.11.1984, leg. E. Diehl [printed] / Sanganus westwoodii (Voll. 1866) ♂ [handwritten], det. Arnold 2007 [printed] / yellow confetti / Zoologische Staatssammlung München [printed]" [Indonesia, Sumatra, Simalungun Regency. Genitalia dissected by the authors]. 15♀♀: BMNH (3 ex.): "Sarawak, Pool of Entomologists, Serial No. [printed] 2392 [handwritten], per C.R. Wallace [printed] / Sanganus sp. [handwritten], M.S.K. Ghauri [printed]" [Malaysia, Borneo Island, Sarawak State; undated]. – "H.H. Karny, Mentewei [printed] 95 [handwritten], Siberoet 23.IX [handwritten] 1924 [printed] / Sanganus sp. [handwritten]" [Indonesia, Mantawi Islands, Siberut Isle]. – "C. Pruett, B.M. 1975 –590 / N. Borneo: Sabah, Sandakan Dist., Rumidi, R, Labuk, 16–30.ix.1973 [printed] / PS. SP. [handwritten]" [Malaysia, Borneo Island, Sabah State, Sandakan District]. – ZMUA (2 ex.): "coll. Zoölogisch Museum, acq. 1938 / Oost-Borneo, Sangasanga-dalem [printed]" [Indonesia, Borneo Island, East Kalimantan Province, Samarinda, Sangasanga-dalam; undated, but before 1939)]. – "Surigao, Mindanao / coll. Dr. D. Mac Gillavry [printed] / Pseudopycanum cf. westwoodii Voll? var?, det. H.J.M.G. [handwritten]" [Philippines, Mindanao, Surigao; undated]. – ZSM (4 ex.): "Sumatra, Mr. Sibohl 2, 14.IX.1996, leg. E. Diehl [printed] / Sanganus westwoodii (Voll. 1866) ♀ [handwritten], det. Arnold 2007 [printed],



Figs 2–6. 2. Head, dorsal view; **3.** right antenna; **4.** pronotum with detailed view of the humeral margin (**4.1**) and variations of the pronotum shape (**4.2**); **5.** scutellum; **6.** hemelytra. **A.** *Sanganus westwoodii*. **B.** *S. jenseni*. **C.** *S. quadrangularis* spec. nov. Figs 2C, 3C, 4A, 4C, 5C, 6A, 6C: ♀ holotype; Figs 2B, 4B, 6B: ♂ holotype.



Figs 7–10. 7. Meso- and metasternum; **8.** thoracic scent efferent system; **9.** ventral spines (arrows) at the distal end of the hind femur; **10.** connexivum, dorsal view with shape variation illustrated in **10.1**. **A.** *Sanganus westwoodii*. **B.** *S. jenseni*. **C.** *S. quadrangularis* spec. nov. **D.** *Pseudopycanum nigromarginatum*. Figs 7C, 8C, 9C, 10C: ♀ holotype; Figs 8B, 9B: ♂ holotype. Abbrevations: **Cx 2**, mesocoxa; **Cx 3**, metacoxa; **Ev**, evaporatorium (dotted area); **Ltd VII**, dorsal laterotergite VII; **Ltv VII**, ventral laterotergite VII; **MA**, median area on posterior margin of mesopleuron; **MsCa**, mesosternal carina; **Msp**, mesopleuron; **MtCa**, metasternal carina; **Mtp**, metapleuron; **O**, ostiole; **PLa**, anterior peritremal lobe; **PLp**, posterior peritremal lobe; **Sp II**, second abdominal spiracle; **Sp 2**, mesothoracic spiracle; **Sp 3**, metathoracic spiracle; **Su**, mesopleural suture.



Figs 11–15. 11. Pygophore of male, ventral view; **12.** left paramere, dorsal view; **13.** aedeagus, inflated; **14.** genital plates of female; **15.** spermatheca. **13.1.** Detailed view of sclerotized proximal conjunctival appendages. **A.** *Sanganus westwoodii*. **B.** *S. jenseni*. **C.** *S. quadrangularis* spec. nov. Figs 11B, 12B, 13B: ♂ holotype. Figs 14A, 14C: ♀ holotype. Abbrevations: **As**, apophysis; **B**, bulb; **DSD**, dilatation of spermathecal duct; **Fd**, distal flange; **Fp**, proximal flange; **mCAd**, membranous distal conjunctival appendage; **mCAm**, membranous median conjunctival appendage; **mCAp**, membranous proximal conjunctival appendage; **PR**, pumping region; **Pt**, phallotheca; **sCAd**, sclerotized distal conjunctival appendage; **sCAp**, sclerotized proximal conjunctival appendage; **SDd**, distal spermathecal duct; **SDp**, proximal spermathecal duct; **SL**, sensory lobe; **V**, vesica. Fig. 12C reproduced from Kumar & Ghauri (1970, figure 68, without indication of size).

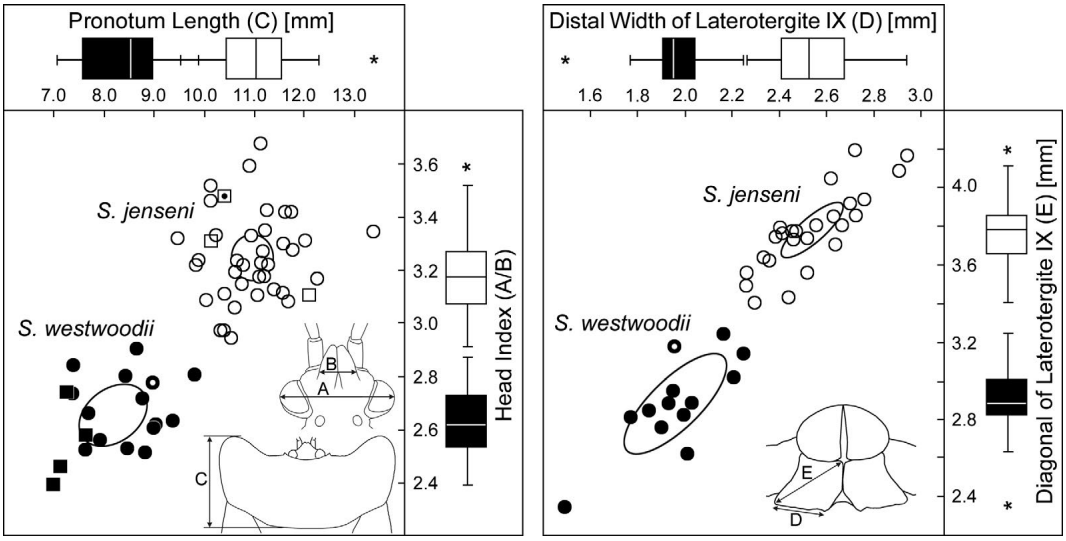


Fig. 16. Morphometric data discriminating between *S. westwoodii* (closed symbols) and *S. jenseni* (open symbols) displayed as scatter plots with 99 % centroid confidence ellipses and box plots indicating variability outside the upper and lower quartiles (* = outliers). Squares = ♂♂, circles = ♀♀; markings with a dot = holotypes.

2007062723 [handwritten] / yellow confetti / Zoologische Staatssammlung München [printed]" [Indonesia, Sumatra, precise location could not be identified]. – "Sumatra, Holzweg 2, 1050m, Simalungun, 03.11.1994, leg. E. Diehl [printed] / Sanganus westwoodii (Voll. 1866) ♀ [handwritten], det. Arnold 2007 [printed] / yellow confetti / Zoologische Staatssammlung München [printed]". – "Sumatra, Holzweg 2/4, 1150m, Simalungun, 03.11.1994, leg. E.W. Diehl / Sanganus westwoodii (Voll. 1866) ♀ [handwritten], det. Arnold 2006 [printed] / Zoologische Staatssammlung München [printed]". – "Sumatra, Holzweg 2/4, 1150m, Simalungun, leg. 13.X.1996, E.W. Diehl / Sanganus westwoodii (Voll. 1866) ♀ [handwritten], det. Arnold 2006 [printed] / Zoologische Staatssammlung München [printed]" [Indonesia, Sumatra, North Sumatra Province, Pematang Siantar, Simalungun]. – cPHM (5 ex.): Peninsular Malaysia, Pahang State, Cameron Highlands, Tapah; 15 March 2002, Dec. 2005, Sept. 2006 [collector not specified]. – cHGK (1 ex.): Not labelled.

Redescription

Colouration. Dorsal and ventral surface of dried specimens saddle-brown.

Head. Mandibular plates laterally convex, distally broadly rounded (Fig. 2A). Antenna with third and proximal part of fourth segment fuscous, remainder light brown; apex of fourth segment yellowish or reddish (Fig. 3A).

Pronotum. Lateral margins nearly straight and parallel (Fig. 4A), distally diverging in one of the specimens studied (Fig. 4.2A); margins narrowly fuscous laterally and antero-laterally; punctures isolated and evenly distributed, more rarely in groups, giving the impression of obscure, coarse punctures (Fig. 4.1A), humeral angles distally surpassing head.

Scutellum rugopunctate; punctures dark brown to black, fine or medium-sized and densely arranged; distal tongue smooth, not or scarcely punctate, often yellowish (Fig. 5A).

Hemelytra (Fig. 6A). Venation of corium quite well-developed, lateral margins of corium slightly diverging in the proximal third, then bent distad at an obtuse angle; membrane distally surpassing abdomen.

Sternum. Metasternal carina only anteriorly developed, with drop-shaped ridge (Fig. 7A).

Metathoracic scent efferent system. Mesopleural evaporatorium rather small and ovoid, approximately in centre of mesopleuron, isolated from posterior mesopleural margin (Fig. 8A).

Abdomen. Shape and size of ventral laterotergites VII typically as shown in Fig. 10A, but quite variable (Fig. 10.1A).

Male genitalia. Distal edge of pygophore distinctly W-shaped, with deep median notch (Fig. 11A). Sensory lobe of paramere reduced, slightly convex (Fig. 12A). Aedeagus (Fig. 13A) as in generic description; sclerotized proximal conjunctival appendages long, distally tapering, apically slightly furrowed (Fig. 13.1A).

Female genitalia. Laterotergites IX subquadrangular, lateral margins concave, sutural margins

distally deeply emarginate (Fig. 14A). Spermatheca as in generic description (Fig. 15A).

Measurements (N = 4 ♂♂, 15 ♀♀). Total body length: ♂ 23.4–23.7 mm, ♀ 24.8–32.2 mm (holotype 30.2 mm). Maximum body width across abdomen: ♂ 13.4–14.9 mm, ♀ 14.9–19.2 mm (holotype 17.9 mm). Head width: ♂ 3.6–3.7 mm, ♀ 3.4–4.4 mm (holotype 4.1 mm). Mean ratios of antennal segments I to IV: ♂ 0.18 : 0.66 : 0.63 : 1.00, ♀ 0.21 : 0.71 : 0.68 : 1.00 (holotype 0.23 : 0.78 : 0.72 : 1.00). Maximum pronotum width: ♂ 12.4–13.3 mm, ♀ 13.0–17.3 mm (holotype 16.3 mm). Maximum pronotum length: ♂ 7.0–7.7 mm, ♀ 7.4–9.8 mm (holotype 9.0 mm). Median scutellum length: ♂ 4.9–5.6 mm, ♀ 5.4–7.0 mm (holotype 6.7 mm). Basal scutellum width: ♂ 7.8–8.6 mm, ♀ 8.4–10.4 mm (holotype 10.4 mm).

Etymology. Dedicated to the British entomologist J. O. Westwood.

Distribution (Fig. 17)**.** Previously, *S. westwoodii* was recorded only from the type locality Sumatra (see Rolston et al. 1993). According to the material examined for this review, the distribution extends over a considerably larger area: Malaysia: Peninsular Malaysia (Selangor, Pahang), Borneo (Sarawak, Sabah). Indonesia: Sumatra, Mantawi Islands (Pulau Siberut), Java?, Borneo (East Kalimantan). Philippines: Mindanao.

Sanganus jenseni Distant, 1909
Fig. 1B

Sanganus jenseni Distant, 1909: 389, pl. X, fig. 6 (spec. nov., description).
Sanganus jenseni: Kirkaldy (1909): 371 (catalogue).
Sanganus jenseni: Blöte (1945): 307 (listed, distribution).
Sanganus jenseni: Kumar & Ghauri (1970): 19–20, 26, figs. 69–70, 108 (key, ♂ and ♀ genitalia).
Sanganus jenseni: Rolston et al. (1993): 75 (catalogue).

Type material examined. Holotype ♂: (BMNH): "Type [printed, round white label with red margin] / Sanga Sanga, E. Borneo, H.D. Jensen, 1907 – 203 [printed] / Sanganus jenseni, type Dist. [handwritten]" [Indonesia, Borneo, East Kalimantan Province, Samarinda, Sangasanga-dalam]. Antennae, fore tibiae and tarsi, left mid leg, right mid tibia and tarsus, left hind tibia (partly) and tarsus, distal segments of right hind tarsus missing (basal tarsal segment present). Needle pinned through scutellum and mesosternum, to the right of the midline. The specimen has been re-pinned thus leaving an extra hole through the scutellum. Genital capsule, aedeagus and left paramere dissected, conserved in a glass vial. Remark: The type label was most probably added by Kumar, who studied the specimen.

Additional material examined. 2 ♂♂: MNHN (1 ex.): "Museum Paris, Bornéo Sept., Pontianak, R. Oberthur 1897 / 367 / Museum Paris, MNHN(EH), 3713 [printed]" [Indonesia, Borneo Island, West Kalimantan, City or Sultanate of Pontianak]. – cPHM (1 ex.): Malaysia, Peninsular Malaysia, Pahang State, Cameron Highlands; 15 March 2002 [Genitalia dissected, mounted on card]. 35 ♀♀: MNHN (1 ex.): "Museum Paris, Bornéo, Chaper 1408-91 / 367 / Museum Paris, MNHN(EH), 3712 [printed]" [Indonesia or Malaysia, Borneo Island; 14 Aug. 1891; leg. M. Chaper]. – ZMUA (8 ex.): "Noesa Kambangan, Java, Drescher [printed], 1.1917 [handwritten] / coll. Dr. D. Mac Gillavry [printed] / Sanganus cf. jenseni Dist., det. H.J.M.G. 1935 [handwritten]" [Indonesia, Java, Central Java Province, Nusa Kambangan Island; leg. F.C. Drescher]. – "coll. Zoölogisch Museum, acq. 1938 / Oost-Borneo, Sangasanga-dalem [printed]" (3 ex.) [Indonesia, Borneo Island, East Kalimantan Province, Samarinda, Sangasanga-dalam; before 1939]. – "1936 don., Kolon. Inst., Patria ignota [printed]" (2 ex.) [unknown locality; before 1937]. – "Sumatra, Alb. de Vries [handwritten] / Museum Natura Artis Magistra [printed]" [Indonesia, Sumatra; undated]. – "Indonesia, Centr. Sumatra, Badjubang, 1°48'S 103°19'E, 1956–1957, H.F. Jansen [printed]" [Indonesia, Sumatra, Jambi Province, Bajubang]. – ZSM (2 ♀♀): "Sumatra, Tinggi Raja III, 350–400m, Deli Serdang, 19.IX.1995, leg. E. Diehl [printed] / Sanganus jenseni Distant ♀, 1909 [handwritten], det. Arnold 2007 [printed] /yellow confetti" [Indonesia, Sumatra, North Sumatra Province, Deli Serdang Regency, Medan]. – "Malaysia, Sabah, North Borneo, District Ranau, Poring Hot Spring, LF, Poring Lodge, 06°02'35 N/116°42'19 E, ca. 650 müNN, leg. 14.–16.V.2002, T. Kothe [printed] / Sanganus jenseni Distant ♀, 1909 [handwritten], det. Arnold 2007 [printed] / yellow confetti / Zoologische Staatssammlung München [printed]". – cPHM (18 ex.): Malaysia, Peninsular Malaysia, Pahang State, Cameron Highlands, 15 March 2002 (4 ex.), Sept. 2002 (1 ex.), 16 Dec. 2005, Sept. 2006 (2 ex.), 16 Dec. 2006 (6 ex.). – Malaysia, Peninsular Malaysia, Perak State, Batang Pedang District, Tapah, Dec. 2005 (5 ex.). – cHGK (6 ex.): Indonesia, Borneo Island, Kalimantan, Sept. 2007 (5 ex.), undated (1 ex.).

Redescription

Colouration. Dorsal surface of dried specimens ochreous, dorsal laterotergites of connexivum and ventral surface dark brown.

Head. Mandibular plates more slender, laterally nearly straight; distally narrowly rounded (Fig. 2B). Antenna with first and second segment obscure, third and fourth segment ochreous (Fig. 3B).

Pronotum. Lateral margins concolourous, in most specimens considerably convex, anteriorly diverging (Fig. 4B, for character variability see Fig. 4.2B); obscure, coarse punctures more numerous than in *S. westwoodii* (Fig. 4.1B); humeral angles of pronotum anteriorly surpassing head.

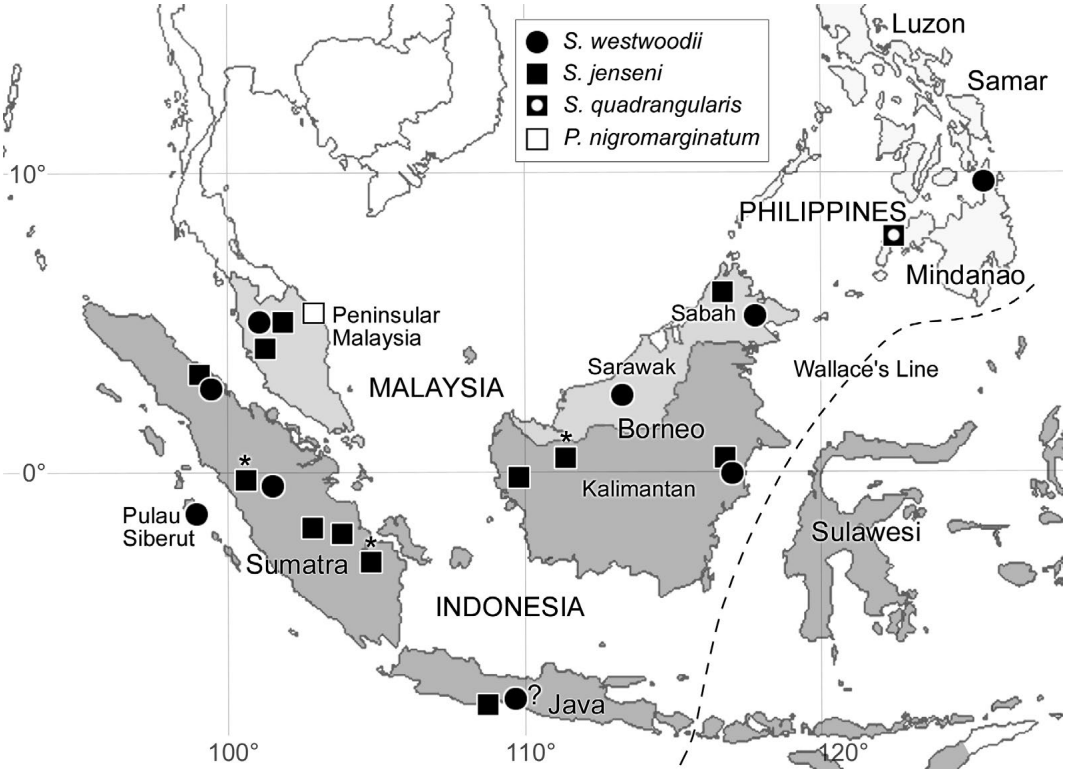


Fig. 17. Geographical distribution of *Sanganus* and *Pseudopycanum* species. * = Additional locations mentioned by Blöte (1945), material not seen by the authors. ? = Location not confirmed. Wallace's line after Mayr (1944).

Scutellum (Fig. 5B) with smooth surface; punctures dark brown to black, larger and slightly less numerous; distal tongue yellow, smooth, impunctate.

Hemelytra (Fig. 6B) as in *S. westwoodii*, but punctures more prominent.

Sternum. Metasternal carina only posteriorly developed, not sulcate (Fig. 7B).

Metathoracic scent efferent system. Mesopleural evaporatorium larger than in *S. westwoodii*, apically widened, basally connected with posterior mesopleural margin (Fig. 8B).

Abdomen. Shape and size of ventral laterotergites VII typically as shown in Fig. 10B with exception of one specimen (see Fig. 10.1B).

Male genitalia. Distal edge of pygophore gently curved, median notch less deep (Fig. 11B). Sensory lobe of paramere ovoid, distinctly protruding (Fig. 12B). Aedeagus (Fig. 13B) as in generic description; ventro-distally with an additional, very short median conjunctival appendage; sclerotized proximal conjunctival appendages short, distally bifid (Fig. 13.1B).

Female genitalia. Laterotergites IX rhomboid, lateral margins concave, sutural margins distally diverging and straight (Fig. 14B). Spermatheca as in generic description (Fig. 15B).

Measurements (N = 3 ♂♂, 37 ♀♀). Total body length: ♂ 28.6–32.3 mm (holotype 29.5 mm), ♀ 32.7–39.0 mm. Maximum body width across abdomen: ♂ 18.4–19.9 mm (holotype 19.1 mm), ♀ 19.8–24.7 mm. Head width: ♂ 4.1–4.2 mm (holotype 4.1 mm), ♀ 4.0–5.1 mm. Mean ratios of antennal segments I to IV: ♂ 0.19 : 0.62 : 0.67 : 1.00 (antennae of holotype missing), ♀ 0.22 : 0.71 : 0.70 : 1.00. Maximum pronotum width: ♂ 15.6–18.4 mm (holotype 15.6 mm), ♀ 17.2–23.3 mm. Maximum pronotum length: ♂ 10.2–12.1 mm (holotype 9.0 mm), ♀ 9.5–13.4 mm. Median scutellum length: ♂ 6.0–6.1 mm (holotype 6.0 mm), ♀ 5.4–9.3 mm. Basal scutellum width: ♂ 9.5–10.1 mm (holotype 9.5 mm), ♀ 11.1–14.2 mm.

Etymology. Dedicated to the collector of the holotype, H. D. Jensen.

Distribution (Fig. 17)**.** Rolston et al. (1993) mention Borneo, Sumatra, and New Guinea, the latter with reference to Blöte (1945), who indicated, however, "Merauke, New Guinea" with a question mark. We

consider it highly unlikely that this species occurs so far east of Wallace's line. The currently known distribution, including the material examined, is as follows: Malaysia: Peninsular Malaysia (Pahang, Perak), Borneo (Sabah). Indonesia: Sumatra, Java, Borneo (Kalimantan). Philippines: Mindanao.

Species separation by morphometric characters (Fig. 16)**.** Both *S. westwoodii* and *S. jenseni* exhibit remarkable variability, in particular regarding body size, shape of pronotum, and shape of ventral laterotergites VII. Discriminant analyses of the morphometric data revealed, however, that the following variables may be used for discriminating between the two species, in addition to the morphological characteristics described above: Maximal length of pronotum and head index (i. e. ratio of head width to width of combined mandibular plates) are the most important variables in the model which classified 100 % of the specimens correctly in both sexes (*S. w.*: N = 19, group means = 8.23 mm and 2.65 mm, respectively; *S. j.*: N = 40, group means = 10.98 mm and 3.25 mm, respectively; maximal length of pronotum: F-to-remove = 26.74; head index: F-to-remove = 121.75; tolerance = 0.98). In females, the distal width of laterotergites IX and the diagonal running from the proximo-medial to the latero-distal angle of laterotergites IX are additional discriminating variables (*S. w.*: N = 13, group means = 2.88 mm and 1.96 mm, respectively; *S. j.*: N = 25, group means = 3.78 mm and 2.54 mm, respectively; diagonal: F-to-remove = 20.46; distal length: F-to-remove = 0.34; tolerance = 0.35). These results confirm the morphological findings that the mandibular plates of *S. jenseni* are more slender and the shape of laterotergites IX is rather rhomboid.

Sanganus quadrangularis spec. nov.
Fig. 1C

Type material. Holotype ♀ (ZSM): "Philippinen [handwritten], leg. G. Böttcher [printed] / Pseudopycanum quadrangularis [handwritten]" [Philippines, Luzon, Samar or Mindanao?; 1914–1919]. Remark: Georg Böttcher (1890–1920), a German insect-trader, spent several years between 1914 and 1919 in the Philippines (Weidner 1964), so that the specimen must be dated from this period. Unfortunately, the precise locality is not specified, but Böttcher is known to have collected in Luzon, Prov. Laguna (possibly his dwelling place), Samar, and Mindanao. The species label was probably written by Hans Werner Taeuber, an antiquarian and heteropterologist from Munich, who came into possession of the vast majority of the Heteroptera collected by Böttcher (now kept in the ZSM). Neither a valid name, nor a description of the specimen has ever been published. – Paratype ♀ (cJPM): "Philippines, Gutalac, Zamboanga del Norte, Mindanao, XI 2014, I. Lumawig [handwritten]".

Description

Colouration. Entire body of dried specimens reddish to saddle brown.

Head. Mandibular plates subtriangular, distally acute (Fig. 2C). Antennal segments obscure (Fig. 3C).

Pronotum. Lateral margins nearly straight and parallel, margins fuscous laterally and anterolaterally (Fig. 4C); punctures fine and concolourous (Fig. 4.1C); humeral angles distally not surpassing head.

Scutellum. Surface wrinkled; punctures concolourous, fine and densely arranged (Fig. 5C); distal tongue concolourous, scarcely punctate.

Hemelytra. Corium with fading venation, lateral margin entirely slightly convex; membrane distally broadly rounded, not extending over abdomen (Fig. 6C).

Sternum. Metasternal carina sulcate along the entire median length of the sternum (Fig. 7C).

Metathoracic scent efferent system. Mesopleural evaporatorium reduced to a narrow strip, not widened apically, basally connected with posterior mesopleural margin (Fig. 8C).

Abdomen. As in generic description (Fig. 10C).

Male genitalia. Not available for this study. Kumar & Ghauri (1970, figure 68) illustrated the paramere of a species named "*Pseudopycanum quadrangularis* Taeuber", without providing any details in the text. The fate of this male individual, which may have been in their keeping, could not be clarified. We reproduce this figure with all due caution (see Fig. 12C). It shows a less strongly bent apophysis of the paramere and a moderately protruding sensory lobe.

Female genitalia. Proximo-distal angle of laterotergites VIII spinose. Laterotergites IX subquadrangular, lateral margins concave, sutural margins distally diverging and straight (Fig. 14C). Spermatheca as in generic description; combined length of bulb and pumping region (1.4 mm) slightly smaller than in *S. westwoodii* (1.7 mm) and *S. jenseni* (1.6 mm); cup-like region of distal flange more extended (Fig. 15C).

Measurements of the ♀ holotype and ♀ paratype (in parentheses). Total body length: 31.7 mm (34.5 mm). Maximum body width across abdomen: 19.6 mm (21.5 mm). Head width: 4.4 mm (4.8 mm). Ratios of antennal segments I to IV: 0.22 : 0.68 : 0.61 : 1.00 (0.21 : 0.76 : 0.69 : 1.00). Maximum pronotum width: 17.7 mm (18.6 mm). Maximum pronotum length: 8.4 mm (9.1 mm). Median scutellum length: 7.1 mm (8.1 mm). Basal scutellum width: 10.7 mm (12.2 mm).

Etymology. The species name *quadrangularis* (=*is*, =*e*) is a Latin adjective composed of the words *quattuor* = four and *angulus* = edge, angle, and refers to the nearly rectangular body shape.

Distribution (Fig.17)**.** Philippines: Mindanao (Zamboanga del Norte).

Comment. Although the pronotal shapes appear similar, we do not share Taeuber's opinion (original label of the holotype) that this species belongs to *Pseudopycanum* (Fig. 1D) for the reasons mentioned in the generic key.

Key to *Sanganus* species

1 Humeral angles of pronotum strongly produced anteriorly, surpassing head; antennae bicoloured; punctures on pronotum, scutellum, and corium dark brown to black; metasternal carina developed only anteriorly or only posteriorly; hemelytral membrane reaching or surpassing distal end of abdomen (Fig. 1A–B). 2

– Humeral angles of pronotum weakly produced anteriorly, not surpassing head; antennae fuscous, uniformly coloured; punctures on pronotum, scutellum, and corium concolourous; metasternal carina developed along the entire median length of the sternum, sulcate; hemelytral membrane not reaching the distal end of abdomen (Fig. 1C). .... *S. quadrangularis* spec. nov.

2 Lateral margins of pronotum usually parallelsided, narrowly fuscous as well as margins of humeral angles (Fig. 4A); mandibular plates wider and apically broadly rounded (Fig. 2A); 4th antennal segment fuscous, apical third yellowish or reddish (Fig. 3A); punctures on scutellum and pronotum medium-sized (Figs 4A, 5A); mesosternal evaporatorium small, not reaching posterior margin of mesopleuron (Fig. 8A); metasternal carina developed only anteriorly, with drop-shaped ridge (Fig. 7A). ♂: distal edge of pygophore with deep median notch (Fig. 11A); sensory lobe of paramere reduced (Fig. 12A); sclerotized proximal conjunctival appendages of aedeagus long, distally tapering (Fig. 13.1A). ♀: laterotergites IX subquadrangular, sutural margins distally deeply emarginate (Fig. 14A). ..... *S. westwoodii* (Vollenhoven, 1866)

– Lateral margins of pronotum usually diverging anteriad, margins not darker than remainder of pronotum (Fig. 4B); mandibular plates more slender, distally narrowly rounded (Fig. 2B); 4th antennal segment yellowish (Fig. 3B); punctures on scutellum and pronotum more coarse (Figs 4B, 5B); mesosternal evaporatorium elongate, reaching posterior margin of mesopleuron (Fig. 8B); metasternal carina developed only posteriorly, not sulcate (Fig. 7B). ♂: distal edge of pygophore gently curved (Fig. 11B); sensory lobe of paramere distinctly protruding (Fig. 12B); sclerotized proximal conjunctival appendages of aedeagus short, distally bifid (Fig. 13.1B). ♀: laterotergites IX rhomboid, sutural margins distally diverging and straight (Fig. 14B). .... *S. jenseni* Distant, 1909

Note

The modified key we used to distinguish *Pseudopycanum* from *Sanganus* is based on *P. nigromarginatum*, the only species hitherto known under that genus. Recently, Maurel & Magnien (2016) have described another species they attributed to the genus *Pseudopycanum*. This species, *Pseudopycanum dusoulieri*, does not share some of the characteristics we mentioned, in particular the shape of the posterior connexivum.

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