

# Five new species of the genera *Heerz* Marsh, *Lissopsius* Marsh and *Ondigus* Braet, Barbalho and van Achterberg (Braconidae, Doryctinae) from the Chamela-Cuixmala biosphere reserve in Jalisco, Mexico

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## Abstract

Five new species belonging to the poorly known Neotropical doryctine parasitoid wasps genera *Heerz* Marsh (*H. ecmahla* **sp. n.** and *H. macrophthalma* **sp. n.**), *Lissopsius* Marsh (*L. pacificus* **sp. n.** and *L. jalisciensis* **sp. n.**) and *Ondigus* Braet, Barbalho & van Achterberg (*O. cuixmalensis* **sp. n.**) are described from the Chamela-Cuixmala Biosphere reserve in Jalisco, Mexico. Keys to the described species of the above three genera are provided. The phylogenetic placement of the examined taxa is investigated based on mitochondrial (COI) and nuclear (28S, 2<sup>nd</sup> and 3<sup>rd</sup> domain regions) DNA sequence data.

## Keywords

new species, *Heerz*, *Lissopsius*, *Ondigus*, 28S, COI

## Introduction

The Doryctinae represents one of the largest subfamilies of braconid parasitoid wasps, probably only behind Braconinae, Microgastrinae, Alysiinae and Opiinae (Jones et al. 2009). Currently, there are almost 200 recognised doryctine genera, of which about 60% have been described from the Neotropical region (Belokobylskij 1992; Belokobylskij et al. 2004; Marsh 2002). The doryctine diversity that occurs north of Costa Rica to central Mexico, however, has been scarcely explored despite that the fauna of this region is known to have high levels of endemism with both Neotropical and Nearctic affinities (e.g. Halffter 1964; Ortega and Arita 1998).

A recent barcoding study carried out in the Chamela-Cuixmala Biosphere Reserve (CCBR) in Jalisco, Mexico, has revealed the existence of an extraordinary, largely neglected doryctine fauna (Zaldivar-Riverón et al. 2010). This reserve is located near the Mexican Pacific coast and is mainly composed by one of the best preserved tropical dry forests in the country (Noguera et al. 2002). Most of the doryctine genera found in this region appear to have Neotropical affinities, with many of them also being reported for Costa Rica (Marsh 2002), although there also are some genera that are mainly from Old World and Nearctic (e.g. *Spathius* Nees, *Caenophanes* Foerster, *Rhaconotus* Ruthe) (Zaldivar-Riverón et al. 2010).

Three new species representing novel records for two doryctine genera in the Mexican territory have so far been described from the CCBR (*Neoheterospilus* Belokobylskij and *Iare* Barbalho & Pentead-Días: Martínez and Zaldivar-Riverón 2010; Martínez et al. 2010). In this work, we describe five new doryctine species from the above region belonging to the rare genera *Heerz* Marsh *Lissopsius* Marsh and *Ondigus* Braet, Barbalho & van Achterberg. The phylogenetic placement of these taxa is also investigated using mitochondrial and nuclear DNA sequence markers. These five species represent new records for their genera in Mexico, and their description becomes relevant since there are plans to build new touristic developments near the CCBR, which is the only known locality for these genera in the country.

## Methods

All the specimens included in this work were collected in several field trips carried out during 2009–2011 to the Chamela Biological station (within the CCBR) owned by the Instituto de Biología, Universidad Nacional Autónoma de México. All the collected specimens were preserved in 100% ethanol, kept at -20°C until they were processed for DNA sequencing, and subsequently dried, labelled and pinned. The material examined in this study is deposited in the Colección Nacional de Insectos, Instituto de Biología, Universidad Nacional Autónoma de México (IB-UNAM CNIN), Museo Argentino de Ciencias Naturales “Bernardino

Rivadavia”, Buenos Aires, Argentina (MACN), and the University of Wyoming Insect Museum (UWIM).

The terminology employed follows Sharkey and Wharton (1997), except for the surface sculpture, which follows Harris (1979). Colour photographs were taken and edited with a Leica® Z16 APO-A stereoscopic microscope, a Leica® DFC295/DFC290 HD camera, and the Leica Application Suite® program. Digital SEM photographs were taken with a FEI INSPECT (5350 NE Dawson Creek Drive Hillsboro, Oregon 97124, USA) SEM) in low vacuum at the Museo Nacional de Ciencias Naturales (CSIC, Madrid, Spain).

### Phylogenetic placement of new taxa

The phylogenetic placement of the new taxa described in this study was reconstructed based on two widely used gene markers, around 658 bp of the barcoding locus [cytochrome oxidase I (COI) mitochondrial (mt) DNA gene], and a ~650 bp fragment corresponding to the second and third domain regions of the nuclear 28S rDNA gene. For the specimens belonging to *Ondigus*, a single leg was removed, placed in a 96-well lysis plate and posted to the University of Guelph for DNA extraction, amplification and sequencing (see laboratory protocols in Smith et al. 2009). DNA extraction and PCR products of the two markers for the specimens belonging to *Heerz* and *Lissopsius* were obtained at IB-UNAM following the protocols described in Ceccarelli et al. (2012). Non-purified PCR products were subsequently sent to the High-Throughput Genomics Unit at the University of Washington (<http://www.htseq.org/index.html>) for DNA sequencing. The COI and 28S primers employed were LepF1/LepRI (Hebert et al. 2004) (LEP-F1: 5'-ATT CAA CCA ATC ATA AAG ATA T-3'; LEP-R1: 5'-TAA ACT TCT GGA TGT CCA AAA A-3') and 28S-FD2 (Belshaw and Quicke 1997) (fwd: 5' GCG AAC AAG TAC CGT GAG GG 3') 28SRD3 (Mardulyn and Whitfield 1999) (rev: 5' TAG TTC ACC ATC TTT CGG GTC CC 3'), respectively. All sequences were edited with Sequencher version 4.0.5 (Gene Codes).

All the sequences generated for this study are deposited in GenBank (see accession numbers below). These sequences will be also available in the project file 'Parasitoid Wasps (Braconidae: Doryctinae) of Chamela-Cuixmala Biosphere Reserve' (ASDOR project) in the projects section of the Barcode of Life Data System ([www.barcodinglife.org](http://www.barcodinglife.org)).

Genetic distances of the COI marker within and among the newly described taxa examined were calculated using the K2P distance model (Kimura 1980) with PAUP version 4.0b10 (Swofford 2002). The phylogenetic placement of these taxa within the Doryctinae was reconstructed using a previously published COI+28S matrix containing 64 doryctine genera (94 species) and 21 outgroups belonging to 12 different cyclostome subfamilies (Zaldivar-Riverón et al. 2008). We also included in the above

matrix published sequences of specimens belonging to *Callihormius* Ashmead, *Iare* and *Panama* Marsh (Martínez et al. 2010; GenBank accession nos HQ535818-20, HQ535830-32). These and the newly generated COI and 28S sequences were included in the published data set, excising the ambiguously aligned regions for the 28S marker.

We ran a Bayesian MCMC partitioned analysis with MrBayes version 3.1.2 (Ronquist and Huelsenbeck 2003) through the University of Oslo bioportal (<http://www.bioportal.uio.no/>). This analysis consisted of two simultaneous runs of 20 million generations each using four chains and default priors. We considered four different partitions, one for the 28S data set and three for COI according to its first, second and third codon positions. The appropriate evolutionary model chosen for each partition was selected following the akaike information criterion obtained with MrModeltest version 2.3 (Nylander 2004) and PAUP version 4.0b10 (Swofford 2002). We excised the first 10 million sampled trees of each run as a conservative measure for securing stationarity and pooled the remaining trees for reconstructing a majority consensus phylogram with posterior probability (PP) of clades, considering values  $\geq 0.95$  as significantly supported (Huelsenbeck and Ronquist 2001).

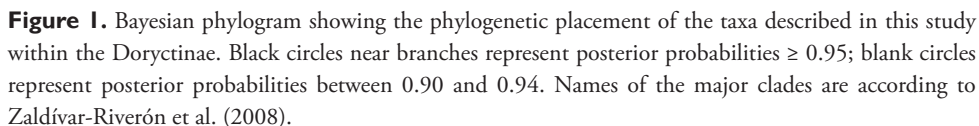
## Results and discussion

### Genetic divergences and phylogenetic placement of new taxa

Genetic distances of the COI marker among the three examined species of *Heerz* using the K2P distance model ranged from 11.1 to 14.6%. Within *H. ecmahla* sp. n., the COI sequence fragment varied from 0.18 to 0.37%, whereas a unique haplotype was found among the three sequenced specimens of *H. macrophthalma* sp. n. *Lissopsius pacificus* sp. n. and *L. jaliscoensis* sp. n. also each had unique haplotypes, with a sequence divergence of 8% between them. The COI distance between the sequenced specimens of *O. cuixmalensis* sp. n. and *O. bicolor* Braet, Barbalho & van Achterberg was of 11.4%.

Our reconstructed Bayesian phylogram based on the concatenated 28S+COI data sets (Fig. 1) recovered the species of the three genera examined in this study within a major ‘South American’ clade (PP = 0.93) also recovered in previous phylogenetic studies of the Doryctinae (Zaldivar-Riverón et al. 2007, 2008). Within this South American clade, *Lissopsius* and *Heerz* were each significantly supported as monophyletic (PP = 1.0 in both cases), and were significantly supported as sister taxa (PP = 1.0). Within *Heerz*, *H. ecmahla* sp. n. was weakly supported (PP = 0.6) as sister taxon of the *H. lukenatcha* Marsh + *H. macrophthalma* sp. n. clade. The specimen assigned to *O. cuixmalensis* sp. n. was on the other hand recovered at the base of a group containing a *Notiospathius* Matthews & Marsh + *Masonius* Marsh + *Tarasco* Marsh + *Hecabolus* Curtis and an *Acrophasmus* Enderlein + *O. bicolor* clades, though with a non-significant support (PP = 0.3).

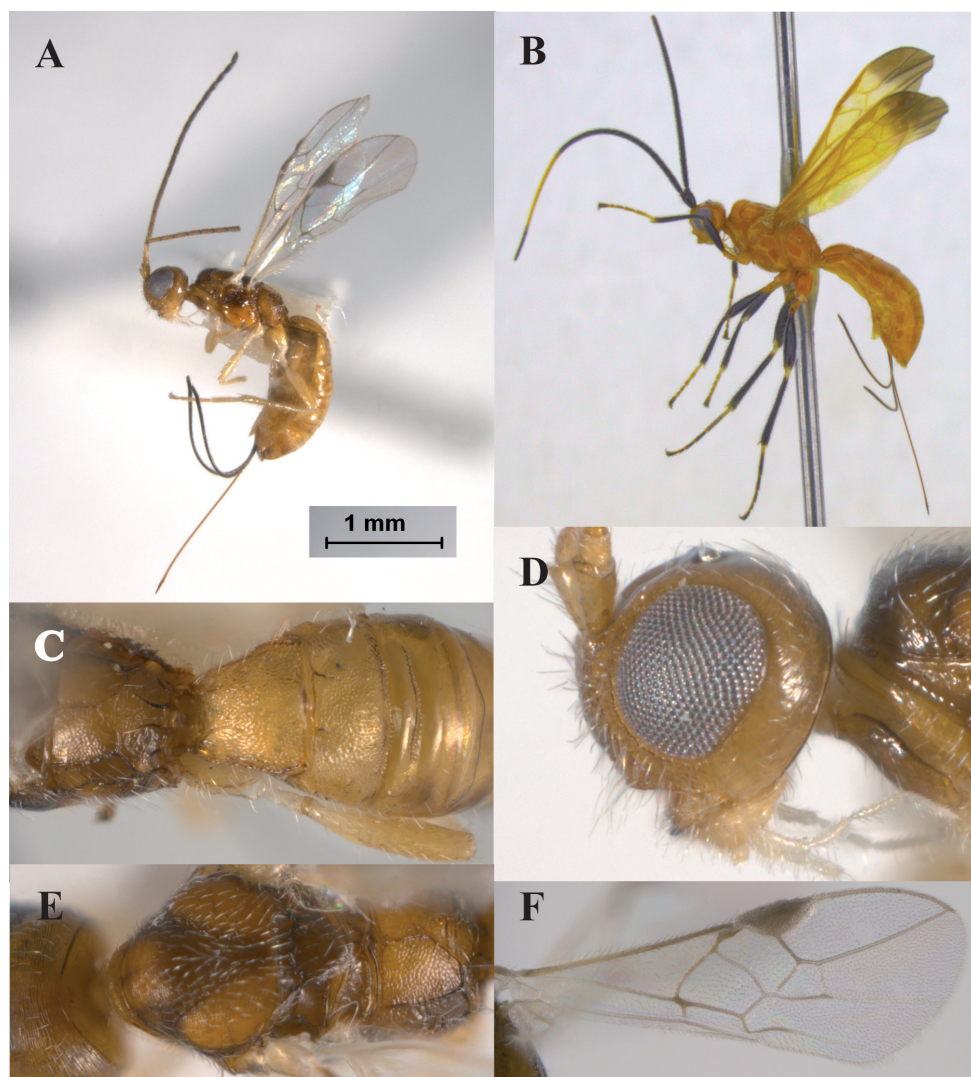




<http://species-id.net/wiki/Heerz>

**Type species.** *Heerz lukenatcha* Marsh

**Description.** Small to moderate size, 2.5-7.0 mm; eyes large, moderately to distinctly emarginated opposite antennal sockets; frons concave; occipital carina present,



**Figure 2.** *Heerz ecmbala* sp. n. (holotype) (A, C–F) and *Heerz lukenatcha* Marsh (B): **A, B** habitus, lateral view **C** propodeum and basal half of metasoma, dorsal view **D** head, lateral view **E** mesosoma, dorsal view **F** fore wing.

meeting hypostomal carina before mandible; labrum distinctly concave; hypoclypeal depression small and round; clypeus short; malar suture absent; maxillary palpi 5-segmented, labial palpi 4-segmented; head and mesosoma smooth or weakly sculptured; mesoscutum declivous anteriorly; prepectal carinae present; precoxal sulcus smooth; surface of propodeum smooth on anterior half, slightly rugose on posterior half, with a median longitudinal carina followed by a pentagonal areola; metapleural flange present; fore tibia with a row of spines along anterior edge; hind coxa with a distinct basoventral tooth; vein m-cu of fore wing antefurcal to vein 2RS, thus (RS+M)b present;

vein 1cu-a postfurcal to vein 1M; vein r-m of fore wing present; second submarginal cell distinctly short; first subdiscal cell of fore wing open at apex; vein M+CU of hind wing slightly shorter to larger than vein 1M; males without pterostigma on hind wing; basal sternal plate (acrosternite) of first metasomal tergite short, 0.2-0.3 times the length of tergum; first and second metasomal tergites sculptured; third metasomal tergite smooth with a transverse furrow; remaining metasomal tergites smooth; ovipositor strongly sclerotised apically; nodes reduced, only one or absent.

**Distribution.** Brazil, Costa Rica and Mexico.

**Remarks.** The two new species of *Heerz* described below considerably modify the previous concept of the genus. The two previously described species, *H. lukenatcha* and *H. tooya* Marsh, are characterised by their smooth mesosoma, dusky wings and relatively large body size. The Mexican species, on the other hand, have a coriaceous mesoscutum, uniformly hyaline wings and are considerably smaller, especially *H. ecmahla*. Moreover, frons excavation is more conspicuous in the two new species compared to *H. lukenatcha* and *H. tooya*. Despite these morphological differences, our comparisons with type material and our DNA sequence data (see below) led us to include the new species within *Heerz*.

### Key to described species of *Heerz* (modified from Marsh 1993)

- 1 Wings partially or totally infusate (Fig. 2B), mesoscutum mostly smooth... 2
- Wings hyaline (Fig. 2A, 3A), mesoscutum coriaceous (Fig. 3C) ..... 3
- 2 Wings yellow on basal  $\frac{3}{4}$ , dusky on apical  $\frac{1}{4}$ , all femora and tibiae black.....  
..... *Heerz lukentacha* Marsh
- Wings evenly dusky; all femora and tibiae yellow ..... *Heerz tooya* Marsh
- 3 Eyes considerably large, their height 5.0 times longer than malar space, inner orbit clearly emarginated (Fig. 3B); second metasomal tergite mostly striate (Fig. 3D); ovipositor 0.5 times as long as metasoma (Fig. 3A) .....  
..... *Heerz macrophthalma* sp. n.
- Eyes small, their height about 3.0 times length of malar space (Fig. 2D), weakly emarginated; second metasomal tergite mostly coriaceous (Fig. 2C); ovipositor slightly longer (about 1.1 times) than metasoma (Fig. 2A) .....  
..... *Heerz ecmahla* sp. n.

### *Heerz ecmahla* Martínez, Zaldívar-Riverón, Ceccarelli & Shaw, sp. n.

urn:lsid:zoobank.org:act:79D0180F-1C9F-4825-97A6-6E4C3C706CCB

[http://species-id.net/wiki/Heerz\\_ecmahla](http://species-id.net/wiki/Heerz_ecmahla)

Figs 2A–F

**Diagnosis.** *Heerz ecmahla* distinguishes from the remaining species of the genus by the uniformly coriaceous sculpture on the first and second metasomal tergites (Fig. 2C). It also distinguishes from the Central and South American species, *H. tooya* and *H. luke-*

*natcha*, by its entirely hyaline wings (Fig. 2A) [wings partially or totally infusate in the latter two species (Fig. 2B)], and from *H. macrophtalma* by its relatively smaller eyes (Fig. 2D) [considerably large in *H. macrophtalma* (Fig. 3B)] and distinctly longer ovipositor (Fig. 2A) [about 0.5 times as long as metasoma in *H. macrophtalma* (Fig. 3A)].

**Description.** Female. *Colour:* Body honey yellow, antennae honey yellow, turning darker apically; legs yellow, median lobe of mesoscutum and upper half of mesopleuron light brown; metasoma slightly lighter; wings hyaline, veins, pterostigma and tegula light brown. *Body length:* 2.5 mm. *Head:* vertex, frons and temple striate, gena smooth, face acinose; eyes large, its height 1.3 times its maximum width (lateral view); malar space about 0.3 times eye height (lateral view); ocello-ocular distance two times the diameter of lateral ocellus and 1.5 times longer than posterior ocellar line; antennae with 21 flagellomeres. *Mesosoma:* length of mesosoma 1.9 times its maximum height; pronotum essentially smooth, pronotal groove largely smooth, with a few rugae medially; mesoscutal lobes coriaceous; notauli scrobiculate, obscured in a posterior rugose median area; scutellum smooth, scutellar sulcus deep and scrobiculate, with four longitudinal carinae; mesopleuron largely smooth, posterior mesopleural sulcus distinct and scrobiculate; subalar groove scrobiculate; precoxal sulcus smooth; metapleuron rugulose; dorsolateral areas of propodeum coriaceous; propodeal areola distinctly delimited by carinae and essentially coriaceous. *Legs:* fore tibia with a row of 12 spines; hind coxa mostly smooth, with a distinct basoventral tooth. *Wings:* fore wing 2.9 times longer than wide; length of pterostigma 2.7 times its maximum width, 0.6 times length of vein R; vein r 1.5 times longer than vein 3RSa; vein 3RSa 0.8 times length of r-m; vein m-cu distinctly antefurcal; (RS+M)b present, 0.3 times length of vein 2RS; hind wing with vein M+CU 0.8 times as long as 1M and 1.5 times length of vein r-m; vein m-cu slightly curved towards wing apex. *Metasoma:* first metasomal tergite short, 1.1 times as long as its apical width, entirely coriaceous, with two dorsolateral carinae running through anterior half of median tergite, without a median dorsal area fully delimited by carinae; second metasomal tergite coriaceous, with two slightly convergent furrows basally; third metasomal tergite smooth, turning coriaceous laterally and with a transverse scrobiculate furrow; remaining metasomal tergites smooth and polished; ovipositor 1.1 times length of metasoma, with a single, reduced node.

Male. Essentially as female, body length 2.7 mm.

Variation. Females: Body length 2.5–2.7 mm; eyes 1.1–1.2 times higher than wide (lateral view); fore wing length 2.5–2.6 times its maximum width; length of pterostigma 2.6–2.7 times its maximum width; hind wing vein M+CU 0.8–1.0 times as long as vein 1M.

Holotype. IB-UNAM CNIN. Female. Mexico, Jalisco, Estación Biológica Chamela, cerca del Laboratorio, 19.49N, -105.04E, 23–24.vi.2009, 95 msnm, light trap, selva baja caducifolia, H. Clebsch, A. Zaldivar, A. Polaszek col., DNA voucher no. ASDOR076 (CHAM-076), GenBank accession nos JF912210, HQ200616 (IB-UNAM CNIN).

Paratypes. IB-UNAM CNIN, MACN. Two specimens. One female, Mexico, Jalisco, Estación Biológica Chamela, cerca del laboratorio, 19.49N, -105.04E, 23–24.vi.2009, 95msnm, light trap, selva baja caducifolia, H. Clebsch, A. Zaldivar, A. Polaszek

col., DNA voucher no. CHAM-075, GenBank accession nos JF912209, HQ200615; one male, Mexico, Jalisco, Estación Biológica Chamela, cerca del laboratorio, 19.49N, -105.04E, 05.v.2011, 99–122 msnm, light trap, selva baja caducifolia, A. Zaldívar, S. Zaragoza, A. Ibarra col., DNA voucher nos CNIN796, ASDOR076 (CHAM-076), GenBank accession nos JQ268746, JF912210, HQ200616.

**Etymology.** The specific epithet is an anagram of Chamela, the type locality of this species.

***Heerz macrophthalma* Martínez, Zaldívar-Riverón, Ceccarelli & Shaw, sp. n.**

urn:lsid:zoobank.org:act:2F240FAD-E0C2-43FD-ACBC-B66E432EA6B2

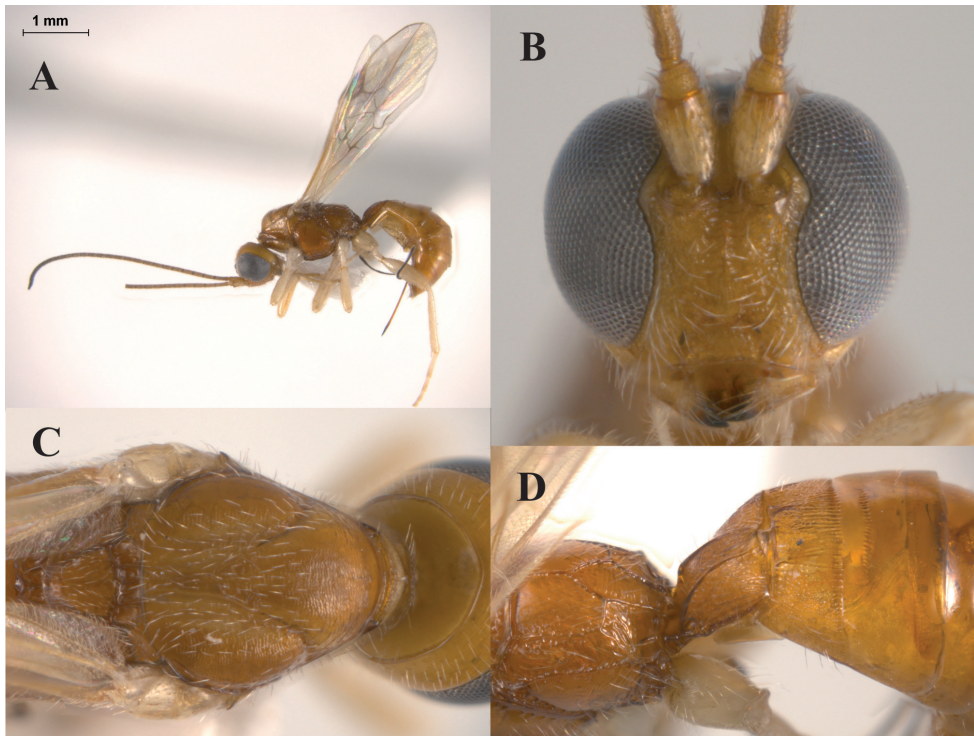
[http://species-id.net/wiki/Heerz\\_macrophthalma](http://species-id.net/wiki/Heerz_macrophthalma)

Figs 3A–D

**Diagnosis.** *Heerz macrophthalma* distinguishes from the remaining species of the genus by its considerably larger eyes (Fig. 3B). It can also be distinguished from the Central and South American species, *H. tooya* and *H. lukenatcha*, by its entirely hyaline wings (Fig. 3A) [wings partially or totally infuscate in the latter two species (Fig. 2B)] and from *H. ecmahla* by the striate sculpture on the second metasomal tergite (Fig. 3D) [coriaceous in *H. ecmahla* (Fig. 2C)].

**Description.** Female. *Colour:* Body mostly honey yellow, antennae honey yellow, turning darker apically; legs creamish white, with apex of tarsomeres darker; wings hyaline, veins, pterostigma and tegula light brown. *Body length:* 4.7 mm. *Head:* vertex, frons and temple striate, face acinose; eyes large, 1.3 times higher than wide (lateral view); malar space about 0.2 times eye height; ocello-ocular distance less than 0.8 times diameter of lateral ocellus and as long as posterior ocellar line; antennae with 31 flagellomeres. *Mesosoma:* length of mesosoma 1.8 times its maximum height; pronotum smooth, pronotal groove scrobiculate; mesoscutal lobes coriaceous; notauli deep and scrobiculate, obscured in a posterior striate-rugose median area; scutellum smooth, scutellar sulcus deep and scrobiculate, with six longitudinal carinae; mesopleuron largely smooth, striate near subalar furrow; posterior mesopleural sulcus distinct and scrobiculate; subalar groove scrobiculate; precoxal sulcus smooth; metapleuron smooth; propodeal areola distinctly delimited by carinae and with crossing transversal rugae. *Legs:* fore tibia with a row of 15 spines; hind coxa striate dorsally, smooth ventrally, with a distinct basoventral tooth. *Wings:* fore wing 2.8 times longer than wide; pterostigma 0.6 times the length of vein R; vein r 1.5 times longer than vein 3RSa; vein 3RSa 0.8 times as long as vein r-m; vein m-cu distinctly antefurcal, vein (Rs+M)b present, 0.2 times length of vein 2RS; hind wing with vein M+CU as long as vein 1M and twice length of vein r-m; vein m-cu slightly curved towards wing apex. *Metasoma:* first metasomal tergite short, about as long as its apical width, with median dorsal area delimited by two dorsolateral carinae, median area rugulose-coriaceous, lateral areas striate; second metasomal tergite striate medially, with coriaceous sculpture in between striations, with two more conspicuous slightly convergent furrows; third metasomal tergite smooth, turning coriaceous later-





**Figure 3.** *Heerz macrophthalma* sp. n. (holotype): **A** habitus, lateral view **B** head, frontal view **C** mesosoma, dorsal view **D** propodeum and basal half of mesosoma, dorsolateral view.

ally, with a transverse scrobiculate furrow; remaining metasomal tergites smooth and polished; ovipositor 0.5 times length of metasoma, without distinct nodes.

Male. Smaller than female, body length 2.7–2.8 mm.

Variation. Female: Body length 4.1–4.6 mm; eyes 1.3–1.4 times higher than wide (lateral view); malar space 0.1–0.2 times eye height (lateral view); ocello-ocular distance 0.7–0.8 times diameter of lateral ocellus; antennae with 28–29 flagellomeres; fore wing length 2.8–2.9 times its maximum width; length of pterostigma 2.6–2.8 times its maximum width; hind wing vein M+CU 1.0–1.1 times longer than vein 1M.

Holotype. IB-UNAM CNIN. Female. Mexico, Jalisco, Estación Biológica Chamela, cerca laboratorio, 19.49, -105.04, 5.v.2011, 99–122 msnm, light trap, selva baja caducifolia, Cham-084, Zaldivar, Zaragoza, Ibarra col. DNA voucher no. CNIN795, GenBank accession nos JQ268745, JQ268749 (IB-UNAM CNIN).

Paratypes. IB-UNAM CNIN, MACN, UWIM. Three specimens. One female, Mexico, Jalisco, Estación Biológica Chamela, camino Búho, 19.49/19.49 N, -105.04/-105.04 E, 25.ii.2010, 106 msnm, sweeping net, selva baja caducifolia, A. Zaldivar col., DNA voucher no. ASDOR761, GenBank accession no. HQ200977; two males, Mexico, Jalisco, Estación Biológica Chamela, cerca laboratorio, 19.49 N, -105.04 E, 20.ii.2011, 99–122 msnm, light trap, selva baja caducifolia, A. Zaldivar, col., DNA voucher nos AS-



DOR551 (Cham-500), ASDOR555 (Cham-504), GenBank accession nos HQ200979, HQ200967 (IB-UNAM CNIN).

**Etymology.** The specific epithet derives from the greek words *makros* and *ophthalmos*, in reference to the very large compound eyes of this species.

### ***Lissopsius* Marsh**

<http://species-id.net/wiki/Lissopsius>

*Lissopsius* Marsh, 2002: 128.

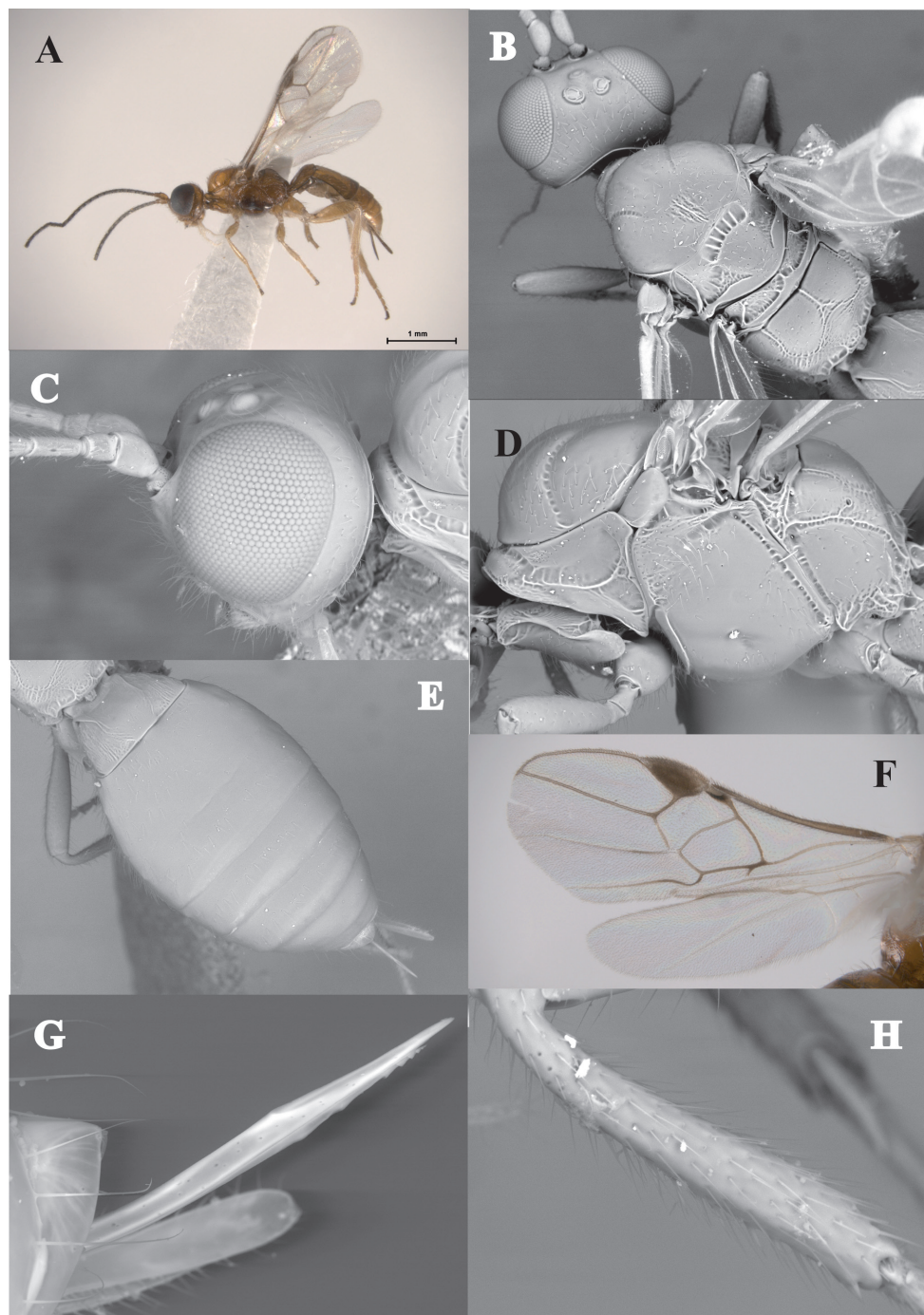
**Type species.** *Lissopsius flavus* Marsh, 2002.

**Diagnosis.** This genus distinguishes from other recognised doryctine genera by the following combination of features: (1) body mostly smooth and polished (Figs 4A-E, 5B-F), (2) propodeum with a median longitudinal carina followed by a pentagonal areola (Figs 4B, 5D), (3) vein r-m of fore wing absent (Fig. 4F), (4) vein M+CU of hind wing larger than vein 1M (Fig. 4F), (5) vein cu-a of hind wing curved at apex towards wing tip (Fig. 4F), (6) hind coxa angled at base, without distinct tubercle or tooth, and (7) ovipositor uniformly sclerotised and with a single nodus (Fig. 4G). *Lissopsius* is closely related to *Heerz* (see above) and both are morphologically similar, with a body mostly smooth and polished, propodeal areola present and vein M+CU of hind wing slightly shorter to longer than vein 1M. However, *Lissopsius* differs from *Heerz* by having the vein r-m of fore wing absent (always present in *Heerz*), hind coxa without basoventral tooth (present in *Heerz*), and ovipositor uniformly sclerotised (strongly sclerotised at apex in *Heerz*).

**Description.** Small size, 2.3-4.5 mm; eyes large, emarginated opposite antennal sockets; occipital carina present, ending before reaching hypostomal carina; labrum distinctly concave; hypoclypeal depression small and round; clypeus short; malar suture absent; maxillary palpi 5-segmented, labial palpi 4-segmented; head, mesosoma and metasoma mostly smooth and polished; mesoscutum declivous anteriorly; prepectal carinae present; precoxal sulcus shallow and almost indistinct; surface of propodeum smooth on anterior half, slightly rugose on posterior half, with median longitudinal carina anteriorly and pentagonal areola posteriorly; metapleural flange present; fore tibia with a row of at least 10 spines along anterior edge (Fig. 4H); hind coxa angled at base, without basoventral tooth; vein m-cu of fore wing considerably antefurcal to vein 2RS, vein (RS+M)b present; vein 1cu-a considerably postfurcal to vein 1M; vein r-m of fore wing absent; first subdiscal cell of fore wing open at apex; vein M+CU of hind wing equal to or slightly longer than vein 1M; males without stigma-like enlargement on hind wing; basal sternal plate (acrosteronite) of first metasomal tergite about 0.25 length of tergite.

**Distribution.** Costa Rica and Mexico.

**Remarks.** In their study describing new ovipositor diagnostic features for the subfamily Doryctinae, Quicke et al. (1995) proposed two potential morphological synapomorphies for the group: the presence of a double nodus on the dorsal valve of the ovipositor and a strongly sclerotised apex. These characters, however, despite being



**Figure 4.** *Lissopsius pacificus* sp. n. (holotype): **A** habitus, lateral view **B** head and mesosoma, dorsal view **C** head, lateral view **D** mesosoma, lateral view **E** metasoma, dorsal view **F** fore and hind wing **G** ovipositor **H** fore tibia.

present in most doryctines, have apparently been reduced or lost in species of various genera (Quicke et al. 1995), including the two of the species of *Heerz* described here (a single or lack of nodus) and the three described known species of *Lissopsius* (uniformly sclerotized apex). The two new species described below represent the first records of the genus outside Costa Rica, and therefore for the Mexican territory. All the specimens of *Lissopsius* included in this work were only collected with light traps, and most of them were collected during three nights in June 2009 and belong to *L. pacificus* sp. n. The colour of the body in the sequenced specimens of the two species of *Lissopsius* described here became slightly darker after carrying out their DNA extractions, since we used the whole individuals and a non-destructive DNA extraction technique.

### Key to described species of *Lissopsius*

- 1 Ovipositor considerably short, no more than 0.25 times as long as metasoma (Figs 4A,G, 5C,F); mesoscutum with triangular, longitudinally rugose area in posteromedian area (Figs 4B, 5D) ..... **2**
- Ovipositor long, slightly shorter than metasoma; mesoscutum entirely smooth (Fig. 5B) ..... ***L. flavus* Marsh**
- 2 Second metasomal tergite mostly smooth, only slightly costate basally (Fig. 4E); ventral part of mesopleuron, precoxal sulcus and venter of mesosoma darker than the rest of the body (Fig. 4A); notauli ending before first half of mesoscutum (Fig. 4B) ..... ***L. pacificus* n. sp.**
- Second metasomal tergite distinctly costate basomedially, remaining area smooth (Fig. 5F); body uniformly yellow (Fig. 5C); notauli ending after first half of mesoscutum (Fig. 5D) ..... ***L. jaliscoensis* n. sp.**

### *Lissopsius pacificus* Zaldívar-Riverón, Martínez, Ceccarelli & Shaw, sp. n.

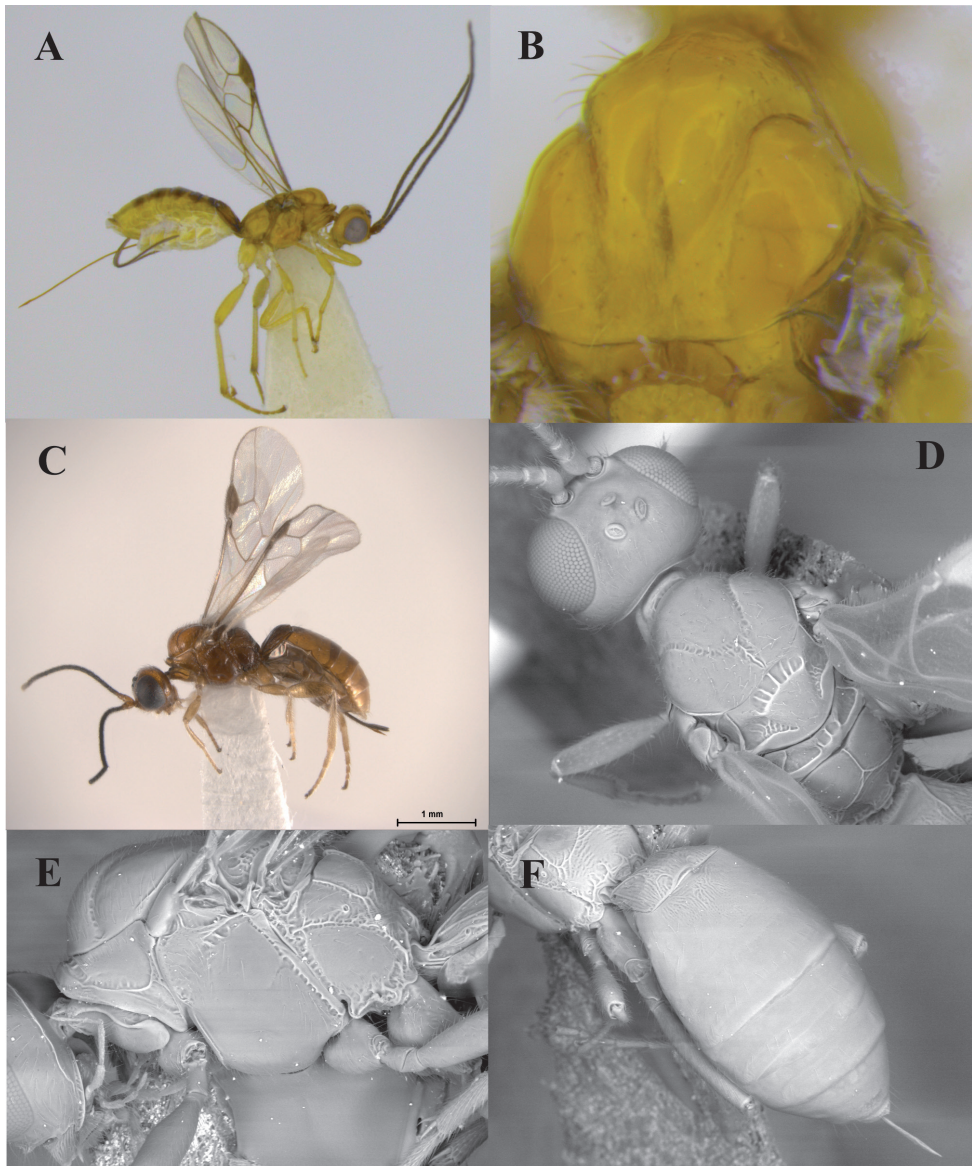
urn:lsid:zoobank.org:act:0DDA9D93-E265-40B9-A525-7E185502A6EB

[http://species-id.net/wiki/Lissopsius\\_pacificus](http://species-id.net/wiki/Lissopsius_pacificus)

Figs 4 A–H

**Diagnosis.** This new species distinguishes from *L. jaliscoensis* sp. n. and *L. flavus* in having a second metasomal tergite mostly smooth, only slightly costate basally (Fig. 4E) [distinctly costate basally, remaining area smooth in *L. flavus*; distinctly costate basomedially, remaining area smooth in *L. jaliscoensis* sp. n. (Fig. 5F)]; ventral part of mesopleuron, precoxal sulcus and venter of mesosoma darker than the rest of the body (Fig. 4A) [mesosoma completely yellow in *L. flavus* and *L. jaliscoensis* (Figs 5A,B)]; and notauli ending before first half of mesoscutum (Fig. 4B) [ending after first half of mesoscutum in *L. flavus* and *L. jaliscoensis* sp. n. (Figs 5B, D)]. *Lissopsius pacificus* also distinguishes from *L. flavus* in having a very short ovipositor, about 0.25 times as long as metasoma (Fig. 4A,G) [ovipositor as long as metasoma in *L. flavus* (Fig. 5A)]; a triangular, longitudinally rugose area in the posteromedian area of mesoscutum (Fig. 4B) [smooth in *L.*





**Figure 5.** *Lissopsius flavus* Marsh: **A** habitus, lateral view **B** mesoscutum, dorsal view. *Lissopsius pacificus* sp. n. (holotype): **C** habitus, lateral view **D** head and mesosoma, dorsal view **E** mesosoma, lateral view **F** metasoma, dorsal view.

*flavus* (Fig. 5B)]; and smooth third metasomal tergite (Fig. 4E) (third metasomal tergite smooth with weak transverse scrobiculate groove apically in *L. flavus*).

**Description.** Female. *Colour*: head yellow, ventral part of mesopleuron, precoxal sulcus and venter of mesosoma light brown, remainder part of mesosoma yellow; metasoma yellow with some areas light brown; pedicel and flagellum yellow to light brown; legs

yellow, hind tarsi light brown; wings hyaline, veins and pterostigma brown, tegula yellow. *Body length*: 3.4 mm. *Head*: entirely smooth, vertex and temple pilose, face strongly pilose; eyes large, malar space about 0.2 times eye height; ocello-ocular distance about 1.5 times diameter of lateral ocellus; eye 1.2 times higher than wide (lateral view); antennae broken, with at least 20 flagellomeres; scape with the same length as first flagellomere; first flagellomere longer than second. *Mesosoma*: length of mesosoma 1.7 times its maximum height; pronotum smooth dorsally, slightly rugose ventrally, pronotal groove slightly scrobiculate; mesoscutal lobes smooth, sparsely pilose medially, with a triangular longitudinal rugose area in the posteromedian area of mesoscutum; notauli deep and scrobiculate, not joining, ending before anterior half of mesoscutum; posterolateral sides of scutellum rugose, remaining areas smooth; scutellar sulcus deep and scrobiculate, with five longitudinal carinae; mesopleuron smooth, posterior mesopleural sulcus distinct and scrobiculate, subalar groove punctate; precoxal sulcus shallow and smooth, ending on anterior half of mesopleuron; metapleuron smooth, propodeum smooth on basal half, slightly rugose on apical half, with a median longitudinal carina followed by a distinct pentagonal areola. *Legs*: hind coxa smooth, protruding forward in ventro-anterior corner, about 1.4 times longer than its maximum width. *Wings*: Fore wing length 3.2 times its maximum width, length of pterostigma 2.9 times its maximum width, vein m-cu clearly antefurcal to vein 2RS, vein 1cu-a clearly postfurcal to vein 1M; hind wing vein M+CU 1.4 times longer than vein 1M; vein cu-a curved at apex toward wing tip. *Metasoma*: first metasomal tergite short, about 0.8 times as long as its apical width, medially smooth, laterally slightly costate-punctate; second metasomal tergite slightly costate basally, remaining area smooth; suture between second and third metasomal tergites poorly defined; remaining metasomal tergites smooth and polished; ovipositor very short, about 0.3 times length of metasoma.

Male. Similar to female; body length 2.3–2.8 mm.

Variation. Females: body length 3.0–4.5 mm; eyes 1.1–1.3 times higher than wide (lateral view); malar space 0.1–0.2 times eye height (lateral view); ocello-ocular distance 1.4–1.5 times diameter of lateral ocellus; antennae with 22–26 flagellomeres; fore wing length 2.9–3.2 times its maximum width; length of pterostigma 2.9–3.5 times its maximum width; hind wing vein M+CU 1.4–1.8 times longer than vein 1M.

Holotype. IB-UNAM CNIN. Female. Mexico, Jalisco, Estación de Biología de Chamela, UNAM, camino Búho, 19.49 N, -105.04 E, 65 msnm, 26–27 June 2009, light trap, tropical dry forest, H. Clebsch, A. Zaldívar-Riverón, A. Polaszek col., DNA voucher no. CNIN740, GenBank accession no. JQ268738 (IB-UNAM CNIN).

Paratypes. IB-UNAM CNIN, MACN, UWIM. One hundred and thirteen specimens. Twenty three females, same data as holotype; 37 females, two males, Mexico, Jalisco, Estación de Biología de Chamela UNAM, camino Búho, 19.49N, -105.04E, 95 msnm, 24–26 June 2009, light trap, tropical dry forest, H. Clebsch, A. Zaldívar, A. Polaszek col.; 49 females, Mexico, Jalisco, Estación Biológica de Chamela, UNAM, cerca del laboratorio, 19.49N, -105.04E, 95 msnm, 23–25 June 2009, light trap, tropical dry forest, H. Clebsch, A. Zaldívar, A. Polaszek col.; four females, Mexico, Jalisco, Estación de Biología de Chamela, UNAM, camino Chachalaca, 19.49N, -105.03E, 56 msnm, 25 June 2009, light trap, tropical dry forest, H. Clebsch, A. Zaldívar, A.

Polaszek col.; one female, Mexico, Jalisco, Estación de Biología de Chamela, UNAM, near lab, 19.49N, -105.04E, 99 msnm, 5 May 2011, light trap, tropical dry forest, H. Clebsch, A. Zaldivar, A. Polaszek col. DNA voucher nos CNIN739, 740, 742, 743, GenBank accession nos JQ268737, JQ268739-40, JQ268747 (IB-UNAM CNIN). Additional material: About three hundred of specimens preserved in 100% ethanol and kept at -20°C.

**Biology.** The two new species of *Lissopsius* described in this study apparently have nocturnal habits, since all their specimens were only collected with light traps. These species appear to be generalist parasitoids of various species of lepidopterans according to an ongoing study (Zaldivar-Riverón et al. in prep.) that is being carried out based on molecular analyses of parasitoid linkages (MAPL; Rougerie et al. 2010).

**Etymology.** The specific name refers to the area where the species was collected, which is situated near the Mexican Pacific coast.

***Lissopsius jaliscoensis* Zaldivar-Riverón, Martínez, Ceccarelli & Shaw, sp. n.**

urn:lsid:zoobank.org:act:169B8D3A-CE52-4AE6-BCA0-F1D752F2B28E

[http://species-id.net/wiki/Lissopsius\\_jaliscoensis](http://species-id.net/wiki/Lissopsius_jaliscoensis)

Figs 5A, F

**Diagnosis.** This species distinguishes from *L. pacificus* and *L. flavus* by having the second metasomal tergite distinctly costate basomedially (Fig. 5F) [mostly smooth, only slightly costate basally in *L. pacificus* (Fig. 4D); distinctly costate basally, remaining area smooth in *L. flavus*]. *Lissopsius jaliscoensis* is morphologically very similar to *L. pacificus*, but differs from this species by having the mesosoma entirely yellow (Fig. 5C) [ventral part of mesopleuron, precoxal sulcus and venter of mesosoma darker than the rest of the body in *L. pacificus* (Fig. 4A)], and notauli ending after first half of mesoscutum (Fig. 5D) [ending before first half of mesoscutum in *L. pacificus* (Fig. 4B)].

**Description.** Female. *Colour:* head and mesosoma yellow, metasoma yellow with some areas light brown; pedicel and flagellum yellow to light brown; legs yellow; wings hyaline, veins and pterostigma light brown, tegula yellow. *Body length:* 3.3 mm. *Head:* entirely smooth, vertex and temple pilose, face strongly pilose; eyes large, malar space about 0.2 times eye height; ocello-ocular distance about 2.0 times diameter of lateral ocellus; eye 1.1 times higher than wide (lateral view); antennae broken, with at least 24 flagellomeres; scape with the same length as first flagellomere; first flagellomere longer than second. *Mesosoma:* length of mesosoma about 1.7 times its maximum height; pronotum smooth to slightly rugose dorsally and ventrally, pronotal groove slightly scrobiculate; mesoscutal lobes smooth, sparsely pilose; notauli deep and scrobiculate, joining in a triangularly rugose area at the end of mesoscutum; posterolateral sides of scutellum rugose, remaining areas smooth; scutellar sulcus deep and scrobiculate, with five longitudinal carinae; mesopleuron smooth, posterior mesopleural sulcus narrow and scrobiculate, subalar groove slightly punctate; precoxal sulcus almost indistinct and smooth, ending on anterior half of mesopleuron; metapleuron smooth, propodeum smooth on basal



half, slightly rugose on apical half, with a median longitudinal carina followed by a distinct pentagonal areola. *Legs*: hind coxa smooth, protruding forward in ventro-anterior corner, about 1.3 times longer than its maximum width. *Wings*: Fore wing length 3.1 its maximum width, length of pterostigma 3.0 times its maximum width, vein m-cu clearly antefurcal to vein 2RS, vein 1cu-a clearly postfurcal to vein 1M; hind wing vein M+CU 1.8 times longer than vein 1M; vein cu-a curved at apex toward wing tip. *Metasoma*: first metasomal tergite short, 0.8 times as long as its apical width, basomedially smooth, remaining area costate with punctate microsculpture; second metasomal tergite distinctly costate with punctate microsculpture basomedially, remaining area smooth; suture between second and third metasomal tergites almost indistinct; remaining metasomal tergites smooth and polished; ovipositor very short, about 0.3 times length of metasoma.

Male. Similar to female. Body length 3.1 mm. Hind wing without stigma-like enlargement.

Variation. Females: body length 3.1–3.7 mm; eye 1.1–1.3 times higher than wide (lateral view); malar space 0.1–0.2 times eye height (lateral view); ocello-ocular distance 1.5–2.0 times diameter of lateral ocellus; all with antennae broken and less than 20 flagellomeres remaining. *Wings*: fore wing length 2.8–2.9 times its maximum width; length of pterostigma 3.8–4.0 times its maximum width; hind wing vein M+CU 1.6–1.8 times longer than vein 1M.

Holotype. IB-UNAM CNIN. Female. Mexico, Jalisco, Estación Biológica de Chamela, UNAM, camino Búho, 19.49N, -105.04E, 65 msnm, 26–27 June 2009, light trap, tropical dry forest. H. Clebsch, A. Zaldívar, A. Polaszek col., DNA voucher no. CNIN798, GenBank accession nos JQ268742, JQ268748 (IB-UNAM CNIN).

Paratypes. IB-UNAM CNIN, MACN, UWIM. Four specimens. Three females. Same data as holotype; one male, Mexico, Jalisco, Estación Biológica de Chamela, UNAM, camino Búho, 19.49N, -105.04E, 95 msnm, 24–25 June 2009, light trap, tropical dry forest, H. Clebsch, A. Zaldívar, A. Polaszek col. DNA voucher nos CNIN741, CNIN798–800, GenBank accession nos JQ268741–44 (IB-UNAM CNIN).

**Etymology.** The specific name refers to Jalisco, the Mexican state where the species was found.

**Remarks.** Only five specimens of this species were collected during all our field trips, contrasting with the approximately 300 specimens collected for *L. pacificus*.

### ***Ondigus* Braet, Barbalho & van Achterberg**

<http://species-id.net/wiki/Ondigus>

*Ondigus* Braet, Barbalho & van Achterberg, 2003: 109–111.

**Type species.** *Ondigus bicolor* Braet, Barbalho & van Achterberg

**Diagnosis.** This genus distinguishes from the remaining doryctine genera by having the following combination of features: (1) first six metasomal tergites sculptured, fourth to sixth granulate (Figs 6B,F); (2) suture between the second and third metasoma-

mal tergites wide, deep, scrobiculate and slightly sinuate (Figs 6B,F); (3) third metasomal tergite with a deep, scrobiculate transverse groove (Figs 6B,F); (4) first subdiscal cell of fore wing open at apex (Figs 6E,G); (5) hind coxa with a distinct basoventral tooth; hind wing vein M+CU approximately the same length of vein 1M (Figs 6E,G); (6) all femora with subbasal tubercles (Fig. 6A).

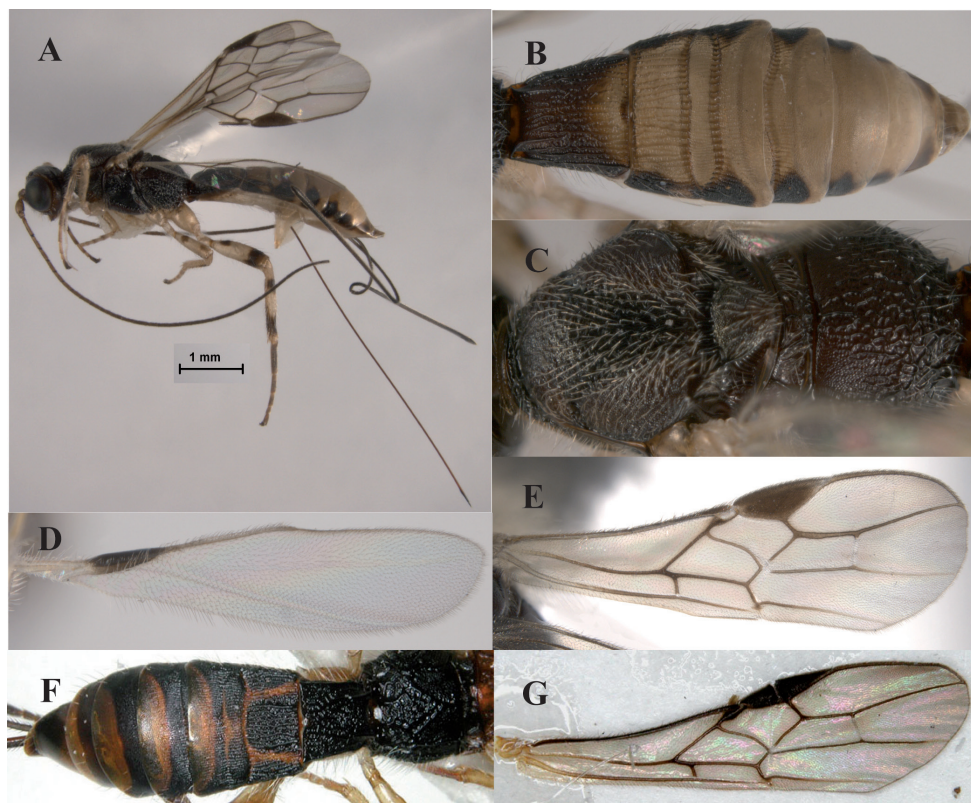
**Description.** Moderate size, female 5.6–6.1 mm, male 4.2 mm; eyes large, moderately emarginated opposite antennal sockets; maxillary palpi 5-segmented, labial palpi 4-segmented; face densely setose; occipital carina present and complete; hypoclypeal depression elliptic; clypeus short and wide; malar suture absent; mesosoma setose and mostly coriaceous; mesoscutum declivous anteriorly; notauli distinct anteriorly, scrobiculate, obscured at half of mesoscutum in a longitudinally rugose area; prepectal carinae present; metapleural flange present; all femora with a subbasal protuberance; fore tibia with a row six to eight spines along anterior edge; hind coxa granulate, pilose, with a basoventral tooth; only known male with pterostigma on hind wing; vein m-cu of fore wing interstitial or slightly antefurcal to vein 2RS; vein 1cu-a considerably postfurcal to vein 1M; vein r-m of fore wing present; second submarginal cell of fore wing long; first subdiscal cell of fore wing open at apex; hind wing vein M+CU equal to or slightly longer than vein 1M; first metasomal tergite about 1.1–1.2 times longer than its apical width; suture between second and third metasomal tergite wide, deep, scrobiculate and slightly sinuate; third metasomal tergite with a deep, scrobiculate transverse groove; basal sternal plate (acrosteronite) of first metasomal tergite about 0.2 length of tergum.

**Distribution.** French Guyana, Mexico.

**Remarks.** The new species of *Ondigus* described here differs in some of the morphological features originally proposed by Braet et al. (2003) to define the genus. These features include a striate vertex, propodeum without longitudinal median carinae and areola, and second metasomal tergite without a pair of sublateral depressions. The above species and *O. bicolor*, however, share a number of diagnostic features on wing venation, legs and sculpture of metasomal tergites. The majority rule consensus tree derived from the Bayesian analysis performed recovered *O. bicolor* and our new species in separate clades; the relationships involved, however, were weakly supported. Based on the above morphological similarities and the unclear phylogenetic relationships obtained, we have decided to place the new species within *Ondigus* until additional help us to confirm the conspecificity of the taxa involved.

### Key to described species of *Ondigus*

- 1 Vertex striate, propodeum without a median longitudinal carina and areola, dorsolateral carinae of first metasomal tergite ending before its anterior half; second metasomal tergite without a pair of sublateral depressions ..... *Ondigus cuixmalensis* sp. n.
- Vertex smooth; propodeum with a median longitudinal carina and a pentagonal areola; dorsolateral carinae of first metasomal median tergite complete; second metasomal tergite with a pair of sublateral depressions ..... *Ondigus bicolor* Braet, Barbalho & van Achterberg



**Figure 6.** *Ondigus cuixmalensis* sp. n. (holotype): **A** habitus, lateral view **B** metasoma, dorsal view **C** mesosoma, dorsal view **D** hind wing, lateral view (male, paratype) **E** fore wing, lateral view. *Ondigus bicolor* Braet, Barbalho & van Achterberg: **F** propodeum and metasoma, dorsal view **G** fore wing.

***Ondigus cuixmalensis* Zaldívar-Riverón, Martínez, Ceccarelli & Shaw, sp. n.**

urn:lsid:zoobank.org:act:5A802A1E-8FE2-4880-8BBF-BA3516F403D3

[http://species-id.net/wiki/Ondigus\\_cuixmalensis](http://species-id.net/wiki/Ondigus_cuixmalensis)

Figs 6 A–G

**Diagnosis.** This species differs from the other described species of the genus, *O. bicolor* by having a vertex striate (smooth in *O. bicolor*), propodeum without a median longitudinal carina and areola (Fig. 6C) [both present in *O. bicolor* (Fig. 6F)], dorsolateral carinae of first metasomal tergite ending before its anterior half (Fig. 6B) [running through the apical end of first metasomal tergite in *O. bicolor* (Fig. 6F)], and second metasomal tergite without a pair of sublateral depressions (Fig. 6B) [present in *O. bicolor* (Fig. 6F)].

**Description.** Female. *Colour:* head and mesosoma dark brown, eye orbits honey yellow; scape and pedicel brown, flagellomeres brown, turning black to apex; palpi pale yellow; first metasomal tergite dark brown, with a semicircular area yellow apically; remaining metasomal tergites yellow, with brown irregular areas laterally; fore, middle and hind coxae,

trochanter and trochantellus pale yellow, femora and tibiae pale yellow with irregular specks medially and apically, tarsi light brown to brown; wings hyaline, veins and pterostigma light brown, tegula pale yellow. *Body length*: 5.6 mm; ovipositor 2.5 mm. *Head*: face, frons and vertex striate, temple and gena smooth; malar space about 0.2 times eye height; occipital carina ending just before reaching hypostomal carina; ocello-ocular distance about the same length than diameter of lateral ocellus; eye 1.2 times higher than wide (lateral view); antennae broken, with at least 31 flagellomeres; scape longer than first flagellomere; first flagellomere longer than second. *Mesosoma*: length of mesosoma about 2.0 times its maximum height; pronotum rugose dorsally and ventrally, pronotal groove scrobiculate; mesoscutal lobes coriaceous, slightly transversally rugose at the edges of notauli; notauli deep and scrobiculate, joining before mesoscutum in a rugose area; scutellar disc coriaceous; scutellar sulcus large, deep and scrobiculate, interrupted by scutellar disc, with at least nine longitudinal carinae on each side; mesopleuron porcate-coriaceous dorsally, coriaceous medially and ventrally; precoxal sulcus complete, wide, deep and scrobiculate; venter of mesopleuron coriaceous; posterior mesopleural sulcus narrow and scrobiculate; metapleuron rugose-areolate with coriaceous microsculpture, propodeum longitudinally rugose with coriaceous microsculpture, with a median longitudinal carina on apical half. *Legs*: hind coxa, femur and tibia coriaceous, about 1.4 times longer than its maximum width. *Wings*: Fore wing length 3.7 times its maximum width, length of pterostigma 2.7 times its maximum width, vein m-cu interstitial to vein 2RS, vein 1cu-a clearly postfurcal to vein 1M; hind wing vein M+CU about the same length as vein 1M. *Metasoma*: first metasomal tergite about the same length as its apical width, costate with rugose microsculpture, with dorsolateral carinae ending before its anterior half; second metasomal tergite costate with rugose microsculpture; third metasomal tergite longitudinally striate with granulose microsculpture, with a deep, wide and scrobiculate transversal groove basally; suture between third and fourth metasomal tergites wide, deep, scrobiculate and sinuate; fourth metasomal tergite granulate with basal longitudinal striae; fifth to seventh metasomal tergites granulate, remaining ones smooth; ovipositor long, about 1.7 times length of metasoma.

Male. Smaller than female, body length 4.2 mm; vertex dark brown, rest of head honey yellow; mesopleuron and dorsal and lateral areas of pronotum dark brown to black, remaining part of mesosoma and basal two thirds of first metasomal tergite brown; 30 flagellomeres (complete); vein m-cu antefurcal to vein 2RS; hind wing with stigma; suture between second and third metasomal tergites straight.

Holotype. IB-UNAM CNIN. Female. Mexico, Jalisco, Estación de Biología de Chamela, UNAM, camino Calandria, 19.50N, -105.03W, 45 m, 3 September 2009, sweeping net, tropical dry forest, Hans Clebsch, Alejandro Zaldivar-Riverón, collectors. DNA voucher no. ASDOR464 (CHAM-368), GenBank accession nos HQ201295, HQ200886 (IB-UNAM CNIN).

Paratype. IB-UNAM CNIN, MACN. One specimen. Male. Mexico, Jalisco, Estación de Biología de Chamela, UNAM, camino Calandria, 19.50N, -105.03W, 45 m, 20 February 2010, light trap, tropical dry forest, Alejandro Zaldivar-Riverón, collector. DNA voucher no. ASDOR514 (CHAM-463), GenBank accession no. HQ201294 (IB-UNAM CNIN).

**Distribution.** Mexico.

**Remarks.** The COI sequences generated in this work allowed us to associate the only two collected specimens of *O. cuixmalensis*, one male and one female, as conspecific. This is the first known male for the genus, and is characterised by having a stigma-like enlargement on the hind wing.

**Etymology.** The specific name refers to the CCBP, where this species was collected.

## Aknowledgments

We thank Hans Clebsh, Vladimir S. De Jesús-Bonilla, Andrew Polaszek and Andrés Reséndiz-Flores for their help during our first two collecting trips in Chamela; Yves Braet for sending pictures of *O. bicolor*; Alberto Jorge García for his help taking the SEM photographs, and María cristina Mayorga Martínez for mounting part of the specimens. This work was supported by grants given by the Universidad Nacional Autónoma de México (IACOD-DGAPA 2011), Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO; grant no. HB-033), CONACyT (Proyecto Ciencia Básica no. 511; Red Temática del Código de Barras de la Vida) and by the Ministerio de Ciencia e Innovación (CGL2010-15786; Spain) to AZR; by the National Fundation grant DEB-10-20751 to SRS (Caterpillars and parasitoids in the Eastern Andes of Ecuador, CAPEA); and by two postdoctoral fellowship given by the Universidad Nacional Autónoma de México (UNAM; DGAPA fellowships) to JJM and FSC. Any opinions, findings, and conclusions expressed are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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# Female genitalia of *Seasogonia* Young from China, with a new synonym and a new record (Hemiptera, Cicadellidae, Cicadellini)

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## Abstract

*Seasogonia* Young, 1986 is a sharpshooter genus with 13 species, four of them recorded from China. In this paper, *S. sandaracata* (Distant, 1908) is recorded as new for China and *S. rufipenna* Li & Wang, 1992 is regarded as a junior synonym of *S. nigromaculata* Kuoh, 1991. The morphological diversity of the female genitalia of *Seasogonia* is still poorly known. We provide herein detailed descriptions and illustrations of three Chinese *Seasogonia* species. Notes on the female genitalia of *Seasogonia*, including intraspecific and interspecific variation, and comparisons between the female genitalia of *Seasogonia* and of other related genera from China are provided. The preliminary results indicate that the female genitalia may provide useful features for the taxonomy of *Seasogonia* and other members of the Old World Cicadellini.

## Keywords

Membracoidea, Auchenorrhyncha, Cicadellinae, sharpshooter, morphology, taxonomy

## Introduction

The sharpshooter genus *Seasogonia* was established by Young (1986) for nine species (including five new ones), with *Tettigoniella dunsiriensis* Distant, 1908 as the type species. There was no species recorded from China at that time. Kuoh (1991) described two new species of *Seasogonia* from China, and later Li and Wang (1992) described an additional one. Kuoh and Zhuo (1996) described another new species, *S. sanguinea*, which was treated as a junior synonym of *S. indosinica* (Jacobi) (Cai and Huang 1999). Wilson et al. (2009) included in the genus the species *S. sikhimensis* (Distant), which was treated as spe-

cies of uncertain position by Young (1986). Until now, 13 species are known in the world and four from China. In this paper, *S. sandaracata* (Distant) is recorded as new for China and *S. rufipenna* Li & Wang is proposed as a junior synonym of *S. nigromaculata* Kuoh.

The female genitalia have yielded useful characters for the taxonomy of sharpshooters (Nielson 1965, Mejdalani 1998, Rodrigues and Mejdalani 2009, Mejdalani and Silva 2010), but the morphological diversity of the female genitalia is still poorly known compared to our current knowledge of the male genitalia. In the monograph of Young (1986), the female genitalia of *Seasogonia* species were only briefly described. The present study provides a detailed description of the previously unknown female genitalia of three Chinese *Seasogonia* species. Notes on the female genitalia of *Seasogonia*, including intraspecific and interspecific variation, and comparisons between the female genitalia of *Seasogonia* and of other related genera from China are provided. We hope that this description will point out useful characters for the taxonomic studies on the Old World Cicadellini.

## Material and methods

The male and female genital structures were prepared according to the techniques described by Oman (1949) and Mejdalani (1998), respectively. The dissected parts in glycerin were stored in microvials and the microvial was attached below the respective specimen to which the genitalia pars belonged. The morphological terminology of the female genitalia follows mainly Davis (1975) and Nielson (1965). Use of the term gonoplac (=valvula III) and the names for the processes of the dorsal and ventral sculptured areas of the first ovipositor valvula follow Mejdalani (1998). The illustrations of the ventral view of basal region of female genitalia are based on undisturbed and intact female genitalia that the valvulae are not separated. Most of specimens studied are housed in the Institute of Entomology, Guizhou University, Guiyang, China (GUGC), and some are deposited in Shanghai Entomological Museum, Chinese Academy of Sciences (SEMCAS). Abbreviations used in this paper are as follows: AP = articulation point, DE = denticles, LB = lobe, PP = preapical prominence, TO = tooth, VHA = ventral hyaline area, VID = ventral interlocking device.

## Results

### List of Chinese *Seasogonia* species and their female genitalia

#### *Seasogonia indosinica* (Jacobi)

[http://species-id.net/wiki/Seasogonia\\_indosinica](http://species-id.net/wiki/Seasogonia_indosinica)

Figs 1–3, 26–34

*Tettigoniella indosinica* Jacobi, 1905: 445

*Seasogonia sanguinea* Kuoh & Zhuo, 1996: 1

**Material examined.** 1 male, China, Guangxi Province, Huaping, 5 June 1997, coll. Yang Mao-fa; 3 males, 2 females, China, Guangxi Province, Jinxiu County, Dayaoshan, Alt. 500m, 28 April 2008, coll. Meng Ze-hong; 2 males, China, Hainan Province, Jianfengling, 14–15 May 1997, coll. Yang Mao-fa; 1 male, China, Hainan Province, Jianfengling, 17 April 2009, coll. Yang Zai-hua; 14 males, China, Hainan Province, Diaoluoshan, 10–12 April 2009, coll. Yang Zai-hua; 1 male, China, Hainan Province, Bawangling, 24 April 2009, coll. Yang Zai-hua; 1 male, China, Sichuan Province, Emeishan, 14 July 1995, coll. Yang Mao-fa; 3 males, China, Guizhou Province, Guiyang City, 5 June 1981, coll. Li Zi-zhong and Ma Gui-yan; 1 male, China, Guizhou Province, Guiyang City, 2 July 1986, coll. Li Zi-zhong; 4 males, 1 female, China, Guizhou Province, Guiyang City, 15 June 1992, coll. Zhang Yu-qiong; 10 males, China, Guizhou Province, Taijiang County, 9–17 May 1985, coll. Li Zi-zhong; 17 males, China, Guizhou Province, Libo County, 19–24 May 1995, coll. Chen Xiang-sheng; 8 males, China, Guizhou Province, Libo County, 24–30 May 1998, coll. Li Zi-zhong and Song Qiong-zhang; 2 males, China, Guizhou Province, Libo County, 14–17 June 2006, coll. Zhou Zhong-hui and Zhang Bin; 5 males, 3 females, China, Guizhou Province, Chishui County, 28 May 2000, Li Zi-zhong and Chen Xiang-sheng; 2 males, 3 females, China, Guizhou Province, Xishui City, 3 June, coll. Li Zi-zhong and Chen Xiang-sheng; 2 males, China, Guizhou Province, Chishui City, 28–30 May 2006, coll. Tang Yi and Yang Zai-hua; 1 male, China, Guizhou Province, Fanjingshan, 27 July 2001, coll. Li Zi-zhong; 2 males, 2 females, China, Guizhou Province, Fanjingshan, 2–3 June 2002, coll. Li Zi-zhong and Yang Mao-fa; 12 males, 7 females, China, Guizhou Province, Daozhen County, Dashahe, 22–27 May 2004, coll. Zhang Bin, Song Qiong-zhang, Xu Fang-ling and Chen Xiang-sheng; 39 males, 4 females, China, Guizhou Province, Leigongshan, 31 May to 5 June 2005, coll. Tang Yi, Li Zi-zhong, Zhang Bin, Song Qiong-zhang, Zhang Zheng-guang, Ge De-yan, Yang Zai-hua and Xu Fang-ling; 1 male, China, Guizhou Province, Anshun City, 20 July 2005, coll. Zhou Zhong-hui; 3 males, China, Guizhou Province, Duyun City, 5 May 2006, coll. Yang Zai-hua and Zhou Zhong-hui; 4 males, China, Guizhou Province, Shibing County, Yuntaishan, 20–21 May 2009, coll. Yang Zai-hua; 43 males, 10 females, China, Guizhou Province, Suiyang County, Kuankuoshui, 2–9 June 2010, coll. Dai Ren-huai, Song Qiong-zhang, Li Hu, Li Yu-jian, Zhang Bin, Zheng Yan-li and Xing Ji-chun.

**Distribution.** Myanmar, Vietnam, India, China (Fujian, Guangxi, Hainan, Sichuan, Guizhou, Yunnan).

**Female genitalia.** Abdominal sternite VII (Fig. 26), in ventral view, broader than long; anterior margin straight; posterior margin well produced medially, sometimes forming two distinct lateral lobes; lateral margins convergent posteriorly; surface with few small setae mostly on basal half. Internal sternite VIII not forming sclerites. Pygofer (Fig. 27), in lateral view, slightly produced posteriorly; posterior margin with subacute apex; surface with macrosetae on posterior portion and extending anteriorly along ventral margin, attaining midlength. Valvifers I, in lateral view (Fig. 28), nearly





**Figures 1–12.** *Seasogonia indosinica* (Jacobi), body of male (9.0 mm): **1** dorsal view **2** lateral view **3** ventral view. *S. nigromaculata* Kuoh, body of male (11.5 mm): **4** dorsal view **5** lateral view **6** ventral view. *S. rosea* Kuoh, body of male (10.9 mm): **7** dorsal view **8** lateral view **9** ventral view. *S. sandaracata* (Distant), body of male (11.2 mm): **10** dorsal view **11** lateral view **12** ventral view.

rectangular, slightly expanded posteriorly, posteroventral margin angulate; in ventral view (Fig. 34), forming lobes (LB) articulating with valvulae I. Valvifers II (Fig. 29), in lateral view, nearly fusiform, with small group of clustered setae near articulation point (AP). Valvulae I of ovipositor, in ventral view (Fig. 34), with base gradually broadening posteriorly; in lateral view (Fig. 30), shaft distinctly curved dorsally and with dorsal margin concave, with ventral hyaline area (VHA) near apex; dorsal sculptured area located on apical half, broadening to near apex and gradually narrowing to apex, formed by dense scale-like processes; ventral sculptured area restricted to apical portion, formed by dense imbricate processes; ventral interlocking device (VID) distinct on basal 2/3 of shaft; apex of shaft acute. Valvulae II of ovipositor (Figs 31 and 32), in lateral view, slightly expanded beyond basal curvature, distinctly curved dorsally and with dorsal margin concave; apex narrowly rounded; preapical prominence (PP) indistinct; shaft bearing approximately 4–6 teeth (TO) distributed on apical half behind basal curvature; each tooth semiround and bearing few denticles (DE) or not bearing denticles; denticles mostly distributed on dorsal margin of shaft between teeth and on dorsal and ventral margins of apical portion, dentate dorsal margin longer than ventral margin; ducts extending toward dorsal margin and toward apical portion of shaft. Gonoplasts (Fig. 33), in lateral view, with basal half narrow and apical half distinctly expanded; apex rounded.

***Seasogonia nigromaculata* Kuoh**

[http://species-id.net/wiki/Seasogonia\\_nigromaculata](http://species-id.net/wiki/Seasogonia_nigromaculata)

Figs 4–6, 13–19

*Seasogonia nigromaculata* Kuoh, 1991: 165

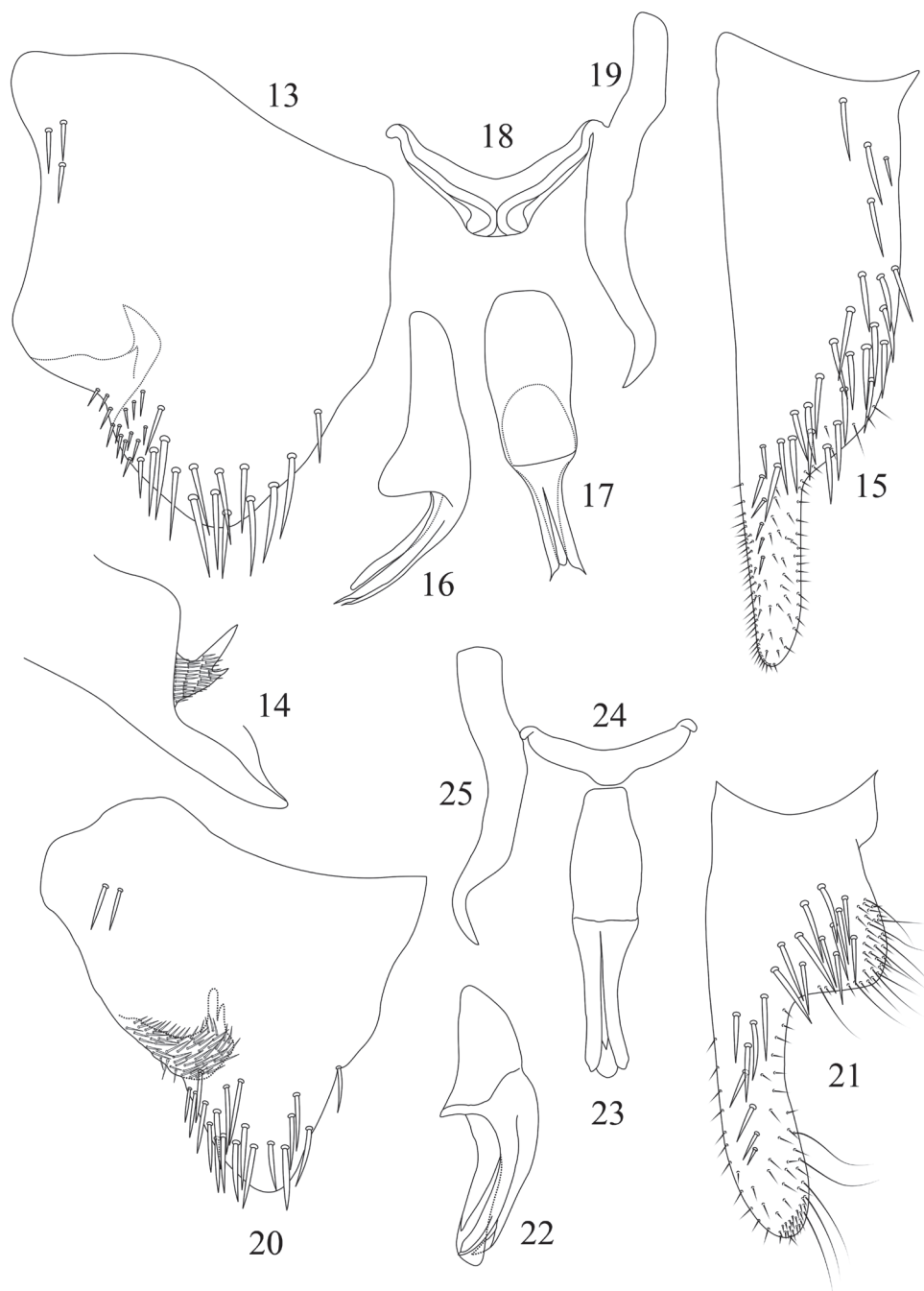
*Seasogonia rufipenna* Li & Wang, 1992: 98, syn. n.

**Notes.** We checked the holotype of *S. rufipenna* Li & Wang. Unfortunately, we failed to check the holotype of *S. nigromaculata* Kuoh, but based on its detailed Chinese descriptions and illustrations of external feature and male genitalia provided by Kuoh (1991), we regarded *S. rufipenna* Li & Wang as a junior synonym of *S. nigromaculata* Kuoh.

**Material examined.** Male, holotype of *S. rufipenna*, Guizhou Province, Taijiang County, Shihuihe, 16 May 1985, coll. Li Zi-zhong.

**Distribution.** China (Guizhou, Yunnan).

**Male genitalia.** Pygofer in lateral view (Fig. 13), with broad base and gradually narrowed posteriorly, posterodorsal margin concave; apex narrowly rounded; with two or three macrosetae on basiventral portion and many macrosetae on posterior portion; pygofer process (Figs 13 and 14) arising near median-ventral margin, extending dorsally, bifurcate apically and divided into two processes and with small process as 1/3 long as the other one; with dense setae on basal and median portion. Subgenital plate (Fig. 15) with multiseriate macrosetae on broad basal two-third portion, with uni-



**Figures 13–25.** *Seasogonia nigromaculata* Kuoh, male genitalia: **13** pygofer, lateral view **14** pygofer process, caudal view **15** subgenital plate, ventral view **16** aedeagus, lateral view **17** aedeagus, ventral view **18** connective, dorsal view **19** style, dorsal view. *S. rosea* Kuoh, male genitalia: **20** pygofer, lateral view **21** subgenital plate, ventral view **22** aedeagus, lateral view **23** aedeagus, ventral view **24** connective, dorsal view **25** style, dorsal view.

seriate macrosetae and some short microsetae on narrowed apical one-third portion. Aedeagus (Figs 16 and 17) broad at basal half and with subrounded median-dorsal process; shaft slender and with paired ventral processes diverging from base of shaft, processes with apex acute and exceeding apex of shaft. Connective (Fig. 18) Y-shaped, stalk short. Style (Fig. 19) slightly unciform apically.

**Female genitalia.** Unknown.

***Seasogonia rosea* Kuoh**

[http://species-id.net/wiki/Seasogonia\\_rosea](http://species-id.net/wiki/Seasogonia_rosea)

Figs 7–9, 20–25 and 35–37

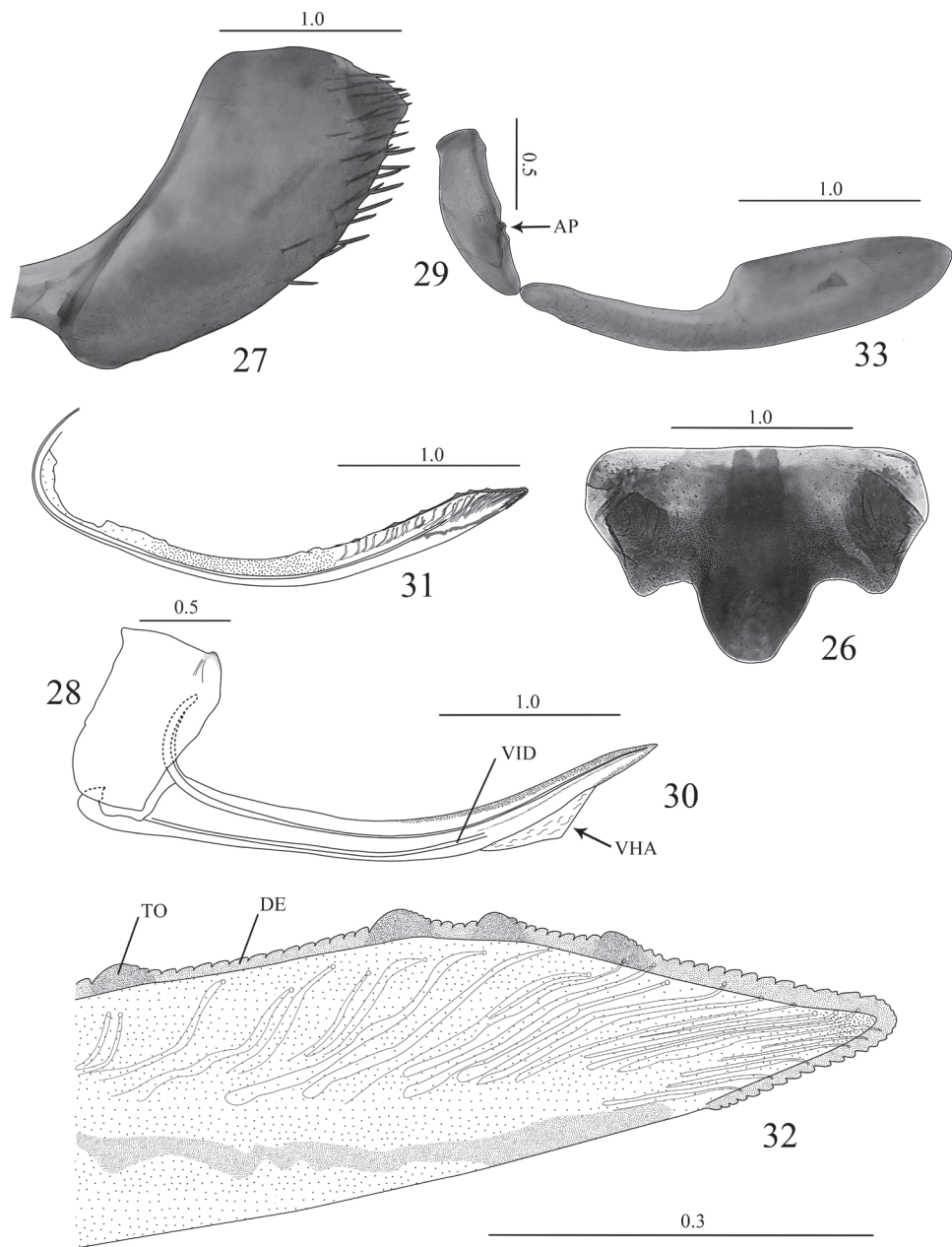
*Seasogonia rosea* Kuoh, 1991: 166

**Material examined.** 1 female, China, Yunnan Province, Tengchong County, Shangyun Village, Alt. 1700–1900m, 15 July 2002, coll. Yang Mao-fa; 1 male, 1 female, China, Yunnan Province, Tengchong County, Gaoligongshan, Alt. 1900–2000m, 17 July 2002, coll. Yang Mao-fa and Song Hong-yan; 21 males, 7 females, China, Yunnan Province, Tengchong County, Gaoligongshan, Baihualing, Alt. 1800–2400m, 28 May to 3 June 2009, coll. Yang Zai-hua and Li Bin; 10 males, 9 females, China, Yunnan Province, Tengchong County, Gaoligongshan, 13–15 June 2011, coll. Yang Zai-hua and Li Yu-jian; 1 male, 1 female, China, Yunnan Province, Yingjiang County, Tongbiguan, Alt. 1400–1500m, 20 July 2002, coll. Yang Mao-fa and Song Hong-yan; 19 males, China, Yunnan Province, Yingjiang County, Tongbiguan, 1–3 June 2011, coll. Yang Zai-hua and Li Yu-jian; 7 males, China, Yunnan Province, Fugong County, Shangpa Town, 17–18 May 2010, coll. Ni Jun-qiang, Li Hu and Zhang Pei.

**Distribution.** China (Yunnan).

**Male genitalia.** Pygofer (Fig. 20) in lateral view, broad and triangular, gradually narrowed posteriorly; with several macrosetae on basiventral portion and many macrosetae on posterior portion; pygofer process arising near median-ventral margin, extending dorsally, bifurcate apically and divided into two processes, short process acute and nearly as 2/3 long as the other one; surface with dense setae except apex. Subgenital plate (Fig. 21) with anterior half broad, surface with multiseriate macrosetae on basal one-half and with uniseriate macrosetae and some short microsetae on posterior half. Aedeagus (Figs 22 and 23) broad at basal half and with angulate median-dorsal process; shaft with acute internal process and with paired ventral processes diverging from base of shaft, ventral processes with apex acute and extending as long as apex of shaft. Connective (Fig. 24) broad, V-shaped. Style (Fig. 25) slightly unciform apically.

**Female genitalia.** Abdominal sternite VII (Fig. 35), in ventral view, with posterior margin conspicuously more produced medially than in *S. indosinica*. Other characteristics as in *S. indosinica*.



**Figures 26–33.** *Seasogonia indosinica* (Jacobi), female genitalia: **26** sternite VII, ventral view **27** Pygofer, lateral view **28** valvifer I, lateral view **29** valvifer II, lateral view **30** valvula I, lateral view **31** valvula II, lateral view **32** apex of valvula II, lateral view **33** gonoplac, lateral view. AP = articulation point, DE = denticles, TO = tooth, VHA = ventral hyaline area, VID = ventral interlocking device. Scale bars in millimeters.



***Seasogonia sandaracata* (Distant)**

[http://species-id.net/wiki/Seasogonia\\_sandaracata](http://species-id.net/wiki/Seasogonia_sandaracata)

Figs 10–12, 38–40, 41–42, and 53–54

*Tettigoniella sandaracata* Distant, 1908: 217

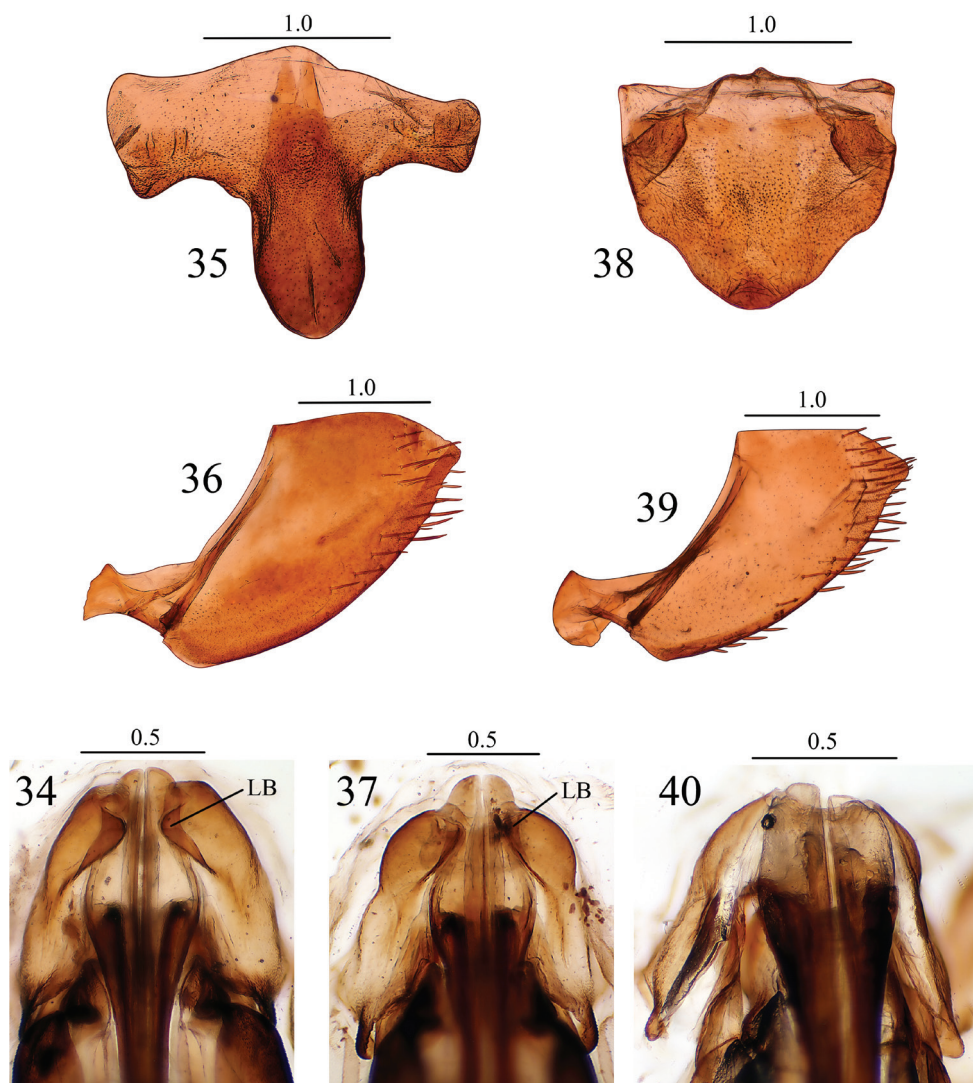
**Material examined.** 5 males, 1 female, China, Yunnan Province, Yingjiang County, Tongbiguan, Alt. 1200m, 15 June 2001, coll. Tian Ming-yi; 10 females, China, Yunnan Province, Yingjiang County, Tongbiguan, Alt. 1400–1500m, 20 July 2002, coll. Yang Mao-fa, Li Zi-zhong, Song Hong-yan and Dai Ren-huai; 32 males, 7 females, China, Yunnan Province, Yingjiang County, 29 May to 3 June 2011, coll. Yang Zai-hua and Li Yu-jian; 13 males, 2 females, China, Yunnan Province, Yingjiang County, Xima Town, Alt. 1700m, 8–10 June 2009, coll. Yang Zai-hua and Li Bin; 2 males, 1 female, China, Yunnan Province, Yingjiang County, Tongbiguan, Alt. 270m, 13 June 2009, coll. Yang Zai-hua and Li Bin; 1 male, 11 females, China, Yunnan Province, Tengchong County, Shangyun Village, Alt. 1400m, 14 July 2002, coll. Li Zi-zhong and Yang Mao-fa; 1 male, 3 females, China, Yunnan Province, Tengchong County, Gaoligongshan, Alt. 1900–2000m, 17 July 2002, coll. Yang Mao-fa, Li Zi-zhong, and Song Hong-yan; 5 females, China, Yunnan Province, Longling County, Longxin, Alt. 1800m, 24 July 2002, coll. Yang Mao-fa, Li Zi-zhong, and Song Hong-yan; 1 male, 1 female, China, Yunnan Province, Tengchong County, Gaoligongshan, Alt. 1800–2400m, 28 May to 5 June 2009, coll. Yang Zai-hua and Li Bin; 3 males, China, Yunnan Province, Ruili County, Moli, Alt. 770m, 15 June 2009, coll. Yang Zai-hua and Li Bin; 7 males, 5 females, China, Yunnan Province, Ruili County, 5–7 June 2011, coll. Li Yu-jian and Yang Zai-hua; 1 male, China, Yunnan Province, Pianma, 10 May 2010, coll. Zhang Bin; 18 males, 4 females, China, Yunnan Province, Pianma, 17–19 June 2011, coll. Li Yu-jian and Yang Zai-hua; 47 males, 30 females, China, Xizang Province, Muotuo County, 6 May to 4 June 1980, coll. Jin Gen-tao and Wu Jian-yi (Specimens are deposited in Shanghai Entomological Museum, Chinese Academy of Sciences (SEMCAS)).

**Distribution.** India, Myanmar, China (Yunnan, Xizang). New Record for China.

**Female genitalia.** Abdominal sternite VII (Fig. 38), in ventral view, nearly as broad as long; anterior margin straight; posterior margin broadly convex. Pygofer (Fig. 39), in lateral view, slightly produced; posterior margin with subacute apex; surface with macrosetae on posterior portion and extending anteriorly along nearly whole of ventral margin. Valvifers I, in ventral view (Fig. 40), not forming lobes articulating with valvulae I. Valvulae I, in ventral view (Fig. 40), much broader than in *S. indosinica*. Other characteristics as in *S. indosinica*.

**Notes on the female genitalia of *Seasogonia***

**Intraspecific variation.** The number of teeth on valvulae II often varied from 4–7 teeth. In addition, the location of each tooth varied among different specimens, or between each valvula of a single specimen.



**Figures 34–40.** *Seasogonia indosinica* (Jacobi): **34** valvifers I and bases of valvulae I, ventral view *S. rosea* Kuoh: **35** Sternite VII, ventral view **36** pygofer, lateral view **37** valvifers I and bases of valvulae I, ventral view *S. sandaracata* (Distant): **38** Sternite VII, ventral view **39** pygofer, lateral view **40** valvifers I and bases of valvulae I, ventral view. LB = lobe. Scale bars in millimeters.

**Interspecific variation.** Females of Chinese *Seasogonia* species can be distinguished from each other mainly by the following characters: (1) the posterior margin of sternite VII is well produced medially and forms a median lobe in *S. indosinica* (Fig. 26) and *S. rosea* (Fig. 35), and the latter species has the projection conspicuously more elongated; in *S. sandaracata* (Fig. 38), the sternite VII is broadly convex and lacks a distinct me-

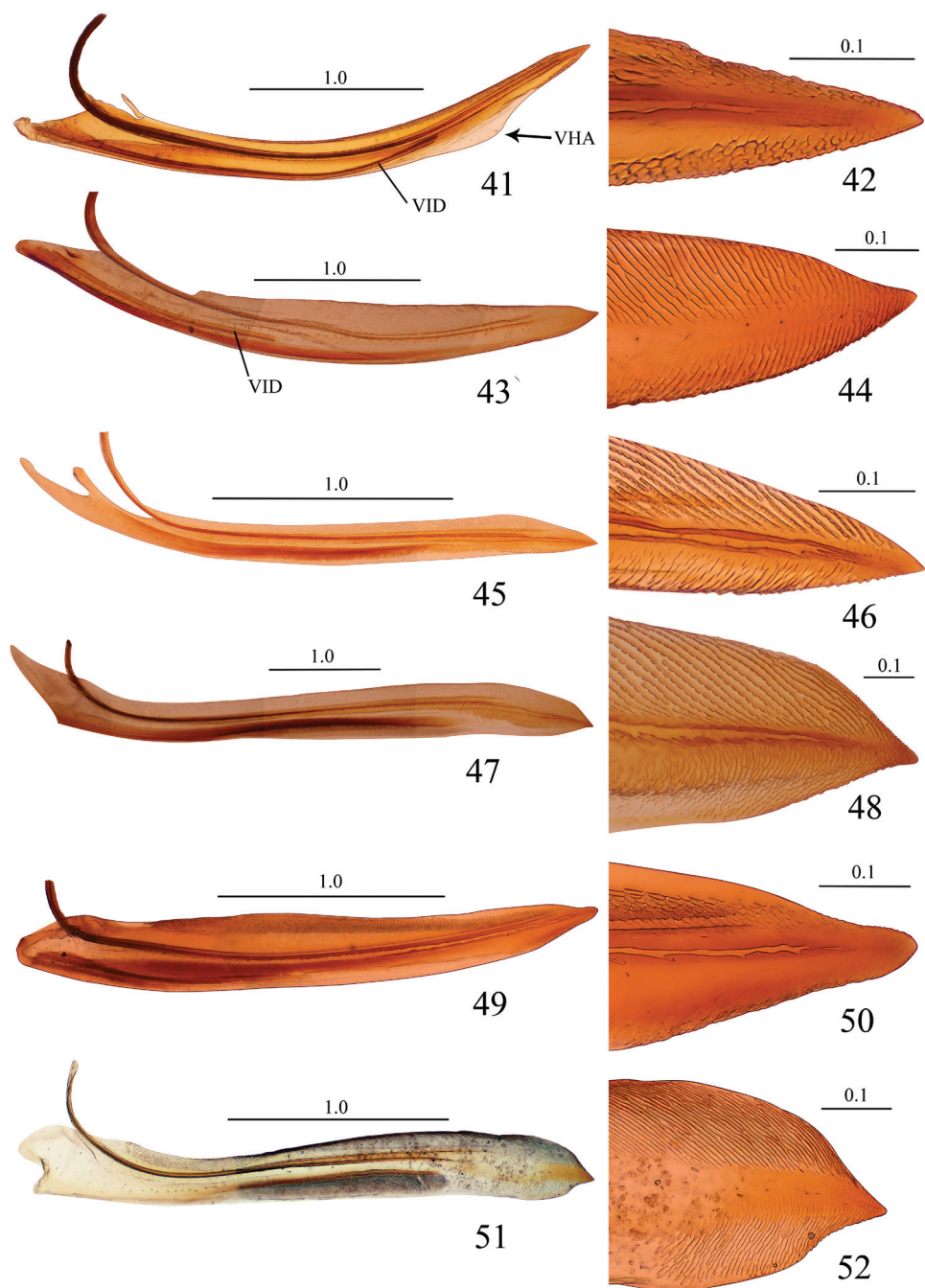
dian lobe; (2) in *S. sandaracata*, the macrosetae on the pygofer surface extend anteriorly distinctly farther than in the other two species (Fig. 39); (3) the valvifers I, in ventral view, form lobes (LB) articulating with valvulae I in *S. indosinica* and *S. rosea* (Figs 34 and 37), and the former species has the lobes slightly larger; *S. sandaracata* lacks the lobes (Fig. 40); (4) in *S. indosinica* and *S. rosea* (Figs 34 and 37), the bases of valvulae I, in ventral view, are more slender than in *S. sandaracata* (Fig. 40). Other characteristics are little changed.

The female abdominal sternite VII overlaps the bases of the ovipositor and usually has much interspecific variation. Young (1986) stated that the female sternite VII varied from slightly to strongly convex apically. We provide the descriptions and illustrations of sternite VII of Chinese *Seasogonia* species, and the characters such as lateral and median lobes of posterior margin can efficiently distinguish Chinese *Seasogonia* species. The female abdominal sternite VII is widely used for separating species of a genus or genera in sharpshooters or several groups of other leafhoppers (Greene 1971, Young 1977, 1986, Krishnankutty and Viraktamath 2008).

The ventral view of basal region of female genitalia has been used to discriminate species in a genus of leafhoppers by some other workers (Greene 1971, Leal et al. 2009). Greene (1971) employed the characters of base of the valvulae I for distinguishing species of deltocephaline genus *Psammotettix*. Based on the present studies, as stated by Greene, the female genitalia characters did not delimit species as precisely as do the aedeagus characters of the male, but the female genitalia such as ventral view of basal region of valvulae I can be used in combination with edge of abdominal sternite VII or other female characters to separate species. Leal et al. (2009) also provided the ventral view of basal portion of female genitalia in sharpshooter genus *Scoposcartula* and discovered the new characters on base of the valvulae which named prevalvifer area and the sclerotised wall. The present study revealed the occurrence of peculiar lobes articulating with valvulae I, which can be added to the combination of features that distinguish species in the genus.

**Comparative notes on *Seasogonia* and other related genera from China.** In the present paper, the previously unknown female genitalia of three species of *Seasogonia* from China were described and illustrated for the first time. *Seasogonia* is apparently closely related to the genus *Sochinsogonia* Young, 1986 in appearance, but in *Sochinsogonia* the posterior margin of the sternite VII is concave, whereas it is convex in *Seasogonia*; in addition, the valvulae I and valvulae II are distinctly curved dorsally in *Seasogonia* and not so in *Sochinsogonia* (Young 1986).

Unfortunately, we did not have at hand specimens of *Sochinsogonia*. Thus, we compared the female genitalia of *Seasogonia* with those of some other related genera from China (Figs 41–64). Based on the female genitalia, *Seasogonia* can be distinguished from other Old World Cicadellini by the following combination of characters: (1) the posterior margin of the sternite VII is distinctly convex (26, 35 and 38); (2) the valvulae I and II are distinctly curved dorsally (Figs 30, 31, 41 and 53); (3) the dorsal sculptured area of valvulae I and the teeth of valvulae II are distributed



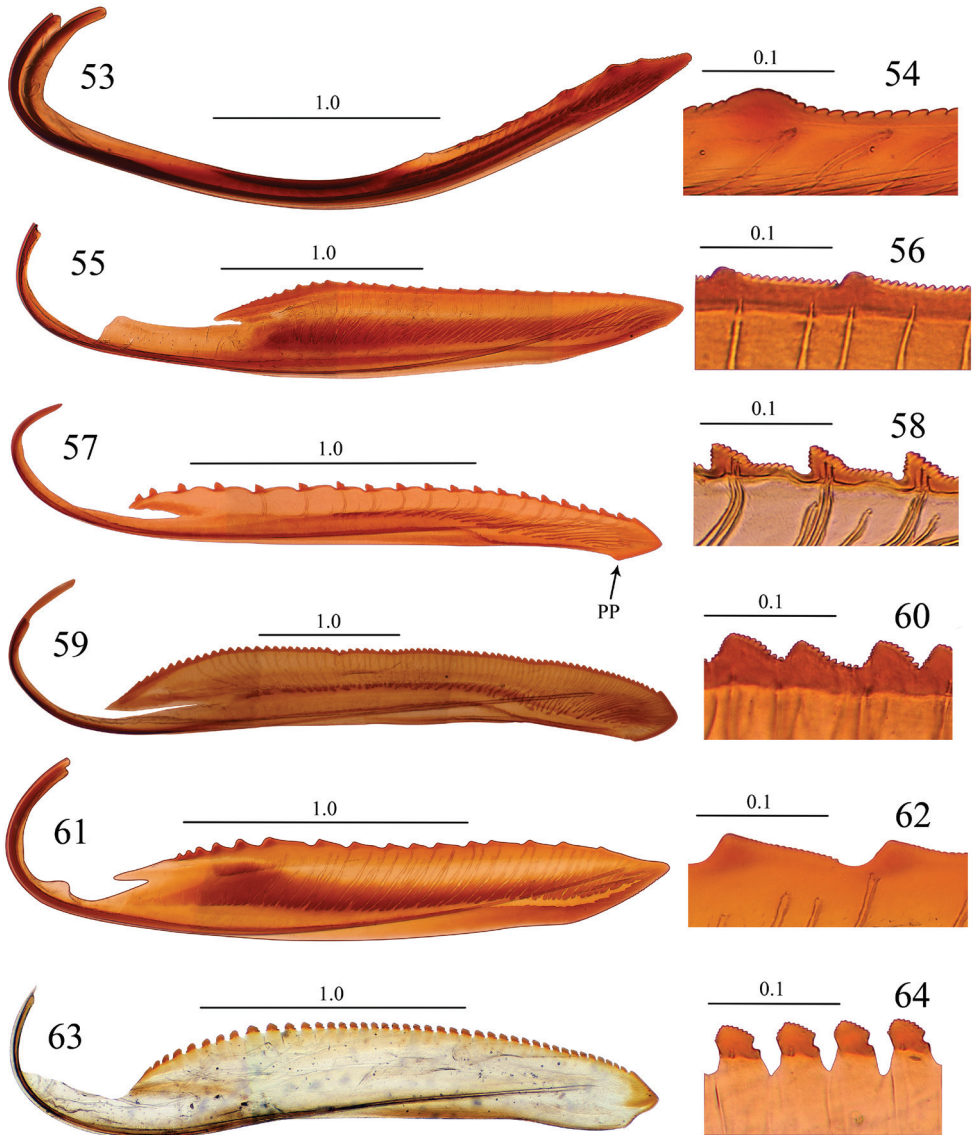
**Figures 41–52.** Valvulae I and their apical portions, lateral view. **41, 42** *Seasogonia sandaracata* (Distant, 1908) **43, 44** *Gununga yoshimotoi* Young, 1986 **45, 46** *Anagonalia melichari* (Distant, 1908) **47, 48** *Sphinctogonia lacta* Zhang & Kuoh, 1993 **49, 50** *Cicadella viridis* (Linnaeus, 1758) **51, 52** *Stenatkina albopennis* Yang, 2007. VHA = ventral hyaline area, VID = ventral interlocking device. Scale bars in millimeters.



only on the apical half of shaft; the valvulae I have a ventral hyaline area (VHA) near apex (Figs 30 and 41); only a small number of teeth is present on valvulae II (Figs 31, 32 and 53); (4) the dorsal and ventral sculptured areas of valvulae I are formed by dense scale-like processes that are not arranged in oblique lines (Figs 30, 41 and 42). It is important to mention that a considerable amount of morphological diversity is observed in the valvifers I, the base of valvulae I and the shape of teeth of valvulae II (Figs 54, 56, 58, 60, 62 and 64). The structure of the valvulae II of *Seasogonia* seems very unusual for Cicadellini in general. We compared the shape and teeth with other cicadellines, but found little similarities on our studied genera of Old world Cicadellini. Young (1977) illustrated valvulae II of many New World genera. We found that the valvulae II of *Seasogonia* are somewhat similar to the New World genus *Versigonalia* (Young 1977, Mejdalani 1998). Just as *Seasogonia* species, the valvulae II are not very expanded beyond basal curvature, shaft just have poorly developed teeth in apical one-third or one-half and apex is narrowly rounded in *Versigonalia*, but the shaft of valvulae does not curve so distinctly as in *Seasogonia* and not have clear dentate apicoventral margin.

The sclerites of the genital chamber described by Young (1986) in females of various Cicadellini are the reduced internal sternite VIII. The sclerotized parts of this sternite can provide shape-related characteristics useful for species distinctions in the subfamily (Nielson 1965, Mejdalani 1998, Takiya and Mejdalani 2004, Leal et al. 2009). We did not observe well sclerotized parts of the sternite VIII in the species of Chinese Cicadellini studied, which is consistent with Young (1986). As Mejdalani (1998) indicated, the features of the female genitalia, especially from the valvulae I and II, such as the shaft form and the teeth form and distribution, can be potentially useful taxonomic characters for the sharpshooter taxonomy. The valvulae I and II usually vary in shape, proportion, armature or texture (Dietrich 2005). We compared the valvulae I and II of some Old World species (Figs 41–64) and concluded that the features of the female genitalia were reliable and useful. The valvulae I can have a straight (Figs 43 and 49), distinctly concave (Fig. 41), or convex or angled to different degrees (Figs 47 and 51) dorsal margin. The dorsal and ventral sculptured areas of valvulae I are arranged in oblique lines (Figs 44, 46, 48 and 52) or not (Figs 42 and 50). The ventral interlocking device (VID) can extend along the basal 2/3 (Fig. 41) or 1/3 (Fig. 43) of the blade, among other proportions. The apex of valvulae I can be curved ventrally (Figs 48 and 52), dorsally (Fig. 44), or be not curved (Fig. 42). The shaft of valvulae II shows also much diversity. Its dorsal margin can be concave (Fig. 53), straight (Figs 55 and 61), or convex (Figs 59 and 63) to different degrees. The valvulae II may bear a ventral preapical prominence (Fig. 57) or not (Fig. 61). The distribution of teeth on valvulae II can be continuous (Fig. 60) or not (Fig. 64). The form of the teeth can be semiround (Fig. 54), triangular with subequal straight sides (Fig. 60), triangular with longer posterior side (Figs 56 and 62), triangular with flat posterior area (Fig. 58), or of irregular shape (Fig. 64). The preliminary results herein discussed indicate that the female genitalia can provide useful features for the taxonomy of *Seasogonia* and other members of the Old World Cicadellini.





**Figures 53–64.** Valvulae II and their teeth, lateral view. **53, 54** *Seasogonia sandaracata* (Distant, 1908) **55, 56** *Gununga yoshimotoi* Young, 1986 **57, 58** *Anagonalia melichari* (Distant, 1908) **59, 60** *Sphinctogonia lacta* Zhang & Kuoh, 1993 **61, 62** *Cicadella viridis* (Linnaeus, 1758) **63, 64** *Stenatkina albopennis* Yang, 2007. PP = preapical prominence. Scale bars in millimeters.

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# Karyotypes of two rare rodents, *Hapalomys delacouri* and *Typhlomys cinereus* (Mammalia, Rodentia), from Vietnam

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## Abstract

Karyotypes of *Hapalomys delacouri* (Rodentia, Muridae) and *Typhlomys cinereus* (Rodentia, Platacanthomyidae) from Vietnam are described for the first time. The diploid karyotype of *H. delacouri* is 38 (NFa=48), consisting of six pairs of bi-armed and 12 pairs of acrocentric autosomes decreasing in size; plus a large metacentric X chromosome and Y chromosome, also metacentric, that is equal in size to the largest pair of acrocentric autosomes. The newly described karyotype differs significantly from that reported for *H. delacouri* from northern Thailand. The latter record very likely represents a different species of *Hapalomys*, possibly the taxon *H. pasquieri* described from north-central Laos. The diploid karyotype of *Typhlomys cinereus* is 38 (NF=48), consisting of five pairs of meta- to submetacentric and 14 pairs of acrocentric chromosomes varying in size from large to small; sex chromosomes were not defined.

## Keywords

karyotypes, *Hapalomys delacouri*, *Hapalomys pasquieri*, *Typhlomys cinereus*, Vietnam

## Introduction

According to the recent checklist by Can et al. (2008), the mammal fauna of Vietnam consists of 295 species. During recent years, a half of dozen of new species have been found in Vietnam, including shrews, bats and a rodent (Jenkins et al.

2009, 2010, Borisenko et al. 2009, Tran et al. 2009, Bannikova et al. 2011). Rodents represent one of the most diverse but yet taxonomically neglected group of Vietnamese mammals.

It is well known that karyological data can be useful for tackling problems of rodent taxonomy and evolution (Volobouev et al. 2002, 2007, Aniskin et al. 2006, Kovalskaya et al. 2011). Therefore, cytotaxonomy represents an important step toward the inventory of the rodent species of Vietnam (Duncan et al. 1970, Cao and Tran 1985, Baskevich and Kuznetsov 1998). In the present paper, the karyotypes of two rare and poorly-known Vietnamese rodents – *Hapalomys delacouri* and *Typhlomys cinereus* – are described for the first time.

## Material and methods

A number of rare and poorly-known mammal species were collected during a biodiversity surveys carried out by the Joint Vietnam-Russian Tropical Research and Technological Centre in 2010. Voucher specimens are deposited in the Zoological Institute of the Russian Academy of Sciences (ZIN), Saint-Petersburg, Russia. Five specimens of the marmoset rat *Hapalomys delacouri* Thomas, 1927 were collected in southern Vietnam, NE of Bu Gia Map Village, Binh Phuoc Province (12°12'N, 107°12'E; ZIN 98922, 99486–99488, 100410). A specimen of the soft-furred tree mouse *Typhlomys cinereus* Milne-Edwards, 1877 was collected in northern Vietnam, near Tram Ton Station of Hoang Lien National Park, W of Sa Pa Village, Lao Cai Province (22°21'N, 103°46'E; ZIN 100411). The collecting localities are shown in Fig. 1.

The rodents were caught alive using locally made cage traps. The specimens were immediately brought to the laboratory where they were karyotyped. Chromosome analysis was carried out on preparations obtained from bone marrow following the standard colchicines method (Ford and Hamerton 1956). Slides were stained with 4% Giemsa in phosphate buffer with pH=6.8. At least 20 quality metaphases were analyzed for each specimen.

## Results and discussion

### *Hapalomys delacouri* Thomas, 1927 – lesser marmoset rat

The marmoset rats have very distinct external and cranial characteristics which preclude an incorrect generic identification (Thomas 1927, Musser 1972, Corbet and Hill 1992) – see Fig. 2.

The diploid chromosome number is  $2n=38$ ,  $NFa=48$  (Fig. 3A). This karyotype consists of six pairs of bi-armed and 12 pairs of acrocentric autosomes decreasing in size, with a large metacentric X chromosome and with Y chromosome, also metacentric, which is equal in size to the largest pair of acrocentric autosomes.



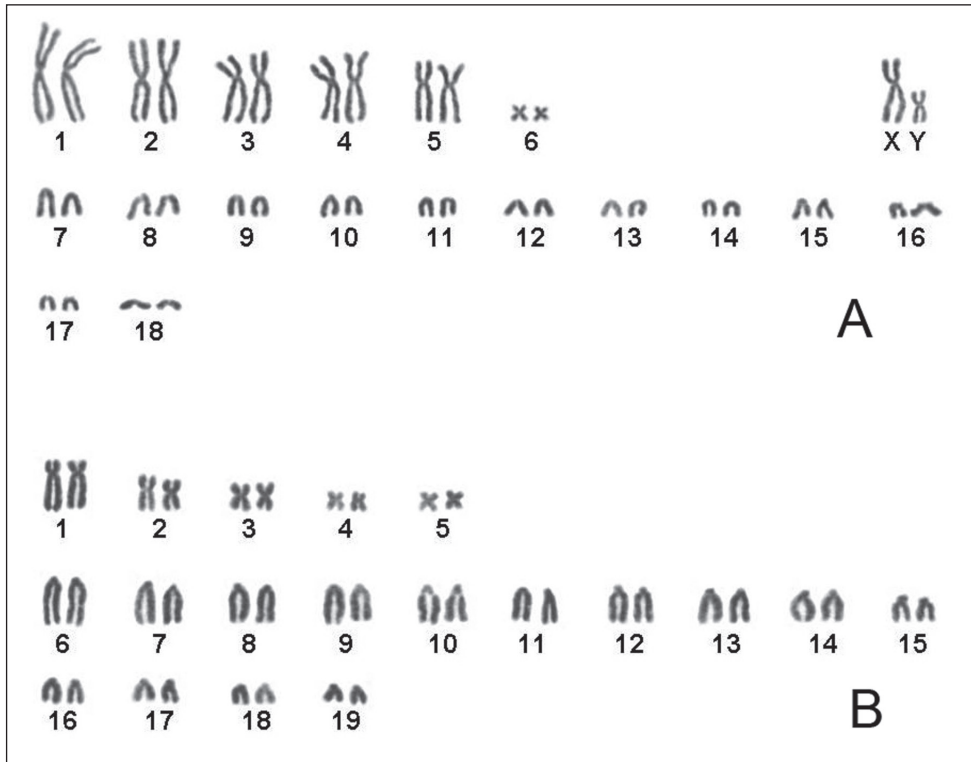


**Figure 1.** Map of localities. **1** sampling locality of *Typhlomys cinereus* **2** type locality of *Hapalomys longicaudatus* **3** locality from Badenhorst et al. 2009 **4** type locality of *Hapalomys pasquieri* **5** type locality of *Hapalomys delacouri* **6** sampling locality of *Hapalomys delacouri* in Bu Gia Map **7** approximate locality for *Hapalomys longicaudatus* record from Yong et al. 1982.



**Figure 2.** *Hapalomys delacouri*. Adult male from Bu Gia Map, Binh Phuoc Province, southern Vietnam. Photographed by Alexei V. Abramov.

The observed karyotype differs significantly from that described by Badenhorst et al. (2009) for *H. delacouri* from Loei, northern Thailand (see Fig. 1). The latter authors reported the karyotype as having  $2n=48$  and  $NFa=92$ . All the autosomes were bi-armed (metacentric or submetacentric). The metacentric X and the acrocentric Y were easily recognizable because they were, respectively, the largest and the smallest elements in the karyotype. Earlier, Yong et al. (1982) described the karyotype of *Hapalomys longicaudatus* Blyth, 1859 based on a specimen from Malaysia. The diploid number of this



**Figure 3. A** Karyotype of male *Hapalomys delacouri* (ZIN 100410),  $2n=38$ ,  $NFa=48$  **B** Karyotype of female *Typhlomys cinereus* (ZIN 100411),  $2n=38$ ,  $NF=48$ .

specimen was  $2n=50$ , consisting of 23 pairs of unarmed and 1 pair of small bi-armed autosomes, metacentric X and subacrocentric Y sex chromosomes. The X chromosome was the largest element in the complement and constituted about 7.8% of the female haploid complement. The Y-chromosome was also distinct, being the only morphological type among the larger sized chromosomes, and constituted about 5.2% of the female haploid complement.

According to recent taxonomic studies (Musser and Carleton 1993, 2005, Nowak 1999), the genus *Hapalomys* consists of two species – *delacouri* and *longicaudatus* – distributed in eastern and western parts of Southeast Asia, respectively. The two species differ in coloration and size (Thomas 1927, Musser 1972, Corbet and Hill 1992). The specimens from Bu Gia Map are similar in coloration, size and body proportions (Table 1) to the lesser marmoset rat *H. delacouri*, which was described by Thomas (1927) from Kon Tum Province in southern Vietnam (Fig. 1). Another form of the marmoset rats was described by Thomas (1927) as *Hapalomys pasquieri* from Xieng Khouang in northern Laos (Fig. 1). Musser (1972) considered this form as a subspecies of *H. delacouri* based on similarities in coloration. Strong karyological differences between our specimen taken from southern Vietnam and the specimen from northern

**Table 1.** External and cranial measurements (range and means, in mm) of *Hapalomys* spp. The cranial measurements are explained in Musser (1970).

Measurements	<i>longicaudatus</i> (from Musser 1972), n=3-4	<i>delacouri</i> (from Musser 1972), n=4-5	<i>delacouri</i> Bu Gia Map, n=4	<i>pasquieri</i> (from Musser 1972), n=1
Length of head and body	162-165 (163.5)	123-136 (131.0)	130-146 (136.7)	121.0
Length of tail	193-202 (198.3)	140-160 (149.2)	155-165 (160.0)	171.0
Greatest length of skull	39.7-41.5 (40.47)	33.6-34.2 (34.00)	34.6-35.7 (35.10)	32.0
Length of nasals	11.5-12.6 (12.25)	11.7-12.0 (11.87)	11.7-11.9 (11.72)	10.5
Length of rostrum	9.7-10.2 (9.93)	9.3-9.7 (9.47)	9.4-10.0 (9.66)	8.3
Height of brain case	11.2-12.0 (11.63)	9.1-9.5 (9.33)	9.1-9.7 (9.49)	9.0
Palatal length	18.1-22.3 (20.78)	16.9-18.0 (17.48)	17.4-18.2 (17.83)	15.8
Maxillary tooth-row*	7.9-8.0	ca. 6.3	6.3-6.6 (6.4)	ca. 5.9

\* Data from Corbet and Hill (1992) except for our specimens.

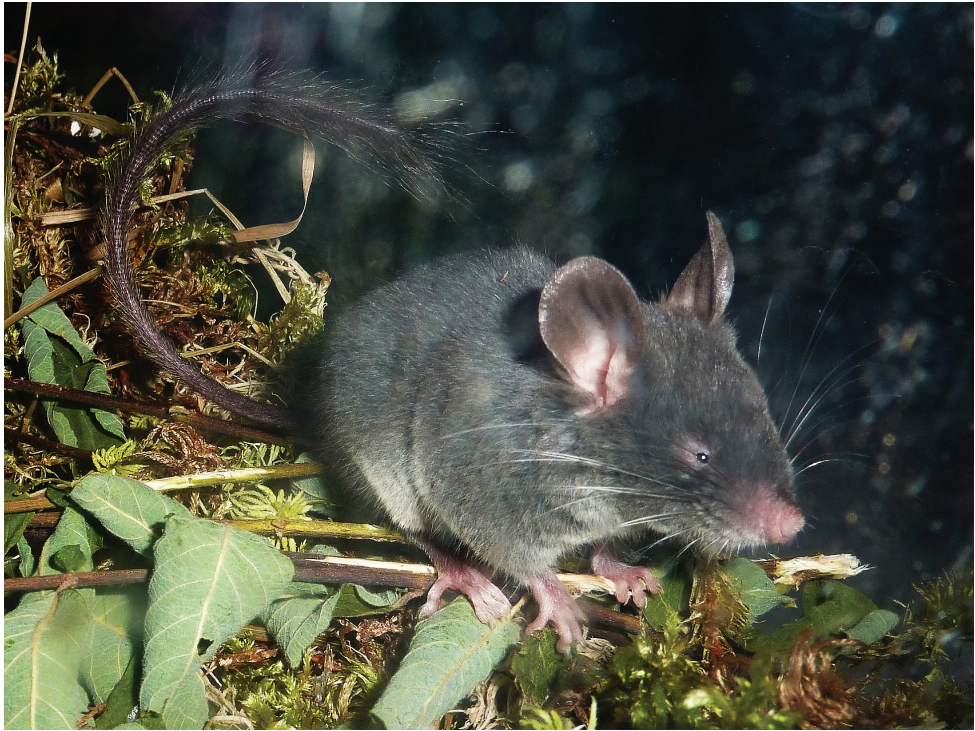
Thailand recorded by Badenhorst et al. (2009) point to a species level divergence. On distributional grounds (Fig. 1) the species in northern Thailand is most likely *H. pasquieri* but this needs confirmation by morphological comparison of the Thai and Laotian specimens. Further taxonomic studies of the genus *Hapalomys* are needed and cytotaxonomy can be a valuable tool for diagnosing the species involved.

***Typhlomys cinereus* Milne-Edwards, 1877 – soft-furred tree mouse**

The diploid chromosome number is 2n=38, NF=48 (Fig. 3B), consisting of five pairs of meta- to submetacentric and 14 pairs of acrocentric chromosomes varying in size from large to small. Sex chromosomes of *T. cinereus* have not defined, as the female only was karyotyped in this study. It is the first karyotype described for a representative of the genus *Typhlomys*.

The soft-furred tree mouse, or pygmy dormouse, *Typhlomys cinereus* (Fig. 4) belongs to the enigmatic family Platacanthomyidae, the earliest phylogenetic offshoot within Muroidea (Jansa et al. 2009). It is best known from mountain forests of southern China, with an outlying population at high elevations in the northern part of Hoang Lien Mts in northern Vietnam (Nowak 1999, Musser and Carleton 2005, Can et al. 2008). The Vietnamese population was described as a separate species, *Typhlomys chapensis* (Osgood 1932) but it is now considered a subspecies of *T. cinereus* (Musser and Carleton 2005). Further morphological and genetic studies are needed to clarify the taxonomic status of the Vietnamese soft-furred tree mouse.





**Figure 4.** *Typhlomys cinereus*. Adult female from Sa Pa, Lao Cai Province, northern Vietnam. Photographed by Alexei V. Abramov.

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# Orthogonius species and diversity in Thailand (Coleoptera, Caraboidea, Orthogoniini), a result from the TIGER project

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## Abstract

The carabid genus *Orthogonius* MacLeay is treated, based mainly on materials collected in Thailand through the TIGER project (the Thailand Inventory Group for Entomological Research). Among 290 specimens, 20 species are identified in total, 10 of them are new species: *O. taghavianae* **sp. n.** (Nakhon Nayok: Khao Yai National Park), *O. coomanioides* **sp. n.** (Phetchabun: Thung Salaeng Luang National Park), *O. similaris* **sp. n.** (Phetchabun: Thung Salaeng Luang National Park; Loei: Phu Kradueng National Park), *O. setosopalpiger* **sp. n.** (Phetchabun: Thung Salaeng Luang National Park), *O. gracililamella* **sp. n.** (Loei: Phu Kradueng National Park; Chaityaphum: Tat Tone National Park), *O. pseudochaudoiri* **sp. n.** (Phetchabun: Thung Salaeng Luang National Park; Nakhon Nayok: Khao Yai National Park), *O. constrictus* **sp. n.** (Phetchabun: Thung Salaeng Luang National Park), *O. pinophilus* **sp. n.** (Phetchabun: Thung Salaeng Luang National Park), *O. vari* **sp. n.** (Cambodia: Siem Reap; Thailand: Ubon Ratchathani: Pha Taem National Park; Phetchabun: Thung Salaeng Luang National Park) and *O. variabilis* **sp. n.** (Thailand: Phetchabun: Thung Salaeng Luang National Park; Nakhon Nayok: Khao Yai National Park; Phetchabun: Nam Nao National Park; China: Yunnan). In addition, *O. mouhoti* Chaudoir, 1871 and *O. kirirom* Tian & Deuve, 2008 are recorded in Thailand for the first time. In total, 30 species of *Orthogonius* have been recorded from Thailand, indicating that Thailand holds one of the richest *Orthogonius* faunas in the world.

A provisional key to all Thai species is provided. A majority of Thai *Orthogonius* species are endemic. Among the ten national parks in which orthogonine beetles were collected, Thung Salaeng Luang holds the richest fauna, including 16 species.

### Keywords

Coleoptera, Caraboidea, Orthogoniini, *Orthogonius*, new species, new record, Thailand

## Introduction

Thailand has a diversity of habitat types, including various kind of forests (tropical rain, dry or semi-evergreen, montane evergreen, coniferous, swamp, including mangroves, and deciduous forests) and savanna. Thailand is a meeting place of many faunal elements including the Himalayan, east Palearctic and Oriental Regions. Faunistically, the country falls within two of the top eight biodiversity hotspots as identified by Myers et al. (2000): Indo-Burma (the majority of the country) and Sundaland (in the southern peninsula).

Since 2006, the TIGER project (the Thailand Inventory Group for Entomological Research) has been organized by Drs Michael Sharkey and Brian Broun (the University of Kentucky, Lexington, USA), by means of collaboration with the Queen Sirikit Botanic Garden in Chang Mai, Thailand. Covering 25 national parks in different regions of Thailand, the project has spanned three years and produced diverse materials available for biodiversity inventory, including 290 specimens of the termitophilous ground beetle genus *Orthogonius*.

Despite the fact that taxonomic research on the tribe Orthogoniini of the ground beetles in the Oriental Region has been carried out continuously since 2000 (Tian and Deuve 2000, 2001, 2003a-c, 2004, 2006a-c, 2007a-b, 2008, 2009, 2010; Abhitha et al. 2009), specimens from the TIGER project represent a surprisingly and unknown diversity of species within Thailand. Among the total of 20 identified species of *Orthogonius*, 10 are new to science and are described and illustrated in the present paper. In addition, *O. mouhoti* Chaudoir, 1871 and *O. kirirom* Tian & Deuve, 2008 are newly recorded in Thailand.

## Materials and methods

The TIGER project has been carried out in 25 national parks in Thailand over a three year period. A total of 290 specimens of *Orthogonius* used for this study were collected in ten of the parks (Figure 1). Almost all specimens were caught by means of Malaise traps, except a few specimens caught in pan traps or extracted from litter samples. In addition, 98 specimens of *Orthogonius variabilis* sp. n. were collected from Bannahe Nature Reserve, southern Yunnan, China. Other *Orthogonius* specimens were borrowed from the Muséum National d'Histoire Naturelle, Paris (MNHN), from the



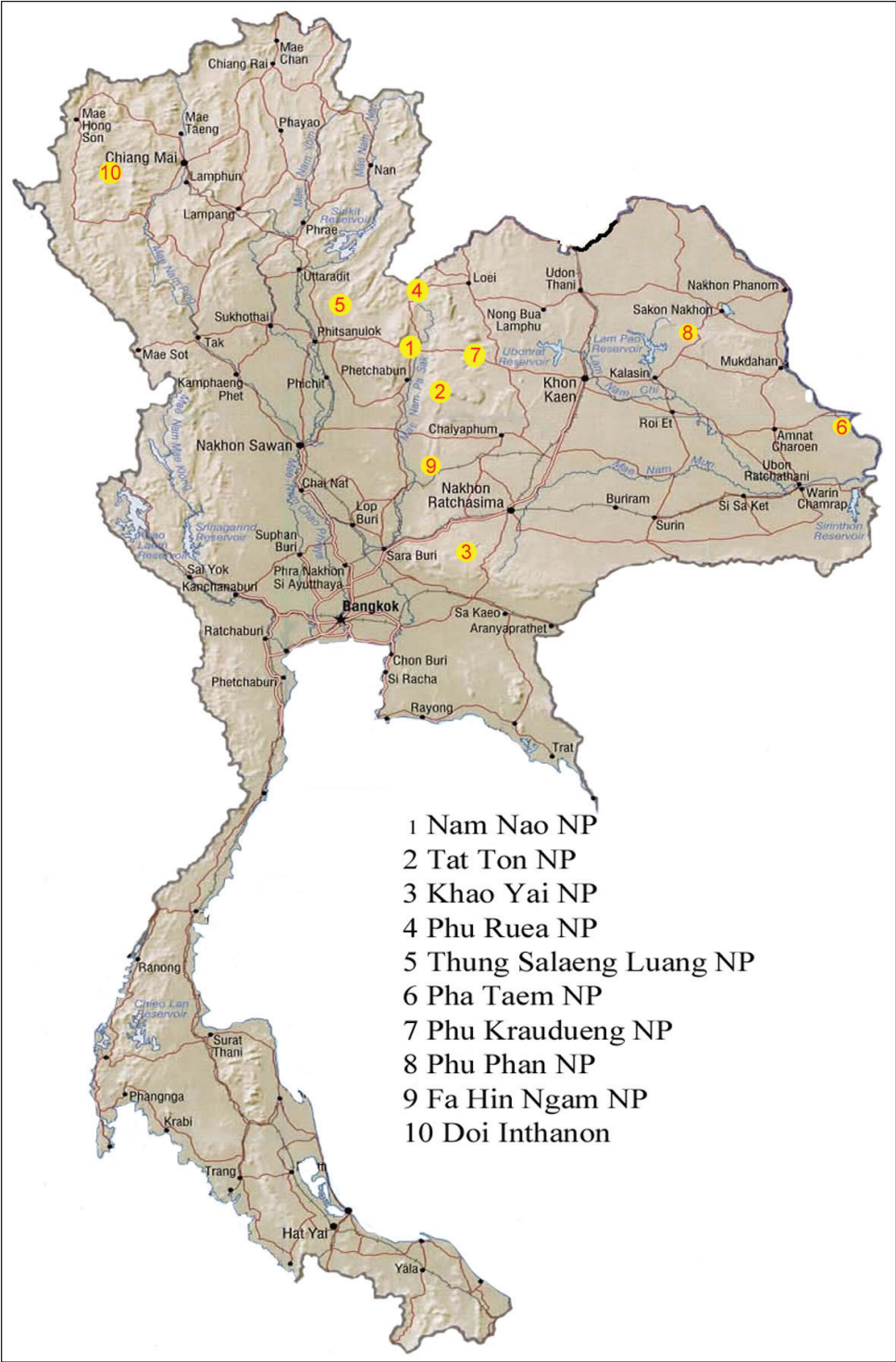


Figure 1. Distribution map of the national parks.

Institut royal des Sciences naturelles de Belgique, Brussels (IRSNB), from Naturhistorisches Museum, Basel (NHMB), and the Museum of Natural History, London (MNHL) for comparative study.

All specimens were dry mounted. Dissections, drawings, and observations were made using a binocular Leica MZ75 dissecting microscope. Dissected genital pieces, including the median lobe and parameres of the aedeagus, were glued on small paper cards and then pinned under the specimen from which they were removed. Digital pictures were originally taken with Canon EOS 40D camera, and then treated by means of CombineZP and Photoshop softwares.

Abbreviations for measurements were the same as in Tian & Deuve (2006a). The specimen depository is as follow:

<b>CRF</b>	Collection Ron Felix, Berkel Enschoot (the Netherlands)
<b>IOZ</b>	Institute of Zoology, Chinese Academy of Sciences, Beijing (China)
<b>IRSNB</b>	Institut royal des Sciences naturelles de Belgique, Brussels (Belgium)
<b>MNHN</b>	Muséum National d'Histoire Naturelle, Paris (France)
<b>QSBG</b>	the Queen Sirikit Botanic Garden, Chang Mai (Thailand)
<b>SCAU</b>	South China Agricultural University, Guangzhou (China)

## Taxonomic treatment

### *Orthogonius taghavianae* Tian, Deuve & Felix, sp. n.

urn:lsid:zoobank.org:act:2C0C2E6E-EBC1-4888-AB48-52063D459855

[http://species-id.net/wiki/Orthogonius\\_taghavianae](http://species-id.net/wiki/Orthogonius_taghavianae)

Figures 2, 16

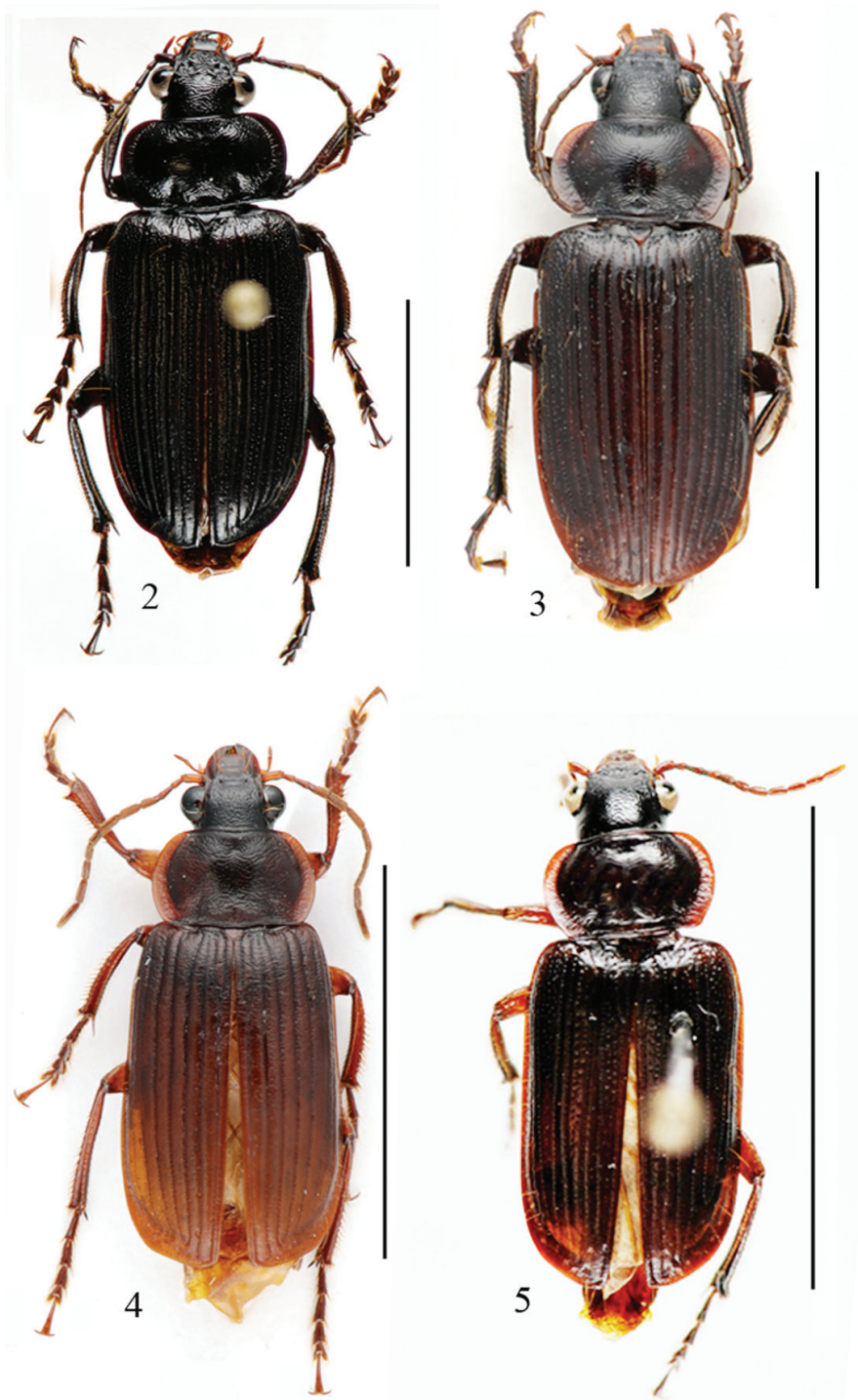
**Diagnosis.** Large sized, even elytra intervals much wider than odd ones, and covered with dense and coarse punctures, head and pronotum intricately wrinkled or striate; aedeagus distinctly constricted at subapex in dorsal view.

Length: 19.0 mm; width: 7.6 mm. Habitus as in Figure 2.

**Description.** Head and pronotum densely and intricately wrinkled, impunctate, elytra with even intervals densely punctate; microsculptural meshes densely isodiametric on elytra, and irregular on pronotum.

Head moderate, slightly longer than wide (HW/HL=1.05), eyes large, strongly prominent, frons rather flat, vertex convex, neck well-marked; labrum straight at frontal margin, sexsetose, clypeus more or less square, bisetose; palpi normal; maxillar palpomeres 3 and 4 subequal in length, labial palpomere 2 longer than palpomere 3; ligula narrow, bisetose at apex; mentum and submentum each with a pair of setae; palpiger short, asetose; antennae extending to 1/7 of elytra from base, densely pubescent from basal 1/4 of antennomere 4; antennomere 3 as long as 4.

Pronotum strongly transverse, PW/PL=1.85, widest at about middle; both fore and hind angles broadly rounded; front and hind margins well beaded; lateral ex-



**Figures 2–5.** Habitus of *Orthogonius* spp. n. **2** *O. taghavianae* sp. n. holotype **3** *O. coomanioides* sp. n. holotype **4** *O. similis* sp. n. paratype **5** *O. setosopalpiger* sp. n. holotype. Scale bar: 10 mm.

panded margins wide, smooth and reflexed; transverse impressions well marked, basal foveae moderate.

Elytra broad and strongly convex; EL/EW=1.58; sides nearly parallel; widest at about middle, apex roundly truncate, strongly sinuate near inner angle which is pointed; base well bordered; shoulders more or less square; striae deep, punctate-striate, intervals convex; even intervals much wider than odd ones (almost twice) and with coarser punctures which extended to the subapical portion, odd intervals with a row of fine and sparse punctures; interval 3 with three discal setiferous pores, and additional two at apical portion; interval 5 with two setae near base; interval 7 narrow and carinate before middle, with seven setiferous pores.

Legs stout, fore tibia with outer angle very sharp and strongly protruded, outer margin distinctly serrate; middle tibia distinctly dilated, and strongly curved in median portion; hind tibia elongate, with tibial spurs short and more or less blunt; hind tarsomere 1 longer than 2, tarsomeres 3 and 4 subequal, tarsomere 4 bilobed; hind femur moderately dilated, with five posterior setae; all tarsal claws pectinate.

Prosternal process well bordered at apex, middle coxa with several setae in median portion; abdominal ventrite VII of male complete at apex.

Male genitalia (Figure 16): Elongate, enlarged at about middle portion, ventral margin sinuate, dorsal opening large and long, abruptly truncate near apex; in dorsal view, apical part narrow, distinctly constricted before apical lamella, apical lamella elongate, about 2.2 times as long as wide, blunt at apex.

**Female.** Unknown.

**Remarks.** This species is a member of the *O. alternans* species group, but with distinctive aedeagal structure.

**Material examined.** Holotype: male, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.167'N, 101°21.850'E, 758 m, 5–12.v.2007, Malaise traps, Pong Sandao leg., T2263”, deposited in QSBG.

**Etymology.** This new species is named in honour of Ms Azadeh Taghavian, a curator of the Coleoptera collection in MNHN, Paris, in thanks for her help in so many ways.

**Distribution.** Thailand. Known only from the type locality.

### ***Orthogonius coomanioides* Tian, Deuve & Felix, sp. n.**

urn:lsid:zoobank.org:act:BF1DD07D-514B-4300-B2A6-B088AE086F18

[http://species-id.net/wiki/Orthogonius\\_coomanioides](http://species-id.net/wiki/Orthogonius_coomanioides)

Figures 3, 17

**Diagnosis.** Medium sized, even elytra intervals wider than odd intervals, but less than twice as wide; similar to *O. coomani* Tian & Deuve, 2006, but a little larger, darker, and broader than the latter; in addition, head and eyes rather smaller and less prominent; middle tibiae strongly curved (not distinctly curved in *O. coomani*); aedeagus stouter, and apical lamella distinctly broader than that of *O. coomani*.

Length: 13.0-14.0 mm; width: 6.5-6.7 mm. Habitus as in Figure 3.

**Description.** Head and pronotum densely and intricately wrinkled, impunctate, microsculptural meshes densely isodiametric on head, pronotum and elytra.

Head moderate, slightly longer than wide, eyes rather small, less prominent, labrum distinctly emarginate at frontal margin, sexsetose, clypeus bisetose; palpi normal; mentum and submentum each with a pair of setae; palpiger asetose; antennae extended to the shoulders of elytra, densely pubescent from antennomere 4.

Pronotum strongly transverse, PW/PL=1.70-1.72, widest a little before middle; both fore and hind angles broadly rounded; lateral expanded margins wide, striate and more or less reflexed; transverse impressions well marked, median line clear.

Elytra broad, strongly convex; EL/EW=1.63-1.64; sides parallel; apex roundly truncate; even intervals well bordered at base; striae deep, punctate-striate; intervals convex, even intervals much wider than odd ones (but less than twice as wide) and with coarser punctures extended to apical 1/3 of elytra; interval 3 with only basal and apical setiferous pores, middle pore absent; interval 5 with two setae near base; interval 7 narrow, distinctly carinate, with eight to nine setiferous pores.

Legs moderate, fore tibia with outer angle very sharp and strongly protruded, outer margin hardly serrate; middle tibia distinctly dilated at apex, and strongly curved in median portion; hind tibia elongate, with tibial spurs moderately long, sword-like, sharp; hind femur moderately dilated, with four posterior setae; hind tarsomere 3 (1.2 times) longer than 4, tarsomere 4 deeply emarginate (a little more than half of the joint); all tarsal claws weakly pectinate.

Prosternal process bordered at apex, middle coxa with several setae; ventrite VII of male complete at apex.

Male genitalia (Figure 17): Short, and stout, ventral margin expanded strongly at middle portion, apex distinctly bent ventrally; dorsal opening very wide and long; apical lamella broad, but much longer than wide.

**Female.** Unknown.

**Remarks.** This species is closely allied to *O. coomani*, with differences as mentioned above.

**Material examined.** Holotype: male, "Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest, 16°35.789'N, 100°52.769'E, 732 m, Malaise trap, 15–22.vi.2007, Pongpitak Pranee & Sathit leg., T2059", in QSBG.

Paratypes: 4 males, "Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest, 16°35.789'N, 100°52.769'E, 732 m, Malaise trap, 15–22.vi.2007, Pongpitak Pranee & Sathit leg., T2059"; 4 males, "Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, pine forest, 16°35.789 N, 100°52.769 E, 723 m, Malaise trap, 6–13.vii.2007, Pongpitak Pranee & Sathit leg., T2068"; 1 male, "Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 22–23.vi.2007, Pan traps, Pongpitak & Sathit leg., T2058"; 4 males, "Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°36.284 N, 100°53.128 E, 749 m, Malaise trap, 29.vi–6.



vii.2007, Pongpitak Pranee & Sathit leg. T2069”, in QSBG, MNHN, SCAU and CRF, respectively.

**Etymology.** The name refers to the similarity of the new species with *O. coomani*, which occurring in Vietnam.

**Distribution.** Thailand. Known only from the type locality and other nearby site in Thung Salaeng Luang NP.

***Orthogonius similaris* Tian, Deuve & Felix, sp. n.**

urn:lsid:zoobank.org:act:FD099C32-02ED-487B-949E-7D012B2D212B

[http://species-id.net/wiki/Orthogonius\\_similaris](http://species-id.net/wiki/Orthogonius_similaris)

Figures 4, 18

**Diagnosis.** A peculiar species with following aspects: medium sized; densely punctate on whole surface; ligula small, but quadrisetose at apex; shape of abdominal ventrite VII in male very similar to that of *Hexachaetus taylorae* Tian & Deuve, 2006.

Length: 14.0 mm; width: 6.0 mm. Habitus as in Figure 4.

**Description.** Dark brown or black, but antennae, expanded pronotal margins, palpi, legs and underside surface reddish brown.

Upper surface densely punctate, pronotum with transverse striae, elytra with dense and very short, transverse and granular wrinkles (esp. near base); underside surface smooth and glabrous, polished.

Microsculptural meshes densely isodiametric.

Head stout, as long as wide, eyes very large, and strongly prominent; frons and vertex strongly convex, frontal impressions small and fovea-like, clypeus bisetose, surface even, labrum sexsetose, sides rounded, middle portion slightly emarginate; ligula small and narrow, quadrisetose at apex; palpi slender, subcylindrical, maxillary palpomere 4 longer than 3, palpomere 3 glabrous, except several setae at apex; maxillary palpomere 4 with very short setae; labial palpomere 3 as long as palpomere 2, palpomere 3 with a few setae at base; labial palpomere 2 bisetose in inner margin, and with two or three additional setae at subapex and apex; palpiger asetose, mentum and submentum each with one pair of setae; mentum without median tooth. Antennae moderate, extended to basal 1/4 of elytra; pubescent from basal 1/3 of antennomere 4; antennomere 3 slightly shorter than antennomere 4.

Pronotum transverse, widest at about basal 1/3, PW/PL=1.74, disc slightly and evenly convex, both fore and hind angles broadly rounded, both basal and fore margins beaded, lateral expanded margins rather wide, even and hardly reflexed; fore and hind transverse impressions faint, basal foveae not well marked.

Elytra elongate ovate, EL/EW=1.64; moderately convex, basal border complete, shoulders broadly square; sides more or less parallel at middle, widest at about middle; striae deep, punctate-striate, intervals distinctly convex; intervals subequal in width in middle; apex quite broadly truncate, inner angle nearly rectangular; interval 3 without setiferous pore, interval 7 simple, without pore.

Prosternal process well bordered at apex. Middle and hind coxae smooth and glabrous. Apical margin of abdominal ventrite VII of male deeply and widely emarginate at apical margin, then strongly sinuate at sides behind paramedial setae.

Legs stout. Fore tibia with apical outer angle nearly rectangular, not protruded or pointed; outer margin distinctly serrate; middle tibia evenly curved, gradually dilated towards apex, in lateral view, while slender in dorsal view; hind tibia slender, apical spurs moderate long, sword-like, tarsomere 1 as long as 2, tarsomere 3 longer than 4, tarsomere 4 bilobed; fore tarsi much wider than middle and hind tarsi (which are slender); all tarsal claws strongly pectinate.

Male genitalia (Figure 18): Median lobe of aedeagus quite stout, less expanded at middle portion; apex broadly blunt; dorsal opening wide and long; in dorsal view apical lamella small and sharp.

**Female.** Unknown.

**Remarks.** This new species is peculiar in its surface extraordinarily densely punctate, the shape of abdominal ventrite VII, and aedeagal structure. It is similar to *Hexachaetus taylorae* Tian & Deuve, 2006, but differs with the latter by: (1) ligula narrow, quadrisetose (wide and sexsetose in *H. taylorae*); (2) pronotum and elytra with dense punctures (sparsely punctate in *H. taylorae*); and (3) the apical lamella of aedeagus shorter and broader (longer and narrower in *H. taylorae*).

**Material examined.** Holotype: male, "Thailand: Phetchabun: Thung Salaeng Luang NP: Gang Wang Nam Yen, 750 m, 16°36.587'N, 100°53.395'E; 17–24.v. 2007, Pongpitak Pranee & Sathit leg. T2080", in QSBG

Paratypes: 1 male, "Thailand: Loei: Phu Kradueng NP, mixed deciduous forest, south of Na Noy Forest Unit, 16°49.099'N, 101°47.624'E, 275 m, 14.xi.2006–18.xi.2006, Litter sample, Suthin Gong-Lasae leg., T1064"; 1 male, "Thailand: Phetchabun: Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°36.587'N, 100°53.395'E, 753 m, 24–31.v.2007, Malaise trap, Pongpitak Pranee & Sathit leg., T2083"; 1 male, "Thailand: Phetchabun: Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°37.531'N, 100°53.745'E, 721 m, 7–14.vi.2007, Malaise trap, Pongpitak Pranee & Sathit leg., T2091"; 2 males, "Thailand: Phitsanulok: Thung Salaeng Luang NP, moist evergreen, 16°50.641'N, 100°52.894'E, 557 m, 11.viii.2006–18.viii.2006, Malaise trap, Pongpitak Pranee leg., T566"; 1 male, "Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°37.178'N, 100°53.504'E, 706 m, Malaise trap, 17–24.v.2007, Pongpitak Pranee & Sathit leg. T2081"; 1 male, "Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 20–21.vi.2007, Pan traps, Pongpitak & Sathit leg., T2056"; 1 male, "Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest, 16°35.789'N, 100°52.769'E, 732 m, Malaise trap, 15–22.vi.2007, Pongpitak Pranee & Sathit leg., T2059", in QSBG, MNHN, SCAU and CRF, respectively.

**Etymology.** The name of this new species refers to its similarity to *H. taylorae*.

**Distribution.** Thailand. Known only from the type locality and other nearby sites in Thung Salaeng Luang NP.

***Orthogonius setosopalpiger* Tian, Deuve & Felix, sp. n.**

urn:lsid:zoobank.org:act:E2CE2CC1-4B62-4F0C-976C-ACD79C64CFFA

[http://species-id.net/wiki/Orthogonius\\_setosopalpiger](http://species-id.net/wiki/Orthogonius_setosopalpiger)

Figures 5, 19

**Diagnosis.** Small sized, even elytral intervals densely punctuate; ligula small, bisetose at apex, palpiger with a long seta near base; allied to *O. grootaerti* Tian & Deuve, 2006 and *O. angkor* Tian & Deuve, 2006, but smaller.

Length: 11.0 mm; width: 4.5 mm. Habitus as in Figure 5.

**Description.** Dark brown, antennae, palps, lateral expanded margins of pronotum, underside surface except head reddish brown.

Head and pronotum irregularly wrinkled, impunctate, elytra with even intervals densely punctate, odd ones smooth; microsculptural meshes densely isodiametric on elytra, irregular on head and pronotum.

Head moderate, as long as wide, eyes moderate, strongly prominent, frons rather flat, vertex convex, neck well-marked; labrum deeply emarginate at frontal margin, sexsetose, clypeus more or less square, bisetose, base processed in middle; palpi normal; maxillar palpomeres 3 and 4 subequal, labial palpomere 2 slightly longer than palpomere 3; ligula narrow, bisetose at apex; mentum and submentum each with a pair of setae; palpiger short, with a long seta at base; antennae extended to base of elytra, densely pubescent from basal 1/3 of antennomere 4; antennomere 3 as long as antennomere 4.

Pronotum moderately transverse, PW/PL=1.52, widest at about middle; both fore and hind angles broadly rounded; front and hind margins well beaded; lateral expanded margins wide, almost evenly wide throughout, and slightly reflexed; transverse impressions well marked at base, faint at subapex; basal foveae small.

Elytra broad and strongly convex; EL/EW=1.67; sides nearly parallel; widest at about middle, apex roundly truncate, not sinuate before inner angles; base well bordered; shoulders more or less square; striae deep, punctate-striate, intervals convex; even intervals much wider than odd intervals (almost twice as wide, except interval 4, which is less twice as wide as 3) and with coarser punctures extended to apical 1/4 of elytra, odd intervals with a few fine punctures more or less arranged in a row; interval 3 with three setiferous pores; interval 5 with one seta near base; interval 7 narrow but not carinate throughout, with eleven setiferous pores.

Legs stout, fore tibia with outer angle very sharp and strongly protruded, outer margin slightly suberrate; middle tibia not distinctly curved in median portion, moderately dilated; hind tibia elongate, with apical tibial spurs short and sword-like; tarsomere 1 longer than tarsomere 2, tarsomere 3 slightly longer than 4, tarsomere 4 asymmetrically bilobed; hind femur moderately dilated, with four posterior setae. All tarsal claws strongly pectinate.

Prosternal process well bordered at apex, middle coxa with three or four setae; ventrite VII of male complete at apex.

Male genitalia (Figure 19): Elongate, more or less straight, less sinuate ventrally as in other species, hardly bent towards apex; in dorsal view, apical lamella broad at apex, symmetrical, longer than wide.

**Female.** Unknown.

**Remarks.** This species is a member of the *O. grootaerti* species group. It differs from *O. grootaerti* and *O. angkor* by its: (1) smaller sized; (2) aedeagus more elongate and apical lamella longer than in both above species; and (3) hind femur 4-setose posteriorly (6-setose in *O. grootaerti* and *O. angkor*).

**Type material.** Holotype: male, “Thailand: Phetchabun: Thung Salaeng Luang NP: Gang Wang Nam Yen, 750 m, 16°37.178'N, 100°5.504'E Pan traps, 23–24.v.2007, Pongpitak Pranee & Sathit leg., T2079”, in QSBG.

**Etymology.** The name of this new species refers to its setose palpiger.

**Distribution.** Thailand. Known only from the type locality.

***Orthogonius pangi* Tian & Deuve, 2006**

[http://species-id.net/wiki/Orthogonius\\_pangi](http://species-id.net/wiki/Orthogonius_pangi)

**Material examined.** 1 male, “21?6”, Thailand: detailed data unclear because of damaged label; either from Khao Yai National Park if the label is “2126”, or from Pha Taem National Park if is “2186”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.762'N, 101°23.527'E, 732 m, 5–12.iv.2007, Malaise trap, Wirat Sukho leg., T2122”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.82'N, 101°23.754'E, 744 m, 26.iv.2007–2.v.2007, Malaise trap, Pong Sandao leg., T2132”, in QSBG and MNHN respectively.

**Distribution.** Thailand.

***Orthogonius huananoides* Tian & Deuve, 2006**

[http://species-id.net/wiki/Orthogonius\\_huananoides](http://species-id.net/wiki/Orthogonius_huananoides)

**Material examined.** 6 males, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.82'N, 101°23.754'E, 744 m, 19–26.iv.2007, Malaise trap, Wirat Sukho leg., T2129”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.565'N, 101°23.442'E, 726 m, 19–26.iv.2007, Malaise trap, Wirat Sukho leg., T2127”; 8 males, “21?6”, Thailand: detail data unclear because of label damaged, either from Khao Yai National Park if the label is “2126”, or from Pha Taem National Park if is “2186”; 2 males, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.565'N, 101°23.442'E, 726 m, 26.iv.2007–2.v.2007, Malaise trap, Pong Sandao leg., T2130”; 8 males, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.762'N, 101°23.527'E, 732 m, 26.iv.2007–2.v.2007, Malaise trap, Wirat Sukho leg., T2131”; 2 males, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.115'N, 101°21.951'E, 733 m, 5–12.v.2007, Malaise traps, Wirat Sukho leg., T2264”; 5 males, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.167'N, 101°21.85'E, 758 m, 5–12.v.2007, Malaise

traps, Pong Sandao leg., T2263”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.115'N, 101°21.951'E, 733 m, 19–26.v.2007, Malaise traps, Pong Sandao leg., T2270”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.820'N, 101°23.754'E, 744 m, 5–12.iv.2007, Malaise trap, Pong Sandao, leg., T2123”; 6 males, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.82'N, 101°23.754'E, 744 m, 26.iv.2007–2.v.2007, Malaise trap, Pong Sandao leg., T2132”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.115'N, 101°21.951'E, 733 m, 10–11.v.2007, Pan traps, Wirat Sukho leg., T2261”; 2 males, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.119'N, 101°21.482'E, 699 m, 12–19.v.2007, Malaise traps, Wirat Sukho leg., T2268”; 3 males, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.762'N, 101°23.527'E, 732 m, 5–12.iv.2007, Malaise trap, Wirat Sukho leg., T2122”; 2 males, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.167'N, 101°21.85'E, 758 m, 19–26.v.2007, Malaise traps, Wirat Sukho leg., T2269”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.115'N, 101°21.951'E, 733 m, 12–19.v.2007, Malaise traps, Pong Sandao leg., T2267”; 8 males, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.762'N, 101°23.527'E, 732 m, 12–19.iv.2007, Malaise trap, Wirat Sukho leg., T2125”; 1 male, “Thailand: Nakhon Ratchasima: Khao Yai NP, Cobra zone near fire protection office, 14°28.524'N, 101°22.928'E, 757 m, 5–12.vi.2007, Malaise trap, Pong Sandao leg., T2221”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.115'N, 101°21.951'E, 733 m, 11–12.v.2007, Pan traps, Pong Sandao leg., T2262”; 1 male, “Thailand: Nakhon Ratchasima: Khao Yai NP, Cobra zone near fire protection office, 14°28.524'N, 101°22.928'E, 757 m, 5–12.vi.2007, Malaise trap, Pong Sandao leg., T2221”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.115'N, 101°21.951'E, 733 m, 6–7.v.2007, Pan traps, Wirat Sukho leg., T2257”; 2 males, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.565'N, 101°23.442'E, 726 m, 12–19.iv.2007, Malaise trap, Wirat Sukho leg., T2124”; 1 male, “Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 22–23.vi.2007, Pan traps, Pongpitak & Sathit leg., T2058”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.762'N, 101°23.527'E, 732 m, 19–26.iv.2007, Malaise trap, Pong Sandao leg., T2128”; 1 male, “Thailand: Ubon Ratchathani: Pha Taem NP, west of HuayPok substation, 15°37.212'N, 105°36.903'E, 438 m, 4–11.iv.2007, Malaise trap, Bunlu Sapsiri leg., T2159”; 2 males, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.82'N, 101°23.754'E, 744 m, 12–19.iv.2007, Malaise trap, Wirat Sukho leg., T2126”, in QSBG, MNHN, SCAU and CRF, respectively.

**Distribution.** Thailand and Vietnam.



***Orthogonius gracililamella* Tian, Deuve & Felix, sp. n.**

urn:lsid:zoobank.org:act:AB7D1670-CFA3-4273-8EBF-9B489C4D699A

[http://species-id.net/wiki/Orthogonius\\_gracililamella](http://species-id.net/wiki/Orthogonius_gracililamella)

Figures 6, 20

**Diagnosis.** Moderate or small sized, member of the *O. longicornis* species group, eyes very large; mentum asetose; apex of elytra shortly and obliquely truncate at inner margin of the tip to form an obvious sutural angle between elytra; labrum slightly emarginate at frontal margin; prosternal process bordered at apex, base of elytra complete; hind tarsomere 4 slightly emarginate at apex, hind femur quite slender, with two setae posteriorly, all tarsal claws strongly pectinate; ventrite VII very slightly emarginate at apical margin; aedeagus with apical lamella long and parallel-sided.

Length: 12.0–13.0 mm; width: 5.0–5.5 mm. Habitus as in Figure 6.

**Description.** Light dark brown (HT) to black (PT), palps, antennae, lateral expanded margin of pronotum, tibiae, femora and trochanters lighter.

Wrinkles and punctures: surface impunctate except elytral intervals 3, 5 and 7 with tiny, and sparse punctures arranged as a row, head wrinkled, pronotum faintly striate.

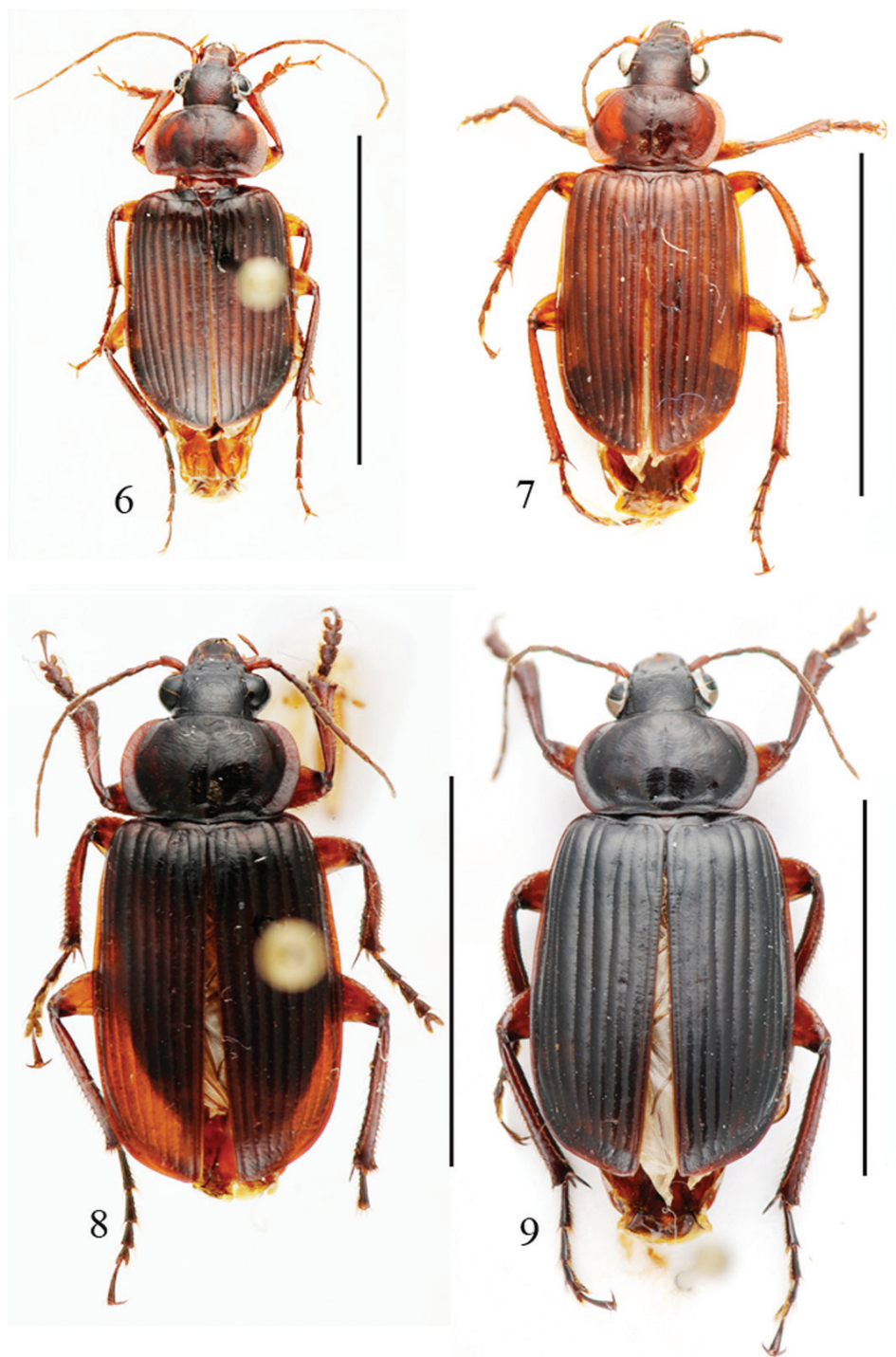
Microsculptural meshes isodiametric on elytra, head and pronotum.

Head as long as wide, eyes very large, strongly prominent; frons and vertex convex, frontal impressions faint, clypeus bisetose, even; labrum quadrate, sexsetose, frontal margin slightly emarginate at frontal margin; mandibles well developed; ligula small and narrow, bisetose at apex; palpi slender, subcylindrical, maxillary palpomere 3 as long as 4, glabrous; labial palpomere 2 longer than 3, 2-setose in inner margin; labial palpomere 3 sparsely pubescent; palpiger asetose, mentum asetose, and submentum with one pair of setae; mentum without median tooth. Antennae extended to near basal 1/4 of elytra; pubescent after basal 1/4 of antennomere 4, antennomeres 4–5, slightly dilated, antennomere 3 shorter than 4 (about 0.7 times as its length).

Pronotum strongly transverse, PW/PL=1.56, moderately convex; sides evenly rounded, widest at about middle, both basal and fore margins beaded, lateral expanded margins well defined, uneven, slightly reflexed; fore and hind angles rounded; fore transverse impression unclear, hind one distinct, basal foveae small, but well marked, middle line clear.

Elytra ovate, EL/EW=1.60, convex, basal border complete, sides slightly expanded, not parallel at middle, striae deep, intervals convex, intervals subequal in width in middle; apex roundly truncate, but shortly and obliquely truncate at inner margin of the tip to form an obvious sutural angle between elytra; interval 3 with three setae, all are well marked; interval 7 not carinate, without seta.

Middle coxa glabrous in median portion; hind coxa with two setae. Legs moderate, fore tibia with outer angle rectangular, serrate on outer margins, apical margin oblique; middle tibia straight in middle, abruptly dilated at apex; hind tibiae slender, slightly dilated only at apex; hind tibial spurs very long and sharp; tarsomere 4 much longer than tarsomere 3 (almost 1.25 times as long), tarsomere 4 very shallowly emarginate



**Figures 6–9.** Habitus of *Orthogonius* spp. n. **6** *O. gracililamella* sp. n. holotype **7–9** *O. pseudochaudoiri* sp. n. paratypes. Scale bar: 10 mm.

at apex; hind femora rather slender, with two setae posteriorly; all tarsal claws strongly pectinate.

Prosternal process well bordered at apex. Apical margin of abdominal ventrite VII very shallowly and slightly emarginate.

Male genitalia (Figure 20): Moderately elongate, ventral margin more or less sinuate ventrally, apex pointed in lateral view; in dorsal view, apical lamella very long and nearly parallel-sided.

**Female.** Unknown.

**Remarks.** The apical portion of the aedeagus is very elongate, a little more twisted in the holotype than in the paratype, and the apical lamella is slender and parallel-sided, with the apex broadly rounded.

**Material examined.** Holotype: male, "Thailand: Loei: Phu Kradueng NP, Huay Lao Kao, 16°52.442N, 101°50.706E, 280 m, Malaise trap, 29–30.viii.2006, Sutin Khonglassae leg. T490", in QSBG.

Paratype: 1 male, "Thailand: Chaiyaphum: Tat Tone NP, water supply station at Taad Fah waterfall, 15°56.468 N, 102°05.855 E, 245 m, Malaise trap, 5–12.ix.2006, Tawit Jaruphan & Orawan Budsawong leg., T686", in QSBG.

**Etymology.** The name refers to the long and narrow apical lamella of aedeagus.

**Distribution.** Thailand. Known only from the type locality.

***Orthogonius pseudochaudoiri* Tian, Deuve & Felix, sp. n.**

urn:lsid:zoobank.org:act:597B2644-6DB2-48DC-81A7-24BC6E304379

[http://species-id.net/wiki/Orthogonius\\_pseudochaudoiri](http://species-id.net/wiki/Orthogonius_pseudochaudoiri)

Figures 7–9, 21

**Diagnosis.** Small to medium sized, labrum straight at frontal margin; prosternal process well bordered at apex, abdominal ventrite VII slightly emarginate at apical margin; very similar to *O. mouhoti* Chaudoir, 1871, but apical lamella of the aedeagus much longer than that of the latter species.

Length: 12.5–16.0 mm; width: 5.5–7.0 mm. Habitus as in Figures 7–9.

**Description.** Dark brown to black, lateral expanded margin of pronotum, antennae, mouthparts palpi, legs and underside surface reddish brown.

Wrinkles and punctures: surface smooth and impunctate; head and pronotum faintly striate, odd elytral intervals (3, 5, 7) with distinct fine punctures which are irregularly rowed; surface strongly shiny.

Microsculptural meshes densely isodiametric, clear on elytra, but faint on pronotum and head.

Head stout, as long as wide; eyes very large, strongly prominent, frons and vertex moderately convex, frontal impressions small, short, fovea-like, clypeus bisetose, rather even, labrum sexsetose, nearly straight at apical margin; ligula very small and narrow, bisetose at apex; palpi slender, subcylindrical, normal; palpiger asetose, mentum without median tooth, asetose, mentum and submentum each with one pair of setae.

Antennae slender, extended beyond basal 1/3 of elytra, pubescent from apical 2/3 of antennomere 4; antennomeres 3, 4 and 5 subequal in length; antennomeres 1–3 glabrous; antennomeres 4–6 distinctly expanded laterally.

Pronotum strongly transverse, PW/PL=1.88–1.90, sides evenly rounded, widest at about middle, both basal and fore margins beaded, lateral expanded margins well defined, wide and even, flat and smooth; both fore and hind angles rounded; disc strongly convex, fore transverse impression faint, basal one moderate, basal foveae small.

Elytra broadly ovate (EL/WL=1.55–1.57), strongly convex, basal border well complete; sides slightly expanded in middle portion, hardly parallel-sided, widest at middle; striae deep, punctate-striate, intervals distinctly convex; intervals 2–5 subequal in width, interval 6 much wider than 5; odd intervals with more distinct fine punctures, irregular in row; apex roundly truncate, inner angle finely toothed, and with a wider sutural angle; interval 3 with three well marked setiferous pores, near striae 3, 2 and 2, respectively; interval 7 simple, wide and not carinate, without seta throughout.

Legs moderate, fore tibia with outer angle nearly rectangular, blunt, outer margin not serrate; middle and hind coxae smooth and glabrous; middle and hind tibia slender, apex slightly dilated, hind apical tibial spurs very long and sharp; tarsomere 3 much longer than 4, tarsomere 4 deeply emarginate at apex (about 1/3 deep as the joint); all tarsal claws strongly pectinate; hind femur with 2 posterior setae on ventral.

Prosternal process well bordered at apex; apical margin of abdominal ventrite VII narrowly and shallowly emarginate in male.

Male genitalia (Figure 21): Very similar to that of *O. chaudiiri*, straight, and arrow-head-shaped at apex in dorsal view, but more distinctly so than in *O. chaudiiri*, upper margin less sinuate, and apical lamella in dorsal view much longer and more elongate.

**Female.** Unknown.

**Remarks.** This species is very similar to *O. chaudiiri*, but the apex of its aedeagus is more distinctly arrowhead-shaped than that of *O. chaudiiri*, less sinuate, and apical lamella much longer; labrum slightly emarginate (straight in latter); body a little more slender; and ventrite VII of male with a small emargination at apical margin.

**Variability.** Shape of the arrow-headed apex of the aedeagus is variable, wider in some specimens, but narrower in others; however, in all specimens of this species examined, the apical lamella is much longer than that of *O. chaudiiri*.

**Material examined.** Holotype: male, “Thailand: Phetchabum, Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°37.531 N, 100°53.745 E, 721 m, Malaise trap, 17–24.v.2007, Pongpitak Pranee & Sathit leg., T2082”, in QSBG.

Paratypes: 1 male, data as holotype; 6 males, “Thailand: Phetchabum: Thung Salaeng Luang NP, pine forest, 16°35.789'N, 100°52.769'E, 732 m, Malaise trap, 15–22.vi.2007, Pongpitak Pranee & Sathit leg., T2059”; 3 males, “Thailand: Phetchabum, Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°36.284 N, 100°53.128 E, 749 m, Malaise trap, 29.vi–6.vii.2007, Pongpitak Pranee & Sathit leg., T2087”; 2 males, “Thailand: Phetchabum: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 15.vi.2007–18.vi.2007, Litter sample, Pongpitak & Sathit leg., T2050”; 1 male,

“Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 30.vi.2007–3.vii.2007, Litter sample, Pongpitak & Sathit leg., T2051”; 6 males, “Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 16–17.vi.2007, Pan traps, Pongpitak & Sathit leg., T2052”; 1 male, “Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 18–19.vi.2007, Pan traps, Pongpitak & Sathit leg., T2054”; 5 males, “Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 20–21.vi.2007, Pan traps, Pongpitak & Sathit leg., T2056”; 1 male, “Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 21–22.vi.2007, Pan traps, Pongpitak & Sathit leg., T2057”; 7 males, “Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 22–23.vi.2007, Pan traps, Pongpitak & Sathit leg., T2058”; 1 male, “Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 22–29.vi.2007, Malaise trap, Pongpitak & Sathit leg., T2063”; 3 males, “Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, pine forest, 16°35.789'N, 100°52.769'E, 723 m, Malaise trap, 6–13.vii.2007, Pongpitak Pranee & Sathit leg., T 2068”; 6 males, “Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, Malaise trap, 29.vi–6.vii.2007, Pongpitak Pranee & Sathit leg., T 2069”; 2 males, “Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, pine forest, 16°35.805'N, 100°52.286'E, 726 m, Malaise trap, 6–13.vii.2007, Pongpitak Pranee & Sathit leg., T 2070”; 3 males, “Thailand: Phetchabun: Thung Salaeng Luang NP: Gang Wang Nam Yen, 750 m, 16°36.587'N, 100°53.395'E; 17–24.v.2007, Pongpitak Pranee & Sathit leg., T2080”; 7 males, “Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°37.178'N, 100°53.504'E, 706 m, Malaise trap, 17–24.v.2007, Pongpitak Pranee & Sathit leg., T2081”; 1 male, “Thailand: Phetchabun: Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°36.587'N, 100°53.395'E, 753 m, 24–31.v.2007, Malaise trap, Pongpitak Pranee & Sathit leg., T2083”; 2 males, “Thailand: Nakhon Nayok: Khao Yai NP, Lum Ta Kong View Point, 14°25.82'N, 101°23.754'E, 744 m, 26.iv.2007–2.v.2007, Malaise trap, Pong Sandao leg., T2132”; 5 males, “Thailand: Nakhon Ratchasima: Khao Yai NP, Cobra zone near fire protection office, 14°27.511'N, 101°22.408'E, 760 m, 5–12.vi.2007, Malaise trap, Pong Sandao leg., T2223”; 1 male, “Thailand: Nakhon Ratchasima: Khao Yai NP, Cobra zone near fire protection office, 14°28.285'N, 101°22.57'E, 751 m, 12–19.vi.2007, Malaise trap, Wirat Sukho leg., T2225”; 1 male, “Thailand: Nakhon Ratchasima: Khao Yai NP, Cobra zone near fire protection office, 14°27.511'N, 101°22.408'E, 760 m, 12–19.vi.2007, Malaise trap, Wirat Sukho leg., T2226”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.115'N, 101°21.951'E, 733 m, 5–6.v.2007, Pan traps, Pong Sandao leg., T2256”; 5 males, “Thailand: Nakhon Nayok: Khao



Yai NP, entrance of Hnong Pak Chee Trail, 14°27.115'N, 101°21.951'E, 733 m, 5–12.v.2007, Malaise traps, Wirat Sukho leg., T2264”; 4 males, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.115'N, 101°21.951'E, 733 m, 12–19.v.2007, Malaise traps, Pong Sandao leg., T2267”; 3 males, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.119'N, 101°21.482'E, 699 m, 12–19.v.2007, Malaise traps, Wirat Sukho leg., T2268”; 2 males, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.167'N, 101°21.85'E, 758 m, 19–26.v.2007, Malaise traps, Wirat Sukho leg., T2269”; 2 males, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.115'N, 101°21.951'E, 733 m, 19–26.v.2007, Malaise traps, Pong Sandao leg., T2270”; 2 males, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.119'N, 101°21.482'E, 699 m, 19–26.v.2007, Malaise traps, Wirat Sukho leg., T2271”; 1 male, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.167'N, 101°21.85'E, 758 m, 26.v.2007–2.vi.2007, Malaise traps, Wirat Sukho leg., T2272”; 2 males, “Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.115'N, 101°21.951'E, 733 m, 26.v.2007–2.vi.2007, Malaise traps, Pong Sandao leg., T2273”; 1 male, label lost; in QSBG, MNHN, SCAU and CRE, respectively.

**Etymology.** The name refers to the similarity of this new species to *O. chaudiiri*.

**Distribution.** Thailand. Known only from the type localities.

***Orthogonius constrictus* Tian, Deuve & Felix, sp. n.**

urn:lsid:zoobank.org:act:DC47F34A-8BBE-48FB-8D65-14C1AEEF87C6

[http://species-id.net/wiki/Orthogonius\\_constrictus](http://species-id.net/wiki/Orthogonius_constrictus)

Figures 10, 22

**Diagnosis.** Medium sized, labrum sexsetose, nearly straight at apical margin, palpiger asetose, even and odd intervals subequal in width in middle portion, prosternal process bordered at apex; apical margin of abdominal ventrite VII widely and rather deeply emarginate in male; a member of the *O. longicornis* species group, distinguished by its aedeagus constricted subapically in dorsal view.

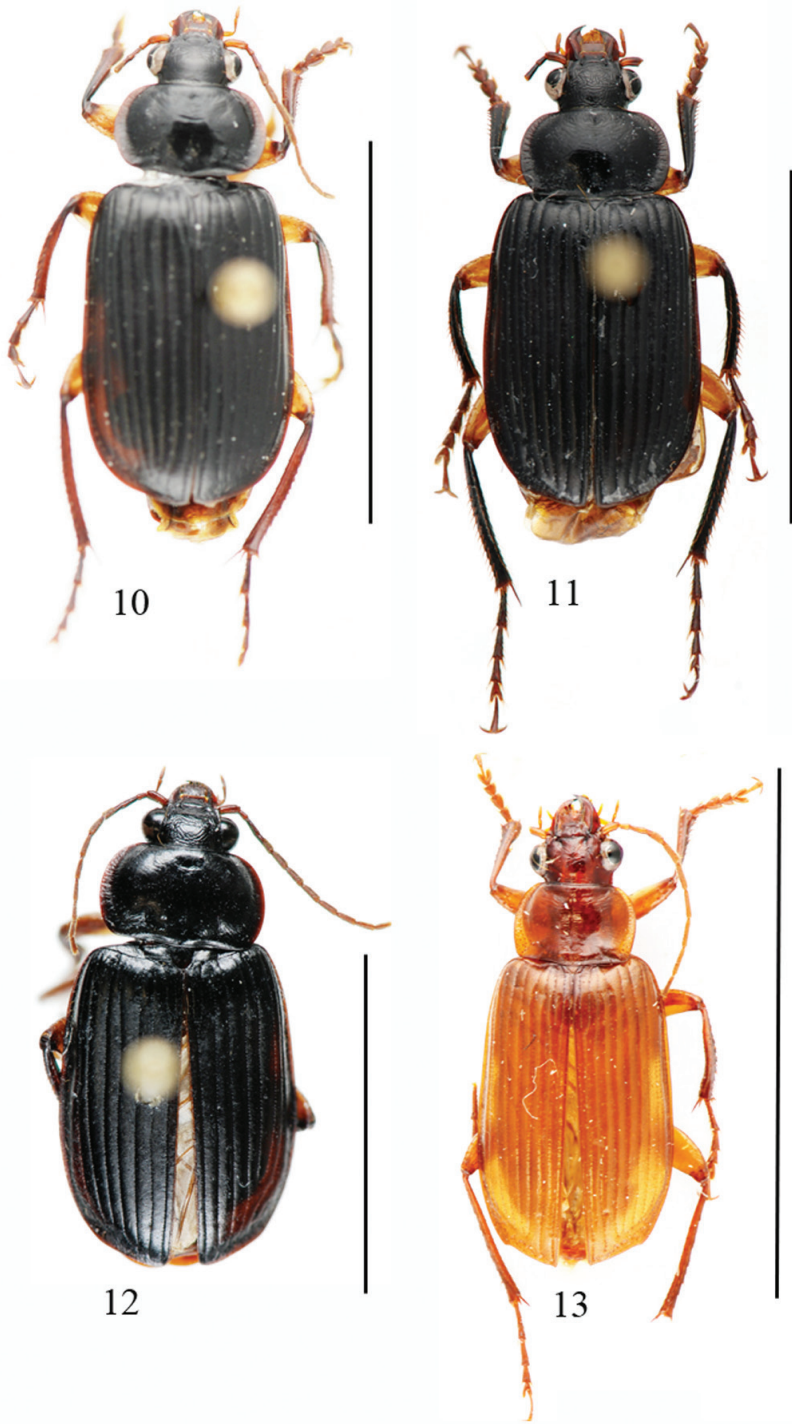
Length: 12.5 mm; width: 5.5 mm. Habitus as in Figure 10.

**Description.** Dark brown or black, but palpi and femora yellowish brown; trochanters, coxae and lateral pronotal margins reddish brown.

Wrinkles and punctures: surface smooth and impunctate; head and pronotum faintly striate, odd elytral intervals (3, 5 and 7) with an irregular row of fine punctures. Surface strongly shiny.

Microsculptural meshes densely isodiametric on elytra, denser and more transverse on pronotum and head.

Head stout, as long as wide; eyes very large, strongly prominent, frons and vertex moderately convex, frontal impressions small, short, fovea-like, clypeus bisetose, rather



**Figures 10–13.** Habitus of *Orthogonius* spp. n. **10** *O. constrictus* sp. n. holotype **11** *O. pinophilus* sp. n. holotype **12** *O. vari* sp. n. holotype **13** *O. variabilis* sp. n. holotype. Scale bar: 10 mm.

even, labrum sexsetose, nearly straight at apical margin; ligula very small and narrow, bisetose at apex; palpi slender, subcylindrical; palpiger asetose, mentum without median tooth, asetose; submentum with one pair of setae. Antennae slender, extended beyond basal 1/4 of elytra, pubescent from apical 2/3 of antennomere 4; antennomeres 3 slightly shorter than 4, antennomeres 4 and 5 subequal in length; antennomeres 1–3 glabrous; antennomeres 4 and 5 distinctly expanded laterally.

Pronotum strongly transverse, PW/PL=1.63, sides evenly rounded, widest at about middle, both basal and fore margins beaded, lateral expanded margins well defined, wide, uneven, smooth and rather flat; both fore and hind angles rounded; disc moderately convex, both transverse impressions not well defined; basal foveae small, middle line distinct.

Elytra ovate (EL/WL=1.55), strongly convex, basal border complete; sides slightly expanded in middle portion, nearly parallel-sided, widest at middle; striae deep, punctate-striate, intervals distinctly convex; intervals 2, 4 and 6 subequal in width, each wider than intervals 1, 3, and 5, respectively, but less than twice as wide; odd intervals with more distinct fine punctures; apex roundly truncate, inner angle broad, without tooth; interval 3 with three well marked setiferous pores (but middle pore absent from left elytron in the holotype and an additional fourth pore present on left elytron in one of the paratypes); interval 7 simple, wide and not carinate, without seta.

Legs moderate, fore tibia with outer angle nearly rectangular, blunt, outer margin faintly serrate; middle and hind coxae smooth and glabrous; middle and hind tibia slender, apex slightly dilated; middle tibia not dilated or curved in middle portion; hind apical tibial spurs very long and sharp; tarsomere 1 much longer than 2, tarsomere 3 slightly longer than 4, tarsomere 4 deeply emarginate at apex (about 1/3 deep as the joint); all tarsal claws strongly pectinate; hind femur moderately dilated, with 2 posterior setae on ventral.

Prosternal process well bordered at apex. Apical margin of abdominal ventrite VII widely and rather deeply emarginate in male.

Male genitalia (Figure 22): Aedeagus elongate, expanded in median portion, sinuate before apex which is more or less bent and pointed at tip; in dorsal view, distinctly constricted before apex, the apical lamella long and slender, 3.4 times as long as wide.

**Female.** Unknown.

**Remarks.** This species is a member of the *O. longicornis* group, but is easily distinguished from other members by its long and slender apical lamella, together with aedeagus more or less constricted before apex in dorsal view.

**Type material.** Holotype: male, “Thailand: Phetchabum, Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°36.284 N, 100°53.128E, 749 m, Malaise trap, 29.vi–6.vii.2007, Pongpitak Pranee & Sathit leg., T 2069”, in QSBG.

Paratypes: 2 males, *ibid*, in QSBG and MNHN, respectively.

**Etymology.** The species name refers to the more or less constricted base of the apical lamella of aedeagus in dorsal view.

**Distribution.** Thailand. Known only from the type locality.

***Orthogonius pinophilus* Tian, Deuve & Felix, sp. n.**

urn:lsid:zoobank.org:act:B788D24D-357A-494C-849B-BB9720434A09

[http://species-id.net/wiki/Orthogonius\\_pinophilus](http://species-id.net/wiki/Orthogonius_pinophilus)

Figures 11, 23

**Diagnosis.** Medium sized, labrum with apical margin straight, prosternal process well bordered at apex, apical margin of abdominal ventrite VII widely emarginate; a member of the *O. longicornis* species group, and easily recognized by its stout and more or less broad apical lamella.

Length: 13.5 mm; width: 6.0 mm. Habitus as in Figure 11.

**Description.** Black, clypeus, mouthparts (except tips of mandibles) and palps, antennomere 1, and coxae, trochanters and femora of legs yellowish brown.

Wrinkles and punctures: surface impunctate except elytral intervals 3, 5 and 7 with tiny, and sparse punctures arranged in a row, head wrinkled, pronotum faintly striate.

Microsculptural meshes isodiametric on elytra, faint or more or less irregular on head and pronotum.

Head as long as wide, eyes very large, strongly prominent; frons and vertex convex, frontal impressions faint, clypeus bisetose, even; labrum quadrate, sexsetose, frontal margin straight; mandibles well developed; ligula small, not expanded at apex, bisetose; palpi slender, subcylindrical, maxillary palpomere 3 as long as 4, glabrous; labial palpomere 2 longer than 3, 2-setose in inner margin; labial palpomere 3 sparsely pubescent; palpiger asetose, mentum asetose, submentum with one pair of setae; mentum without median tooth. Antennae, except left antennomeres 1–3 and right antennomere 1 absent.

Pronotum strongly transverse, PW/PL=66/45, strongly convex; sides evenly rounded, widest at about middle, both basal and fore margins beaded, lateral expanded margins well defined, with few transverse striae, slightly reflexed, and uneven, fore and hind angles rounded; fore transverse impression indistinct, hind one faint, basal foveae small, but well marked, middle line distinct.

Elytra ovate, convex, basal border complete, sides slightly expanded, not parallel at middle, striae deep, intervals very convex, intervals subequal in width in middle; apex roundly truncate; interval 3 with three setae, all are well marked; interval 7 not carinate, without seta.

Legs moderate, middle tibia slightly curved in middle, abruptly and slightly dilated at apex; middle coxae glabrous in median portion; hind tibiae slender, slightly dilated only at apex; hind tibial spurs long and sharp; tarsomere 3 much shorter than tarsomere 4 (almost 1:1.5), tarsomere 4 symmetrically and shallowly emarginate at apex (depth of emargination equal about 2/5 length of the joint); femora rather slender, hind femur with two setae posteriorly; all tarsal claws strongly pectinate.

Prosternal process well bordered at apex. Apical margin of abdominal ventrite VII widely emarginate.

Male genitalia (Figure 23): Median lobe of aedeagus moderately stout for the group, slightly dilated in middle portion, gradually constricted towards apex in lateral view; in dorsal view apical lamella stout and somewhat expanded at tip.

**Female.** Unknown.

**Remarks.** This species is a member of the *O. longicornis* species group, but is easily separated from other members by its stout apical lamella of aedeagus.

**Material examined.** Holotype: male, “Thailand: Phetchabum, Thung Salaeng Luang NP, Gang Wang Nam Yen, pine forest, 16°36.284N, 100°53.128E, 749 m, Malaise trap, 29.vi–6.vii.2007, Pongpitak Pranee & Sathit leg., T 2066”, in QSBG.

**Etymology.** The name refers to the fact that the holotype of this new species was collected in pine forest.

**Distribution.** Thailand. Known only from the type locality.

***Orthogonius vari* Tian, Deuve & Felix, sp. n.**

urn:lsid:zoobank.org:act:C88DF58F-C106-45F6-BDEA-57AF91BF66B5

[http://species-id.net/wiki/Orthogonius\\_vari](http://species-id.net/wiki/Orthogonius_vari)

Figures 12, 24

**Diagnosis.** A stout and broad species; eyes very large and prominent, pronotum and elytra strongly convex; labrum straight at front; mentum asetose; lateral expanded margin of pronotum tapered from base to front, not reflexed; elytra well bordered at base, apex roundly truncate, inner angle broad; interval 3 with three setiferous pores, interval 7 normal; prosternal process well bordered at apex; ventrite VII in male distinctly emarginate; fore tibia with outer angle nearly rectangular, blunt, and not protruded, outer margin not serrate; middle and hind tibiae slender; hind tibial spur very long and sharp, hind tarsomere 3 much longer than 4, tarsomere 4 shallowly emarginate; all tarsal claws very strongly pectinate; femora moderately dilated; hind femur with two posterior setae.

Length: 13.0–14.0 mm; width: 6.3–6.5 mm. Habitus as in Figure 12.

**Description.** Black on upper and lower surfaces, except margin of pronotum, antennae (1–2 much lighter than other antennomeres), palpi, and labrum brown, coxae, trochanters and femora yellowish, tibiae and tarsi dark brown.

Surface smooth and impunctate; head intricately striate, pronotum very finely striate; odd elytral intervals (3, 5, 7) with distinct fine punctures in an irregularly row. Surface strongly shiny. Microsculptural meshes densely isodiametric, clear on elytra, but faint on pronotum and head.

Head stout, wider than long; HW/HL=1.1, eyes very large, strongly prominent, frons and vertex moderately convex, frontal impressions small, short, fovea-like, clypeus bisetose, rather even, labrum sexsetose, straight at apical margin; ligula very small and narrow, bisetose at apex; palpi slender, subcylindrical, normal; palpiger asetose, mentum without median tooth, asetose, submentum with one pair of setae. Antennae slender, extended to basal 1/3 of elytra, pubescent from apical 2/3 of antennomere 4; antennomere 3 as long as 4, both shorter than antennomere 1



and slightly longer than 5; antennomeres 1-3 glabrous; antennomere 4 distinctly expanded laterally.

Pronotum strongly transverse,  $PW/PL=1.57$ , sides evenly rounded, widest at about middle, both basal and fore margins beaded, lateral expanded margins well defined, flat and distinctly tapered from base to front, wide and smooth; both fore and hind angles rounded; disc strongly convex, fore transverse impression indistinct, basal transverse impression moderate, basal foveae distinct and deep.

Elytra broadly ovate ( $EL/WL=1.46$ ), strongly convex, basal border complete; sides slightly expanded in middle portion, slightly parallel-sided, widest slightly behind middle; striae deep, punctate-striate; intervals slightly convex, subequal in width; odd intervals with more distinct fine punctures in an irregular row; apex roundly truncate, inner angle broad; interval 3 with three setiferous pores, near striae 3, 2 and 2, respectively, and well marked; interval 7 normal, wide and not carinate, without setiferous pore.

Middle and hind coxae smooth and glabrous. Legs moderate, fore tibiae with outer angle nearly rectangular, blunt, outer margin not serrate; middle and hind tibiae slender, apex slightly dilated, apical spurs very long and sharp; tarsomere 3 much longer than 4, tarsomere 4 shallowly emarginate at apex; all tarsal claws strongly pectinate; hind femur with 2 posterior setae on ventral.

Prosternal process well bordered at apex. Apical margin of abdominal ventrite VII widely but shallowly emarginate in male.

Male genitalia (Figure 24): Median lobe long and distinctly expanded in median portion, upper margin abruptly sinuate, apex gradually tapered; ventral margin sinuate, dorsal opening long and wide; the apical lamella quite elongate, two times as long as wide, and tip rounded, and nearly parallel-sided.

**Female.** Unknown.

**Remarks.** This species is similar to *O. kirirom* Tian & Deuve, 2008, but is easily distinguished from the latter by its stouter body, elytral inner angle broad, hind femur slightly more dilated, and aedeagus more elongate, with apical lamella more slender and almost parallel-sided.

**Material examined.** Holotype, male, "Coll. I. R. Sc. N. B. / Cambodia, Siem Reap Prov., Angkor Preah Kahm, Malaise Trap, 28/III-05/IV-2006. leg. I. Var"; in IRSNB.

Paratypes: 1 male, "Thailand: Ubon Ratchathani: Pha Taem NP, Wild flower field 1, 15°27.336'N, 105°34.87'E, 232 m, 23–30.v.2007, Malaise trap, Sorawit Mingman leg., T2195"; 1 male, "Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 20–21.vi.2007, Pan traps, Pongpitak & Sathit leg., T2056"; 1 male, "Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, 16.37.178 N, 100.53.504 E, 706 m, Malaise trap, 17–24.v. 2007, Pongpitak Pranee & Sathit leg. T2081"; in QSBG and MNHN respectively.

**Etymology.** This new species is named in honor of Mr I. Var, the collector of the holotype.

**Distribution.** Cambodia and Thailand.

***Orthogonius kirirom* Tian & Deuve, 2008**

[http://species-id.net/wiki/Orthogonius\\_kirirom](http://species-id.net/wiki/Orthogonius_kirirom)

**Material examined.** 1 male, “Thailand: Ubon Ratchathani: Pha Taem NP, wild flower field, 15°27.336'N, 105°34.87'E, 232 m, 2–9.v.2007, Malaise trap, Sorawit Mingman leg., T2186”, in QSBG; 1 male, “Thailand: Phetchabun: Thung Salaeng Luang NP: Gang Wang Nam Yen, 750 m, 16°36.587'N 100°53.395'E; 17–24.v.2007, Pongpitak Pranee & Sathit leg., T2080”, in QSBG.

**Distribution.** Cambodia and Thailand. This species is recorded from Thailand here for the first time.

***Orthogonius leoeinsis* Tian & Deuve, 2006**

[http://species-id.net/wiki/Orthogonius\\_leoeinsis](http://species-id.net/wiki/Orthogonius_leoeinsis)

**Material examined.** 1 male, “Thailand: Ubon Ratchathani: Pha Taem NP, wild flower field, 15°27.336'N, 105°34.87'E, 232 m, 2–9.v.2007, Malaise trap, Sorawit Mingman leg., T2186”, in QSBG.

**Remarks.** Head punctate, pronotum glabrous; the aedeagus of our specimen is slightly wider than that of the type specimen.

**Distribution.** Thailand.

***Orthogonius thailandensis* Tian & Deuve, 2006**

[http://species-id.net/wiki/Orthogonius\\_thailandensis](http://species-id.net/wiki/Orthogonius_thailandensis)

**Material examined.** 1 male, “Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, Malaise trap, 29.vi–6.vii.2007, Pongpitak Pranee & Sathit leg., T 2069”, in QSBG.

**Remarks.** Our specimen is a smaller individual, and slightly stouter than the holotype specimen; length 8.5 mm, width 3.7 mm;

**Distribution.** Thailand.

***Orthogonius pseudolongicornis* Tian & Deuve, 2006**

[http://species-id.net/wiki/Orthogonius\\_pseudolongicornis](http://species-id.net/wiki/Orthogonius_pseudolongicornis)

**Material examined.** 2 males, “Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, pine forest, 16°35.789'N, 100°52.769'E, 723 m, Malaise trap, 6–13.vii.2007, Pongpitak Pranee & Sathit leg., T2068”; 1 male, “Thailand: Phetchabun: Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°37.178'N, 100°53.504'E, 706 m, 24–31.v.2007, Malaise trap, Pongpitak Pranee & Sathit leg., T2084”, in QSBG and MNHN.

**Remarks.** In one of the specimens from sample T2068, the ligula is very thin and narrow, 6-setose at apex (rather than 4-setae as Ron Felix's noted label), but all other characters are typical for the species. Therefore, we treat it as an abnormal individual.

**Distribution.** Myanmar, Vietnam, Cambodia and Thailand.

***Orthogonius longicornis* Chaudoir, 1871**

[http://species-id.net/wiki/Orthogonius\\_longicornis](http://species-id.net/wiki/Orthogonius_longicornis)

**Material examined.** 2 males, “Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 16–17.vi.2007, Pan traps, Pongpitak & Sathit leg., T2052”; 1 male, “Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 20–21.vi.2007, Pan traps, Pongpitak & Sathit leg., T2056”; 1 male, “Thailand: Sakon Nakhon: Phu Phan NP, Kam Hom waterfall at Haew Sin Chai, 17°7.415'N, 104°1.179'E, 347 m, 16.ix.2006–22.ix.2006, Malaise trap, Winlon Khongnara leg., T616”; 1 male, “Thailand: Loei: Phu Kradueng NP, dry dipterocarp forest at Loei forest unit 2 (E-lerd), 16°56.651'N, 101°48.903'E, 273 m, 18.ix.2006–25.ix.2006, Malaise trap, Sutin Glong-Lasae leg., T952”; 1 male, “Thailand: Loei: Phu Kradueng NP, Bamboo forest at Lam Huay Taad at Loei, forest unit 2 (E-lerd), 16°56.565'N, 101°48.896'E, 273 m, 11.ix.2006–18.ix.2006, Malaise trap, Sutin Glong-Lasae leg., T948”; 1 male, “Thailand: Loei: Phu Kradueng NP, Koke Hin Ngam, 16°51.958'N 101°50.668'E, 280 m, 9.viii.2006–16.viii.2006, Malaise trap, Sutin Khonglasae, T482”, in QSBG, MNHN, SCAU and CRF, respectively.

**Distribution.** Thailand.

***Orthogonius nahaeo* Tian & Deuve, 2006**

[http://species-id.net/wiki/Orthogonius\\_nahaeo](http://species-id.net/wiki/Orthogonius_nahaeo)

**Material examined.** 3 males, “Thailand: Ubon Ratchathani: Pha Taem NP, wild flower field, 15°27.336'N, 105°34.87'E, 232 m, 2–9.v.2007, Malaise trap, Sorawit Mingman leg., T2186”; 1 male, “Thailand: Phetchabun: Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°36.587'N, 100°53.395'E, 753 m, 31.v.2007–7.vi.2007, Malaise trap, Pongpitak Pranee & Sathit leg., T2086”. in QSBG, MNHN and SCAU, respectively.

**Remarks.** In general, members of *O. nahaeo* have no seta on the mentum, but in one specimen collected in sample T2186, the mentum has a short seta (compared to setae on the submentum) on the right side.

**Distribution.** Thailand.

***Orthogonius siamensis* Tian & Deuve, 2006**

[http://species-id.net/wiki/Orthogonius\\_siamensis](http://species-id.net/wiki/Orthogonius_siamensis)

**Material examined.** 1 male, “Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, Malaise trap, 29.vi–6.vii.2007, Pongpitak Pranee & Sathit leg., T 2069”, in QSBG.

**Distribution.** Thailand.

***Orthogonius mouhoti* Chaudoir, 1871**

[http://species-id.net/wiki/Orthogonius\\_mouhoti](http://species-id.net/wiki/Orthogonius_mouhoti)

**Material examined.** 2 males, “Thailand: Phetchabun: Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°37.178'N, 100°53.504'E, 706 m, 24–31.v.2007, Malaise trap, Pongpitak Pranee & Sathit leg., T2084”; 1 male, “Thailand: Chaiyaphum: Pa Hin Ngam NP, Ecotone between mix deciduous/dry dipterocarp, 15°38.1'N 101°23.857'E, 700 m, 5.viii.2006–11.viii.2006, Malaise trap, Katae Sa-Nog & Buakaw Adnafai leg., T440”; 1 male, “Thailand: Loei: Phu Kradueng NP, Huay Ta Hack, 16°51.958'N 101°50.668'E, 280 m, 30.viii.2006–6.ix.2006, Malaise trap, Sutin Khonglasae leg., T491”; 1 male, “Thailand: Ubon Ratchathani: Pha Taem NP, Don Huay Sa-nhom, 15°27.435'N, 105°34.838'E, 238 m. 9–16.v.2007, Malaise trap, Sorawit Mingman leg., T2187”; 1 male, “Thailand: Chaiyaphum: Tat Tone NP, Lam Pa Tao, dry ever-green forest head water, 15°58.486'N, 102°2.239'E, 270 m, 5.viii.2006–12.viii.2006, Malaise trap, Tawit Jaruphan & Orawan Budsawong leg., T546”; 1 male, “Thailand: Loei: Phu Kradueng NP, Koke Hin Ngam, 16°51.958'N 101°50.668'E, 280 m, 9.viii.2006–16.viii.2006, Malaise trap, Sutin Khonglasae, T482”; 1 male, “Thailand: Phetchabun: Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°37.178'N, 100°53.504'E, 706 m, 24–31.v.2007, Malaise trap, Pongpitak Pranee & Sathit leg., T2084”; 1 male, “Thailand: Ubon Ratchathani: Pha Taem NP, Wild flower field 1, 15°27.336'N, 105°34.87'E, 232 m, 23–30.v.2007, Malaise trap, Sorawit Mingman leg., T2195”, in QSBG, MNHN, SCAU and CRF, respectively.

**Distribution.** Laos and Thailand. This species is here first recorded from Thailand.

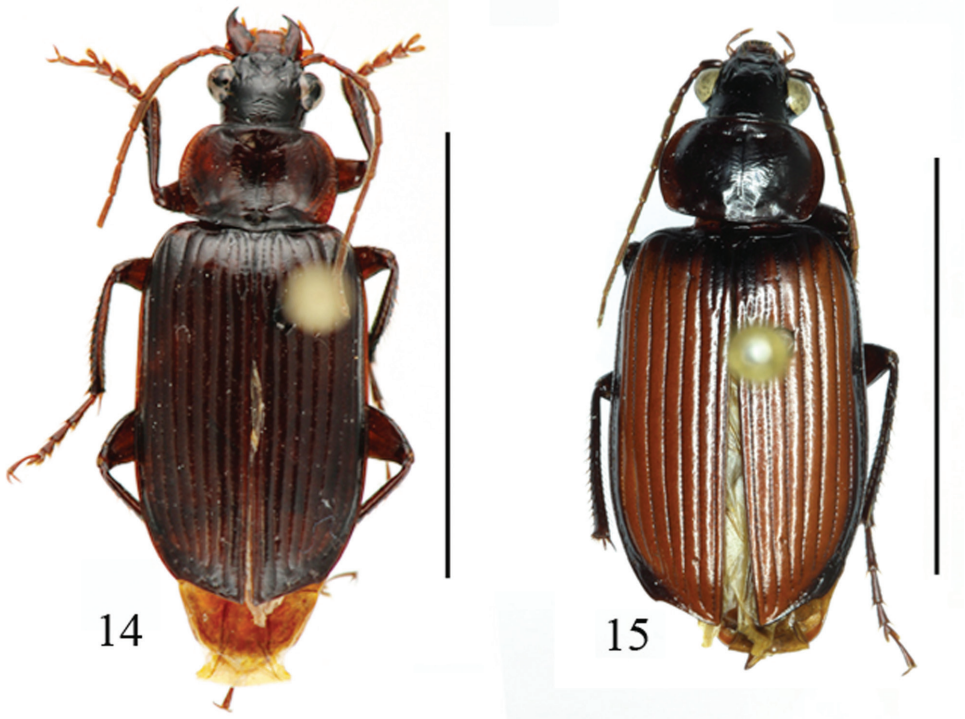
***Orthogonius variabilis* Tian, Deuve & Felix, sp. n.**

[urn:lsid:zoobank.org:act:FE855CF8-60A2-4705-9F5D-C5A4909A9AA5](http://species-id.net/wiki/Orthogonius_variabilis)

[http://species-id.net/wiki/Orthogonius\\_variabilis](http://species-id.net/wiki/Orthogonius_variabilis)

Figures 13–15, 25

**Diagnosis.** Medium to quite small sized, ligula quadrisetose or sexsetose (in 4 paratypes), aedeagus somewhat similar to that of *O. perakensis* Tian & Deuve, 2006; elytral interval 3 with two setiferous pores (middle pore absent); elytra obliquely and sinuately truncate, with apical inner angles acute and sharp.



**Figures 14–15.** Habitus of *Orthogonius variabilis* sp. n. paratypes. Scale bar: 10 mm.

Length: 9.0–13.5 mm; width: 4.0–5.0 mm. Habitus as in Figure 13–15.

**Description.** Body dark brown to yellow (That means the coloration is variable for some species of Orthogoniini, and the size too, not only shapes, but legs, pronotum, elytra, head and so on as well).

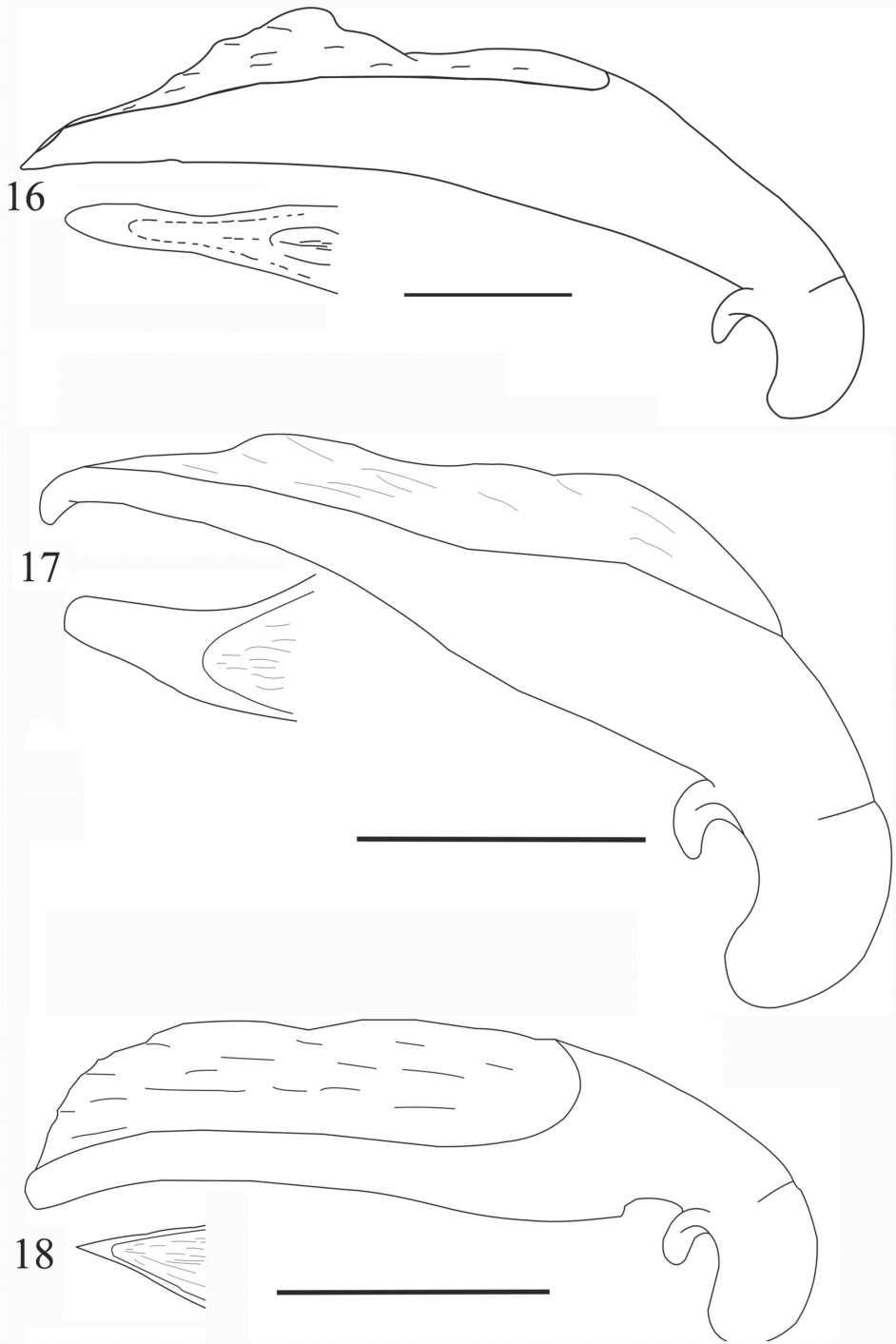
Body with varied coloration: from yellowish to black.

Upper surface smooth and glabrous, impunctate (but punctate in one paratype), elytral intervals each with an irregular row of tiny punctures along median portion; moderately shiny.

Microsculptural meshes densely isodiametric on elytra, irregularly and densely on head and pronotum.

Head stout, slightly wider than long, eyes very large and strongly prominent; frons and vertex moderately convex, frontal impressions small and fovea-like, clypeus bisetose, surface with a transverse impression and a median fovea near base; labrum sexsetose, frontal margin almost straight; ligula short, quadrisetose (sexsetose in a few individuals) at apex; palpi slender, subcylindrical, maxillary palpomere 4 longer than 3, palpomere 3 glabrous, except several setae at apex; maxillary palpomere 4 glabrous with very short setae; labial palpomere 3 slightly shorter than palpomere 2, palpomere 3 with a few setae at base; labial palpomere 2 bisetose in inner margin, and with two or three additional setae at subapex and apex; palpi aetose, mentum and submentum each with one pair of setae; mentum without median tooth. Antennae moderate, ex-





**Figures 16–18.** Aedeagus of *Orthogonius* spp. n. (lateral view, and apex in dorsal view) **16** *O. taghavi-anae* sp. n. holotype **17** *O. coomanioides* sp. n. holotype **18** *O. similis* sp. n. holotype. Scale bar: 1 mm.

tended to middle of elytra; pubescent from basal 1/3 of antennomere 4; antennomere 3 slightly shorter than antennomere 4.

Pronotum transverse, widest at about middle,  $PW/PL=1.17-1.22$ , disc slightly and evenly convex, both angles broadly rounded, both basal and fore margins beaded, lateral expanded margins wide, rather flat or somewhat reflexed; fore and hind transverse impressions distinct, basal foveae well-marked.

Elytra elongate ovate,  $EL/EW=1.7$ ; moderately convex, basal border complete, shoulders broadly square; sides more or less parallel at middle, widest at about middle; striae deep, punctate-striate; intervals moderately convex, and subequal in width in middle; apex quite narrowly and obliquely truncate, outer angle well marked, inner angle sharp and denticulate; interval 3 with two setiferous pores (the middle pore absent); interval 7 simple.

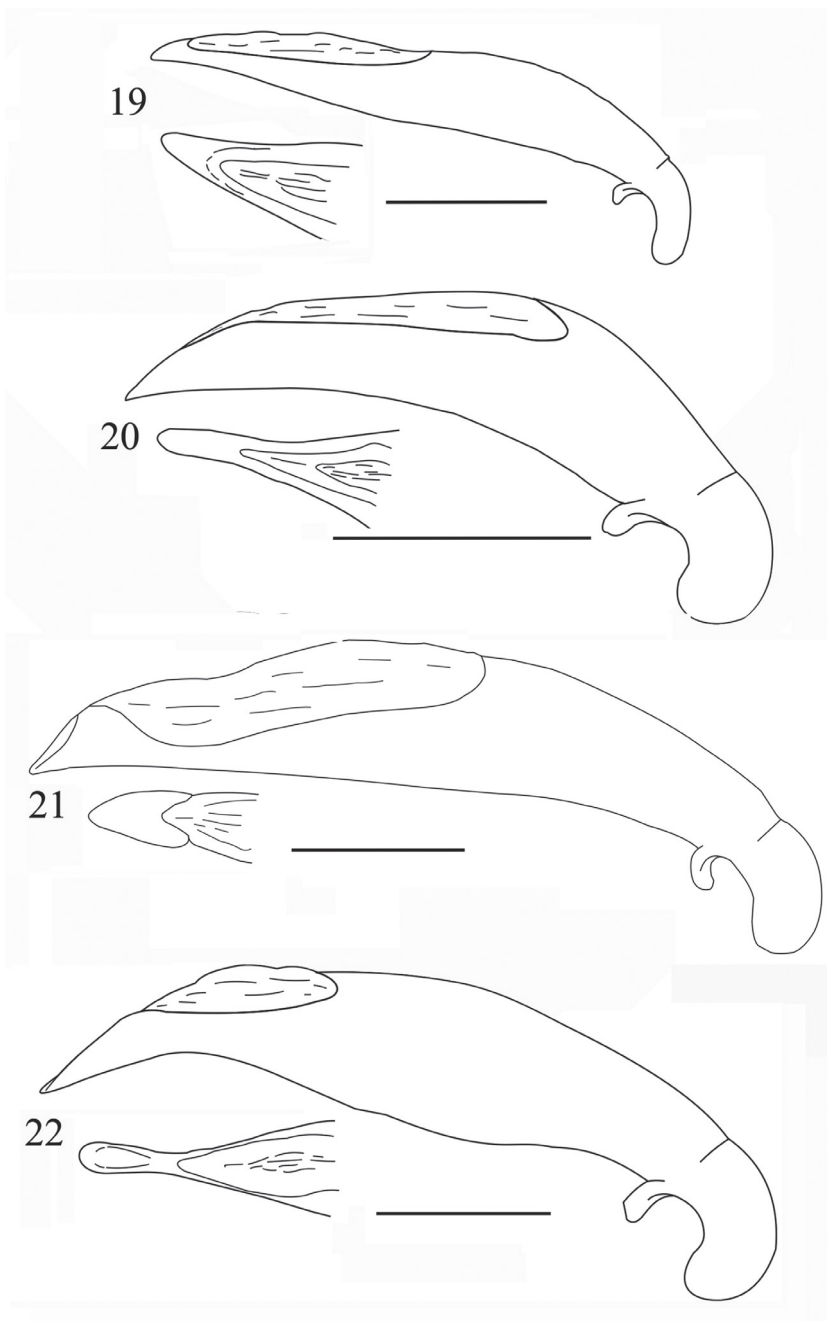
Legs slender. Fore tibiae with apical outer angle obtuse; outer margin distinctly serrate; middle and hind coxae smooth and glabrous; middle tibiae evenly curved, gradually dilated towards apex; hind tibiae slender, apical spurs short and sharp, tarsomere 1 slightly longer than 2, tarsomere 3 distinctly longer than 4, tarsomere 4 bilobed; fore tarsi much wider than middle and hind ones; all tarsal claws strongly pectinate.

Prosternal process unbordered at apex. Apical margin of abdominal ventrite VII of male narrowly but distinctly emarginate at apical margin.

Male genitalia (Figure 25): the median lobe of the aedeagus somewhat stout, slightly or evenly expanded at middle portion; dorsal opening wide and long; in dorsal view apical lamella very short, , broadly pointed at apex.

**Remarks.** This species differs from the Perakian species, *O. perakensis* Tian & Deuve, 2006, by its slender and flat body; and is easily separated from *O. perroti* Tian & Deuve, 2006 by the shape of its elytral apex.

**Variability.** To treat this species is somewhat a challenge, because of the variability in several important characters such as coloration, shape of pronotum, elytral apex, aedeagus and middle tibia, and seta number on ligula. Several species might be “recognized” if there were only a few individuals available. Fortunately the large series of the specimens make it possible to realize the complicated variations of this species. The variations appeared in the following aspects: (1) sized: 9.0–13.5 mm; (2) coloration: from pure yellowish (4 ex), brown (24 ex), dark brown (13 ex), then to black (10 ex). Among Chinese specimens, five are bicoloured on the elytra (Fig. 15); (3) generally the apex of elytra of this species distinctly obliquely truncate, but in one male paratype the outer angle of apical elytra rounded and less sinuate, and inner angle less pointed; (4) pronotum: narrow to wide, and intermediate shapes, occurring in specimens of different size and coloration; (5) middle tibia: slightly curved (majority) or distinctly curved (11 ex); slightly dilated (29 ex) or strongly dilated in median portion; (6) aedeagus: stouter (6 ex) or a little more elongate at apex in dorsal view; (7) ligula: generally quadrisetose, only sexsetose in three specimens in Thailand species (but on the contrary, sexsetose in most Chinese specimens); and (8) punctures: generally impunctate, but one specimen distinctly punctate on vertex of the head.

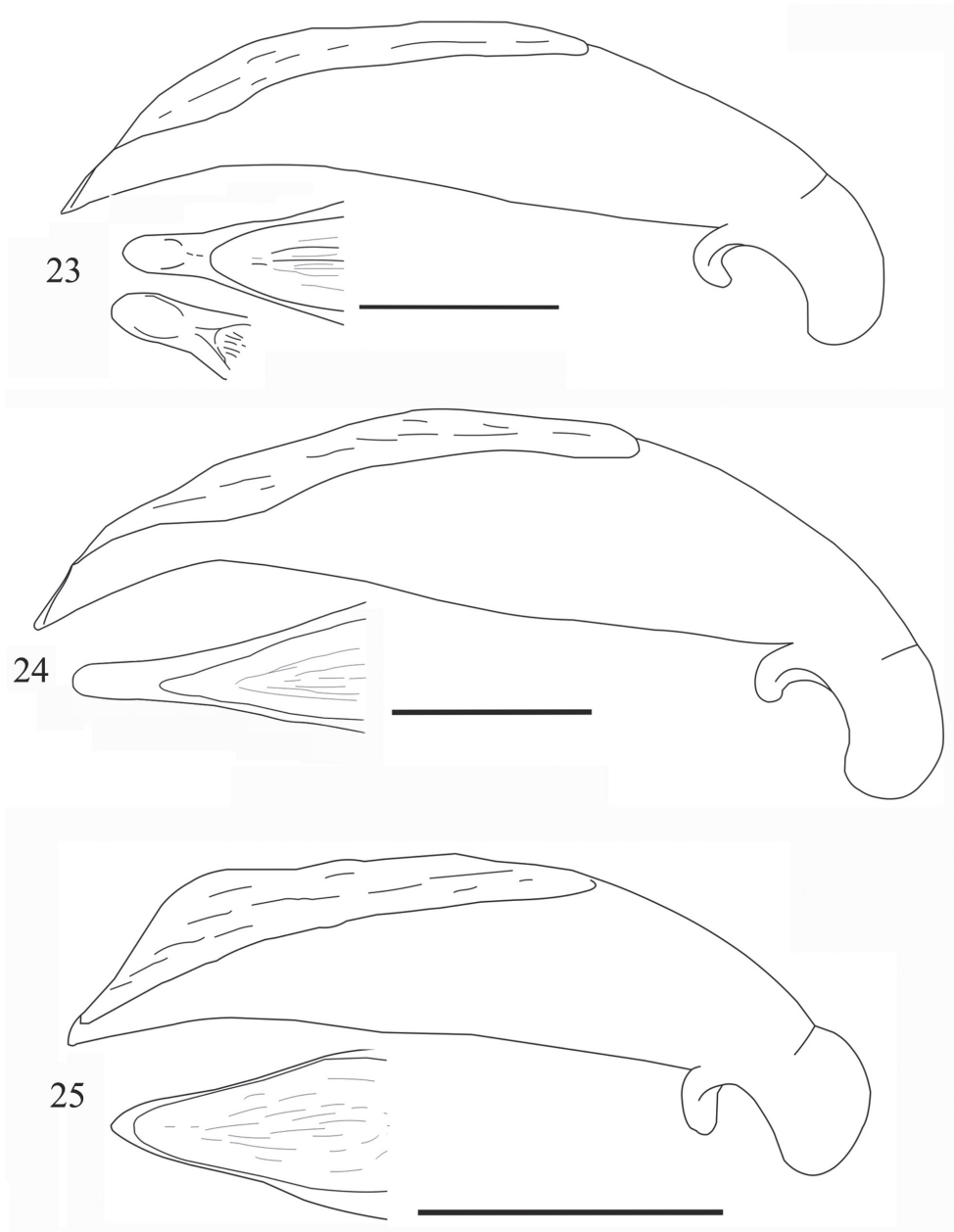


**Figures 19–22.** Aedeagus of *Orthogonius* spp. n. (lateral view, and apex in dorsal view) **19** *O. setosopalpiger* sp. n. holotype **20** *O. gracililamella* sp. n. holotype **21** *O. pseudochaudoiri* sp. n. holotype **22** *O. constrictus* sp. n. holotype. Scale bar: 1 mm.

According to Chaudoir (1871), presence of a sexsetose ligula is one main character for the genus *Hexachaetus* Chaudoir. Nonetheless, we treat this species as a member of *Orthogonius* considering that the number of setae on the ligula is variable.

**Material examined.** Holotype: male, "Thailand: Phetchabun: Thung Salaeng Luang NP, Gang Wang Nam Yen, 16°37.531'N, 100°53.745'E, 721 m, 24–31.v.2007, Malaise trap, Pongpitak Pranee & Sathit leg., T2085", in QSBG.

**Paratypes. Thailand.** 2 males, *ibid*; 1 male, "Thailand: Phitsanulok: Thung Salaeng Luang NP, moist evergreen, 16°50.641'N, 100°52.894'E, 557 m, 11.viii.2006–18.viii.2006, Malaise trap, Pongpitak Pranee leg., T566"; 1 male, "Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, pine forest, 16°36.284'N, 100°53.128'E, 749 m, Malaise trap, 29.vi–6.vii.2007, Pongpitak Pranee & Sathit leg., T 2066"; 15 males, "Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.167'N, 101°21.85'E, 758 m, 26.v.2007–2.vi.2007, Malaise traps, Wirat Sukho leg., T2272"; 1 male, "Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen, pine forest, 16°35.789'N, 100°52.769'E, 723 m, Malaise trap, 6–13.vii.2007, Pongpitak Pranee & Sathit leg., T 2068"; 2 males, "Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.167'N, 101°21.85'E, 758 m, 5–12.v.2007, Malaise traps, Pong Sandao leg., T2263"; 3 males, "Thailand: Nakhon Ratchasima: Khao Yai NP, Cobra zone near fire protection office, 14°28.285'N, 101°22.57'E, 751 m, 5–12.vi.2007, Malaise trap, Wirat Sukho leg., T2222"; 1 male, "Thailand: Phetchabun: Nam Nao NP, Checkpoint, 16°43.695'N, 101°33.797'E, 921 m, 27.ii.2007–1.iii.2007, Litter sample, Noopean Hongyothi & Leng Janteab leg., T2275"; 7 males, "Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.167'N, 101°21.85'E, 758 m, 19–26.v.2007, Malaise traps, Wirat Sukho leg., T2269"; 1 male, "Thailand: Nakhon Ratchasima: Khao Yai NP, Cobra zone near fire protection office, 14°28.285'N, 101°22.57'E, 751 m, 12–19.vi.2007, Malaise trap, Wirat Sukho leg., T2225"; 2 males, "Thailand: Nakhon Ratchasima: Khao Yai NP, Cobra zone near fire protection office, 14°28.524'N, 101°22.928'E, 757 m, 19–26.vi.2007, Malaise trap, Wirat Sukho leg., T2227"; 3 males, "Thailand: Nakhon Nayok: Khao Yai NP, entrance of Hnong Pak Chee Trail, 14°27.119'N, 101°21.482'E, 699 m, 19–26.v.2007, Malaise traps, Wirat Sukho leg., T2271"; 1 male, "Thailand: Nakhon Ratchasima: Khao Yai NP, Cobra zone near fire protection office, 14°28.524'N, 101°22.928'E, 757 m, 12–19.vi.2007, Malaise trap, Pong Sandao leg., T2224"; 1 male, "Thailand: Nakhon Ratchasima: Khao Yai NP, Cobra zone near fire protection office, 14°28.524'N, 101°22.928'E, 757 m, 5–12.vi.2007, Malaise trap, Pong Sandao leg., T2221"; 2 males, "Thailand: Nakhon Ratchasima: Khao Yai NP, Elephant Trail near fire protection office, 14°28.285'N, 101°22.57'E, 751 m, 26.vi.2007–2.vii.2007, Malaise trap, Wirat Sukho leg., T2231"; 1 male, "Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°35.805'N, 100°52.286'E, 726 m, 22–29.vi.2007, Malaise trap, Pongpitak & Sathit leg., T2064"; 2 males, "Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N, 100°53.128'E, 749 m, 18–19.vi.2007, Pan traps, Pongpitak & Sathit leg., T2054"; 2 males, "Thailand: Phetchabun: Thung Salaeng Luang NP, pine forest; Gang Wang Nam Yen, 16°36.284'N,



**Figures 23–25.** Aedeagus of *Orthogonius* spp. n. (lateral view, and apex in dorsal view) **23** *O. pinophilus* sp. n. holotype **24** *O. vari* n. sp. holotype **25** *O. variabilis* sp. n. holotype. Scale bar: 1 mm.

100°53.128'E, 749 m, 20–21.vi.2007, Pan traps, Pongpitak & Sathit leg., T2056"; 1 male, "Thailand: Phetchabun: Thung Salaeng Luang NP: Gang Wang Nam Yen, 750 m, 16°36.587'N 100°53.395'E; 17–24.v.2007, Pongpitak Pranee & Sathit leg., T2080"; 1 male, "Thailand: Phetchabun, Thung Salaeng Luang NP, Gang Wang Nam Yen,



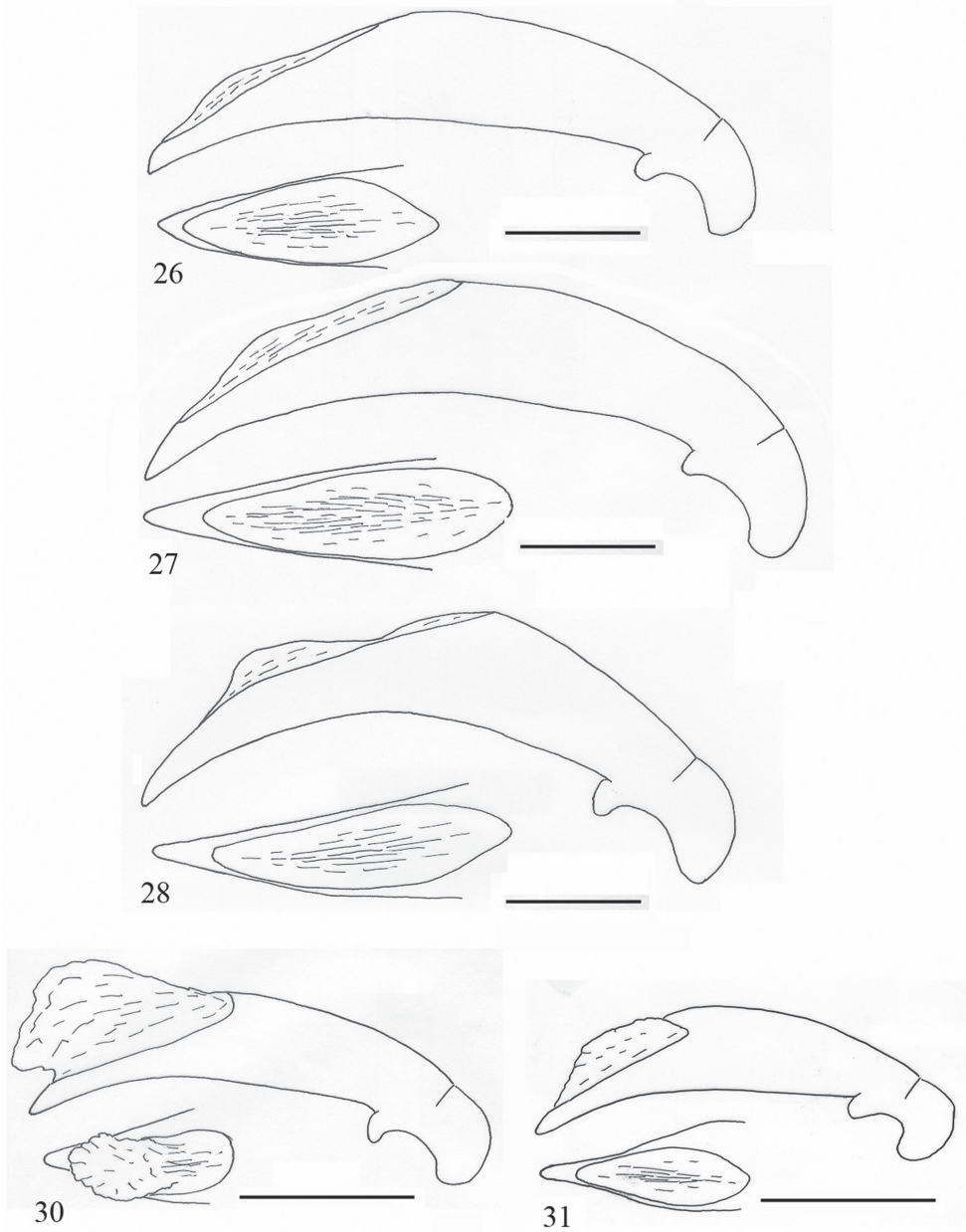
16°37.178'N, 100°53.504'E, 706 m, Malaise trap, 17–24.v.2007, Pongpitak Pranee & Sathit leg., T2081”, deposited in QSBG, MNHN, SCAU and CRF, respectively. **China.** 5 males and 5 females, “China: Yunnan, Jinghong, Banna NR, Mandian (forest), 22°12.961'N, 100°66.612'E, 746 m, Flying-stop trap, 26.v.2009, Meng Lingzeng leg.”; 6 males and 18 females, *ibid*, 06.vi.2009; 1 male and 1 female, *ibid*, 26.vi.2009; 4 males and 3 females, *ibid*, 16.vi.2009; 3 females, *ibid*, pitfall trap 16.vi.2009; 1 male, *ibid*, rubber forest, 26.vi.2009; 1 male and 3 females, *ibid*, 16.v.2009; 1 female, *ibid*, 22°13.059'N, 100°66.817'E, 753 m, 16.vi.2009; 1 female, *ibid*, 26.vi.2009; 1 female, *ibid*, 26.v.2009; 1 female, *ibid*, 16.v.2009; 1 female, *ibid*, 06.vi.2009; 2 males and 1 female, “China: Yunnan, Jinghong, Banna NR, Anmaxinzhai (forest), 22°19.577'N, 100°64.532'E, 772 m, Flying-stop trap, 16.vi.2009, Meng Lingzeng leg.”; 1 male and 1 female, *ibid*, 26.vi.2009; 2 males, *ibid*, 06.vi.2009; 1 male, *ibid*, 6.vi.2009; 1 male, “China: Yunnan, Jinghong, Banna NR, Guomengshan (paddy-field), 22°24.527'N, 100°60.380'E, 1110 m, Malaise, 26.v.2009, Meng Lingzeng leg.”; 1 female, *ibid*, 26.vi.2009; 1 male, *ibid*, forest, 22°24.644'N, 100°60.616'E, 1114 m, 26.vi.2009; 1 female, *ibid*, 22°24.526'N, 100°60.411'E, 1107 m, 06.vi.2009; 1 male and 1 female, *ibid*, 6.vi.2009; 1 female, *ibid*, pitfall trap, 06.vi.2009; 2 males and 1 female, “China: Yunnan, Jinghong, Banna NR, Mandian (rubber forest), 22°13.059'N, 100°66.817'E, 753 m, Flying-stop trap, 16.v.2009, Meng Lingzeng leg.”; 4 males and 1 female, “China: Yunnan, Jinghong, Banna NR, Danuoyou (waste land), 22°20.699'N, 100°63.761'E, 770 m, Malaise, 16.v.2009, Meng Lingzeng leg.”; 1 female, *ibid*, 6.vi.2009; 1 male and 1 female, “China: Yunnan, Jinghong, Banna NR, Naban tea garden (waste land), 22°15.857'N, 100°66.529'E, 709 m, Malaise, 26.v.2009, Meng Lingzeng leg.”; 1 female, *ibid*, 6.vi.2009; 1 female, *ibid*, 16.v.2009; 1 male, *ibid*, 22°13.091'N, 100°66.861'E, 689 m, 26.v.2009; 1 male, *ibid*, rubber forest, 22°15.843'N, 100°66.487'E, 732 m, Yellow-pot, 26.v.2009; 1 female, *ibid*, Malaise; 1 male and 3 females, *ibid*, forest, 22°15.810'N, 100°66.543'E, 729 m, Flying-stop trap; 1 female, *ibid*, 26.v.2009; 1 male, *ibid*, Malaise; 1 male, *ibid*, 16.v.2009; 2 females, *ibid*, 22°15.843'N, 100°66.487'E, 732 m, 26.vi.2009; 1 female, “China: Yunnan, Jinghong, Banna NR, Jinghong Farm, rubber forest, 22°10.607'N, 100°68.500'E, 759 m, Malaise, 16.v.2009, Meng Lingzeng leg.”; all are deposited in IOZ, except 5 males and 5 females in SCAU.

**Etymology.** The species name, “*variabilis*”, means changeable and refers to the varied characters of this new species.

**Distribution.** Thailand and China.

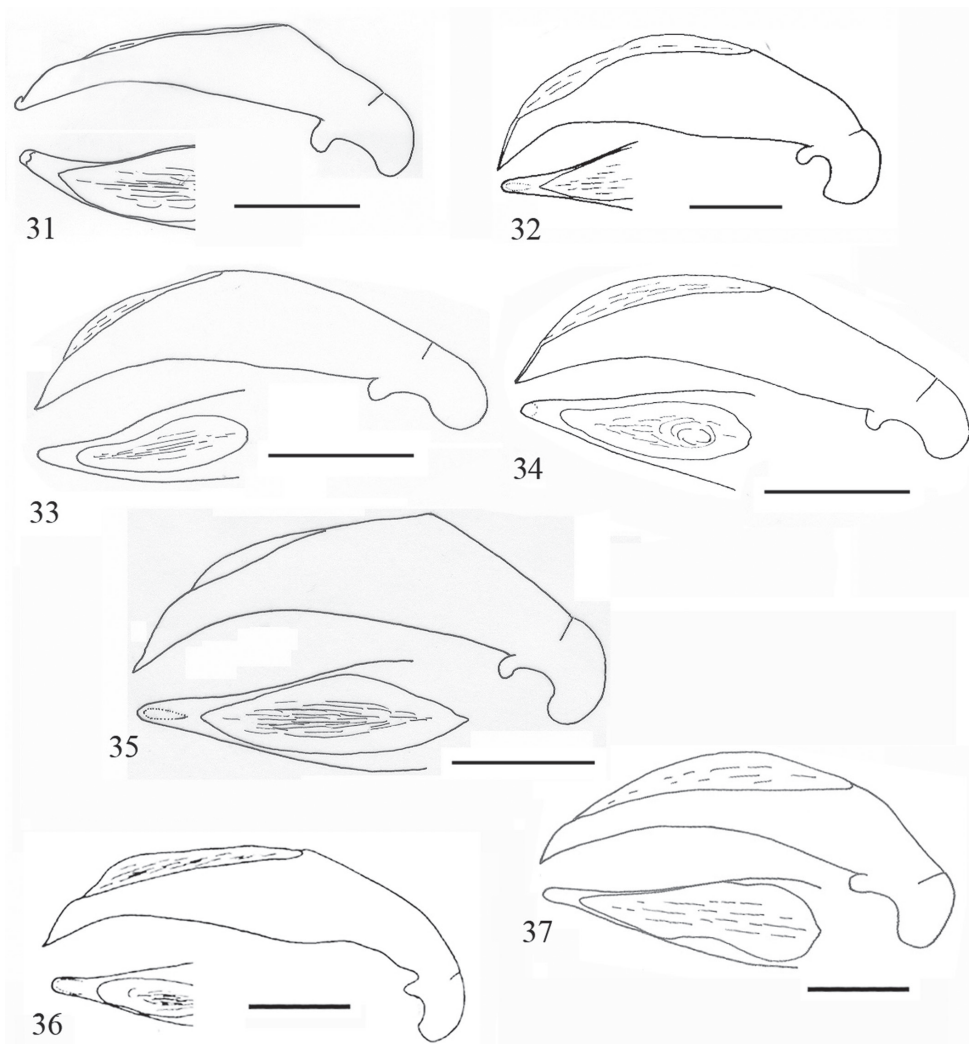
### Unidentified materials

There are 27 specimens still not identified. All of them are females except one male (from Khao Pu-Khao Ya National Park, Trang), from which the aedeagus has been lost. Without reference to male genital characteristics, it is almost impossible to identify the *Orthogonius* species which belonging to either *O. longicornis* species group (viz. *O. mouhoti*, *O. thaicus*, *O. pseudochaudoiri*, *O. nahaeo*, *O. loeicus*, *O. constrictus*, *O. vari*,



**Figures 26–30.** Aedeagus of *Orthogonius* spp. (lateral view, and apex in dorsal view) **26** *O. thaiensis* Tian & Deuve **27** *O. pangi* Tian & Deuve **28** *O. huananoides* Tian & Deuve **29** *O. nahao* Tian & Deuve **30** *O. loeicus* Tian & Deuve. Scale bar: 1 mm.

*O. kirirom*, *O. pinophilus*, *O. gracililamella*, *O. longicornis*, *O. pseudolongicornis* etc.) or *O. alternans* species group (viz. *O. taghaviana*, *O. paris*, *O. thaiensis*, *O. pangi*, *O. huananoides* etc.) in Thailand and its adjacent countries.



**Figures 31–37.** Aedeagus of *Orthogonius* spp. (lateral view, and apex in dorsal view) **31** *O. loeiensis* Tian & Deuve **32** *O. kirirom* Tian & Deuve **33** *O. pachlatkoi* Tian & Deuve **34** *O. siamensis* Tian & Deuve **35** *O. Chiangensis* Tian & Deuve **36** *O. pseudolongicornis* Tian & Deuve **37** *O. longicornis* Chaudoir. Scale bar: 1 mm.

### A provisional key to species of *Orthogonius* in Thailand

- 1      Ligula quadrisetose or sexsetose at apex.....2
- Ligula bisetose at apex.....3
- 2      Ligula quadrisetose in all individuals, surface densely punctate, elytra roundly truncate at apex ..... ***O. similaris* sp. n.**
- Ligula quadrisetose or sexsetose, surface impunctate, elytra obliquely and sinuately truncate, with apical inner angles acute and very sharp.....  
.....***O. variabilis* sp. n.**

3	Palpiger unisetose at base .....	4
–	Palpiger asetose at base.....	5
4	Small (11 mm in length), hind femur quadrisetose posteriorly.....	
	..... <i>O. setosopalpiger</i> sp. n.	
–	Larger (14–16 mm in length), hind femur sexsetose posteriorly.....	
	..... <i>O. grootaerti</i> Tian & Deuve, 2006	
5	Even elytral intervals distinctly and coarsely punctate, much wider than odd intervals .....	6
–	Even elytral intervals glabrous, as wide as odd intervals .....	11
6	Median lobe of aedeagus quite straight in profile, symmetrically constricted at subapex in dorsal aspect (Fig. 16).....	<i>O. taghavianae</i> sp. n.
–	Median lobe of aedeagus more or less bent in profile, not symmetrically constricted at subapex.....	7
7	Even elytral intervals very wide, more than twice as wide as odd intervals...	8
–	Even elytral intervals normal, less than twice width of odd intervals .....	
	..... <i>O. coomanioides</i> sp. n.	
8	Midcoxa setose, 3 <sup>rd</sup> elytral interval with at least two setiferous pores .....	9
–	Midcoxa glabrous, 3 <sup>rd</sup> elytral interval with only one setiferous pore.....	
	..... <i>O. paris</i> Tian & Deuve, 2006	
9	Apical lamella of aedeagus short, as long as wide (Fig. 26) .....	
	..... <i>O. thaiensis</i> Tian & Deuve, 2006	
–	Apical lamella of aedeagus longer .....	10
10	Median lobe of aedeagus less arcuate ventrally, apical lamella broader (Fig. 27).....	<i>O. pangi</i> Tian & Deuve, 2006
–	Median lobe of aedeagus more arcuate ventrally, apical lamella narrower (Fig. 28).....	<i>O. huananoides</i> Tian & Deuve, 2006
11	7 <sup>th</sup> elytral interval carinate at basal portion.....	
	..... <i>O. morvani</i> Tian & Deuve, 2003	
–	7 <sup>th</sup> elytral interval not carinate.....	12
12	Mentum with a pair of setae .....	13
–	Mentum asetose.....	17
13	Labrum straight at frontal margin.....	<i>O. mouhoti</i> Chaudoir, 1871
–	Labrum emarginate at frontal margin .....	14
14	Clypeus quadrisetose.....	<i>O. thaicus</i> Tian & Deuve, 2003
–	Clypeus bisetose.....	15
15	Median lobe of aedeagus with apex arrowhead-shaped in dorsal view (Fig. 21).....	<i>O. pseudochaudoiri</i> sp. n.
–	Median lobe of aedeagus with apex not arrowhead-shaped.....	16
16	Apical lamella of aedeagus shorter (Fig. 29).....	
	..... <i>O. nahao</i> Tian & Deuve, 2006	
–	Apical lamella of aedeagus longer (Fig. 30).....	
	..... <i>O. loeicus</i> Tian & Deuve, 2006	
17	Labrum straight at frontal margin.....	18

–	Labrum either convex or emarginate at frontal margin.....	25
18	Median lobe of aedeagus notched at apical tip (Fig. 31) .....	
	..... <i>O. loeiensis</i> Tian & Deuve, 2006	
–	Median lobe of aedeagus not notched .....	19
19	Median lobe of aedeagus constricted at sub-apex (Fig. 22) .....	
	..... <i>O. constrictus</i> sp. n.	
–	Median lobe of aedeagus not constricted.....	20
20	Apical lamella of aedeagus elongate, almost twice as long as wide.....	21
–	Apical lamella of aedeagus stout, clearly less twice as long as wide.....	23
21	Apical lamella of aedeagus nearly parallel-sided (Fig. 24) .....	<i>O. vari</i> sp. n.
–	Apical lamella of aedeagus gradually narrowed towards apex .....	22
22	Median lobe of aedeagus stout (Fig. 32)....	<i>O. kirirom</i> Tian & Deuve, 2008
–	Median lobe of aedeagus elongate (Fig. 36).....	
	..... <i>O. pseudolongicornis</i> Tian & Deuve, 2006	
23	Median lobe of aedeagus broad at apex in dorsal view (Fig. 23) .....	24
–	Median lobe of aedeagus narrowed at apex in dorsal view (Fig. 20).....	25
24	4 <sup>th</sup> hind tarsomere shallowly emarginate at apex.....	
	..... <i>O. kubani</i> Tian & Deuve, 2006	
–	4 <sup>th</sup> hind tarsomere deeply emarginate at apex.....	<i>O. pinophilus</i> sp. n.
25	Median lobe of aedeagus longer, distinctly sinuate at sub-apex (Fig. 33) .....	
	..... <i>O. pachlatkoi</i> Tian & Deuve, 2006	
–	Median lobe of aedeagus shorter, not sinuate at sub-apex (Fig. 34) .....	
	..... <i>O. siamensis</i> Tian & Deuve, 2006	
26	Labrum emarginate at frontal margin .....	27
–	Labrum convex at frontal margin.....	29
27	Apical lamella of aedeagus narrow and elongate .....	28
–	Apical lamella of aedeagus stout and wide (Fig. 35) .....	
	..... <i>O. chiangensis</i> Tian & Deuve, 2006	
28	Apical lamella of aedeagus longer, nearly parallel-sided (Fig. 20) .....	
	..... <i>O. gracililamella</i> sp. n.	
–	Apical lamella of aedeagus shorter, gradually constricted towards apex (Fig. 37).....	<i>O. longicornis</i> Chaudoir, 1871
29	Body slender, elytra nearly parallel-sided .....	
	..... <i>O. thailandensis</i> Tian & Deuve, 2006	
–	Body stout, elytra distinctly expanded at sides .....	
	..... <i>O. brancuccii</i> Tian & Deuve, 2006	

## Discussion and conclusions

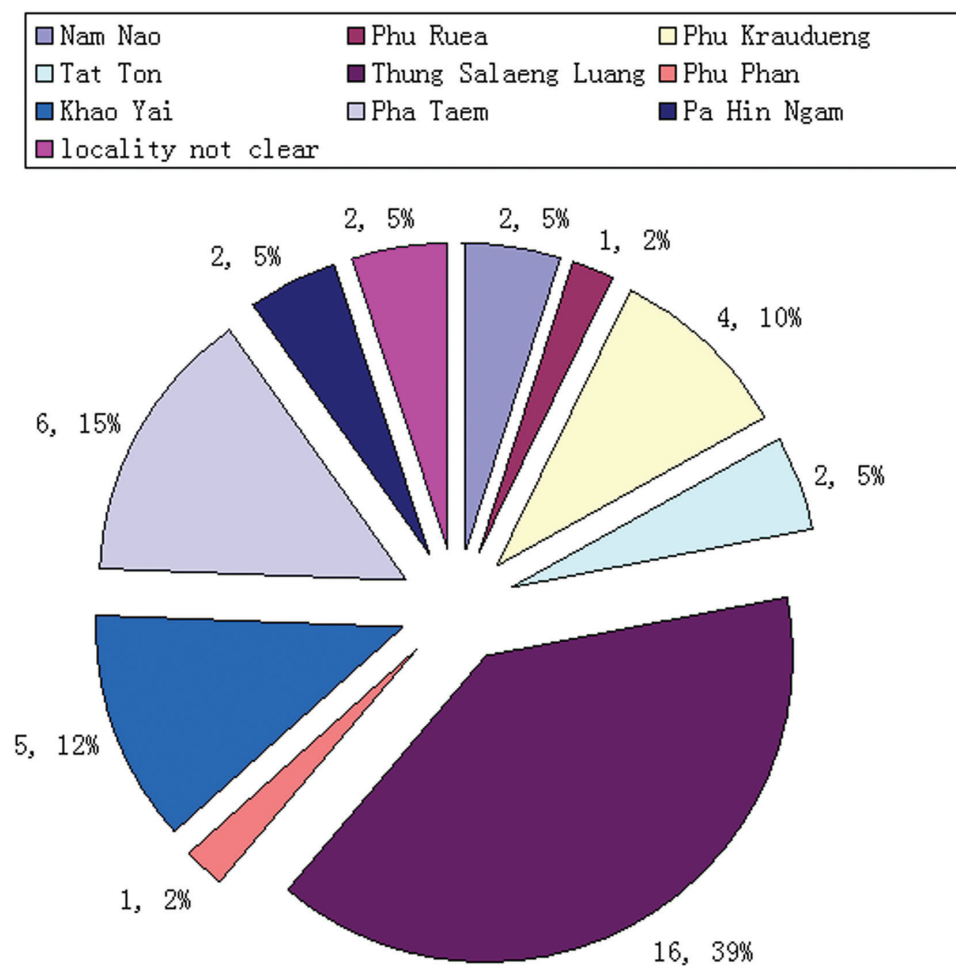
Our result shows that Thailand has one of the most diverse *Orthogonius* faunas in the world, comprised of 30 recorded species. This ranks Thailand behind Indonesia with 54 species and India with 46 species, despite the fact the total area of Thailand is much



less than that of these two other countries. Malaise traps are mainly used to collect Hymenoptera and Diptera, but they are also efficient when used to catch beetles like *Orthogonius* species that are strong fliers. The majority of the specimens collected in the course of this study were collected in Malaise traps.

*Orthogonius* specimens were only collected in ten of the 25 national parks sampled in Thailand. Only one species was collected in two parks, viz. *O. longicornis* in Phu Phan and *O. sp.* in Phu Ruea; two species were collected in three parks (Nam Nao, Tat Ton and Pha Hin Ngam); and four, five and six species were collected in Phu Kraudueng, Khao Yai and Pha Taem, respectively. Thung Salaeng Luang National Park holds the richest fauna for *Orthogonius*, with 16 species recorded from that park (Figure 38).

Almost all records of *Orthogonius* species from the TIGER project provide new distribution records for the genus. Detailed collecting data make it possible to analyze



**Figure 38.** Species number and composition (%) of *Orthogonius* in different national parks in Thailand

the geographical distribution patterns of species in the genus *Orthogonius* in Thailand. Although *Orthogonius* beetles are able to fly, their dispersal ability appears to be limited because the majority of the species of this genus represented in Thailand are endemic, with just a few (six) species known to occur also in other countries nearby, such as Vietnam, Cambodia and China.

## Acknowledgements

We are grateful to Drs Michael Sharkey and Brian Broun (the University of Kentucky, Lexington) for providing us with the opportunity to study the interesting materials from the TIGER project. Our hearty appreciation goes also to Mr Alain Drumont (IRSNB, Brussels), Ms Azadeh Taghavian (MNHN, Paris), Ms Christine Taylor (MNHL), Drs Michel Brancucci and Daniel Burckhardt (NHMB), Drs Hongbin Ling and Meiyang Lin (Institute of Zoology, Beijing) for providing type or unidentified specimens for our study, and Profs Achille Casale (University of Sassari, Sassari), David H. Kavanaugh (California Academy of Sciences, San Francisco), and an anonymous reviewer for suggestions to improve the quality of the manuscript. The first author would like to thank MNHN, Paris for its long-term financial and logistical support for his carabidological studies.

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