

# Taxonomic study of the leafhopper tribe Sudrini (Hemiptera: Cicadellidae: Hylicinae)

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**Abstract:** The genus *Parasudra* Schmidt **syn. nov.** is found to be a new junior synonym of *Balala* Distant, and its type species *Parasudra sumatrana* Schmidt is transferred to *Balala* as a new combination, *Balala sumatrana* (Schmidt) **comb. nov.** *Pseudosudra* Schmidt **syn. nov.** is proposed as a new junior synonym of *Sudra* Distant, and *Pseudosudra borneensis* (Schmidt) is recovered as *Sudra borneensis* **stat. retr.** *Sudra insularis* Schmidt **syn. nov.** is found to be a junior synonym of *Sudra notanda* Distant. A new species *Kalasha brachyala* **sp. nov.** is described, and *Balala sumatrana* (Schmidt) **comb. nov.** and *Sudra borneensis* **stat. retr.** are redescribed. Figures for all species are provided.

**Key words:** Auchenorrhyncha; taxonomy; key

## 锥头杆叶蝉族分类研究（半翅目：叶蝉科：杆叶蝉亚科）

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**摘要:** 确认 *Parasudra* Schmidt **syn. nov.** 为 *Balala* Distant 的新异名, 将 *Parasudra sumatrana* Schmidt 移入 *Balala* 作为新组合 *Balala sumatrana* (Schmidt) **comb. nov.**。确认 *Pseudosudra* Schmidt **syn. nov.** 为 *Sudra* Distant 的新异名, 恢复了 *Sudra borneensis* Schmidt **stat. retr.** 在 *Sudra* 的原始地位。将 *Sudra insularis* Schmidt **syn. nov.** 作为 *Sudra notanda* Distant 的新异名。记述 1 新种 *Kalasha brachyala* **sp. nov.**, 并对 *Balala sumatrana* (Schmidt) **comb. nov.** 和 *Sudra borneensis* **stat. retr.** 作了重新描述、提供了所有物种的特征图。

**关键词:** 头喙亚目; 分类; 检索表

## Introduction

The Oriental leafhopper tribe Sudrini of the subfamily Hylicinae was established by Schmidt (1920a) based on *Sudra* Distant 1908. He also included *Balala* Distant 1908, *Parasudra* Schmidt 1909, and *Pseudosudra* Schmidt 1920 to Sudrini. Oman *et al.* (1990) included *Kalasha* Distant 1908 to Sudrini. All these genera are studied in this paper.

Accepted 15 January 2023. Published online 27 February 2023. Published 25 March 2023.

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*Parasudra* Schmidt was established by Schmidt (1909) and the type species, *Parasudra sumatrana*, was described based on a male specimen. This species was simply described and drawn (Schmidt 1909). *Balala* Distant was reviewed by Tang & Zhang (2020). After morphological study, we find that *Parasudra sumatrana* conforms to the diagnosis of *Balala*. And we have then transferred this species to *Balala*, and also propose a new combination, *Balala sumatrana* **comb. nov.**, which is redescribed and illustrated based on the type specimen. Therefore, the monotypic genus *Parasudra* Schmidt **syn. nov.** is proposed as a new junior synonym of *Balala* Distant. In this study, we redescribe this species and provide figures of external and genital morphology.

The type species of the genus *Sudra*, *S. notanda* Distant, and *S. insularis* Schmidt were both established based on female specimens (Distant 1908; Schmidt 1920a). Schmidt (1920a) noted that the setae bands on the pronotum of *S. insularis* are the same to those of *S. notanda*. Kramer (1964) described *S. manorga* and reviewed *Sudra*, and provided a key to this genus. He and China (Kramer 1964) believed that differences between *S. insularis* and *S. notanda* involved intraspecific variation and need to be further studied based on more specimens, especially the males. We obtained the type specimens of *S. insularis* and *S. notanda* as well as many additional male specimens. After comparison, we propose *S. insularis* Schmidt **syn. nov.** as a junior synonym of *Sudra notanda* Distant in this study, and provide figures of external morphology and genitalia for *S. notanda* and a key to species of *Sudra*.

Schmidt (1909) reported the species *Sudra borneensis* based on a female specimen. Schmidt (1920a) established the genus *Pseudosudra* to accommodate *Sudra borneensis* after comparing this species with other species of *Sudra*. In this study, we have examined the type specimen and an additional male specimen of *Pseudosudra borneensis*, and find that the male genitalia of this additional specimen is very similar to *Sudra* species. We therefore retrieve the former status of this species *Sudra borneensis* **stat. retr.**, and *Pseudosudra* Schmidt **syn. nov.** is proposed as a new junior synonym of *Sudra*. In this study, we have redescribed and illustrated this species with external and genital morphology.

*Kalasha* Distant included 4 species and was reviewed by Tang & Zhang (2019). A new species in this genus, *K. brachyala* **sp. nov.**, from Vietnam is described and illustrated.

## Material and methods

The male terminalia containing the genitalia were dissected out and soaked in a 10% NaOH solution for about 24 h to dissolve muscle, then washed in distilled water and transferred to glycerol for dissection, examination and storage. After examination, the dissected parts were stored in a micro vial with fresh glycerol and pinned below each corresponding specimen. Line diagrams were drawn using an Olympus PM-10AD microscope with a drawing tube. Photos of genitalia were taken using a QImaging Retiga 2000R digital camera (CCD) mounted on a Nikon AFX-II stereomicroscope and were then combined using Auto-Montage software. Photos of habitus were taken using a Carl Zeiss stereomicroscope. Photographs were modified with Adobe Photoshop CS software. The morphological terminology used in the descriptions mainly follows Dietrich (2005) and Zhang (1990). All measurements of the body are in millimeters (mm).

The material examined are deposited in the institutions abbreviated in the text as follows:

BMNH — The Natural History Museum (formerly British Museum of Natural History), London, UK.

HBU — Hebei University, Baoding, China.

INHS — Illinois Natural History Survey, Champaign, USA.

MIZPAS — Museum and Institute of Zoology, Polish Academy of Science, Warszawa, Poland.

NWAFU — Northwest A&F University, Yangling, China.

RBINS — Royal Belgian Institute of Natural Sciences, Brussels, Belgium.

ZMB — Zoologisches Museum in Berlin, Berlin, Germany.

## Taxonomy

### Tribe Sudrini Schmidt

Sudrini Schmidt 1920a: 116.

### Genus *Balala* Distant 1908

*Balala* Distant 1908: 250; Schmidt 1909: 262; Schmidt 1911: 229; Jacobi 1914: 380; Schmidt 1920a: 117, 118; Schmidt 1920b: 127; Evans 1946: 46; Metcalf 1962: 13.

*Wania* Liu 1939: 297. Synonymised by China 1941: 255; Evans 1946: 47. Type species: *Wania membracioidea* Liu 1939; by original designation.

*Parasudra* Schmidt 1909: 263. Type species: *Parasudra sumatrana* Schmidt 1909, by original designation. **syn. nov.**

Type species. *Penthimia fulviventris* Walker 1851, by original designation.

#### 1. *Balala sumatrana* (Schmidt 1909) **comb. nov.** (Fig. 1)

*Parasudra sumatrana* Schmidt 1909: 265; Schmidt 1920a: 118, 119; Evans 1947: 258; Metcalf 1962: 8.

Length. ♂ 12.0 mm.

External morphology. Body (Fig. 1A) generally dark brown, forewing somewhat pale brown, abdomen with two pair of yellowish spots on tergite III and IV.

Crown (Fig. 1A) triangularly produced, shorter than 1/2 pronotum. Pronotum (Figs 1A, B) elevated post-moderately, then gradually sinuate to sides and anterior margin, obviously shorter than exposed part of mesonotum and scutellum, about as long as 2.5× crown. Exposed part of mesonotum and scutellum (Figs 1A, B) triangular, apex narrowly elongated, reaching to middle of tergite IV, as long as 1.5× pronotum, median elevated obviously but not forming to strong process, apical half with mid-longitudinal ridge.

Male genitalia. Pygofer (Figs 1C–E) wide and broad, narrowing to apex in lateral view, apical margin with 4–5 stout setae, surface with scattered dense setae; ventral appendages shorter than pygofer, base wide and tapering to apex, apical half bent laterad; subgenital plate (Fig. 1F) with base shortly fused, length slightly shorter than 2.0× width, lateral margins convex; connective (Figs 1I, J) longer than wide, wide apically and narrower basally, median with large “Y”-shaped vertical process; style (Figs 1I, J) with apodeme long, apophysis relatively short with several slender setae distally; aedeagus tubular and curved dorsad, dorsal surface with dental process along lateral margin, gonopore at apex.

**Specimens examined.** 1♂ (Holotype, MIZPAS), ‘Soekaranda Januar 1894 Dohrn’, ‘Type’, ‘Mus. Zool. Polonicum Worszawa 12/45’, ‘*Parasudra sumatrana* ♂ Edm. Schmidt determ. 1909.’.

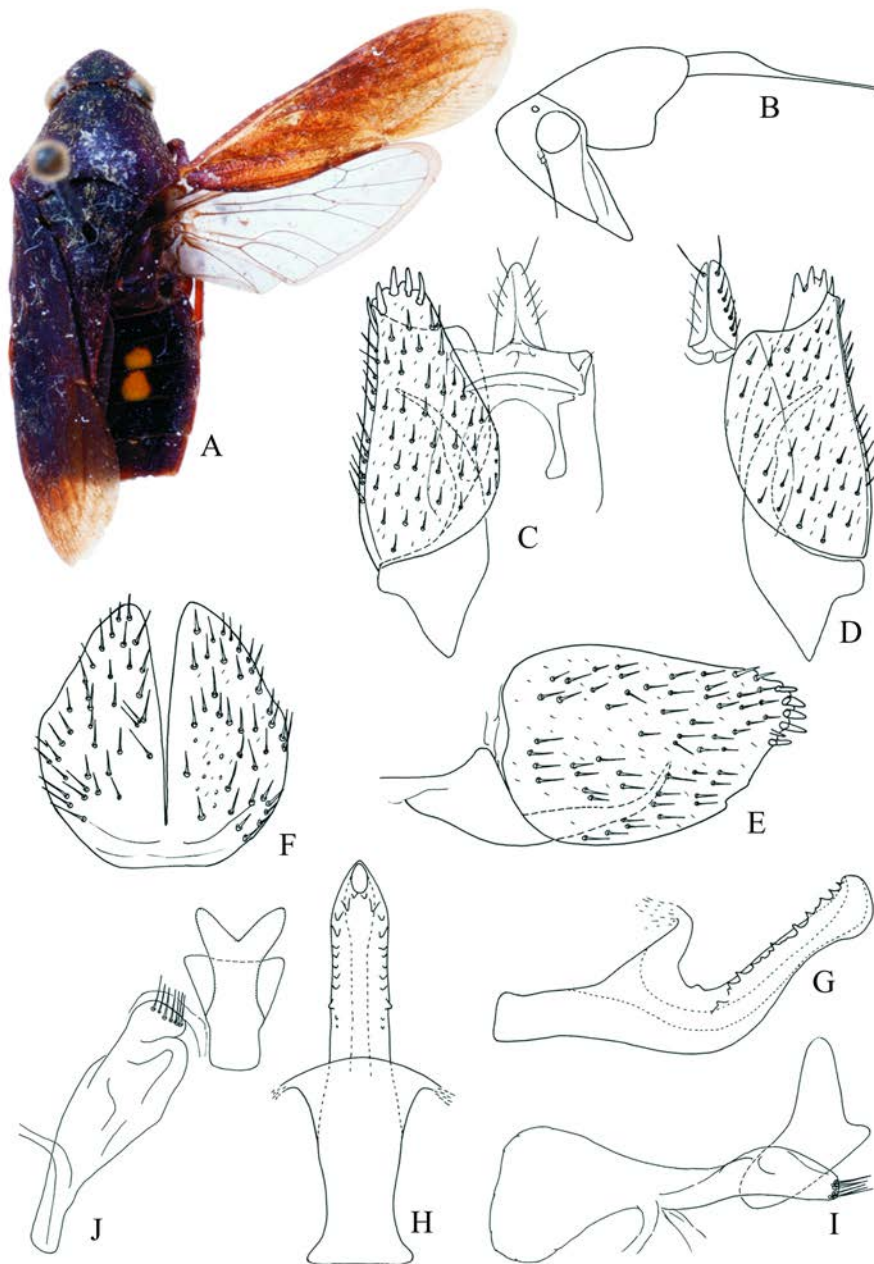


Figure 1. *Balala sumatrana* (Schmidt) **comb. nov.** ♂, holotype. A. Habitus, dorsal view; B. Head and thorax, lateral view; C–E. Pygofer, dorsal, ventral and lateral views; F. Subgenital plate, ventral view; G, H. Aedeagus, lateral and dorsal views; I, J. Connective and style, lateral and ventral views.

Distribution. Indonesia.

Remarks. This species conforms to the diagnosis of *Balala*: 1) body very robust; 2) head short and deflected; 3) front tibia strongly dilated and compressed. It can be distinguished

from other *Balala* species by: 1) head somewhat triangular produced and nearly 1/2 width, and 2) different shape of ventral appendages and aedeagus.

### Genus *Sudra* Distant 1908

*Sudra* Distant 1908: 257; Schmidt 1909: 265; Schmidt 1911: 229; Schmidt 1920a: 117; Schmidt 1920b: 127; Evans 1946: 47; Metcalf 1962: 7; Kramer 1964: 47; Oman, Knight and Nielson 1990: 254.

*Pseudosudra* Schmidt 1920a: 118; Evans 1947: 258; Metcalf 1962: 9; Oman, Knight and Nielson 1990: 246. Type species: *Sudra borneensis* Schmidt 1909. **syn. nov.**

Type species. *Sudra notanda* Distant 1908, by original designation.

Diagnosis. This genus with body robust, head produced forward to process without longitudinal ridges, exposed part of mesonotum and scutellum approaching or reaching to apex of clavus, appendix of forewing developed and approximately triangular, abdomen slightly shorter than forewing.

#### Key to species of *Sudra* Distant (males)

1. Head process columnar, exposed part of mesonotum and scutellum reaching apex of clavus ..... 2
- Head process oblate, exposed part of mesonotum and scutellum approaching apex of clavus ..... *S. manorga*
2. Crown longer than 1.5× width, apical half of pygofer ventral appendages folded ..... *S. notanda*
- Crown with length slightly shorter than width, apical half of pygofer ventral appendages unfolded ..... *S. borneensis* **stat. retr.**

### 2. *Sudra notanda* Distant 1908 (Fig. 2)

*Sudra notanda* Distant 1908: 257; Schmidt 1920a: 117; Evans 1946: 47; Metcalf 1962: 8; Kramer 1964: 49.

*Sudra insularis* Schmidt 1920a: 117; Metcalf 1962: 8; Kramer 1964: 51 **syn. nov.**

Length. ♂ 12.9–14.8 mm, ♀ 15.0–17.1 mm.

This species was described by Distant (1908), Schmidt (1920a) and Kramer (1964). We provide illustrations (Fig. 2) of habitus and male genitalia based on type specimens and additional specimens.

**Specimens examined.** 1♀ (Lectotype of *Sudra notanda*, here designated, BMNH), ‘*Sudra notanda* Dist.; Karen Hills (Doherty); Syn-type; Type; Distant Coll. 1911-383.’; 1♀ (Lectotype of *Sudra notanda*, here designated, ZMB), ‘Ober-Langkat Deli Sumatra 1894 M. U de S.; Typus.; *Sudra insularis* ♀ Edm. Schmidt determ. 1920; Zoolog. Museum Berlin (ZMB) Germany; *Sudra insularis* Schmidt’; 2♂ (INHS), 19°24.187’N 98°55.312’E, 491 m, Doi Chiang Dao WS Nature Trail, Chiang Mai, Thailand, 28-VIII-04-IX-2007, Malaise trap, Songkran. Jagsu & Apichal Watwanich, T2831; 1♂ (BMNH), ‘Haut Mekong, Pou Hai Katoui 6.IV.1918 R. V. de Salvaza.; Indo China. R. V. de Salvaza. 1918-1; *Sudra notanda* Distant 1908 Det. Zhang Ya-Lin’; 1♂ (NWFU), **China**, Xishuangbanna 540 m, Yunnan, 21–30-IV-1974, Io CHOU, Feng YUAN & Yinyue HU; 1♂ (NWFU), **China**, Xishuangbanna 800 m, Yunnan, 09-VI-1991, Yinglun WANG & Rungang TIAN; 1♂ (HBU), **China**, Xishuangbanna, Yunnan, 28-VIII-2012, Jishan XU, Lingxiao WANG & Haoyu LIU.

Distribution. China (Yunnan, Shaanxi); Myanmar; Thailand; Indonesia.

Remarks. We point out here that in Kramer’s (1964) description, the style he referred to is not actually the style connected with the connective, but the pygofer ventral appendages. In our study, 6 male specimens and 2 type specimens were observed. After examining and comparing the specimens, we find that there is no significant difference in the genitalia among

the specimens even their crown shape varied. Therefore, *S. insularis* is proposed as a junior synonym of *S. notanda*.

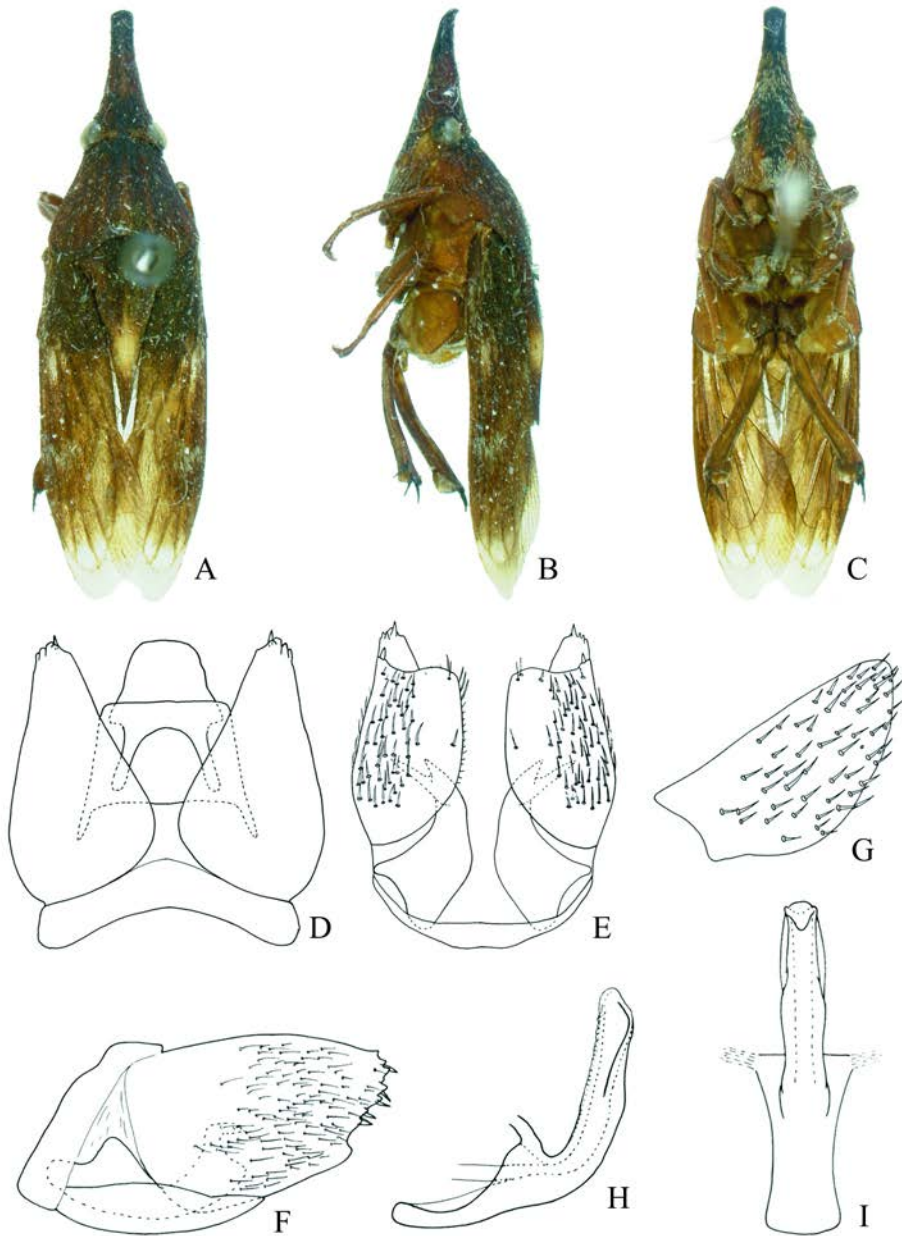


Figure 2. *Sudra notanda* Distant. ♂. A–C. Habitus, dorsal, lateral and ventral views; D–F. Pygofer, dorsal, ventral and lateral views; G. Subgenital plate, ventral view; H, I. Aedeagus, lateral and ventral views.

3. *Sudra borneensis* Schmidt 1909 stat. retr. (Fig. 3)

*Sudra borneensis* Schmidt 1909: 265.

*Pseudosudra borneensis* (Schmidt), Schmidt 1920a: 119; Evans 1946: 47; Evans 1947: 258; Metcalf 1962: 9. **stat. retr.**

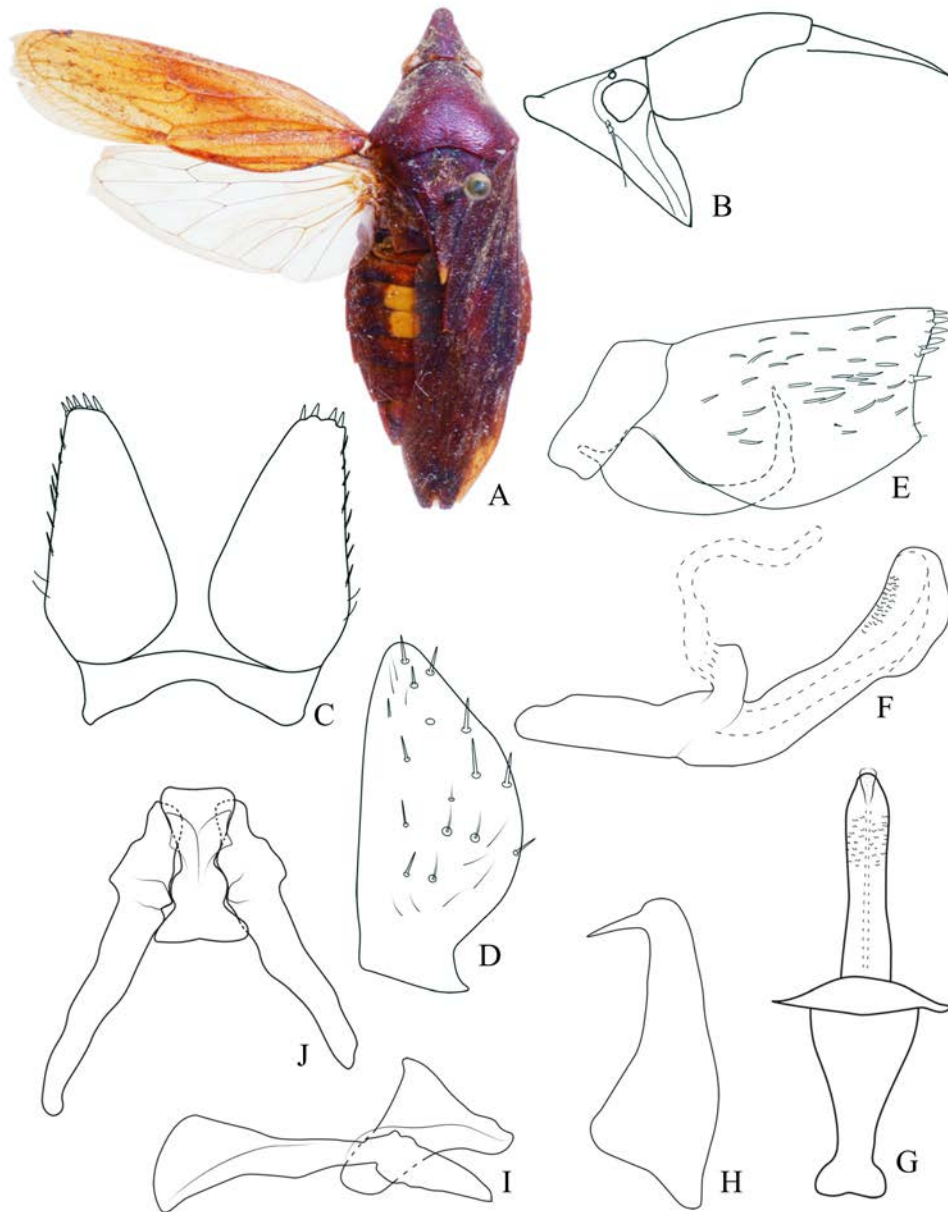


Figure 3. *Sudra borneensis* (Schmidt) **comb. nov.** ♀, holotype. A. Habitus, dorsal view; B. Head and thorax, lateral view (♂); C. Pygofer, dorsal view; D. Subgenital plate, ventral view; E. Pygofer, lateral view; F, G. Aedeagus, lateral and dorsal views; H. Pygofer ventral appendage, ventral view; I, J. Connective and style, lateral and dorsal views.

Length. ♂ 14.5 mm, ♀ 18.5 mm.

External morphology. Body (Fig. 3A) dark reddish brown, ocelli, eyes somewhat orange, tip of scutellum and two spots on tergite III and IV yellow, forewing with appendix a little pale brown. Crown (Figs 3A, B) triangularly produced from base to roundly truncate and flat apex, with a fair carina anteriorly, slightly wider than long, length  $2/3$  of pronotum, much narrower than the later, ocelli close to anterior margin of eyes. Rostrum reaching to middle coxae, limb slender with 2 sections approximately same length. Pronotum (Figs 3A, B) with anterior margin roundly produced, and posterior margin wavy and sinuate medially, widening from anterior to posterior,  $2/3$  part the widest, elevated post-moderately, then depressed to sides and anterior margin. Exposed part of mesonotum and scutellum (Figs 3A, B) as long as crown and pronotum, tip narrower, without elevation moderately.

Male genitalia. Pygofer (Figs 3C, E) length slightly longer than width, apical margin concave and with about 6 stout setae in lateral view; ventral appendages (Figs 3E, H) with base broad and apical part sharp and curved laterad near right angle; subgenital plate (Fig. 3D) with constriction near base, base of outer margins evenly convex, rest somewhat concave, length about  $2.0\times$  width; connective (Figs 3I, J) with length about  $2.0\times$  width of base, lateral margins somewhat wavy, dorsal surface with vertical process; style (Figs 3I, J) longer than  $2.0\times$  connective, connected to base of connective, apophysis with base broad and terminus tapering, not surpassing apex of connective, with several setae at apex; aedeagus (Figs 3F, G) tubular, apex with ventral margin downward expanding, dorsal surface with fine wrinkles scattered near apex, gonopore at ventral surface near apex.

**Specimens examined.** 1♀ (Holotype, MIZPAS), 'Nord-Borneo Waterstradt, 304, in Mus. Zool. Polonicum Worazawa with label *Pseudosudra borneensis* Schmidt, ♀, Edm Schmidt, determ. 1909'; 1♂, **Thailand**, (INHS), 12°49.151'N 99°22.483'E, 950 m, Panernthung/km27/water pump, Petchaburi, Kaeng Krachan NP, 11–18-VII-2008, Malaise trap, Sirichai&Chusak, T4334.

Distribution. Borneo; Thailand.

Remarks. We examined the female type specimen of this species. According to the external morphology, a male specimen of this species was then identified. After examining the 2 specimens, we found that this species conforms to the diagnosis of *Sudra*. It can be distinguished from other *Sudra* species by: 1) head apex roundly truncate, and 2) different shape of ventral appendages and aedeagus.

### Genus *Kalasha* Distant 1908

*Kalasha* Distant 1908: 254; Jacobi 1914: 379; Evans 1946: 47; Metcalf 1962: 9; Oman, Knight and Nielson 1990: 222; Shen & Zhang 1995: 185; Tang & Zhang 2019: 409.

Type species. *Kalasha nativa* Distant 1908, by original designation.

#### 4. *Kalasha brachyala* sp. nov. (Fig. 4)

Length. ♂ 6.8–8.8 mm, ♀ 9.1–10.1 mm.

External morphology. Body (Figs 4A–E) reddish brown to dark brown, crown and dorsal abdomen paler than dorsal thorax and forewing, face dark brown, center with yellow region, female usually larger and with longer crown. Crown (Figs 4A–C) triangularly produced, length shorter than width, with black mid-longitudinal line, nearly horizontal in lateral view. Face (Fig. 4D) with length about same as width, lateral margin concave and connected to apical margin at near right angle, frontoclypeus and anteclypeus convex and former weaker



than latter in lateral view, apex somewhat bent to horizontal, anteclypeus with lateral sides concave in anterior view, and with mid-longitudinal ridge. Pronotum (Figs 4A, B) as long as crown, length about 1/2 width, posterior margin with middle somewhat concaved forward. Scutoscuteellar sulcus nearly straight, exposed part of mesonotum slightly shorter than scutellum, mildly humped after scutoscuteellar sulcus. Forewing (Fig. 4A) reduced, reaching to tergite V, leathery, veins blurry.

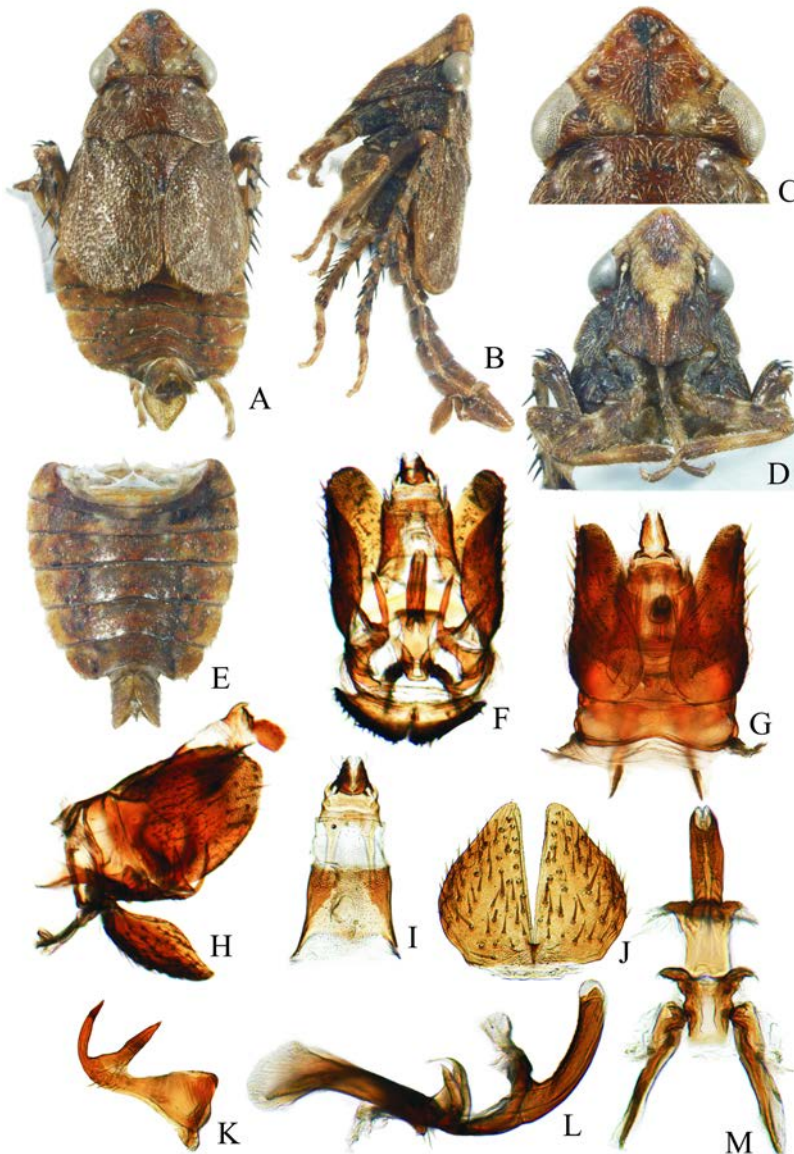


Figure 4. *Kalasha brachyala* sp. nov., holotype, ♂. A, B. Habitus, dorsal and lateral views; C. Crown; D. Face; E. Abdomen, dorsal view; F, G, H. Pygofer, ventral, dorsal and lateral views; I. Anal tube, ventral view; J. Subgenital plate, ventral view; K. Pygofer ventral appendage, ventral view; L, M. Aedeagus, connective and style, lateral and dorsal views.

Male genitalia. Pygofer (Figs 4F–H) length longer than width, apical margin arcuate lateral view; ventral appendages (Figs 4F, K) with base broad and apical half branched and curved laterad, reaching 1/2 pygofer, branches stout and well separated from each other in ventral view, lateral branch above and more slender than central one in lateral view, 5–6 setae on base of branches; subgenital plate (Fig. 4J) about 1/2 pygofer long, with base of outer margins evenly convex, rest somewhat concave, length longer than width; connective (Figs 4L, M) with length about 1.5× width of middle, apical margin concave, vertical process apex surpassing apical margin; style (Figs 4L, M) about 2.0× connective, apophysis disc-like apically and with 4–5 setae on ventral surface, not surpassing apex of connective; aedeagus (Figs 4L, M) tubular, depressed in middle on dorsal surface, sides keeled and transversely rugose throughout length on dorsal surface except for base; shaft long, slender and of nearly uniform width throughout length, gonopore at apex.

**Holotype.** ♂, **Vietnam**, (RBINS), 22°36'N/105°53'E, Pia-Oac Pitfall Summit, 04–06-VIII-2010, J. Constant & P. Limbourg, I.G.: 31.668. **Paratypes.** 1♂ (RBINS), same data as Holotype; 1♀ (RBINS), **Vietnam**, 22°36'N/105°53'E, Pia-Oac Pitfall forest, 04–06-VIII-2010, J. Constant & P. Limbourg, I.G.: 31.668.

Etymology. The specific epithet is derived from the Greek word “*brachys*” and Latin “*ala*” referring to its short and reduced forewing.

Remarks. This species is the only known species of *Kalasha* with an extremely reduced forewing. It is similar to other species of *Kalasha* in having a triangular crown, branched ventral appendages and tubular aedeagus, but different in forewing and some other details.

## Acknowledgements

We would like to express our sincere gratitude to Dr. C. H. DIETRICH (the Illinois Natural History Survey, USA) for his helpful comments on an earlier draft of the manuscript. We sincerely thank Prof. John Richard SCHROCK (Emporia State University, USA) for reviewing this manuscript. This study was supported by the National Natural Science Foundation of China (31420103911, 39270116), the Ministry of Science and Technology of China (2006FY120100) and the National Animal Collection Resource Center, China.

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