

# A new species of jumping spider *Neonella* Gertsch, with notes on the genus and male identification key (Araneae, Salticidae)

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## Abstract

The American genus *Neonella* Gertsch, 1936 consists of very small jumping spiders whose biology is not well known. The genus currently includes eleven valid species, of which eight are known from both sexes and two are only known from one sex. This paper describes and illustrates a new species *Neonella acostae* sp. n., demonstrates male palpal variation in *Neonella montana* Galiano, 1988, and provides some information on the ecology of three sympatric species. New records of *N. montana* and *N. minuta* Galiano, 1965 are reported. Because the previously described species of *Neonella* were well illustrated and diagnosed, a dichotomous key to males is given along with genital illustrations of both sexes for all known species.

## Keywords

Argentina, dichotomous key, neotropical, salticids

## Introduction

The American genus *Neonella* Gertsch currently includes eleven valid species (Metzner 2015, WSC 2015, Ott et al. 2015), of which eight are known from both sexes and two are known from only one sex (*sensu* Prószyński 2015, updated in Ott et al. 2015). *Neonella vinnula* Gertsch, 1936, from the United States, was the first species described for the genus, and is the type species by monotypy. Subsequently, Galiano (1965, 1988, 1998) carried out the largest contributions to the genus and described eight species from Latin America: *N. minuta* Galiano, 1965; *N. antillana* Galiano, 1988; *N. lubrica* Galiano, 1988; *N. montana* Galiano, 1988; *N. nana* Galiano, 1988; *N. cabana* Galiano, 1998; *N. colalao* Galiano, 1998, and *N. mayaguez* Galiano, 1998. More recently, *N. camillae* Edwards, 2003 was described from Florida, USA. In addition, two Brazilian species were recently described, *N. salafraria* Ruiz & Brescovit, 2004 and *N. noronha* Ruiz, Brescovit & Freitas, 2007. The latest contribution to the genus was carried out by Ott et al. (2015), in which *N. cabana* was synonymized with *N. montana*.

*Neonella* jumping spiders are very small and easily unnoticed. The females are usually less than 2 mm in body length and the males are even smaller (Galiano 1998). This genus is similar to *Neon* Simon, 1876 (another genus of small jumping spiders) but can be distinguished by: 1) the absence of fovea; 2) the presence of abdominal scutum in males; and 3) the epigynal openings inside funnel-like atria (see Galiano 1988; and more detail in Gertsch 1936). The shorter distal embolus with thick tip is no longer considered a diagnostic character after Edwards (2003) described *N. camillae*, the first *Neonella* that has long and twisted embolus (“a retrolateral spiral with a proximal embolar disk”; see Edwards 2003, Fig. 5), and this kind of coiled retrolateral embolus was subsequently described for *N. salafraria* (see Ruiz and Brescovit 2004, Fig. 3) and *N. noronha* (see Ruiz et al. 2007, Fig. 13).

Recent phylogenetic analyses suggest that *Neonella* belongs to the subfamily Euphryinae, and falls within a clade with the Neotropical genera *Ecuadattus* Zhang & Maddison, 2012, *Belliensia* Simon, 1902 and *Ilargus* Simon, 1901 (Zhang and Maddison 2013, 2015). Morphological characters indicate *Neonella* may be most closely related to *Darwinneon* Cutler, 1971 (not included in phylogenetic analyses), both of which are very small jumping spiders usually with a distinctive proximal tegular lobe (TL) and short RTA on male palp, and short and wide copulatory duct (Zhang and Maddison 2015).

The biology of these species is not well known. They have been found on the ground, e.g., *N. lubrica* and *N. nana* inhabiting leaf litter or underneath and in rotten wood (Galiano 1988), *N. camillae* in Australian pine litter no more than one cm in depth (Edwards 2003), *N. minuta* on grassland up to 40 cm high (Galiano 1965) and *N. montana* under small rocks (Galiano 1988). Probably their poor biological and taxonomic knowledge are due to their hidden habitat and the small size of individuals. As a result of an ecological study in Córdoba city, Argentina, several specimens of both sexes of three species of *Neonella* were collected: *N. minuta*, *N. montana* and an undescribed species. In this paper we describe and illustrate the new species, which we name *N. acostae* sp. n., show a variation of the male palp in *N. montana*, and provide

some information on their ecology. Because the previously described species of *Neonella* were well illustrated and diagnosed, a dichotomous key for males to all known species is also given with this contribution.

## Material and methods

Specimens were collected in different sites in Córdoba city (central Argentina), using a Garden-Vacuum method to suck spiders from the vegetation (for details on the method, see Rubio and González 2010). We collected on thirty sites around Córdoba city, in urban and peri-urban habitats (in November 2013, springtime), from which nine sites provided *Neonella* species (Fig. 1A). Sites that were positive for *Neonella* were re-sampled the following February-March 2014 (summertime) and July-August 2014 (wintertime). The study area is located within the Espinal ecoregion (Brown et al. 2006), a thorny deciduous shrubland forest (Fund 2014), but has been historically subjected to intense anthropogenic disturbance and modifications (including deforestation, urbanization and agriculture). The sampling sites ranged from forest remnants to urban parks (Fig. 1B, C).

Description formats and morphological terms follow Ruiz and Brescovit (2004), Zhang and Maddison (2015), and Ramírez (2014). Female epigynum was dissected and cleared in clove oil to study the internal structures as in Levi (1965); the male bulb was similarly prepared. Temporary preparations were examined using a Leica DM500 compound microscope and a Leica M60 stereomicroscope. All measurements are in millimeters, were made with an ocular micrometer, and were measured as in Galiano (1963: 275). Leg measurements are shown as total length (femur, patella and tibia, metatarsus, tarsus). Specimens examined are deposited at the arachnological collections of: Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires (MACN-Ar, C. Scioscia), Instituto de Biología Subtropical, Misiones (IBSI-Ara, G. Rubio) and Centro de Relevamiento y Evaluación de Recursos Agrícolas y Naturales, Córdoba (CREAN, C. Argañaraz).

Drawings in Figure 4 were modified from the following original sources: Edwards 2003 (Fig. 4A); Ruiz and Brescovit 2004 (Fig. 4B); Ruiz et al. 2007 (Fig. 4C); Galiano 1988, 1998 (Fig. 4E, I); Galiano 1998 (Fig. 4F, L); Galiano 1988, Ruiz et al. 2007, Zhang and Maddison 2015 (Fig. 4G); Galiano 1965, 1988 (Fig. 4H); Galiano 1988 (Fig. 4J, K).

The three species were collected together or at different locations. In order to explore the strength of the association or the degree to which two species occur jointly in a number of locations, Cole’s index (1949) was utilized. This association coefficient has been used in various applications over animals and plant ecology (Warrens 2008). The index was constructed by  $2 \times 2$  contingency tables and  $\chi^2$ . A site was considered positive when a species was detected at least once either in the spring or the summer sampling ( $n = 9$  sites). Significant associations could indicate interspecific interactions or similar responses to the same environment (Soosairaj et al. 2005).

Abbreviations used: ALE = anterior lateral eye; AME = anterior median eye; CD = copulatory duct; CO = copulatory opening; DS = dorsal scutum; E = embolus; EB = embolus base; FD = fertilization duct; MS = median septum; PA = patellar apophysis; PLE = posterior lateral eye; PME = posterior median eye (the smaller); LE = lamella of embolus; S = spermatheca; PSPL = prolateral spermophore loop; RSPL = retrolateral spermophore loop; RTA = retrolateral tibial apophysis; SP = spermophore; TL = tegular lobe; W = window of epigynum.

## Results

### Taxonomy

**Family Salticidae Blackwall, 1841**

**Subfamily Euophryinae Simon, 1901**

**Genus *Neonella* Gertsch, 1936**

***Neonella acostae* sp. n.**

<http://zoobank.org/5925FF00-8AAD-4B19-B948-72334CA4EFAB>

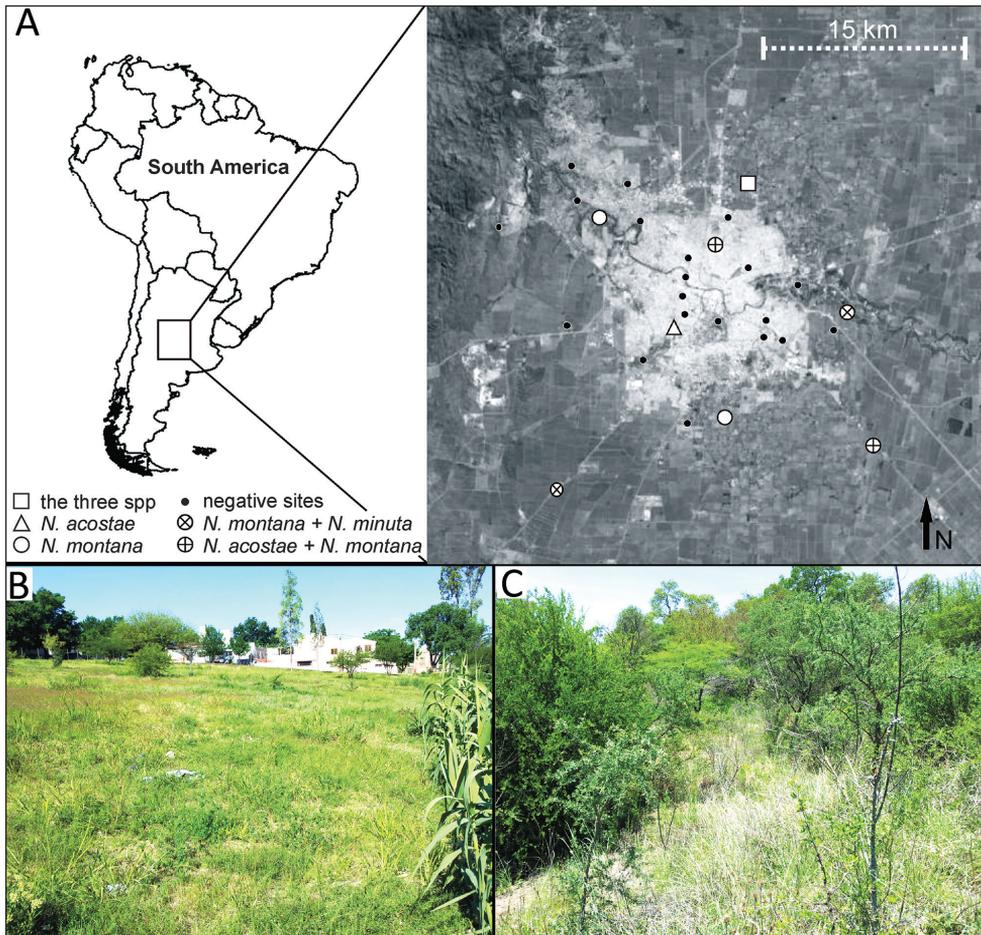
Figs 1A, B; 2; 4D

**Type material.** Holotype ♂ (MACN-Ar 34509) from near Toledo (31°32'10.54"S, 64°1'43.97"W; 381 m asl), Córdoba province, Argentina, 24.XI.2013, C.I. Argañaraz leg. Paratypes: 1 ♂ and 1 ♀ (IBSI-Ara 00242) and 1 ♀ (MACN-Ar 34510) from Ciudad de Córdoba (31°22'27.67"S, 64°10'42.70"W; 430 m asl), Córdoba province, Argentina, 23.XI.2013, C.I. Argañaraz leg.

**Other material examined.** ARGENTINA: Córdoba: Ciudad de Córdoba, site 1 (31°22'27.67"S, 64°10'42.70"W; 430 m asl), 15.III.2014, C.I. Argañaraz & R.M. Gleiser leg., 1 ♂ (CREAN, tissue sample [tiss.s.] CIA 010); site 2 (31°26'6.13"S, 64°12'47.42"W; 441 m asl), 21.XI.2013, C.I. Argañaraz leg., 2 ♂ (CREAN); site 3 (31°20'18.24"S, 64°9'30.97"W; 438 m asl), 15.III.2014, C.I. Argañaraz & R.M. Gleiser leg., 1 ♀ (CREAN, tiss.s. CIA 008); near Toledo (31°32'10.54"S, 64°1'43.97"W; 381 m asl), 24.XI.2013, C.I. Argañaraz leg., 2 ♀ (CREAN).

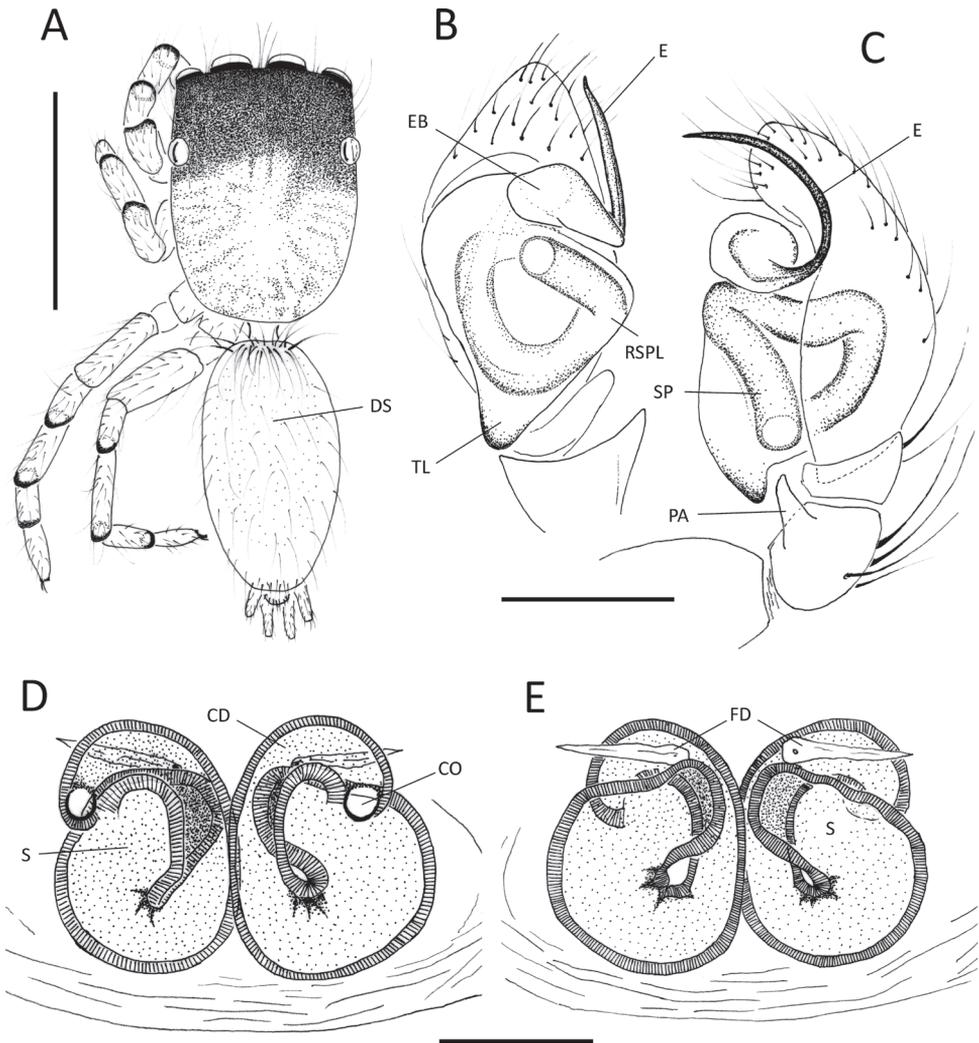
**Diagnosis.** Males of *N. acostae* are similar to those of *N. camillae* and *N. noronha* in the coiled (semi-spiral) embolus (E), but can be distinguished from those and others with long spiral embolus by having only one patellar apophysis (PA) of palp (Fig. 2C; compare among Figs 4A–D). Furthermore, males differ from *N. noronha* in the shorter embolus. Females also resemble *N. noronha* and *N. salafriaria* in having two small, round, simple copulatory openings (CO), but can be distinguished by having them more laterally placed and with different course of the copulatory ducts (CD) (Fig. 2D, E; compare with Figs 14, 15 in Ruiz et al. 2007 and Figs 4, 5 in Ruiz and Brescovit 2004).

**Description.** Male holotype (Fig. 2A–C). Total length: 1.27. Carapace 0.62 long, 0.47 wide, 0.25 high; abdomen 0.62 long, 0.36 wide. Eye sizes: AME 0.12, ALE



**Figure 1. A** Sampling location, positives sites for *Neonella* species and their distribution. Key: black circle = negative sites (further localities that were sampled but that did not yield *Neonella* spp.); white circle = *N. montana*; white triangle = *N. acostae*; white circle with a cross = *N. acostae* and *N. montana*; white circle with a X = *N. montana* and *N. minuta*; white squares = *N. acostae*, *N. minuta*, and *N. montana* **B** Typical location/habitat for *N. acostae* **C** Typical location/habitat for *N. montana*.

0.087, PME 0.026, PLE 0.087. Ocular quadrangle 0.31 long. Anterior eye row 0.45 wide, posterior 0.47 wide. Clypeus height 0.017. Chelicerae with two very tiny pro-marginal teeth, hard to see; retromarginal teeth inconspicuous. Sternum longer (0.30) than wide (0.23). Leg measurements: I 0.78 (0.26, 0.25, 0.12, 0.14); II 0.70 (0.20, 0.25, 0.12, 0.12); III 0.86 (0.27, 0.29, 0.12, 0.17); IV 1.00 (0.31, 0.32, 0.17, 0.18). Carapace yellow with black spots, uniformly distributed; cephalic region darker to black, covered by white hairs. Thoracic region slightly lighter. Clypeus very low. Chelicerae tiny, yellow, grayish brown proximally. Legs pale yellow, with dark rings around the distal ends of the patella, tibia and metatarsus. Sternum and labium pale yellow. Palp (Fig. 2B, C): dark brown to black; cymbium brown, distally darker. Patella with



**Figure 2.** *Neonella acostae* sp. n.; **A–C** male (holotype) **A** dorsal habitus **B, C** male palp in ventral (**B**) and retrolateral (**C**) view **D, E** female (IBSI-Ara 00242) epigynum in ventral (**D**) and dorsal (**E**) view. (EB = embolus base; CD = copulatory duct; CO = copulatory opening; DS = dorsal scutum; E = embolus; FD = fertilization duct; PA = patellar apophysis; S = spermatheca; RSPL = retrolateral spermophore loop; SP = spermophore; TL = tegular lobe). Scale bars: 0.5 mm (**A**); 0.1 mm (**B, C**); 0.05 mm (**D, E**).

a pointed retrolateroventral apophysis (PA). Copulatory bulb brown, with tegular lobe (TL) and conspicuous embolus base (EB). Embolus long (E), with a retrolateral half spiral (Fig. 2C). Abdomen pale yellow, uniformly covered with small black hairs; with an inconspicuous small thin dorsal abdominal scutum (DS). Spinnerets pale yellow. Variation (n=5): none apparent.

Female paratype (IBSI-Ara 00242) (Fig. 2D, E). Total length: 1.70. Carapace 0.75 long, 0.51 wide, 0.30 high; abdomen 0.87 long, 0.57 wide. Eye sizes: AME 0.14,

ALE 0.075, PME 0.025, PLE 0.10. Ocular quadrangle 0.37 long. Anterior eye row 0.47 wide, posterior 0.50 wide. Clypeus height 0.012. Chelicerae as in male. Sternum longer (0.32) than wide (0.22). Leg measurements: I 0.93 (0.30, 0.32, 0.15, 0.15); II 0.86 (0.26, 0.30, 0.15, 0.15); III 0.99 (0.32, 0.32, 0.16, 0.17); IV 1.20 (0.37, 0.40, 0.22, 0.20). Carapace in general as in male, thoracic region slightly lighter. Clypeus very low. Chelicerae as in male, but light brown proximally. Legs, sternum and labium as in male. Palp yellow. Epigynum wider than long, with a thin translucent plate; two small copulatory openings (CO). Spermathecae tubular (S), connected to thick copulatory ducts (CD). Abdomen and spinnerets as in male; dorsal abdominal scutum absent. Variation (n=5): one female is more pigmented, with more dark spots on thoracic region.

**Etymology.** The specific name is a Latinized patronym in honor of Dr. Luis E. Acosta, arachnologist of Universidad Nacional de Córdoba, who was major professor for the PhD of G.D.R. and advisor for the bachelor thesis of C.I.A.

**Distribution.** Known only from Córdoba province (Fig. 1A): Ciudad de Córdoba and near Toledo, Argentina.

**Sexual dimorphism.** Males and females differ only slightly in their somatic morphology. Females are slightly larger than males, mainly due to their larger abdomen. The carapace is somewhat more pigmented in males than in females.

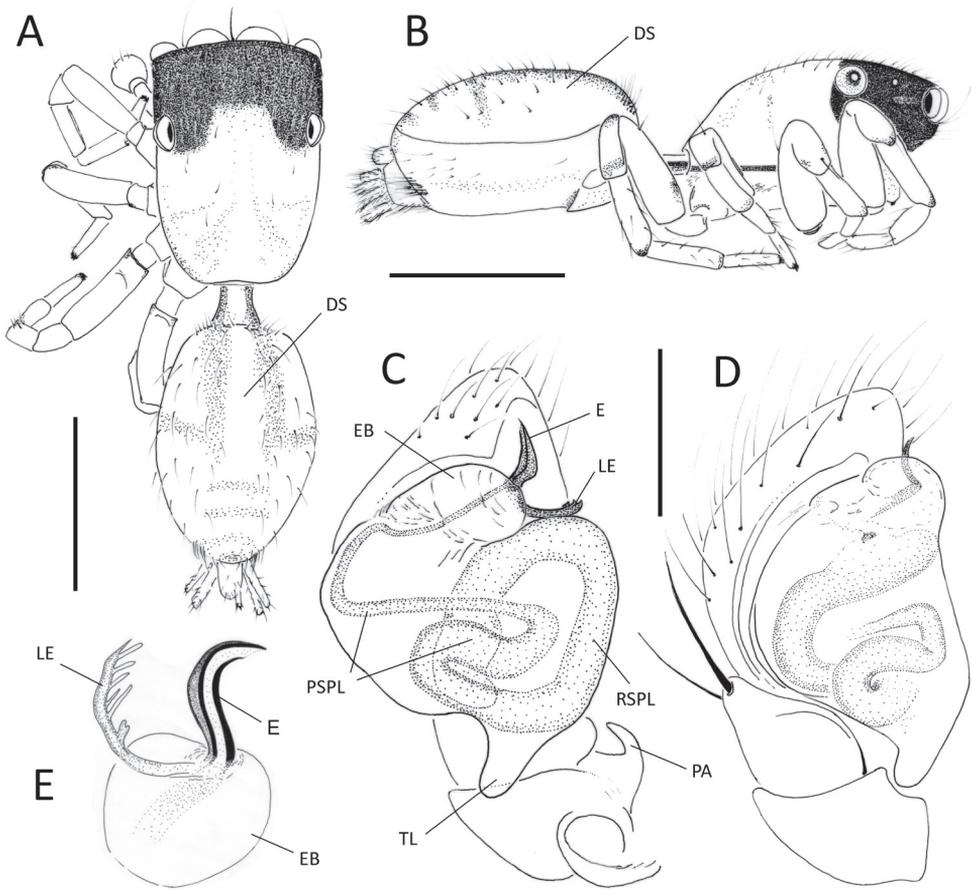
### *Neonella montana* Galiano, 1988

Figs 1A, C; 3; 4E

*Neonella montana* Galiano, 1988: 447, figs 14, 21 (holotype ♀ from ARGENTINA: Córdoba province, Cuesta Cura Brochero, deposited in MACN-Ar 8409, not examined); Ott et al. 2015: 586, figs 9–12, 20–25; Prószyński 2015; WSC 2015.

*Neonella cabana* Galiano, 1998: 15, figs 4–6, 11, 12 (holotype ♂ from Cabana, Córdoba province, Argentina, not reexamined). Synonymized by Ott et al. (2015): 586.

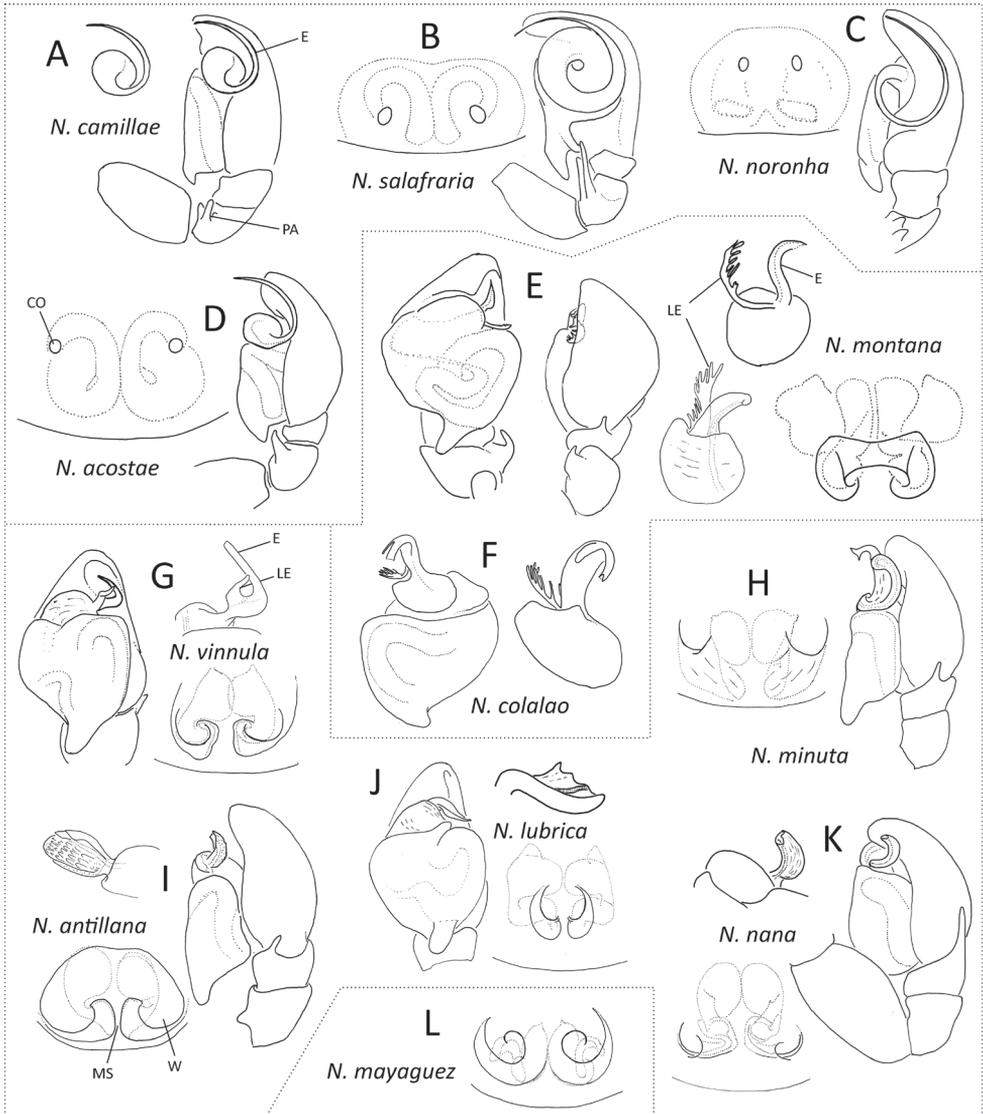
**Material examined (new records).** ARGENTINA: Córdoba: Ciudad de Córdoba, site 1 (31°22'27.67"S, 64°10'42.70"W; 430 m asl), 15.III.2014, C.I. Argañaraz & R.M. Gleiser leg., 1 ♀ (CREAN); site 3 (31°20'18.24"S, 64°9'30.97"W; 438 m asl), 23.XI.2013, C.I. Argañaraz leg., 1 ♂ and 1 ♀ (CREAN); Ciudad de Córdoba, site 4 (31°28'25.54"S, 64°11'17.44"W; 449 m asl), 21.XI.2013, C.I. Argañaraz leg., 1 ♂ and 1 ♀ (IBSI-Ara 00243); same loc., 20.III.2014, C.I. Argañaraz & R.M. Gleiser leg., 1 ♂ (MACN-Ar 34511); site 5 (31°21'41.23"S, 64°16'2.66"W; 451 m asl), 7.III.2014, C.I. Argañaraz & R.M. Gleiser leg., 1 ♂ (CREAN, tiss.s. CIA 001), 1 ♂ (CREAN, tiss.s. CIA 002), 1 ♂ (CREAN, tiss.s. CIA 003) and 1 ♀ (CREAN, tiss.s. CIA 004); near Comunidad Los Cedros (31°32'25.54"S, 64°18'14.69"W; 540 m asl), 28.XI.2013, C.I. Argañaraz leg., 1 ♂ (CREAN); near Ciudad de Córdoba (31°26'35.25"S, 64°3'48.09"W; 391 m asl), 29.XI.2013, C.I. Argañaraz leg., 3 ♂ and 1 ♀ (CREAN); same loc., 11/III/2014, C.I. Argañaraz & R.M. Gleiser leg., 3



**Figure 3.** *Neonella montana* Galiano, 1988; **A–E** male (IBSI-Ara 00243); **A, B** habitus in dorsal (**A**) and lateral (**B**) view **C, D** male palp in ventral (**C**) and prolateral (**D**) view **E** detail of EB in dorsal view. (EB = embolus base; DS = dorsal scutum; E = embolus; PA = patellar apophysis; LE = lamella of embolus; PSPL = prolateral spermophore loop; RSPL = retrolateral spermophore loop; TL = tegular lobe). Scale bars: 0.5 mm (**A, B**); 0.09 mm (**C, D**).

♂ and 3 ♀ (CREAN); Juarez Celman (31°15'13.69"S, 64°9'58.55"W; 500 m asl), 15.III.2014, C.I. Argañaraz & R.M. Gleiser leg., 4 ♂ and 1 ♀ (CREAN); near Toledo (31°32'10.54"S, 64°1'43.97"W; 381 m asl), 27.II.2014, C.I. Argañaraz & R.M. Gleiser leg., 1 ♀ (CREAN).

**Note.** The holotype was requested for study but so far it is unavailable. However, we do not consider this a major drawback since in a recent contribution, Ott et al. (2015) synonymized *N. cabana* with *N. montana* based on specimens collected in southern Brazil, which had been noted as a possibility by Galiano (1998). In agreement with Ott and collaborators, we found that males of *N. montana* have variations



**Figure 4.** Schematic identification for species of *Neonella* Gertsch, 1936; **A–L** drawings modified from the original papers and descriptions (sources in method section). (CO = copulatory opening; E = embolus; MS = median septum; PA = patellar apophysis; LE = lamella of embolus; W = window of epigynum).

in both somatic and reproductive structures. Therefore, an updated diagnosis including both sexes and an additional re-description of the male including the variation found in the palp of specimens from Argentina (near the type locality) are given below.

**Diagnosis.** Males of *N. montana* are similar to those of *N. colalao* in sharing a comb-like, branched lamella of embolus (LE), but can be distinguished from this species by

having non bifurcated terminal apex of the embolus (Fig. 3E; and Galiano (1998): Figs 11, 12, compare with Figs 7–10). Females of *N. montana* can be distinguished from the other species of *Neonella* by having only one opening on the epigynal plate, formed by a large, trapezoid atrium (Fig. 4E; and Galiano 1988: 447, Figs 14, 21).

**Description.** Male from Ciudad de Córdoba (IBSI-Ara 00243) (Fig. 3). Total length: 1.47. Carapace 0.67 long, 0.47 wide, 0.32 high; abdomen 0.67 long, 0.44 wide. Eye sizes: AME 0.15, ALE 0.10, PME 0.025, PLE 0.090. Ocular quadrangle 0.35 long. Anterior eye row 0.50 wide, posterior 0.50 wide. Clypeus height 0.012. Teeth of chelicerae inconspicuous. Sternum longer (0.32) than wide (0.22). Leg measurements: I 0.96 (0.31, 0.32, 0.17, 0.15); II 0.80 (0.25, 0.27, 0.15, 0.12); III 0.96 (0.27, 0.32, 0.19, 0.17); IV 1.15 (0.32, 0.40, 0.22, 0.20). Carapace light brown with narrow black margins. Cephalic region black, covered by white hairs; thoracic region with a lighter longitudinal band. Clypeus very low. Chelicerae tiny, yellow, light brown proximally. Legs light brown, with blackish irregular bands on femurs side (pro and retrolateral), and blackish rings around the distal ends of the patella and tibia, and scarcely on metatarsus. Sternum and labium yellow. Palp (Fig. 3C–E): brown; cymbium yellow. Femur and patella black proximally, with a hook-shaped retrolateral apophysis (PA). Copulatory bulb light brown, with conspicuous tegular lobe (TL) and embolus base (EB). Embolus (E) short, with comb-like lamella (LE). Abdomen light brown, with a few scattered black hairs; with a pair of longitudinal dark stripes on the abdomen in anterior half, and the posterior half with chevrons. Dorsal abdomen completely covered with a scutum (DS). Spinnerets pale yellow. Variation (n=10): some specimens from Córdoba vary in thickness and shape of embolus and LE respectively; for comparison see Figure 4E; in addition, the blackish irregular bands of the femora may be less developed.

Female (Holotype, MACN-Ar 8409). The female is well illustrated and described in previous contributions: See Galiano (1988): 447 and illustration in Ott et al. (2015).

**Distribution.** Central and southeast Argentina: in Córdoba (Fig. 1A) and Buenos Aires provinces, and southern Brazil: Rio Grande do Sul.

### *Neonella minuta* Galiano, 1965

Figs 1A; 4H

*Neonella minuta* Galiano, 1965: 25, figs 1–8; Galiano 1988: 439, figs 17, 19; Ott et al. 2015: 585, figs 5–8, 17–19; Prószyński 2015; WSC 2015.

**New records.** ARGENTINA: Córdoba: Juarez Celman (31°15'13.69"S, 64°9'58.55"W; 500 m asl), 23.XI.2013, C.I. Argañaraz leg., 1 ♀ (CREAN); same loc., 15.III.2014, C.I. Argañaraz & R.M. Gleiser leg., 1 ♀ (CREAN); near Ciudad de Córdoba (31°26'35.25"S, 64°3'48.09"W; 391 m asl), 29.XI.2013, C.I. Argañaraz leg., 2 ♀ (IBSI-Ara 00288); Ciudad de Córdoba, site 3 (31°20'18.24"S, 64°9'30.97"W; 438 m asl), 15.III.2014, C.I. Argañaraz & R.M. Gleiser leg., 1 ♀ (CREAN, tiss.s. CIA 009),

1 ♂ (CREAN), 1 ♂ and 1 ♀ (CREAN); near Comunidad Los Cedros (31°32'25.54"S, 64°18'14.69"W; 540 m asl), 26.II.2014, C.I. Argañaraz leg., 1 ♀ (CREAN).

**Comments.** In a recent contribution, Ott et al. (2015) extend the distribution of *N. minuta* toward Rio Grande do Sul (Brazil), which was originally only known endemic to Buenos Aires (Argentina) by Galiano (1965). Our present work enhances the geographical distribution of this species, representing the westernmost record so far (Córdoba province, Central Argentina).

**Ecology of the collected species.** The three species of *Neonella* were collected during the spring and the summer but were not detected in the winter samples. They were found in the lower strata of vegetation (0 to 35 cm), consisting mainly of grasses and forbs. *Neonella acostae* was collected both within the urban environment (Fig. 1A, B) and in more natural sites on the periphery of the city (Fig. 1A, C), while *N. montana* and *N. minuta* were mostly collected from more natural sites with dense vegetation on the city periphery (Fig. 1A, C). Based on Cole's index (1949), *N. acostae* was negatively associated with *N. minuta* ( $-0.44 \pm 0.42$ ; mean association  $\pm$  standard error) and *N. montana* ( $-0.13 \pm 0.11$ ), suggesting moderately dissimilar habitat disturbance tolerances because *N. acostae* was collected at a wider range of sites in terms of plant cover, or alternatively a moderate degree of interspecific competition because they occasionally occurred at the same site. Cumming and Wesolowska (2004) explained high Salticidae richness in small suburban areas as a result of strong host-plant associations. More detailed studies of microhabitat use should be carried out to confirm these explanations. *Neonella minuta* and *N. montana* were not significantly associated ( $0.1 \pm 0.11$ ), suggesting independent occurrences of the species.

### Provisional identification of species groups of *Neonella*

Known species of *Neonella* are more easily distinguished if based on the morphology of male organs; however, males with long and spiral embolus could have conspecificity with females having copulatory openings as two simple round holes and, apparently, without window of epigynum (W) or median septum (MS) (Fig. 4). All species included in the genus, 11 plus one described here, can be separated into two large main groups; 1) those with long spiral embolus: *N. camillae*, *N. salafraria*, *N. noronha*, and *N. acostae* (Fig. 4A–D), and 2) the remainder having short and generally more stout embolus. Within this latter group we can distinguish two subgroups; 2<sub>a</sub>) species having a visible branched lamella of embolus (LE): *N. montana* and *N. colalao* (Fig. 4E, F) and 2<sub>b</sub>) without such lamella or is very difficult to see, but in this case unbranched: *N. vinnula*, *N. minuta*, *N. antillana*, *N. lubrica*, and *N. nana* (Fig. 4G–K). Although it has been found that *N. noronha* has a tiny lamella of embolus (paraembolic projection *sensu* Ruiz et al. (2007)), this species has a long spiral embolus. *Neonella mayaguez* is known only from females (Fig. 4L).

The following key to species has some limitations because it is constructed based only on the males. Males have diagnostic characters which are much more apparent and applicable. On the other hand, in females, the diagnostic characters are mainly in the internal genitalia (ducts and spermathecae) in ventral and dorsal views (vulva),

and these are more ambiguous. Therefore, we consider the need to complement this contribution with a comprehensive review of the genus to provide a key with both sexes in the future.

### Key to males of species of *Neonella*

- 1 Copulatory bulb with long spiral embolus (Fig. 4A–D) ..... **2**
- Copulatory bulb with short and generally stouter embolus (Fig. 4E–K)..... **5**
- 2 Palpal patella with only one apophysis (Fig. 4D) (Argentina)..... ***N. acostae***
- Palpal patella with two or more apophyses (Fig. 4A–C) ..... **3**
- 3 Palpal patella with two long apophyses (Fig. 4B) (Brazil) ..... ***N. salafraria***
- Palpal patella with short apophyses (Fig. 4A, C) ..... **4**
- 4 Palpal patella with a spatulate apophysis, and two shorter apophyses (Fig. 4A) (USA) ..... ***N. camillae***
- Palpal patella with two short, triangular apophyses (Fig. 4C) (Brazil) ..... ***N. noronha***
- 5 Copulatory bulb with a comb-like, branched lamella of embolus (Fig. 4E, F)... **6**
- Copulatory bulb without such lamella or, if present, unbranched (Fig. 4G–K) ..... **7**
- 6 Embolic apex with two terminal rami (Fig. 4F) (Argentina)..... ***N. colalao***
- Embolic apex non-bifurcated (Fig. 4E) (Argentina and Brazil).... ***N. montana***
- 7 Copulatory bulb with a small lamella of embolus, as a separated structure (Fig. 4G) (USA)..... ***N. vinnula***
- Copulatory bulb without such separated lamella of embolus (Fig. 4H–K) .... **8**
- 8 Embolus retrolaterally directed, with an associated, laminar structure (Fig. 4J) (Paraguay) ..... ***N. lubrica***
- Copulatory bulb with the embolus apically directed (Fig. 4H, I, K)..... **9**
- 9 Large, long embolus, with a dilated embolic apex (Fig. 4H) (Argentina)..... ***N. minuta***
- Small, short, thick embolus, with a blunt embolic apex (Fig. 4I, K)..... **10**
- 10 Short retrolateral tibial apophysis, surface of embolus conspicuously squamous (Fig. 4I) (Jamaica) ..... ***N. antillana***
- Retrolateral tibial apophysis longer, embolus without such surface (Fig. 4K) (Paraguay)..... ***N. nana***

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# Review of the genus *Ceresium* Newman, 1842 (Coleoptera, Cerambycidae) in Fiji

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## Abstract

A taxonomic review of the genus *Ceresium* (Coleoptera: Cerambycidae) found within the Fiji Islands is presented. A total of 17 species is treated. Full morphological descriptions and comparative images of each species are included, along with a dichotomous key for their identification.

## Keywords

Longhorned beetles, endemic species, taxonomy

## Introduction

Several widespread Cerambycidae genera exist within the Fiji Islands. Among these, the genus *Ceresium* Newman (Cerambycidae: Cerambycinae: Callidiopini) is known to be represented on most oceanic islands by one or two widespread species, with additional local species restricted to either a single island or an island group (Bigger and Schofield 1983). Fiji has the highest number of species in this genus, followed by Papua New Guinea where 13 species are recorded (Bigger and Schofield 1983).

The Fijian *Ceresium* species have received little attention since their initial description. A taxonomic study on the Cerambycidae of the Fiji Islands by Dillon and Dillon (1952) concluded that a more thorough revision of the genus was needed and that the presence of additional species was likely. Lingafelter (2008) concluded, “*Ceresium* is in need of revision, and many species need to be studied more thoroughly as they are known only from their often brief original descriptions.” All of the 17 species treated herein are considered native, with 14 of them endemic to Fiji and three having a much broader distribution.

**Introduction to the Subfamily Cerambycinae; Tribe Callidiopini; Genus *Ceresium*.** The subfamily Cerambycinae has 121 tribes attributed to it globally (Tavakilian and Chevillotte 2015). Beetles within this subfamily can be characterized by the prognathous head, apically expanded palpi, rounded thorax, and relatively slender body. The tribe Callidiopini contains 61 genera globally, of which two genera are recorded for Fiji (*Ceresium* and *Oxymagis* Pascoe). The genus *Ceresium* can be differentiated from *Oxymagis* in the lengths of the antennae with *Ceresium* having its antennae usually as long as its body or longer while *Oxymagis* has antennae almost two thirds the length of its body (Dillon and Dillon 1952). *Ceresium* beetles are usually red-brown to dark brown in color, medium-sized, typically measuring 10–25 mm in total body length, head weakly exserted, and eyes deeply emarginate and pronotum elongate or subquadrate.

The genus *Ceresium* is the most speciose in the tribe, comprising 136 species and subspecies globally (Tavakilian and Chevillotte 2015). The highest diversity of *Ceresium* is found in the southeast Asia region and the Pacific Islands. However, the genus has also been recorded in Africa, Australia, and Papua New Guinea (Gressitt 1959; Hawkeswood 1993), with several additional records from North America and the Caribbean that may represent artificial introductions.

**Biology and ecology of the genus *Ceresium*.** Little has been published on the biology and ecology of *Ceresium*. Duffy (1963), Webb et al. (1988) and Hawkeswood and Dauber (1990) have summarized information available on the biology of the genus. Two species within the genus are widespread species: *C. flavipes* (Fabricius) and *C. unicolor* (Fabricius). *C. unicolor* is widespread in Melanesia being recorded from Waigeo Island, Papua New Guinea, Bismarck Archipelago, Solomon Islands, Vanuatu and Fiji (Bigger and Schofield 1983). Both species are polyphagous in the larval stages, breeding on a range of flowering plants from botanically unrelated families. A study by Hawkeswood and Dauber (1990) indicated that some species are able to adapt well to feeding on the wood and/or sap of foreign plant species as well as native plants.

The habits of adult *Ceresium* are virtually unknown. A study on the species *C. pachymerum* Pascoe in Papua New Guinea by Hawkeswood and Dauber (1990) suggested that adult beetles emerge throughout the year. In addition, adults of *C. pachymerum* appeared to be predominantly nocturnal, often attracted to bright lights around human habitation and usually flying early on warm nights after rain. The adults of *C. pachymerum* do not produce any offensive odours or secretions as do other Cerambycinae, but usually stridulate softly and attempt to bite and arch their antennae repeatedly backwards as a defense mechanism (Hawkeswood and Dauber 1990).

**Distribution of *Ceresium* in Fiji.** Members of the genus in Fiji are known from the islands of Viti Levu, Vanua Levu, Taveuni, Ovalau, Gau, Koro, Kadavu and the Lau group (Dillon and Dillon 1952). Sixteen species have been recorded on the largest island of Viti Levu (Dillon and Dillon 1952; Waqa and Lingafelter 2009). The species *C. gracilipes* Fairmaire is quite widespread throughout most of the Fiji islands and is abundant in the Lau island group. The recently described species *C. tuberculatum* Waqa & Lingafelter, 2009 has been recorded from only two islands; Viti Levu and Gau, being more abundant in Gau Island. Vanua Levu is the second largest island in Fiji yet only *C. gracilipes* has been recorded there. However, this is probably attributable to the lack of insect sampling rather than true absence of species. It is likely that further survey work on the islands of Gau, Koro and Vanua Levu may yield more species with more intensive sampling effort since they have intact forest patches that are likely to harbor representatives of the genus.

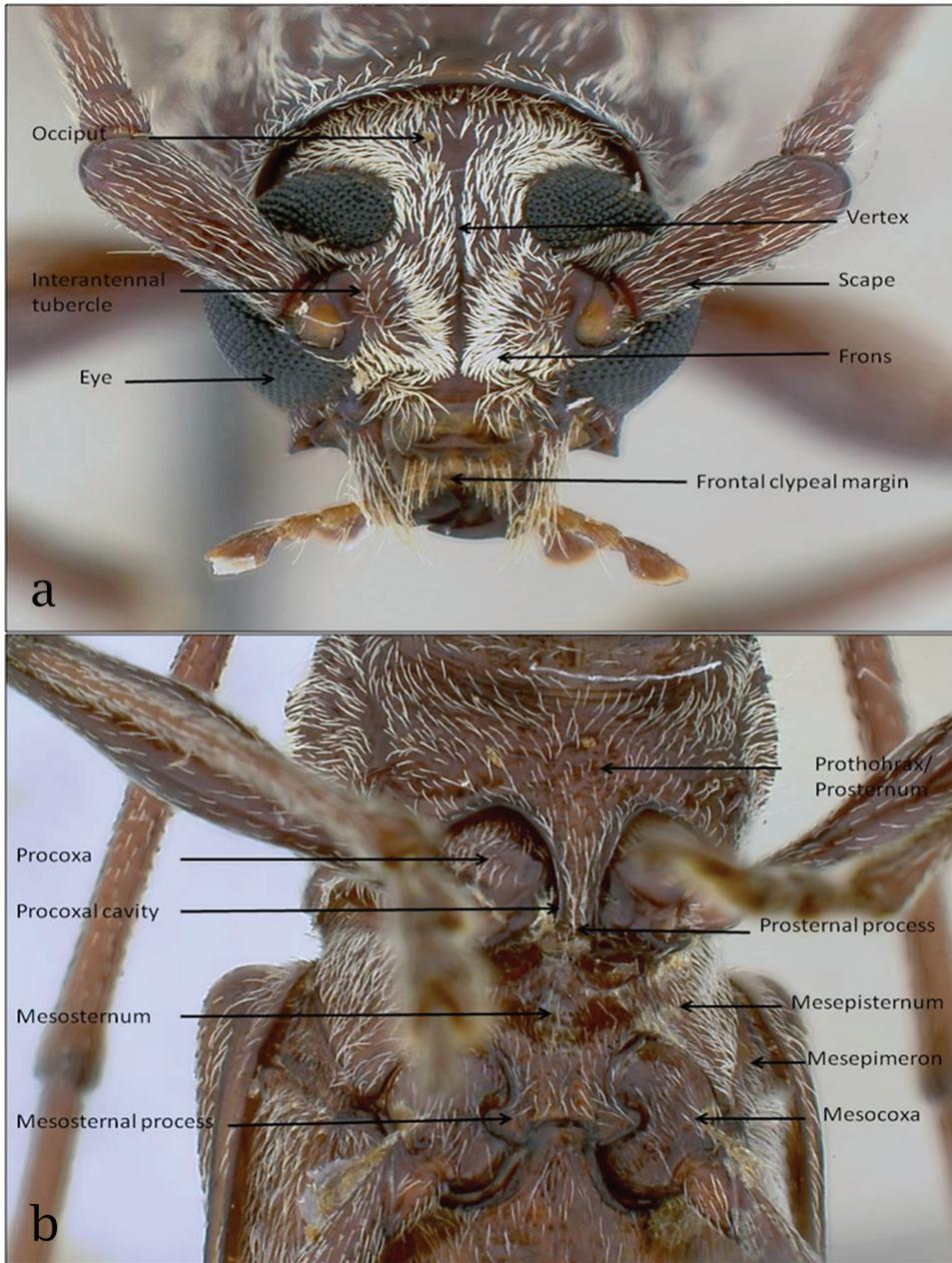
## Materials and methods

**Sources and deposition of material.** Holotypes of the species recorded for Fiji and described by Dillon and Dillon (1952) are maintained in the Bernice P. Bishop Museum (BPBM), Hawaii. Those described by Fairmaire (1850; 1881) are deposited in the Muséum national d'Histoire naturelle, Paris, France (MNHN). Additional material examined is deposited in the Natural History Museum, London, UK (NHM), the Smithsonian Institution, Washington DC, USA (USNM) and the Institut royal des Sciences naturelles de Belgique, Brussels, Belgium (IRSB), and the entomological collection at the University of the South Pacific, Fiji (USP).

Where possible, redescriptions were based on examination of holotype specimens. Occasionally, it was necessary to examine photographs of types or original literature as supplemental references—the latter especially if the holotypes or lectotypes could not be found and presumed lost.

**Species description procedure.** Species descriptions were made using a standard template for each of the 17 species of *Ceresium*. Much of the descriptions of each taxon were updated, but, the original text was retained whenever possible when reviewing each species. Observations include detailed descriptions for the head region (vertex and occiput, antennae, frons and frontoclypeal margin; Figure 1a); pronotal region (elytra, scutellum and legs, Fig. 1b) and the ventral region (venter, prosternal process and mesosternum; Fig. 1b). These morphological characters were observed using a stereomicroscope and any measurements were taken using inbuilt eyepiece graticules. Morphological characters were described consistently across species using a glossary of terms and definitions by Gordh and Headrick (2001).

Original descriptions were also adapted to include detailed high resolution color photographs of each specimen. Photographs of museum voucher specimens were taken using a Leica MZApo stereomicroscope. Extended focus images were taken using a JVC digital camera KY-F70 and Archimed software (Microvision Instruments).



**Figure 1.** Key anatomy of *Ceresium*: **a** head **b** pro- and mesothorax.

Detailed photographs taken for each species included: a) dorsal habitus, b) head region, c) pronotal region and d) ventral region. A key was then developed to provide a means to distinguish individual species.

## Systematics

### *Ceresium decorum* Dillon & Dillon, 1952

Fig. 2

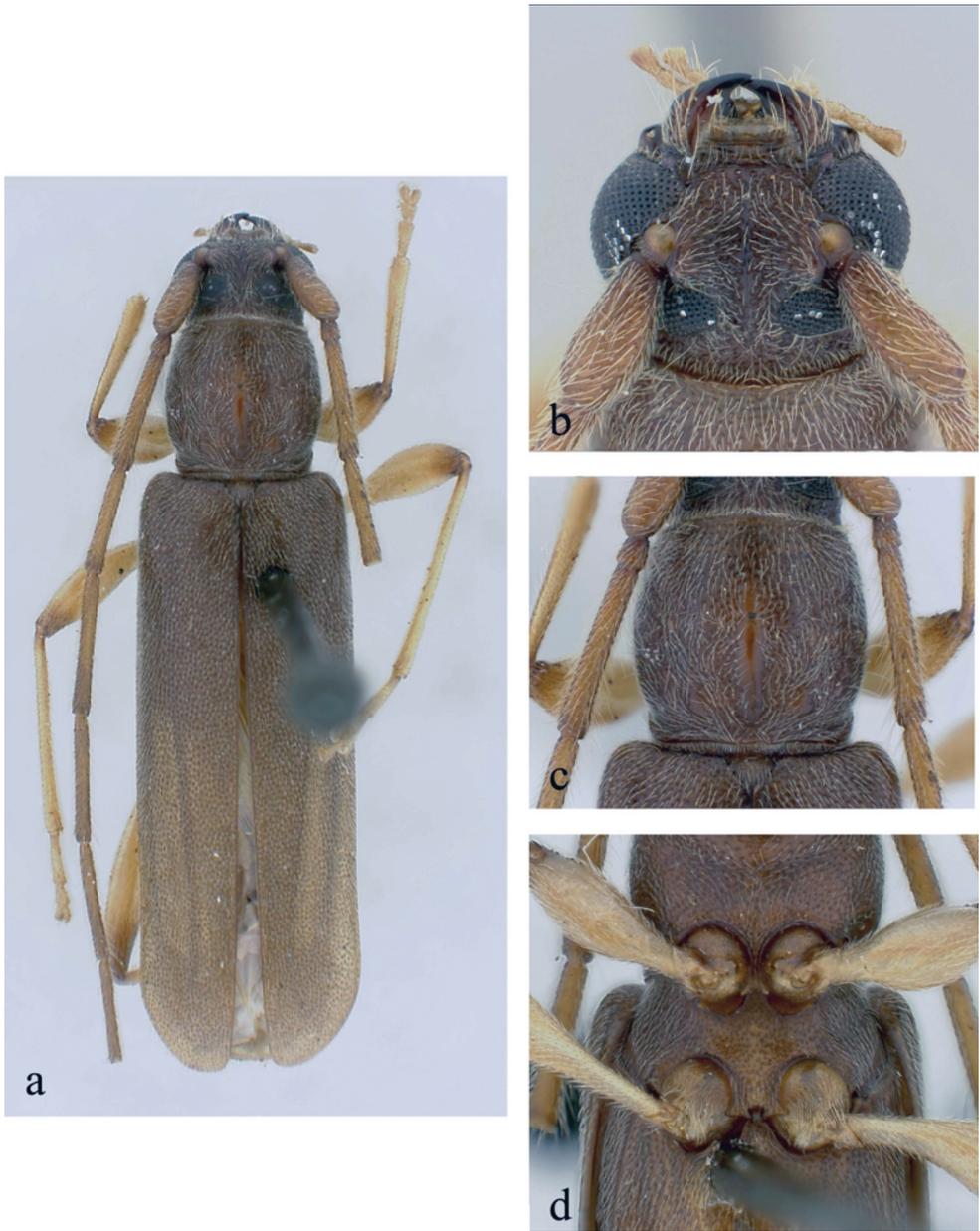
*Ceresium decorum*: Dillon and Dillon 1952: 22, Fiji: Moala, Vanuka, holotype (BPBM).

**Redescription.** Based on the holotype specimen (BPBM) and original description. *Size* 11.7 mm long, 2.8 mm wide at humeri; integument color brown (paler towards elytral apex; Fig. 2a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with very sparse ochraceous pubescence on tubercles and throughout frons; vertex and occiput with sparser ochraceous pubescence. Ochraceous pubescence less dense around eye margins. Frons and frontoclypeal margin punctate with sparse, short and long, ochraceous hairs (see head details on Figure 2b). *Antennae* long, extending beyond elytra by three antennomeres. Antennae with vestiture of short, moderately dense, ochraceous setae (longer at apices of antennomeres). Antennomeres unspined and not expanded at apices; Antennomeres 9–11 were damaged. Antennomere 3 and 4 each longer than scape; 5 longest. Very short scape, wide, extending just slightly beyond pronotal front.

*Pronotum* broadly arcuate, widest across middle, and almost as wide as long. Pronotum with glabrous median vertical line, glabrous patch on either basal sides of median line. Pronotum with sparse punctures and sparsely scattered pubescence elsewhere (Fig 2c). *Elytron* with sparse and regularly spaced ochraceous pubescence. Punctuation dense, shallow and gradually becoming shallower and smaller in size towards apex. Elytral apex rounded to suture. Scutellum triangular, narrowly rounded, covered with sparse, ochraceous pubescence. *Legs* moderate in length, femora distinctly but gradually clavate, length of hind femora (3.64 mm), base of femur extending to apical margin of 5<sup>th</sup> ventrite.

*Venter* of abdomen and thorax with sparse translucent to pale, ochraceous pubescence throughout. Length of abdomen 4.38 mm. Prosternal process very narrow, gradually declivous, weakly notched and expanded at apex, approximately 1/8 width of procoxa. Procoxal cavities widely open posteriorly. Mesocoxae closed laterally to mesepimeron. Mesosternum not produced vertically, without anterior tubercle or sulcus; with weak but acute lateral projections into mesocoxae (Fig. 2d). Apex of terminal ventrite subtruncate without notch.

**Remarks.** This species is most similar to *C. promissum* Dillon & Dillon based on the key characters. It is distinguished from that species by having the mesosternal process basal notch angled (parallel-sided in *C. promissum*) and the pronotum having a narrow, glabrous, longitudinal line centrally located (restricted to posterior half in *C. promissum*). This species is endemic to Fiji and known only from Moala, Viti Levu, and Lau Islands. It has been collected from rotten logs and dead branches in August and October (Dillon and Dillon 1952).



**Figure 2.** *Ceresium decorum* Dillan & Dillan: **a** dorsal habitus showing integument color (paler towards elytral apex) **b** head detail **c** pronotal detail **d** ventral detail.

***Ceresium epilais* Dillon & Dillon, 1952**

Fig. 3

*Ceresium epilais*: Dillon and Dillon 1952: 23, Fiji: Viti Levu, Colo-i-Suva, holotype (BPBM).

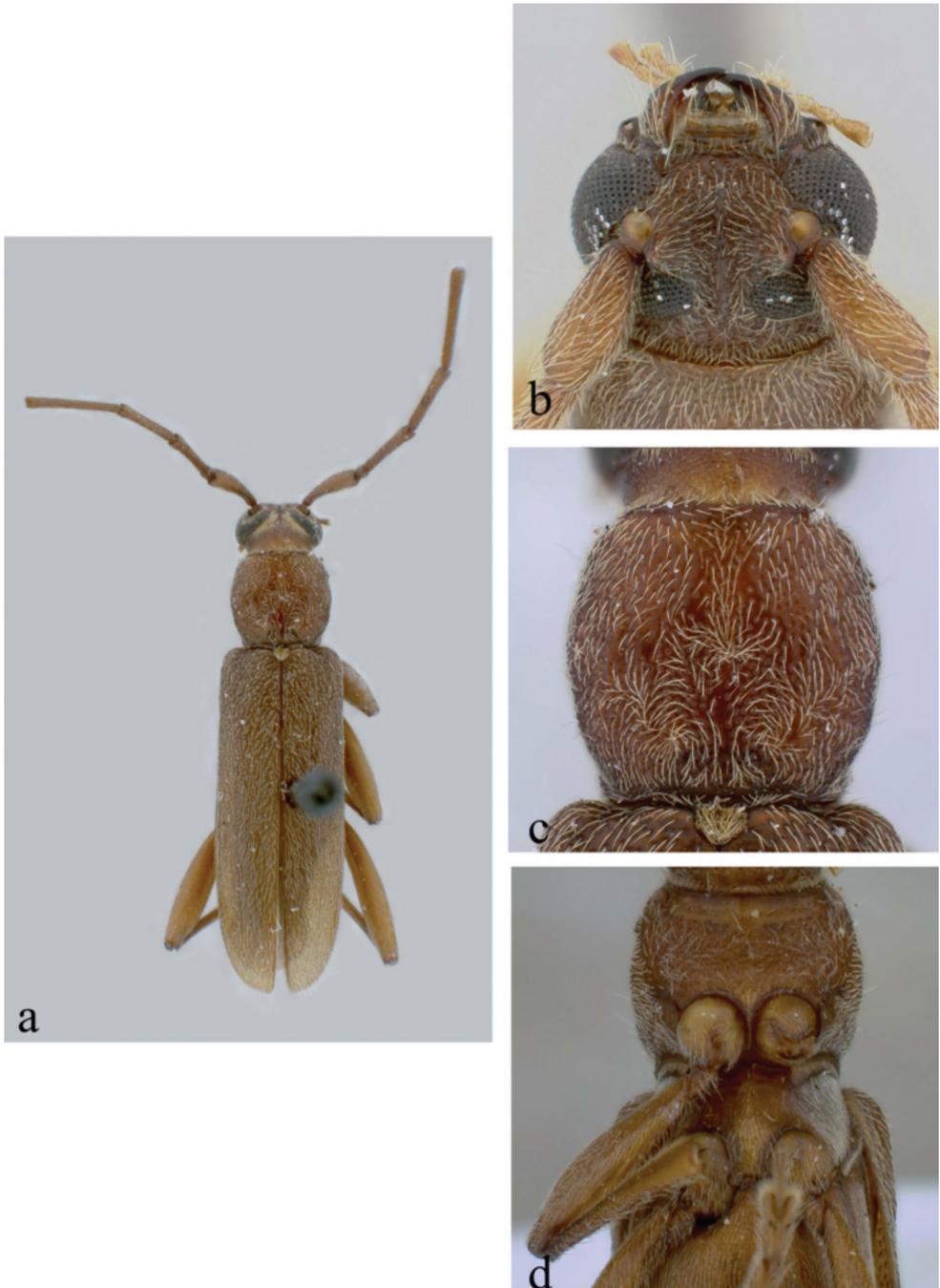
**Description. Based on the holotype specimen (BPBM) and original description.**

*Size* 11.5 mm long, 3.1 mm wide at humeri; integument color brown to light brown (Fig. 3a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with very sparse ochraceous pubescence on tubercles and throughout frons; vertex and occiput with sparser ochraceous pubescence. Ochraceous pubescence denser around lower eye margins and around lower antennal insertions. Frons and frontoclypeal margin punctate with sparse, short and long, ochraceous hairs (Fig. 3b). *Antennae* long, extending beyond elytra by two antennomeres. Antennae with vestiture of short, dense, ochraceous setae (longer at apices of antennomeres). Antennomeres unspined and not expanded at apices; Antennomeres 6–11 damaged. Antennomere 3 subequal in length to scape (1.34 mm), Antennomeres 4 and 5 longer than scape, 5 being the longest (2.35 mm). Scape moderate in length (1.34 mm), clavate apically, extending to apical fourth of pronotum.

*Pronotum* broadly arcuate, widest across middle, and slightly wider than long; apex a little narrower than base. Disc densely punctate with sparsely scattered pubescence elsewhere (Fig. 3c). *Elytron* with subparallel sides, with coarsely dense punctures and regularly spaced ochraceous pubescence. Elytral apex rounded to suture. Scutellum narrowly rounded, covered with dense, rugose (matted), ochraceous pubescence. *Legs* moderate in length (4.02 mm), femora distinctly but gradually clavate, hind femora extending apical margin of 5<sup>th</sup> ventrite.

*Venter* of abdomen and thorax with mostly sparse, pale ochraceous pubescence throughout, becoming most dense on episternites. Length of abdomen 3.64 mm. Prosternal process very narrow, barely separating and not extending to posterior margin of procoxae; gradually declivous, not expanded at apex, less than 1/15 width of procoxa. Procoxal cavities widely open posteriorly. Mesocoxae closed laterally to mesepimeron. Mesosternum not produced vertically, without anterior tubercle or sulcus; without lateral projections into mesocoxae (Fig. 3d). Apex of terminal ventrite broadly truncate apically without notch.

**Remarks.** Superficially similar in form and color to *C. vacillans* Dillon & Dillon, it is easily distinguished from that species by having the pronotum more rounded laterally and the elytra lacking glabrous patches. In the key characters, it is most similar to *C. lucidum* Dillon & Dillon, but is distinguished by having the pronotum widest at middle (widest anteriorly in *C. lucidum*). This species is endemic to Fiji and known only from a single specimen collected on Viti Levu in June (Dillon and Dillon 1952).



**Figure 3.** *Ceresium epilais* Dillon & Dillon: **a** dorsal habitus **b** head detail **c** pronotal detail **d** ventral detail.

***Ceresium gracilipes* Fairmaire, 1881**

Fig. 4

*Ceresium gracilipes*: Fairmaire 1881: 473, Fiji: Ovalau, lectotype (MNHN).

**Description.** Based on photograph of lectotype (MNHN) and redescription of Dillon and Dillon (1952). *Size* 4.0–8.5 mm long, 0.7–1.5 mm wide at humeri; elongate-oblong, slender, convex; head and pronotum medium reddish brown, elytra testaceous, laterally darker and with a narrow indistinct fascia behind middle darker; entirely covered with thin pale-fulvous pubescence, which is moderately long; abdomen testaceous (Fig. 4a). Legs testaceous, femora on apical half darker with pubescence as above, antennae slightly darker with slightly longer pubescence. *Head* very coarsely, roughly punctate. *Antennae* extending beyond half times body length; scape short reaching to apex of pronotum, robust, gradually thickened apically, coarsely punctate, antennomere 3 slightly shorter than scape, antennomere 4 shorter than 3<sup>rd</sup>; 5<sup>th</sup> longer than 3<sup>rd</sup>, remaining gradually shorter.

*Pronotum* feebly elongate; base and apex subequal; sides distinctly arcuate, apical sulcus very broad and shallow; an elongate narrow, median callosity at base; disk slightly less coarsely punctate than head. *Elytra* with sides nearly parallel to apical quarter, apices slightly, narrowly rounded, entire disk coarsely, densely rugose. Scutellum broadly rounded, sparsely pubescent with an indistinct, dark macula postmedially. *Legs* moderate in length, femora moderately clavate with hind femora extending well before elytral apex.

*Venter* with pubescence unexamined. *Prosternum* very narrow between procoxae and broadly expanded apically. *Mesosternum* process wide and strongly expanded at apex, apical margin subtruncate, angle fitting into grooves in mesocoxae; mesocoxae subcontiguous. Fifth sternite attenuate, apical margin strongly emarginate in male; subtruncate in female.

**Remarks.** This species is recognized by the relatively narrow, parallel-sided appearance and elytra with an indistinct, postmedial dark macula that extends toward the base. It is distinguished from the similar *C. olidum* (Fairmaire) by having the elytra more finely punctate and the pronotum less regularly and densely punctate. This species is endemic to Fiji and known from Viti Levu, Taveuni, Ovalau, and the Lau Islands where it has been collected by beating shrubs from August through November (Dillon and Dillon 1952).

***Ceresium grandipenne* Fairmaire, 1881**

Fig. 5a–d

*Ceresium grandipenne*: Fairmaire 1881: 472, Fiji: Viti Levu, holotype (MNHN).

**Description.** Based on a specimen housed in USP matching original description (the holotype at MNHN is lost). *Size* 21.5–34.0 mm long, 6.0–8.5 mm wide at humeri;

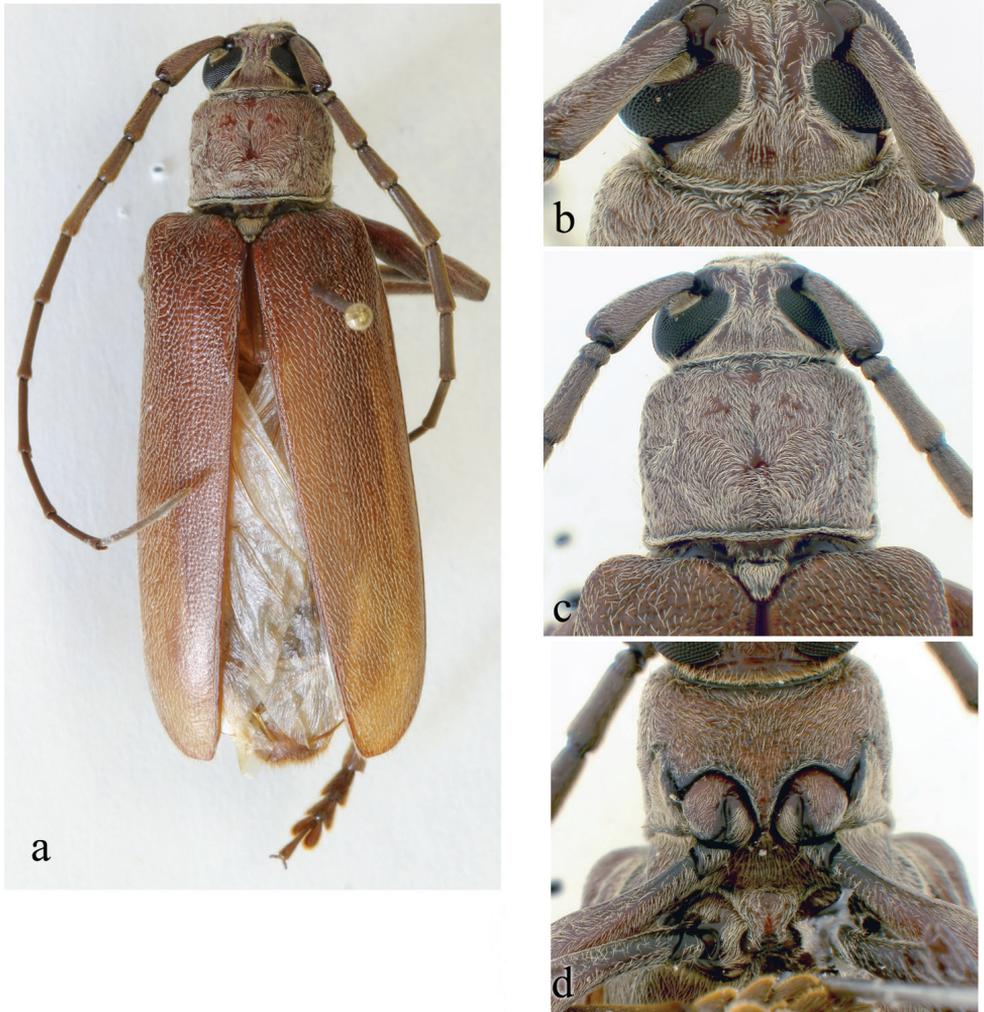


**Figure 4.** *Ceresium gracilipes* Fairmaire: **a** dorsal habitus **b** lectotype specimen labels.

integument light brown to brown (Fig. 5a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with very sparse ochraceous pubescence on tubercles and throughout frons except center being glabrous; vertex and occiput with moderately dense ochraceous pubescence. Ochraceous pubescence denser around eye margins. Frons and frontoclypeal margin moderately dense, coarsely punctate with sparse, long, ochraceous hairs (Fig. 5b). *Antennae* long, just almost reaching elytral apex. Antennae with vestiture of short, dense, ochraceous setae (longer at apices of antennomeres). Antennomeres unspined and expanded at apices; last antennomere about 1.6 times length of penultimate. Antennomere 3–10 each shorter than scape, 3 being the shortest; 11 longest. Scape long, clavate, extending to apical eighth of pronotum.

*Pronotum* quadrate, slightly widest at apical third, and wider than long; not tuberculate; calli absent. Pronotum with moderately dense ochraceous pubescence throughout and moderately dense punctures (Fig. 5c). *Elytron* with sparse, evenly spaced ochraceous pubescence throughout. Punctation shallow, moderately dense gradually becoming shallower and indistinct towards apex. Elytral apex rounded to suture. Scutellum triangular, covered with dense, ochraceous pubescence. *Legs* moderate in length, femora distinctly but gradually clavate, hind femora extending to base of third ventrite.

*Venter* of abdomen and thorax with moderately dense, ochraceous pubescence at sides, sparse ochraceous pubescence along middle; prosternum sparsely pubescent throughout and on sides. Prosternal process narrow, vertical and acutely declivous, about 1/6 width of procoxa, strongly notched and expanded at apex. Procoxal cavities open posteriorly. Mesocoxae closed laterally to mesepimeron. Mesosternum rather acutely declivous, with small anterior tubercle, and sulcate anteriorly. Mesosternal



**Figure 5.** *Ceresium grandipenne* Fairmaire: **a** dorsal habitus **b** head detail **c** pronotal detail **d** ventral detail.

apex expanded circularly and inserted into mesocoxa (Fig. 5d). Metasternum with a distinct median line running longitudinally along middle. Apex of terminal ventrite truncate to unevenly rounded, without notch.

**Remarks.** There is some inconsistency between the original description (Fairmaire 1881) and redescription (Dillon and Dillon 1952) of this rarely collected species. The latter states that the pronotum is much narrower anteriorly than at base and possesses a tubercle on each side, however our examination of a specimen matching the original

description reveals the pronotum to be quadrate, without lateral tubercles. The large size of this species, along with the quadrate pronotum and opaque integument are distinctive. This species is endemic to Fiji and known only from Viti Levu. Specimens have been collected from August through October, mostly at lights (Dillon and Dillon 1952).

***Ceresium guttaticolle* (Fairmaire, 1850), rev. stat.**

Fig. 6

*Hesperophanes guttaticollis*: Fairmaire 1850: 63, Tahiti, holotype (MNHN).

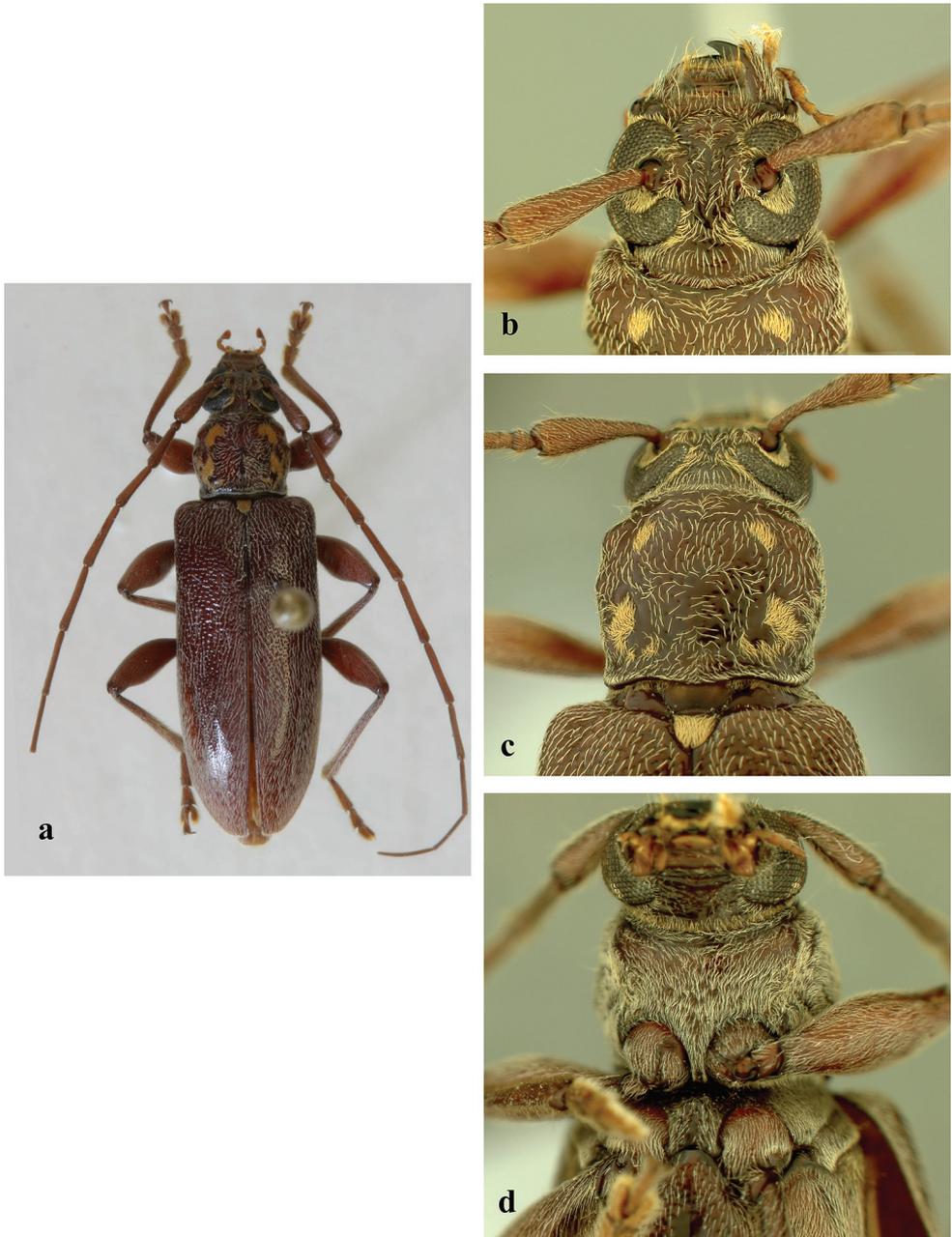
*Ceresium guttaticolle yapense*: Gressitt 1956: 86, Micronesia: Yap Islands, holotype (USNM).

**Description.** Based on the holotype (MNHN), holotype of the subspecies *yapense* Gressitt (USNM), and four specimens from 1988 and 2008 surveys (FNIC, USP). *Size* 12.5–15.0 mm long, 3.0–3.5 mm wide at humeri; integument color orangish-brown (occasionally maroon-brown) (Fig. 6a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with very sparse ochraceous pubescence on tubercles and throughout frons; vertex and occiput with sparser ochraceous pubescence. Ochraceous pubescence denser around eye margins. Frons and frontoclypeal margin punctate with sparse, short and long, ochraceous hairs (Fig. 6b). *Antennae* long, extending beyond elytra by 1 antennomere. Antennae with vestiture of short, dense, ochraceous setae (longer at apices of antennomeres). Antennomeres unspined and not expanded at apices; last antennomere approximately 1.3 times length of penultimate. Antennomere 3 and 4 each shorter than scape; 5 and 6 longest except for 11 and subequal in length. Scape long, clavate, extending to apical fifth of pronotum.

*Pronotum* broadly arcuate, widest across middle and slightly wider than long; small tubercles at sides located at middle of sides and anterolaterally. Pronotum with two dense yellow patches of pubescence on either side of pronotum almost subequal in size. Pronotum with sparse punctures and sparsely scattered pubescence elsewhere (Fig. 6c). *Elytron* with sparse and regularly spaced ochraceous pubescence. Punctuation dense, shallow and gradually becoming shallower and smaller in size towards apex. Elytral apex rounded to suture. Scutellum narrowly rounded, covered with dense, yellow pubescence. *Legs* moderate in length, femora distinctly but gradually clavate, hind femora extending to between 4<sup>th</sup>–5<sup>th</sup> ventrite.

*Venter* of abdomen and thorax with moderately dense, ochraceous pubescence throughout becoming less abundant towards 5<sup>th</sup> ventrite. Prosternal process broad, vertical and acutely declivous, approximately 1/5 width of procoxa, weakly notched and not expanded at apex. Procoxal cavities open posteriorly. Mesocoxae closed laterally to mesepimeron (Fig. 6d). Mesosternum rather acutely declivous, with small anterior tubercle, and sulcate anteriorly. Apex of terminal ventrite subtruncate without notch.

**Remarks.** Although first described under the name *Hesperophanes guttaticollis*, the holotype actually has a label indicating “*guttatus*”. This is one of the easiest species to recognize due to the yellow pubescent maculations on the pronotum. Only one other



**Figure 6.** *Ceresium guttaticolle* (Fairmaire): **a** dorsal habitus **b** head detail **c** pronotal detail **d** ventral detail.

species, *C. nigroapicale* Dillon & Dillon has this feature. *Ceresium guttaticolle* has two patches on either side, subequal in length, while *C. nigroapicale* has three or four areas of yellowish pubescence on either side, with the apical noticeably larger. This species

was originally described from Tahiti and is also known from Viti Levu, Taveuni, and the Lau Islands in Fiji. The subspecies *Ceresium guttaticolle yapense* Gressitt, 1956 is known from the Yap Islands, Micronesia. Specimens have been collected, mostly at lights, from July through October (Dillon and Dillon 1952). We remove this from synonymy with *Ceresium unicolor* (Fabricius, 1787).

### ***Ceresium lucidum* Dillon & Dillon, 1952**

Fig. 7

*Ceresium lucidum*: Dillon and Dillon 1952: 25, Fiji: Viti Levu, holotype (BPBM).

**Description.** Based on the holotype specimen (BPBM). *Size* 9.5 mm long, 2.0 mm wide at humeri; integument color reddish brown, lighter brown towards elytral apex (Fig. 7a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with sparse ochraceous pubescence on tubercles and throughout frons; vertex and occiput with sparse ochraceous pubescence. Frons and frontoclypeal margin punctate with sparse and long, ochraceous hairs (Fig. 7b). *Antennae* long, extending beyond elytra by < 2 antennomeres. Antennae with vestiture of short, dense, ochraceous setae. Antennomeres unspined and not expanded at apices; antennomeres 9–11 damaged. Antennomere 4 almost subequal to scape (0.9 mm); 5 longest. Scape very short, gradually clavate, extending slightly beyond apex of pronotum.

*Pronotum* broadly arcuate, widest across middle, and almost as wide as long. Pronotum with sparse punctures and sparsely scattered pubescence elsewhere (Fig. 7c). *Elytron* with sparse and regularly spaced ochraceous pubescence. Punctuation dense, shallow and gradually becoming shallower and smaller in size towards apex. Elytral apex rounded to suture. Scutellum triangular and narrowly rounded covered with sparse, ochraceous pubescence. *Legs* moderate in length, femora distinctly but gradually clavate, base of hind femora (3.02 mm) extending to apical margin of 5<sup>th</sup> ventrite.

*Venter* of abdomen and thorax sparsely ochraceous pubescent throughout, not obscuring integument. Length of abdomen 3.82 mm. Prosternal process very narrow, gradually declivous, weakly notched and expanded at apex, less than 1/5 width of procoxa. Procoxal cavities widely open posteriorly. Mesocoxae closed laterally to mesepimeron (Fig. 7d). Mesosternum not produced vertically, without anterior tubercle or sulcus; without lateral projections into mesocoxae. Apex of terminal ventrite subtruncate without notch.

**Remarks.** The key characters show this species to be closest to *C. epilais*. *Ceresium lucidum* is distinguished by having the pronotum with a diffuse, dark macula at either side of middle, and being widest anterior of the midpoint while *C. epilais* lacks pronotal maculae and is widest medially at sides. This rare species is endemic to Fiji and known only from the holotype that was collected on Viti Levu at lights during October (Dillon and Dillon 1952).



**Figure 7.** *Ceresium lucidum* Dillon & Dillon: **a** dorsal habitus **b** head detail **c** pronotal detail **d** ventral detail.

***Ceresium nigroapicale* Dillon & Dillon, 1952**

Fig. 8

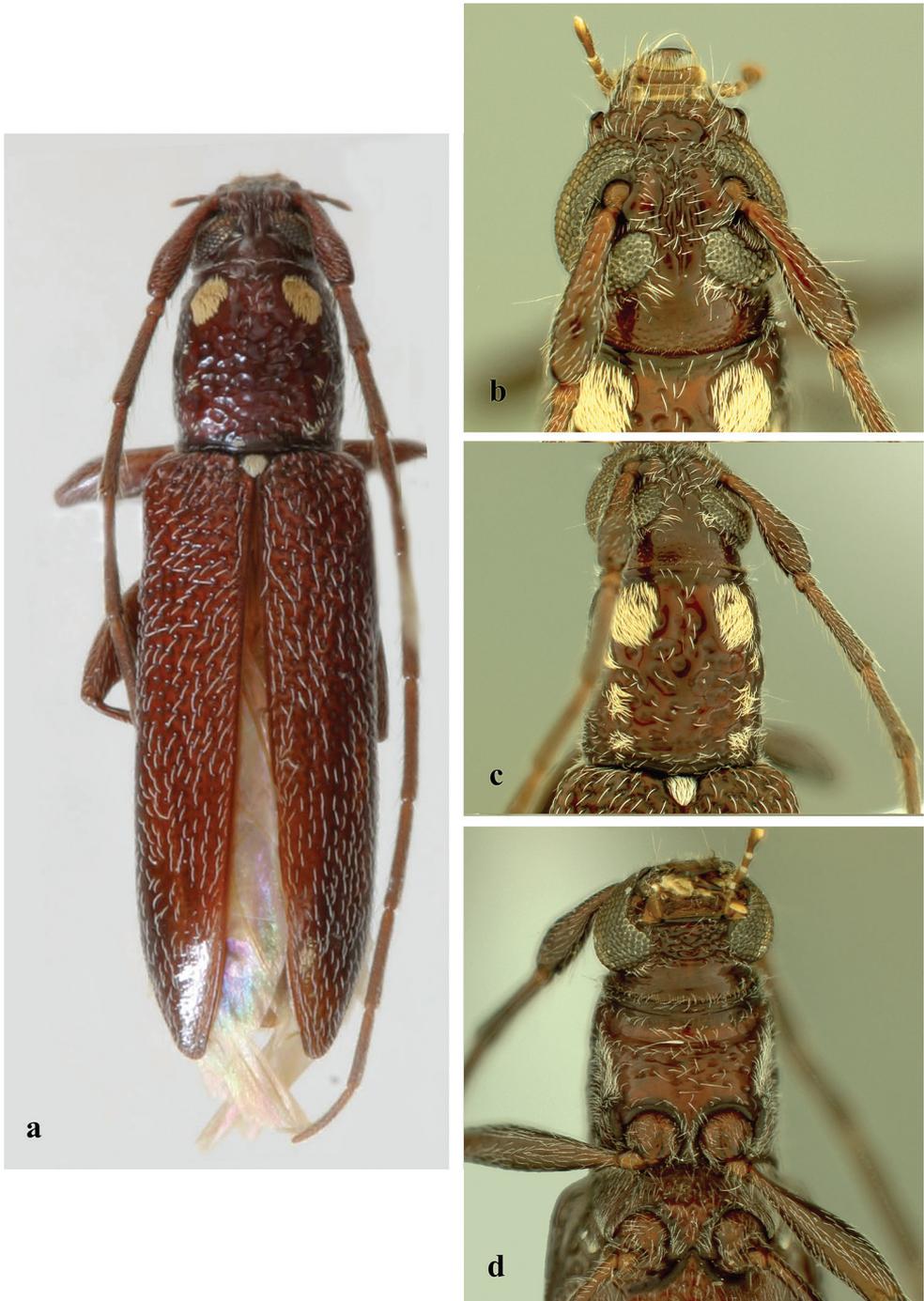
*Ceresium nigroapicale*: Dillon and Dillon 1952: 27, Fiji: Viti Levu, holotype (BPBM).

**Description.** Based on the holotype specimen (BPBM) and two specimens from 2008 surveys (FNIC, USP). *Size* 8.5–12.0 mm long, 2.0–2.5 mm wide at humeri; integument color maroonish-brown (Fig. 8a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with very sparse ochraceous pubescence on tubercles and throughout frons; vertex and occiput bare. Ochraceous pubescence sparsely around eye margins. Frons and frontoclypeal margin coarsely punctate with sparse, short and long, ochraceous hairs (Fig. 8b). *Antennae* long, extending beyond elytra by almost two antennomeres. Antennae with vestiture of short, dense, ochraceous setae (longer at apices of antennomeres). Antennomeres unspined and not expanded at apices; last antennomere almost subequal in length of penultimate. Antennomere 3 and 4 each shorter than scape; 5–9 longest except for 10–11 and subequal in length. Scape long, clavate, extending to apical fifth of pronotum.

*Pronotum* cylindrical, widest at basal third and slightly longer than wide. Pronotum with four dense patches of yellow pubescence on either side. Apical one largest in size and remaining three almost subequal in size, all arranged longitudinally on either side of pronotum. Pronotum glabrous at center with a few scattered yellow setae with large irregular punctures (Fig. 8c). *Elytron* with sparse, evenly spaced ochraceous pubescence. Punctuation shallow, sparse, gradually becoming shallower and indistinct towards apex. Elytral apex rounded to suture. Scutellum narrowly rounded, covered with dense, ochraceous pubescence. *Legs* small to moderate in length, femora distinctly but gradually clavate, hind femora extending to base of fourth ventrite.

*Venter* of abdomen and thorax with sparse ochraceous pubescence throughout. Prosternal process narrow, approximately 1/4 width of procoxa, notched and expanded at apex. Procoxal cavities open posteriorly (Fig. 8d). Mesocoxae closed laterally to mesepimeron. Mesosternum slightly declivous, without anterior tubercle, and sulcate anteriorly. Apex of terminal ventrite truncate to unevenly rounded, without notch. In males, fifth sternite narrow elongate, with a deep V-shape emargination medially extending basally more than one-half its length.

**Remarks.** This is one of two species characterized by dense pubescent maculae on the pronotum, the other being *Ceresium guttaticolle*. That species has two patches on either side, subequal in length, while *C. nigroapicale* has three or four areas of yellowish pubescence on either side, with the apical noticeably larger. *Ceresium nigroapicale* is further distinguished by the elytra having diffusely darker coloration apically and laterally and very coarse punctuation on the basal half. This is another rare species that is endemic to Fiji and known only from Viti Levu. Specimens have been collected in July and September by beating vegetation (Dillon and Dillon 1952).



**Figure 8.** *Ceresium nigroapicale* Dillon & Dillon: **a** dorsal habitus (holotype, BPBM) **b** head detail **c** pronotal detail **d** ventral detail.

***Ceresium olidum* (Fairmaire, 1850)**

Fig. 9

*Hesperophanes olidus*: Fairmaire 1850: 63, Tahiti, holotype (MNHN).

**Description.** Based on a photograph of the holotype specimen (MNHN) and two specimens from 2008 surveys (FNIC, USP). *Size* 6.5–7.0 mm long, 1.0–1.5 mm wide at humeri; integument color orangish-brown (Fig. 9a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with very sparse ochraceous pubescence on tubercles and throughout frons; vertex and occiput with sparser ochraceous pubescence. Frons and frontoclypeal margin punctate with sparse, long, ochraceous hairs (Fig. 9b). *Antennae* long, extending beyond elytra by two antennomeres. Antennae with vestiture of short, dense, ochraceous setae. Antennomeres unspined and slightly expanded at apices; last antennomere almost subequal the length of penultimate. Antennomere 3 and 4 each shorter than scape; 5 longest. Scape long, clavate, extending to apical fifth of pronotum.

*Pronotum* rounded, widest across middle, and as long as wide. Pronotum with fine, sparse and evenly spaced punctures throughout (Fig. 9c). *Elytron* with fine, evenly spaced ochraceous pubescence throughout. Punctuation shallow becoming shallower and indistinct towards apex. Elytral apex broadly rounded to suture. Scutellum triangular in shape, covered with sparse, translucent, inconspicuous pubescence. *Legs* small in length, femora distinctly but gradually clavate, hind femora extending to elytral apex.

*Venter* of abdomen and thorax with sparse, ochraceous pubescence throughout. Prosternal process absent. Procoxal cavities open posteriorly. Mesocoxae closed laterally to mesepimeron (Fig. 9d). Mesosternum rather gradually declivous, without anterior tubercle, and sulcate anteriorly. Apex of terminal ventrite truncate to unevenly rounded, without notch.

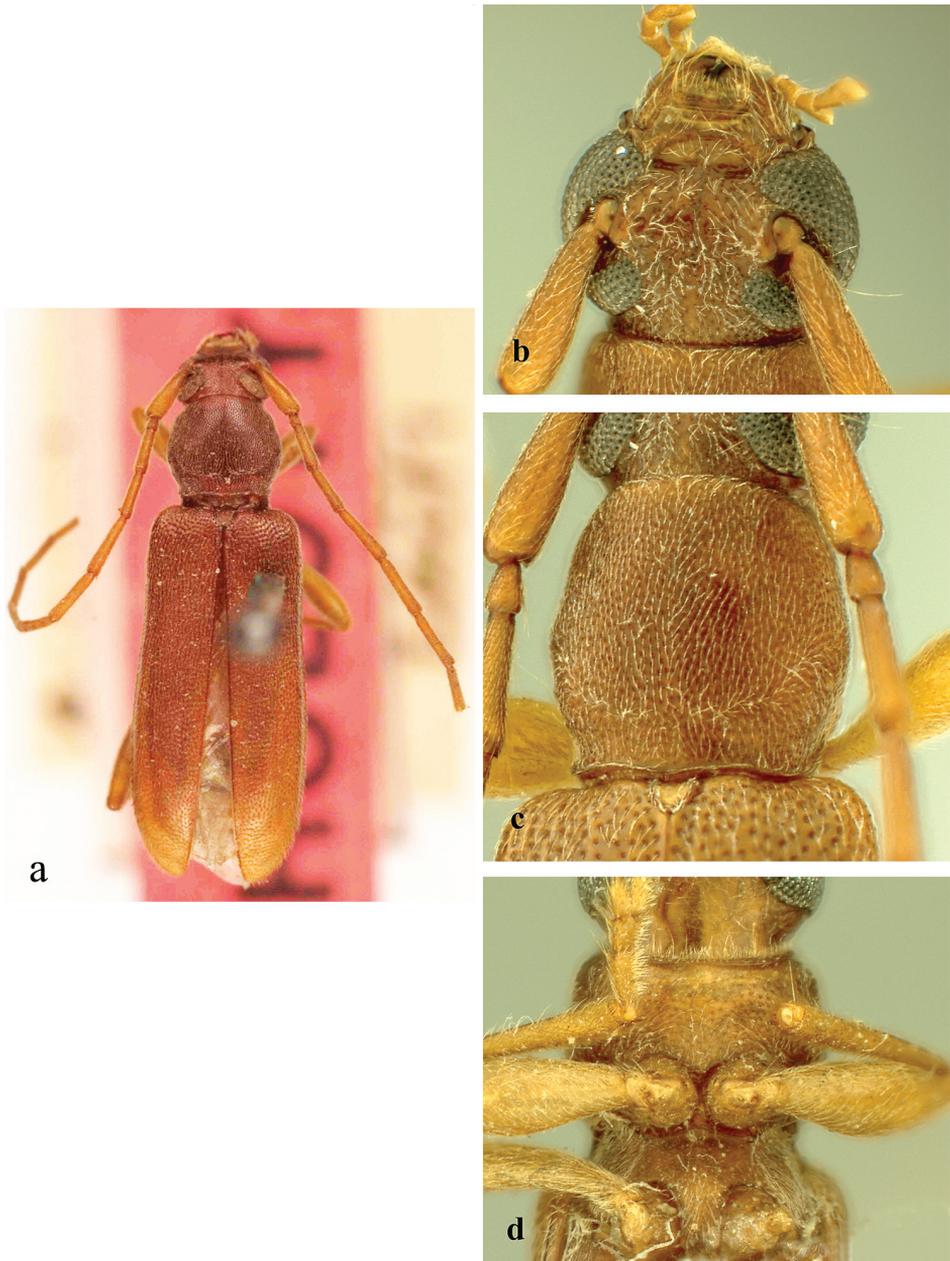
**Remarks.** This species is distinguished by having the pronotum with uniform, dense punctuation, the third antennal segment extending to about the midpoint of pronotum, and the head, pronotum and scutellum with fine, sparse, ochraceous pubescence. It shares with *C. scutellaris* an incomplete prosternal process between the procoxae. Originally described as *Hesperophanes*, it is known from Viti Levu and the Lau Islands, Fiji and also recorded from Tahiti and Raiatea of the Society Islands of French Polynesia in the original description (Dillon and Dillon 1952; Fairmaire 1850).

***Ceresium promissum* Dillon & Dillon, 1952**

Fig. 10

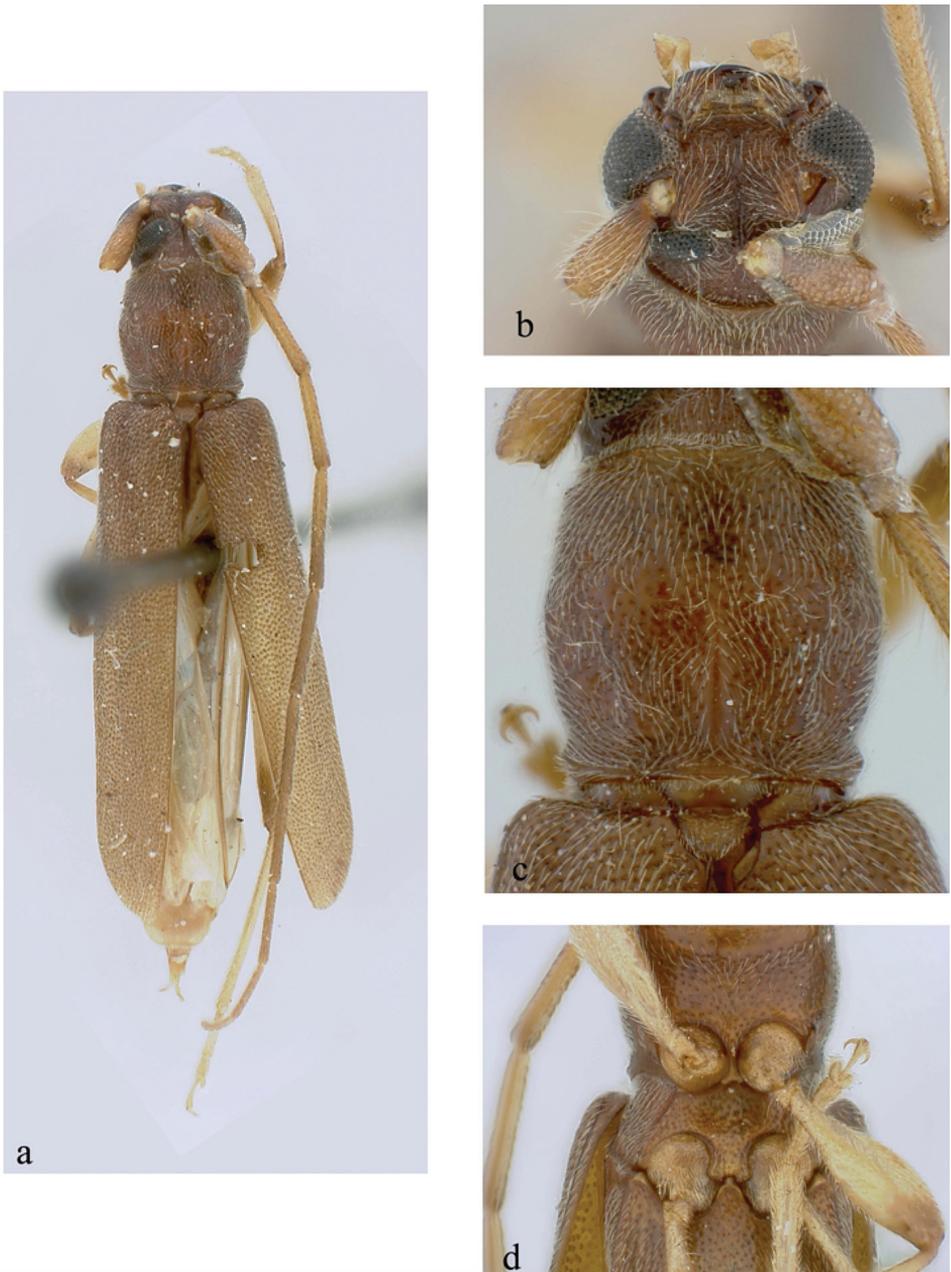
*Ceresium promissum*: Dillon and Dillon 1952: 25, Fiji: Viti Levu, Colo-i-Suva, holotype (BPBM).

**Description.** Based on the holotype specimen (BPBM) and original description. *Size* 8.9 mm long, 1.9 mm wide at humeri; integument color dark brown (pale brown to-



**Figure 9.** *Ceresium olidum* (Fairmaire): **a** dorsal habitus (holotype, MNHN) **b** head detail **c** pronotal detail **d** ventral detail.

wards elytral apex) (Fig. 10a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with very sparse ochraceous pubescence on tubercles and throughout frons; vertex and occiput with sparser ochraceous pubescence. Frons



**Figure 10.** *Ceresium promissum* Dillon & Dillon: **a** dorsal habitus **b** head detail **c** pronotal detail **d** ventral detail.

and frontoclypeal margin punctate with sparse, short and long, ochraceous hairs (Fig. 10b). *Antennae* long, extending beyond elytra by two antennomeres. Antennae with vestiture of short, dense, ochraceous setae. Antennomeres unspined and expanded

at apices; last antennomere about 1.1 times length of penultimate. Scape shortest in length almost subequal to antennomere 10; 5 longest. Scape short, broad and clavate, extending slightly beyond pronotal front.

*Pronotum* broadly arcuate, widest across middle and slightly longer than wide; glabrous median line, vertically on basal center of pronotum. Pronotum with sparse punctures and sparsely scattered pubescence elsewhere (Fig. 10c). *Elytron* with sparse and regularly spaced ochraceous pubescence. Punctuation dense, shallow and gradually becoming shallower and smaller in size towards apex. Elytral apex rounded to suture. Scutellum triangular, narrowly rounded, covered with sparse, short ochraceous pubescence. *Legs* moderate in length, femora distinctly but gradually clavate, hind femora 2.98 mm in length extending to apical margin of 5<sup>th</sup> ventrite.

*Venter* of abdomen and thorax with sparse, translucent pubescence throughout, not obscuring integument. Length of abdomen 4.04 mm. Prosternal process very narrow, only extending about halfway between procoxae which are nearly contiguous as a result. Procoxal cavities widely open posteriorly (Fig. 10d). Mesocoxae closed laterally to mesepimeron. Mesosternum not produced vertically, without anterior tubercle or sulcus; with very slight lateral projections into mesocoxae. Apex of terminal ventrite subtruncate without notch.

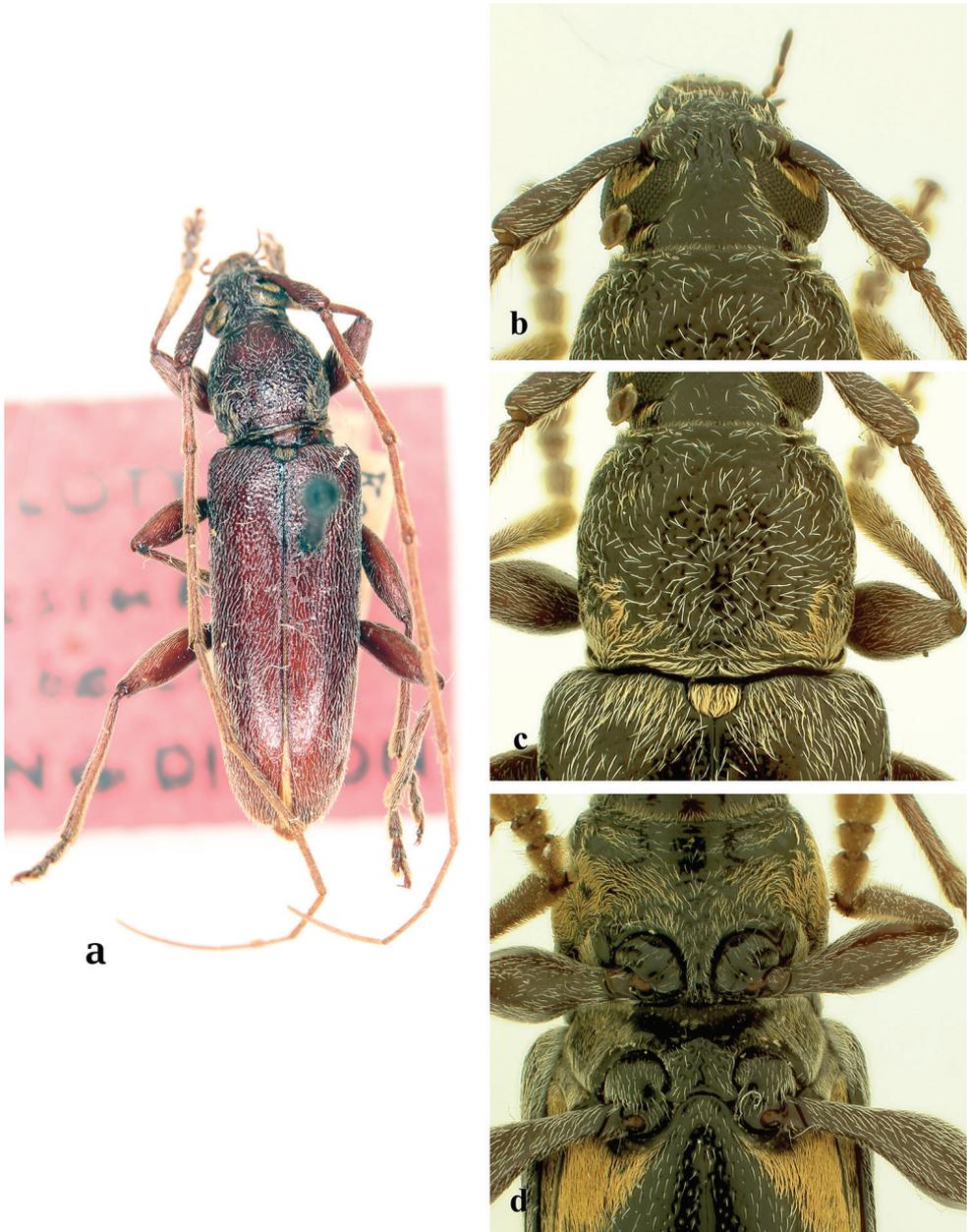
**Remarks.** By the key characters, *C. promissum* is most similar to *C. decorum*. In *C. promissum*, the mesosternal process has its basal notch parallel-sided and the pronotum has a narrow, glabrous, impunctate line at the middle restricted to the posterior half. In *C. decorum*, the mesosternal process has the basal notch at an angle and the pronotum has the narrow, glabrous, impunctate line at middle centrally located. This species is endemic to Fiji and known only from Viti Levu where the holotype was collected in June (Dillon and Dillon 1952).

### ***Ceresium pubescens* Dillon & Dillon, 1952**

Fig. 11

*Ceresium pubescens*: Dillon and Dillon 1952: 19, Fiji: Viti Levu, Tailevu, holotype (BPBM).

**Description.** Based on the holotype and a paratype (BPBM) and six specimens from 2005 surveys (FNIC, USP). *Size* 12.0–17.5 mm long, 3.5–4.7 mm wide at humeri; integument color light brown (occasionally piceous) (Fig. 11a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with very sparse ochraceous pubescence on tubercles and throughout frons; vertex and occiput with sparser ochraceous pubescence. Ochraceous pubescence slightly denser around eye margins. Frons and frontoclypeal margin densely, coarsely punctate with sparse, short and long, ochraceous hairs (Fig. 11b). *Antennae* long, extending beyond elytra by 1–2 antennomeres. Antennae with vestiture of short, dense, ochraceous setae (longer at apices of antennomeres). Antennomeres unspined and moderately expanded at apices;



**Figure 11.** *Ceresium pubescens* Dillon & Dillon: **a** dorsal habitus (holotype, BPBM) **b** head detail **c** pronotal detail **d** ventral detail.

last antennomere slightly shorter in length to penultimate. Antennomere 3 and 4 each shorter than scape; 5–9 longest and subequal in length. Scape long, clavate, extending to apical fifth of pronotum.

*Pronotum* uniformly arcuate, widest at middle, and slightly wider than long; not tuberculate. Calli absent. Pronotum with sparse yellow pubescence, denser at basal sides; center of disk mostly glabrous. Pronotum with sparse, ill-defined punctures (Fig. 11c). *Elytron* with moderately dense yellow pubescence throughout. Punctuation shallow, sparse, gradually becoming shallower and indistinct towards apex. Elytral apex subarcuately rounded to suture. Scutellum broadly rounded, covered with dense, yellow pubescence. *Legs* moderate in length, femora pedunculate clavate, hind femora extending to base of third ventrite.

*Venter* of abdomen and thorax with moderately dense, golden pubescence at sides, but very sparse golden pubescence along middle; except for prosternum which is densely pubescent throughout and on sides. Prosternal process moderately narrow, vertical and acutely declivous, about 1/3 width of procoxa, weakly notched and expanded at apex. Procoxal cavities open posteriorly (Fig. 11d). Mesocoxae closed laterally to mesepimeron. Mesosternum rather acutely declivous, with small anterior tubercle, and sulcate anteriorly. Mesosternum with large punctures. Mesosternal process expanded at apex, distinctly tuberculate and inserted into mesocoxae. Apex of terminal ventrite truncate to unevenly rounded, without notch.

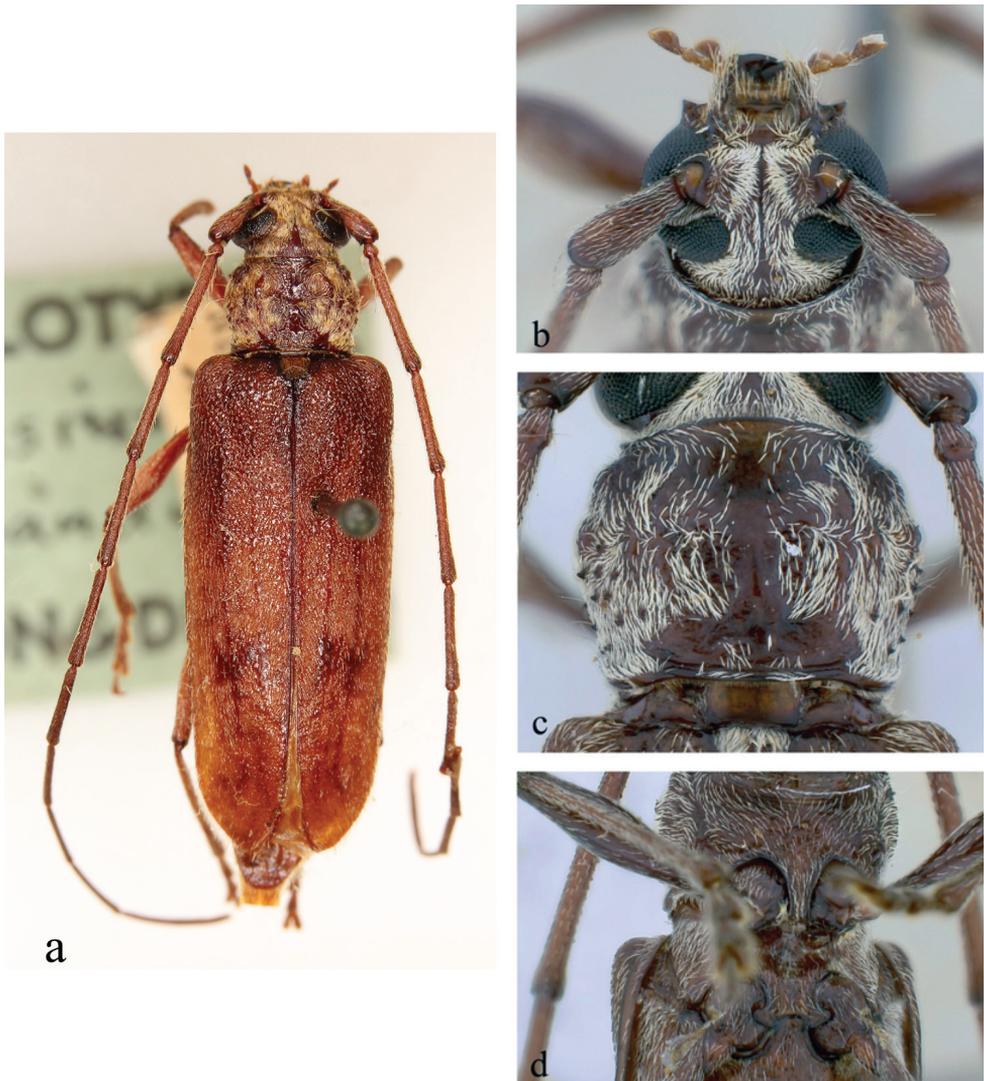
**Remarks.** One of the characters that define this species is the moderately dense, yellowish pubescence that extends from the sides of the pronotum across the base. In the key, it falls nearest *C. grandipenne*, but it easily distinguished by the much smaller size (always less than 20 mm while *C. grandipenne* is always larger than 21 mm). This species is widespread in Fiji and known from Viti Levu, Ovalau, Moala, and the Lau Islands (Dillon and Dillon 1952).

### *Ceresium repandum* Dillon & Dillon, 1952

Fig. 12

*Ceresium repandum* Dillon & Dillon, 1952: 16, Fiji: Viti Levu, Nandarivatu, holotype (BPBM).

**Redescription.** Based on the holotype specimen (BPBM) and original description. *Size* 14.3–18.0 mm long, 3.5–5.2 mm wide at humeri; integument color brown to reddish brown (Fig. 12a). *Head* with deep interantennal tubercle region, tubercles raised; punctate with dense ochraceous pubescence on tubercles and throughout frons; vertex and occiput with sparser ochraceous pubescence. Ochraceous pubescence denser around eye margins. Frons and frontoclypeal margin punctate with sparse, short and long, ochraceous hairs (Fig. 12b). *Antennae* long, extending beyond elytral apices by 5 antennomeres. Antennae with vestiture of short, dense, ochraceous setae. Antennomeres unspined and not expanded at apices; last antennomere about 1.3 times length of penultimate. Antennomere 5–6 longest except for 11 (4.12 mm) and subequal in length. Scape short (1.55 mm), clavate, just extending to pronotal apex.



**Figure 12.** *Ceresium repandum* Dillon & Dillon: **a** dorsal habitus (holotype, BPBM) **b** head detail **c** pronotal detail **d** ventral detail.

*Pronotum* strongly arcuate, widest across slightly above middle, and slightly wider than long; small tubercles at sides located at the lateral lower half. Pronotum with sparse punctures and dense pubescence laterally (Fig. 12c). *Elytron* with parallel sides and gradually attenuate, with dense and regularly spaced ochraceous pubescence. Punctuation sparse, shallow and gradually becoming shallower and smaller in size towards apex. Elytral apex rounded to suture. Scutellum narrowly rounded, covered with dense, ochraceous pubescence. *Legs* moderate in length, femora distinctly but gradually clavate, hind femora (5.02 mm) base extending to apical margin of fifth ventrite.

Venter of abdomen and thorax with sparse, ochraceous pubescence throughout, not obscuring integument. Length of abdomen 4.95 mm. Prosternal process narrow, gradually declivous, weakly expanded at apex, approximately 1/4 width of procoxa. Procoxal cavities open posteriorly (Fig. 12d). Mesocoxae closed laterally to mesepimeron. Mesosternum not produced vertically, without anterior tubercle or sulcus; with pronounced lateral projections into mesocoxae. Apex of terminal ventrite subtruncate without notch.

**Remarks.** This species is very distinctive among the Fijian *Ceresium* by having very long antennae (extending beyond the elytral apices by more than 5 segments), by the laterally multi-tuberculate pronotum, and by the post-medial black macula on each elytron. It is most similar to *C. tuberculatum* in the key characters but can be distinguished from that species by having the pronotum strongly arcuate with dense, white pubescence at the sides (the pronotum in *C. tuberculatum* is quadrate with patchy yellow pubescence on sides and posterior margin). This species is endemic to Fiji and known only from Viti Levu where both known specimens were taken at lights in October (Dillon and Dillon 1952).

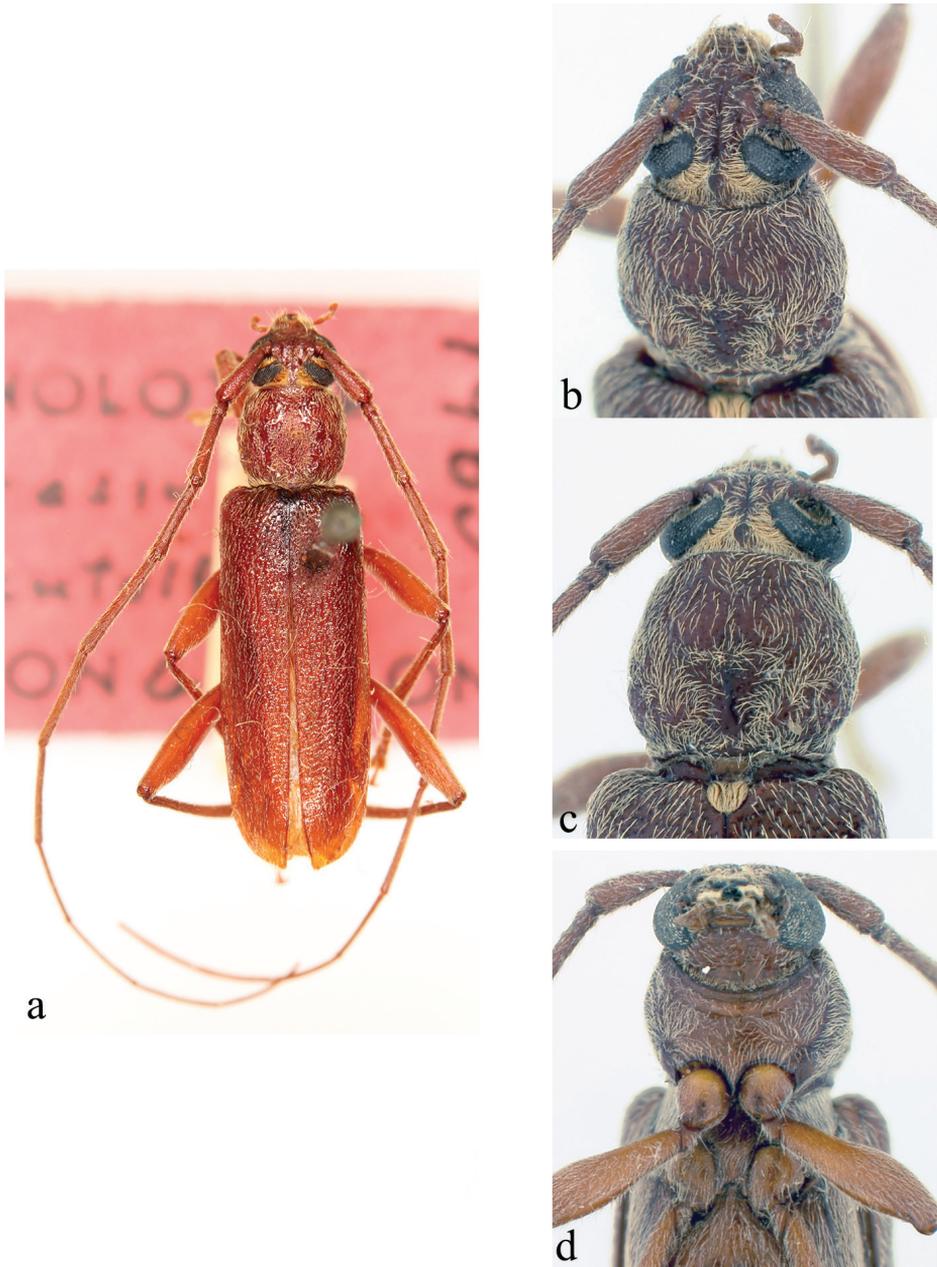
### *Ceresium scutellaris* Dillon & Dillon, 1952

Fig. 13

*Ceresium scutellaris*: Dillon and Dillon 1952: 19, Fiji: Viti Levu, Nandarivatu, holotype (BPBM).

**Description.** Based on the holotype specimen (BPBM) and four specimens from 1981 and 2004 surveys (FNIC, USP). *Size* 11.5–16.5 mm long, 2.2–3.5 mm wide at humeri; integument color light brown (Fig. 13a). *Head* with very shallow interantennal tubercle region, tubercles only slightly raised; punctate with very sparse golden pubescence on tubercles and throughout frons; vertex and occiput with dense golden pubescence and a glabrous median line running longitudinally. Golden pubescence denser around eye margins. Frons and frontoclypeal margin densely, coarsely punctate with sparse, long, golden hairs (Fig. 13b). *Antennae* long, extending beyond elytra by 3–4 antennomeres. Antennae with vestiture of short, dense, ochraceous setae (longer at apices of antennomeres). Antennomeres unspined and expanded at apices except for antennae 9–11; last antennomere about 1.2 times length of penultimate. Antennomere 3 shorter than scape; 5 very long and the longest. Scape long, clavate, extending to apical sixth of pronotum.

*Pronotum* arcuate, slightly transverse, apex slightly narrower than base; tubercles absent. No calli. Pronotum with fine, sparse, evenly spaced golden pubescence throughout. Pronotum with fine and dense punctures (Fig. 13c). *Elytron* finely granulate punctures becoming shallower and indistinct towards apex. Sparse golden pubescence, evenly spaced throughout. Elytral apex rounded to suture. Scutellum parallel-sided and then broadly rounded at apex, covered with dense, golden pubescence. *Legs* moderate in length, femora distinctly but gradually clavate, hind femora extending to beyond base of fourth ventrite.



**Figure 13.** *Ceresium scutellaris* Dillon & Dillon: **a** dorsal habitus (holotype, BPBM) **b** head detail **c** pronotal detail **d** ventral detail.

*Venter* of abdomen and thorax with moderately dense, ochraceous pubescence at sides, but sparse pubescence along middle, except for prosternum which is sparsely pubescent throughout. Prosternal process very, weakly notched and not expanded at

apex. Procoxal cavities open posteriorly (Fig. 13d). Mesocoxae closed laterally to mesepimeron. Mesosternum declivous, without anterior tubercle, and sulcate anteriorly. Apex of terminal ventrite truncate to unevenly rounded, without notch.

**Remarks.** This species was not included in the key in the original publication (Dillon and Dillon 1952). It is distinct, along with *C. olidum*, in having an incomplete prosternal process between the procoxae. It is distinguished from that species by having the pronotum with uneven punctation, the third antennal segment extending nearly to the posterior margin of pronotum, and having the head, pronotum and scutellum with dense yellowish tomentum. In *C. olidum*, the pronotum has uniform, dense punctation, the third antennal segment extends to about the midpoint of pronotum, and the head, pronotum and scutellum has fine, sparse, ochraceous pubescence. This species is endemic to Fiji and known only from Viti Levu where specimens have been taken on dead branches and at lights (Dillon and Dillon 1952).

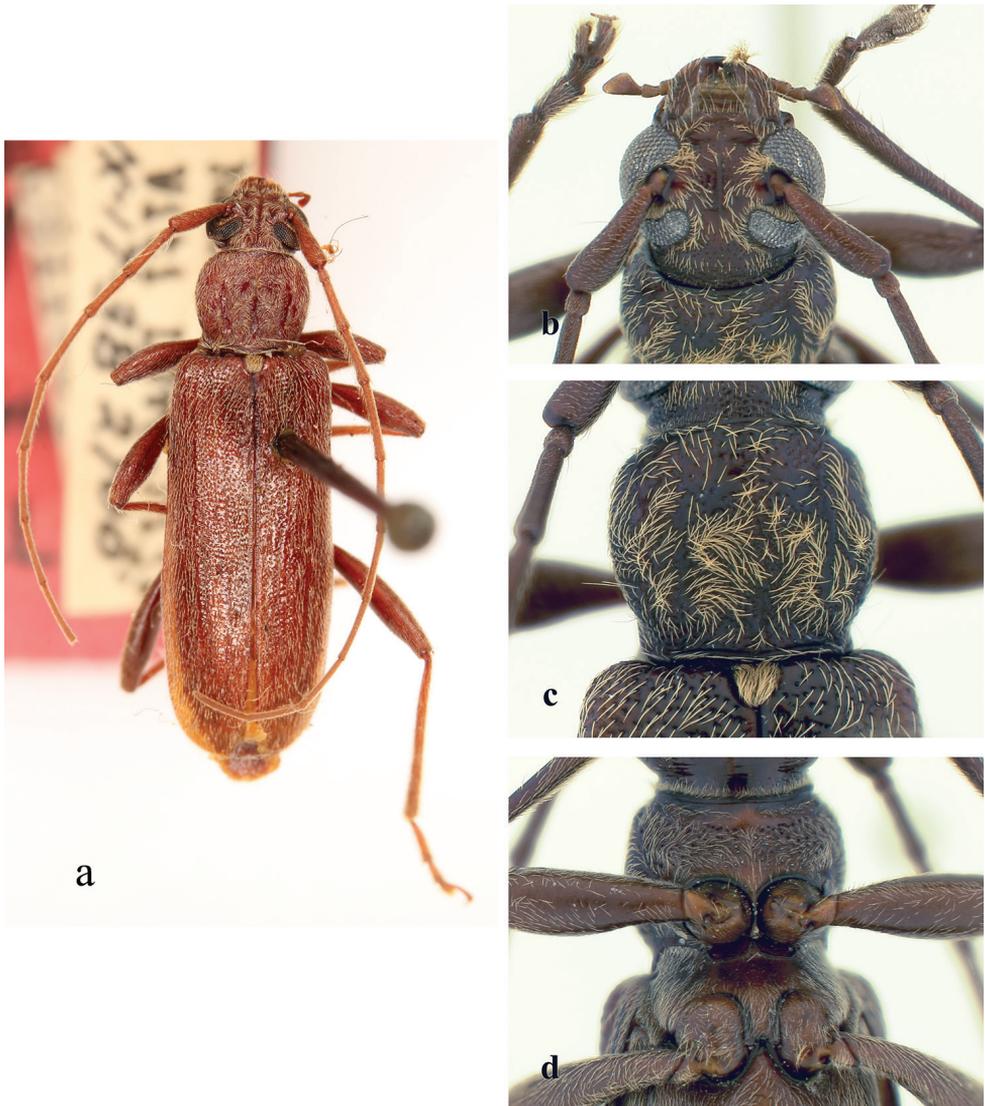
### *Ceresium striatipenne* Dillon & Dillon, 1952

Fig. 14

*Ceresium striatipenne*: Dillon and Dillon 1952: 15, Fiji: Viti Levu, Nandarivatu, holotype (BPBM).

**Description.** Based on the holotype and a paratype specimen (BPBM) and two specimens from 2008 surveys (FNIC, USP). *Size* 9.5–11.0 mm long, 2.0–2.5 mm wide at humeri; integument color maroon-brown; darker at head becoming paler towards elytral apex (Fig. 14a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with very sparse golden pubescence on tubercle margin; vertex and occiput with sparser almost bare golden pubescence and punctate. Distinct median line running longitudinally between eye lobes. Golden pubescence denser around eye margins (Fig. 14b). *Antennae* long, extending beyond elytra by one antennomere. Antennae with vestiture of short, dense, ochraceous setae (longer at apices of antennomeres). Antennomeres unspined and expanded at apices; last antennomere slightly shorter than penultimate. Antennomere 3 shorter than scape; 4 subequal in length to scape; 5 very long and the longest. Scape long, clavate, extending to apical sixth of pronotum.

*Pronotum* broadly arcuate, widest below middle, and transverse. Narrower at anteriorly than posteriorly. Pronotum with three longitudinally glabrous lines with moderately dense golden pubescence between glabrous lines and sparsely pubescent elsewhere. Pronotum with moderately dense punctures in center between glabrous lines and sparsely elsewhere (Fig. 14c). *Elytron* glabrous with sparse golden pubescence. Disk coarsely, irregularly punctate, punctures finer behind apical quarter. Elytral apex together rounded. Scutellum broadly rounded, covered with dense, golden pubescence. *Legs* small to moderate in length, femora distinctly but gradually clavate, hind femora extending to beyond base of fourth ventrite.



**Figure 14.** *Ceresium striatipenne* Dillon & Dillon: **a** dorsal habitus (holotype, BPBM) **b** head detail **c** pronotal detail **d** ventral detail.

*Venter* of abdomen and thorax with sparse ochraceous pubescence at sides with sparser pubescence along middle. Prosternal process narrow, weakly notched and expanded at apex. Procoxal cavities closed posteriorly (Fig. 14d). Mesocoxae closed laterally to mesepimeron. Mesosternal process broad, slightly expanded at apex and inserted into mesocoxa. Mesosternum gradually declivous, without anterior tubercle, and sulcate anteriorly. Apex of terminal ventrite truncate to unevenly rounded, without notch.

**Remarks.** The distinctive, longitudinal, glabrous striae characterize this species. The only other species with semi-regular glabrous areas on the elytra is *C. vacillans*, but in that species these regions are in the form of spots rather than lines. This species is endemic to Fiji and known only from Viti Levu where the type specimens were collected at lights in August (Dillon and Dillon 1952).

### *Ceresium thyra* Dillon & Dillon, 1952

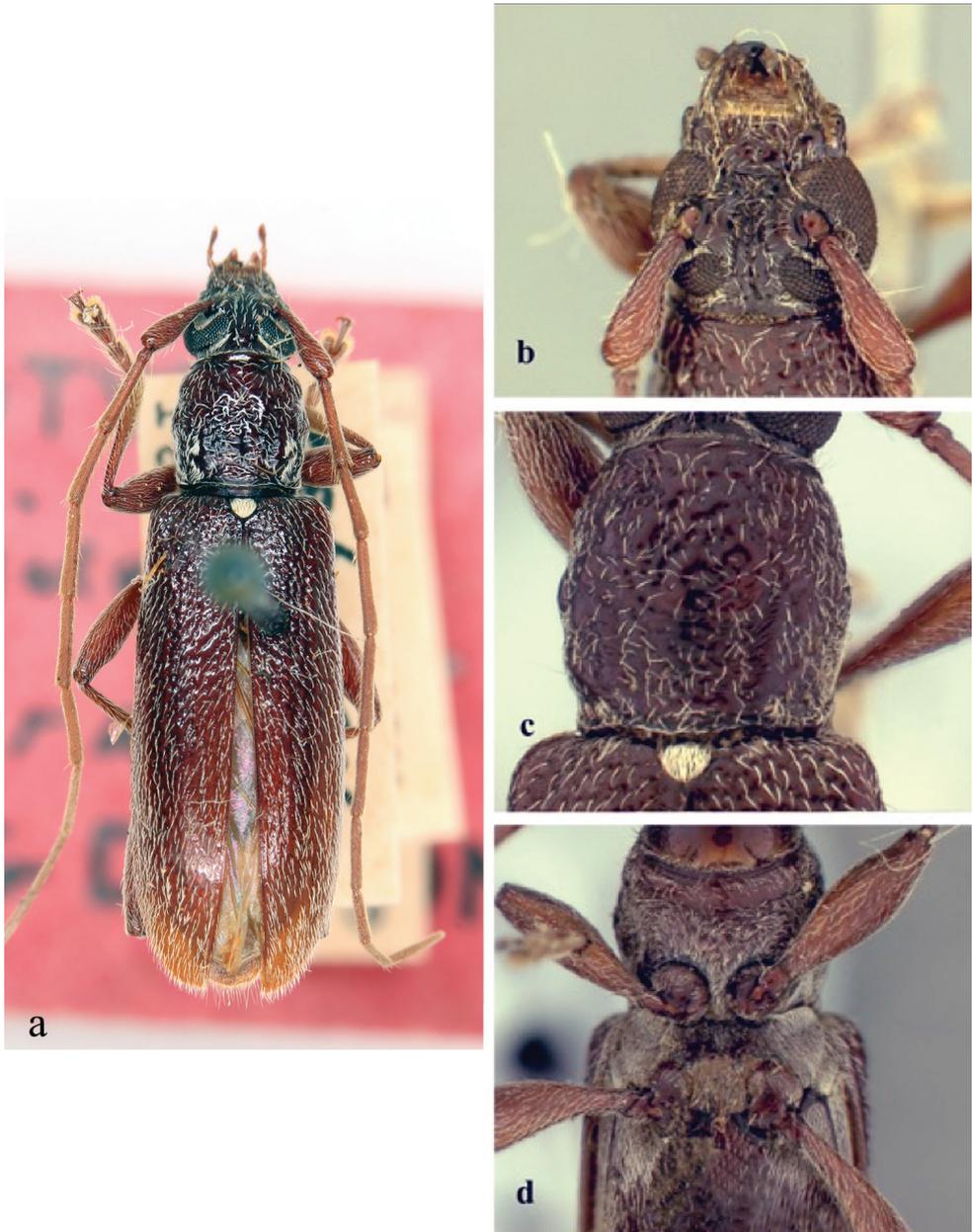
Fig. 15

*Ceresium thyra*: Dillon and Dillon 1952: 21, Fiji: Viti Levu, Tailevu, holotype (BPBM).

**Description.** Based on photograph of the holotype specimen (BPBM) and five specimens from 1992 and 2004–2005 surveys (FNIC, USP). *Size* 13.0 mm long, 3.0 mm wide at humeri; integument color maroonish brown (Fig. 15a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; coarsely punctate with very sparse ochraceous pubescence on tubercles and throughout frons; vertex and occiput with sparser ochraceous pubescence almost bare. Ochraceous pubescence denser around eye margins. Frons and frontoclypeal margin densely, coarsely punctate with sparse, long, ochraceous hairs (Fig. 15b). *Antennae* long, extending beyond elytra by 2 antennomeres. Antennae with vestiture of short, dense, ochraceous setae (longer at apices of antennomeres). Antennomeres unspined and not expanded at apices; last antennomere about 1.1 times length of penultimate. Antennomere 4 shorter than scape; 3 almost subequal in length to scape; 5 longest. Scape long, clavate, extending to apical quarter of pronotum.

*Pronotum* arcuate, widest across middle, and almost as long as wide. No tubercles or callus present. Pronotum with sparse ochraceous pubescence. Pronotum with sparse, ill-defined punctures (Fig. 15c). *Elytron* with sparse, evenly spaced ochraceous pubescence. Punctuation shallow, sparse, gradually becoming shallower and indistinct towards apex. Elytral apex narrowly rounded to suture. Scutellum narrowly rounded, covered with dense, white pubescence. *Legs* moderate in length, femora distinctly but gradually clavate, hind femora extending to beyond base of fourth ventrite.

*Venter* of abdomen with sparse white pubescence and metasternum with sparse white pubescence at center and moderately dense on sides. Mesosternum also moderately dense with white pubescence. Prosternal process moderately narrow, vertical and acutely declivous, approximately 1/3 width of procoxa, notched and expanded at apex. Procoxal cavities open posteriorly (Fig. 15d). Mesocoxae closed laterally to mesepimeron. Mesosternum process broad, declivous but not tuberculate and sulcate anteriorly; at apex each side expands into a triangular tooth inserted into mesocoxae. Metasternum with black line running full length longitudinally along middle. Apex of terminal ventrite truncate with a small bump in middle.



**Figure 15.** *Ceresium thyra* Dillon & Dillon: **a** dorsal habitus (holotype, BPBM) **b** head detail **c** pronotal detail **d** ventral detail.

**Remarks.** The very dense, nearly white pubescence of the scutellum is distinctive, along with the dorsally callous pronotum. This species is endemic to Fiji and known only from Viti Levu where specimens were collected in September (Dillon and Dillon 1952).

***Ceresium tuberculatum* Waqa & Lingafelter, 2009**

Fig. 16

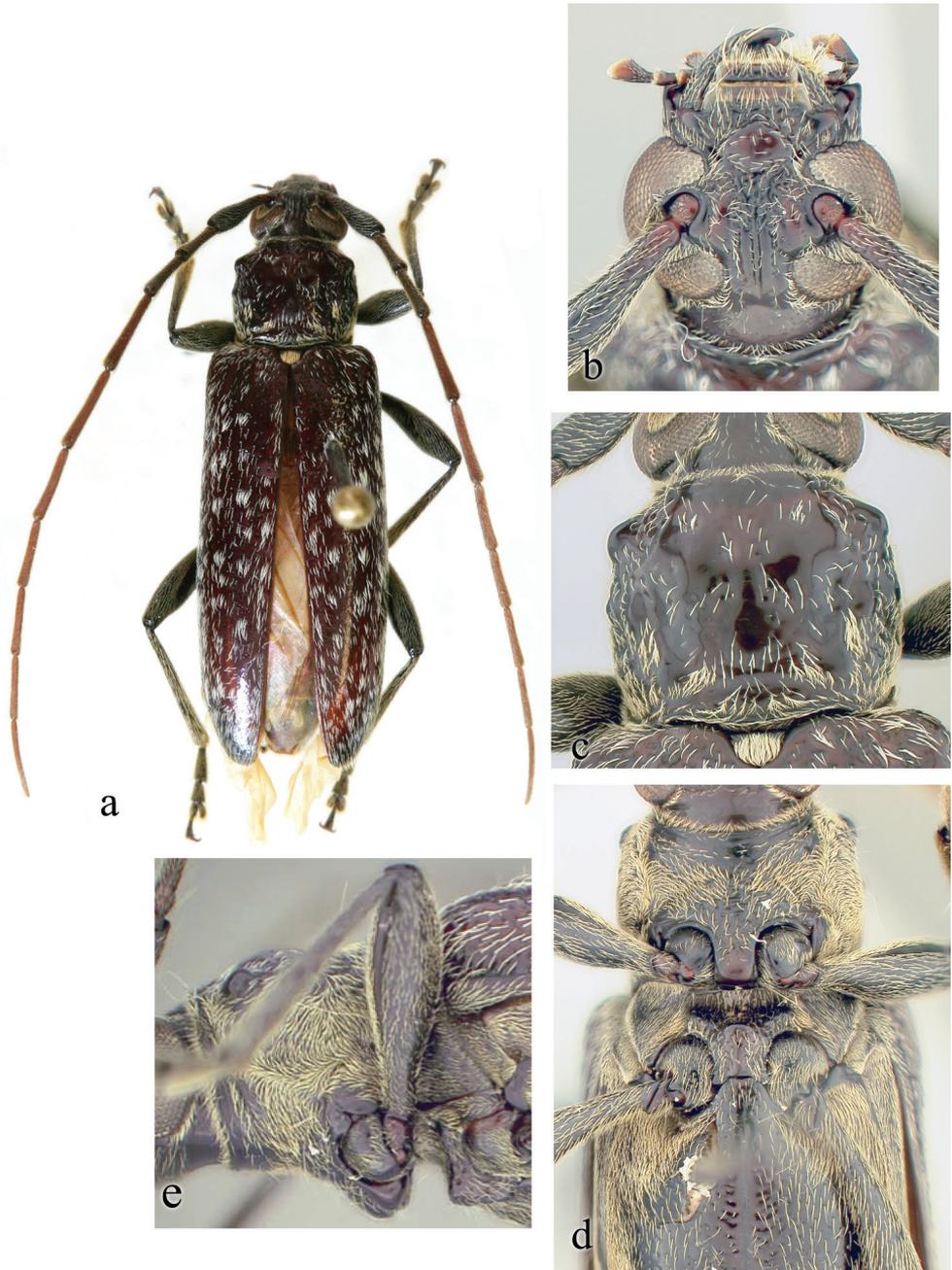
*Ceresium tuberculatum*: Waqa and Lingafelter 2009: 4, Fiji: Gau, holotype (BPBM).

**Description.** Based on the holotype specimen (BPBM), 15 paratypes from 2005 surveys (FNIC, USP), and original description of Waqa and Lingafelter (2009). *Size* 14.0–18.0 mm long, 3.5–4.5 mm wide at humeri; integument color dark reddish brown (occasionally piceous) (Fig. 16a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with very sparse ochraceous pubescence on tubercles and throughout frons; vertex and occiput with sparser ochraceous pubescence. Ochraceous pubescence denser around eye margins. Frons and frontoclypeal margin densely, coarsely punctate with sparse, long, ochraceous hairs. *Antennae* long, extending beyond elytra by 3–4 antennomeres (longer in males than females). Antennae with vestiture of short, dense, ochraceous setae (longer at apices of antennomeres). Antennomeres unspined and not expanded at apices; last antennomere approximately 1.4 times length of penultimate in males (about 1.2 times length of penultimate in females). Antennomere 3 and 4 each shorter than scape; 5–9 longest except for 11 and subequal in length. Scape long, clavate, extending to apical fifth of pronotum.

*Pronotum* quadrate, slightly widest anteriorly, and slightly wider than long; tuberculate at sides; constricted subbasally and apically. Raised tubercles present at middle of sides and anterolaterally. Three poorly-defined calli on disk: 1 medial and 2 anteromedial between middle callus and anterolateral tubercle. Pronotum with patchy ochraceous pubescence, denser at sides and posterior margin, slightly less dense anteriorly; center of disk mostly glabrous. Pronotum with sparse, poorly-defined punctures in males (except on smooth calli), only sparse depressions present in females (Fig. 16b, c). *Elytron* glabrous except for scattered sparse patches of white (occasionally ochraceous) pubescence. Punctuation shallow, sparse, gradually becoming shallower and indistinct towards apex. Elytral apex rounded to suture. Scutellum broadly rounded, covered with dense, ochraceous pubescence. *Legs* moderate in length, femora distinctly but gradually clavate, hind femora extending to beyond base of fourth ventrite.

*Venter* of abdomen and thorax with moderately dense, ochraceous pubescence at sides, but mostly glabrous along middle, except for prosternum which is densely pubescent. Prosternal process broad, vertical and acutely declivous, approximately 1/3 width of procoxa, weakly notched and expanded at apex. Procoxal cavities open posteriorly. Mesocoxae closed laterally to mesepimeron. Mesosternum rather acutely declivous, with small anterior tubercle, and sulcate anteriorly (Fig 16d, e). Apex of terminal ventrite in males with median notch; in females truncate to unevenly rounded, without notch.

**Remarks.** The prominent anterolateral pronotal tubercles, narrowly tapering pronotum posteriorly, and acutely declivous prosternal process are distinctive for this species. This recently described species is endemic to Fiji and known only from Gau and Viti Levu Islands where specimens have been collected in Malaise traps, mostly, from April through June and October through November (Waqa and Lingafelter 2009).



**Figure 16.** *Ceresium tuberculatum* Waqa & Lingafelter: **a** dorsal habitus, male paratype **b** head detail, male **c** pronotal detail, male **d** ventral view showing width of prosternal and mesosternal intercoxal processes, along with pubescence distribution **e** lateral view showing acutely declivous prosternal process, weakly tuberculate, acutely declivous mesosternal process, and laterally closed mesocoxa.

***Ceresium unicolor* (Fabricius, 1787)**

Fig. 17

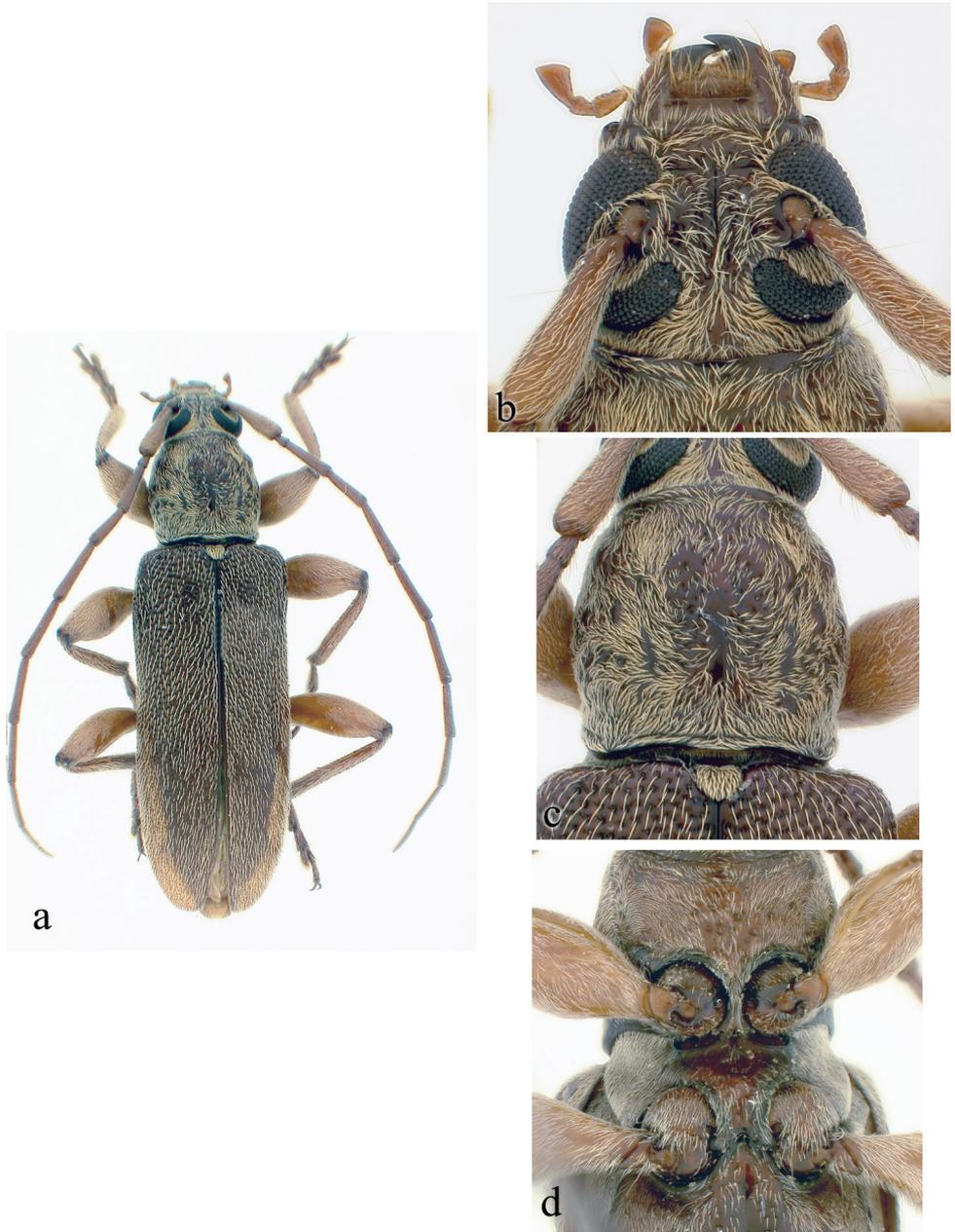
*Saperda unicolor*: Fabricius 1787: 147, Amsterdam Island, French Southern Islands, holotype (BMNH).

**Description.** Based on the original description (Fabricius 1787) and specimens from 1938, 2005 and 2007 surveys (FNIC, USP). *Size* 15.0–17.0 mm long, 3.0–4.0 mm wide at humeri; integument color orangish-brown to maroon-brown (occasionally piceous) (Fig. 17a). *Head* with shallow interantennal tubercle region, tubercles only slightly raised; punctate with moderately dense yellow pubescence on tubercles; vertex and occiput with sparser yellow pubescence. Yellow pubescence denser around eye margins. Frons and frontoclypeal margin densely, coarsely punctate with sparse, long, yellow hairs (Fig. 17b). *Antennae* long, extending beyond elytra by 1–2 antennomeres. Antennae with vestiture of short, dense, ochraceous setae (longer at apices of antennomeres). Antennomeres unspined and slightly expanded at apices; last antennomere subequal in length of penultimate. Antennomere 3 and 4 each shorter than scape; 3 shortest; 5–9 longest and subequal in length. Scape long, clavate, extending to apical sixth of pronotum.

*Pronotum* broadly arcuate quadrate, widest across middle, and as long as wide. Tubercles absent. Pronotum with a broad median line and a fine line slightly half-way between middle and sides on each side of pronotum. Pronotum with moderately dense to dense yellow pubescence. Pronotum with sparse, coarse punctures (Fig. 17c). *Elytron* with sparse and evenly spaced yellow pubescence throughout. Punctuation shallow, sparse, gradually becoming shallower and smaller in size towards apex. Elytral apex rounded to suture. Scutellum broadly rounded, covered with dense, yellow pubescence. *Legs* moderate in length, femora distinctly but gradually clavate, hind femora reaching base of fourth ventrite.

*Venter* of abdomen and metasternum with sparse yellow pubescence towards center and becoming denser on sides. Prosternal process moderately narrow, vertical and acutely declivous, about 1/4 width of procoxa, weakly notched and not expanded at apex. Procoxal cavities open posteriorly (Fig. 17d). Mesocoxae closed laterally to mesepimeron. Mesosternum rather acutely declivous, with small anterior tubercle, and sulcate anteriorly. Mesosternal process expanded at base into tubular tooth inserted into mesocoxa. Apex of terminal ventrite truncate with a slight bump towards middle.

**Remarks.** This species is somewhat variable and lacking a suite of very distinctive characters. In the key, it is distinguished by the pronotum lacking maculae and lateral tubercles but having several dorsal calli, and having pubescence of the head, pronotum, elytra and scutellum similar in density and coloration. This species is widespread and known from Mauritius, Seychelles, New Zealand, Waigeo Island, Papua New Guinea, Bismarck Archipelago, Solomon Islands, Vanuatu, Hawaii, and Fiji (Bigger and Schofield 1983). In Fiji, it is known from Viti Levu, Taveuni, Lau Islands, and Vanua Levu where specimens have been collected throughout the year, most commonly at lights (Dillon and Dillon 1952).



**Figure 17.** *Ceresium unicolor* (Fabricius): **a** dorsal habitus **b** head detail **c** pronotal detail **d** ventral detail.

***Ceresium vacillans* Dillon & Dillon, 1952**

Fig. 18

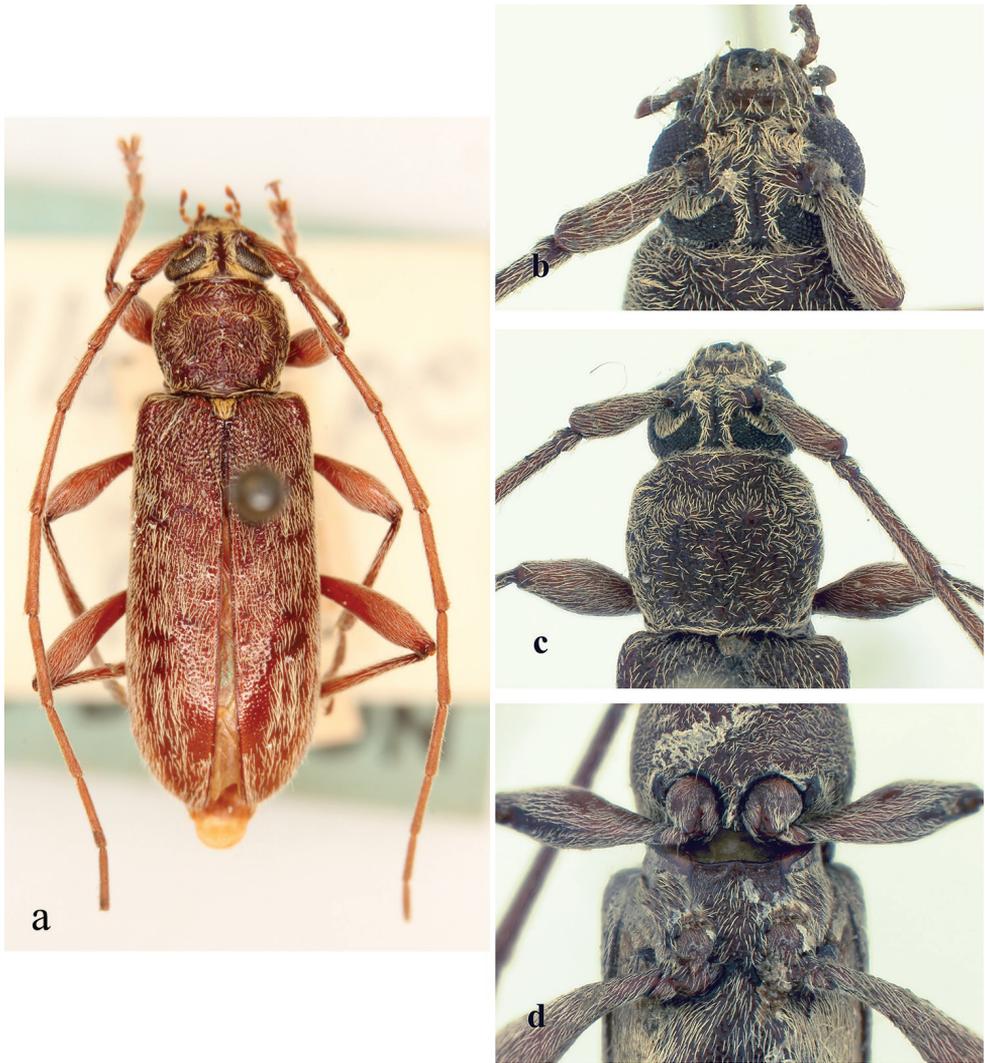
*Ceresium vacillans*: Dillon and Dillon 1952: 24, Fiji: Lau Islands, Thikombia, holotype (BPBM).

**Description.** Based on the holotype specimen (BPBM) and a specimen from 1998 survey (USP). *Size* 9.0–13.0 mm long, 2.0–3.0 mm wide at humeri; integument color maroonish brown (Fig. 18a). *Head* with slightly deep interantennal tubercle region, tubercles only slightly raised; punctate with moderately dense yellow pubescence on tubercles and throughout frons; vertex and occiput bare. Distinct median line between eye lobes. Yellow pubescence denser around eye margins and basal head margin. Frons and frontoclypeal margin moderately dense and coarsely punctate with sparse, long, yellow hairs (Fig. 18b). *Antennae* long, extending beyond elytra by four antennomeres. Antennae with vestiture of short, dense, ochraceous setae. Antennomeres unspined and expanded at apices; last antennomere just slightly longer than penultimate. Scape shorter than all antennomeres; 5–7 very long and the longest and subequal in length. Scape short, clavate, extending to apical fifth of pronotum.

*Pronotum* arcuate, wider across middle, transverse, apical margin narrower than base. Disk moderately dense with ochraceous pubescence, and coarsely punctate. Medially with a broad transversely ovate impression limited by two low tubercles in front, two behind and a fifth one in its center (Fig. 18c). *Elytra* with irregularly disposed ochraceous pubescence with irregular, small, glabrous maculae. Punctuation shallow, dense, gradually becoming shallower and indistinct towards apex. Elytral apex together rounded. Scutellum broadly rounded, covered with dense, ochraceous pubescence. *Legs* moderate in length, femora distinctly but gradually clavate, hind femora just reaching elytral apex.

*Venter* of abdomen with moderately dense, ochraceous pubescence at sides, sparse ochraceous pubescence along middle, except for prosternum which is sparsely pubescent throughout and on sides. Prosternal process broad, vertical and acutely declivous, about 1/4 width of procoxa, weakly notched and expanded at apex. Procoxal cavities open posteriorly (Fig. 18d). Mesocoxae closed laterally to mesepimeron. Mesosternal process broad, expanded at apex, inserted into mesocoxa. Mesosternum rather acutely declivous, with small anterior tubercle, and sulcate anteriorly. Apex of terminal ventrite truncate to unevenly rounded, without notch.

**Remarks.** This species is most similar to *C. striatipenne* in that it possesses glabrous regions on the elytra, however in this species, the glabrous regions are irregular and small rather than forming narrow lines as in *C. striatipenne*. This species is endemic to Fiji and known only from Viti Levu and the Lau Islands where specimens have been collected in July and September (Dillon and Dillon 1952).



**Figure 18.** *Ceresium vacillans* Dillon & Dillon: **a** dorsal habitus (holotype, BPBM) **b** head detail **c** pronotal detail **d** ventral detail.

**Key to species of *Ceresium* of Fiji**

Diagnostic features in the key include easily coded character states: presence/absence of a macula on the pronotum; shape and color of the macula on pronotum; shape of pronotum (i.e. tuberculate, strongly/weakly arcuate); color of pubescence on pronotum; density of pubescence on pronotum; pronotum with or without calli; and elytra with/without a glabrous line or macula.

- 1 Pronotum with yellow macula ..... 2
- Pronotum without yellow macula ..... 3

- 2(1) Pronotum with two dense areas of yellowish pubescence on either side, subequal in length..... *C. guttaticolle* (Fairmaire)
- Pronotum with three or four areas of yellowish pubescence on either side, apical one largest..... *C. nigroapicale* Dillon & Dillon
- 3(1) Pronotum tuberculate laterally..... 4
- Pronotum not tuberculate..... 5
- 4(3) Pronotum strongly arcuate with white pubescence denser on either lateral sides..... *C. repandum* Dillon & Dillon
- Pronotum quadrate, posteriorly narrowed, with patchy yellow pubescence denser on either sides and posterior margin ..... *C. tuberculatum* Waqa & Lingafelter
- 5(3) Pronotum with calli..... 6
- Pronotum without calli..... 7
- 6(5) Head and pronotum with moderately dense yellowish pubescence. Scutellum with pubescence of similar color as that on pronotum and elytra ..... *C. unicolor* (Fabricius)
- Head and pronotum with sparse ochraceous pubescence. Scutellum with much paler pubescence than on pronotum and elytra ..... *C. thyra* Dillon & Dillon
- 7(5) Mesosternal process tuberculate anteriorly ..... 8
- Mesosternal process not tuberculate..... 9
- 8(7) Pronotum quadrate in shape. Integument rather opaque, not strongly shining. Large species (>21 mm in length) ..... *C. grandipenne* Fairmaire
- Pronotum uniformly rounded laterally. Integument very shiny. Moderate to small species (<20 mm in length)..... *C. pubescens* Dillon & Dillon
- 9(7) Elytra with glabrous lines or spots between pubescence..... 10
- Elytra without glabrous lines or maculae..... 11
- 10(9) Elytra with fine glabrous linear regions between pubescence. Prosternal process very narrow between procoxae ..... *C. striatipenne* Dillon & Dillon
- Elytra with small scattered glabrous spots between pubescent patches. Prosternal process moderately wide between procoxae ..... *C. vacillans* Dillon & Dillon
- 11(9) Prosternal process incomplete between procoxae..... 12
- Prosternal process fully extending between procoxae..... 13
- 12(11) Pronotum with uneven punctation. Third antennal segment extending nearly to posterior margin of pronotum. Head, pronotum and scutellum with dense yellowish tomentum ..... *C. scutellaris* Dillon & Dillon
- Pronotum with uniform, dense punctation. Third antennal segment extending to about midpoint of pronotum. Head, pronotum and scutellum with finely sparse ochraceous pubescence..... *C. olidum* (Fairmaire)
- 13(11) Pronotum strongly arcuate laterally..... 14
- Pronotum weakly arcuate/feebly elongate ..... 15
- 14(13) Pronotum almost hexagonal in shape, with a diffuse, dark macula in the integument either side of middle, widest before middle ..... *C. lucidum* Dillon & Dillon

- Pronotum with sides broadly rounded, without maculae on integument, widest medially ..... *C. epilais* Dillon & Dillon
- 15(13) Elytra with apical third paler than rest ..... *C. gracilipes* Fairmaire
- Elytra uniformly colored ..... 16
- 16(15) Mesosternal process basal notch parallel sided. Pronotum with narrow, glabrous, impunctate line at middle restricted to posterior half .....  
..... *C. promissum* Dillon & Dillon
- Mesosternal process basal notch at an angle. Pronotum with narrow, glabrous, impunctate line at middle centrally located ..... *C. decorum* Dillon & Dillon

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# Review of the genus *Urgleptes* Dillon (1956) of Hispaniola (Coleoptera, Cerambycidae, Acanthocinini): descriptions of five new species and one new synonymy

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## Abstract

The genus *Urgleptes* Dillon (1956) is reviewed for Hispaniola. Five new species of *Urgleptes* from the Dominican Republic are described herein: *U. charynae* Ravin & Lingafelter, **sp. n.** (La Vega province), *U. conjunctus* Ravin & Lingafelter, **sp. n.** (Peravia Prov.), *U. curtipennis* Ravin & Lingafelter, **sp. n.** (Independencia Prov.), *U. marionae* Ravin & Lingafelter, **sp. n.** (Monseñor Nouel Prov.), and *U. obliteratus* Ravin & Lingafelter, **sp. n.** (Pedernales Prov.). Two additional, previously described species are newly recorded for Hispaniola: *U. puertoricensis* Gilmour and *U. sandersoni* Gilmour. It is established that *U. haitiensis* Gilmour is a new synonym of *U. sandersoni*. Thus there are seven species of *Urgleptes* recorded for Hispaniola. For all species photographs, illustrations, full descriptions, distribution maps, and a dichotomous key are included for their identification.

## Keywords

Longhorned beetle, endemism, intraspecific variation, taxonomy, systematics, synonymy, new species

## Introduction

The genus *Urgleptes* is among the largest in the Acanthocinini (Lamiini) with 79 described species (Monné 2015). Of these, 11 species were described from the Caribbean region. These include: *Urgleptes borikensis* Micheli and Micheli (2004) from Puerto Rico, *U. chamaeropsis* (Fisher, 1926) from Cuba and the Bahamas, *U. clarkei* Chemsak (1966) from Peter Island and Antigua, *U. cobbeni* Gilmour (1963) from the Lesser Antilles, Curaçao, Bonaire, and Barbados, *U. gahani* Chalumeau (1983) from St. Vincent, *U. guadeloupensis* (Fleutiaux & Sallé, 1889) originally described from Guadeloupe, and reported from throughout the Lesser Antilles and Greater Antilles, *U. haitiensis* Gilmour (1963) from Haiti, *U. hummelincki* Gilmour (1968) from Aruba, *U. leopaulini* Touroult (2004) from Guadeloupe, Martinique, and Saint Lucia, *U. puertoricensis* Gilmour (1963) from Puerto Rico, and *U. sandersoni* Gilmour (1963) from Puerto Rico (Monné 2015; Tavakilian and Chevillotte 2015).

*Urgleptes* Dillon (1956) is very similar to the even larger genus, *Lepturges* Bates (1863). Species of *Urgleptes* have distinct punctures limited to a row along the basal transverse sulcus extending behind the lateral pronotal spines (Fig. 8e). In *Lepturges*, punctures along the basal transverse sulcus do not extend behind the lateral pronotal spines and there are other scattered, large punctures on the pronotal disk (Dillon 1956; Lingafelter 2007).

Results of these studies demonstrate that seven species of *Urgleptes* occur in Hispaniola. These include five endemic species described as new herein: *U. charynae*, *U. conjunctus*, *U. curtipennis*, *U. marionae*, *U. obliteratus*, and two formerly described species that represent new country records for the Dominican Republic: *U. puertoricensis* and *U. sandersoni*. We provide justification for the new synonymy of *U. haitiensis* with *U. sandersoni*.

## Materials and methods

The material consulted in this study is primarily the result of expeditions from the Smithsonian Institution (second author), Carnegie Museum (John Rawlins, Robert Androw, and Robert Davidson), Florida State Collection of Arthropods (Paul Skelley and Michael Thomas), and The West Indian Beetle Fauna Project (Michael Ivie), along with the individual collections of Edmund Giesbert, Kelvin Guerrero, Charyn Micheli, Julien Touroult, Robert Turnbow, James Wappes, Norman Woodley, and many others. Acronyms for collections consulted herein are listed below:

- ACMT** American Coleoptera Museum San Antonio, TX, USA (J. Wappes)  
**CMNH** Carnegie Museum of Natural History, Pittsburgh, PA, USA (J. Rawlins, R. Davidson, R. Androw)  
**FSCA** Florida State Collection of Arthropods, Gainesville, FL, USA (E. Giesbert, P. Skelley, M. Thomas)

<b>RHTC</b>	Robert H. Turnbow, Jr. Private Collection, Ft. Rucker, AL, USA
<b>SWLC</b>	Steven W. Lingafelter Private Collection, North Potomac, MD, USA
<b>USNM</b>	Smithsonian Institution, Washington, DC, USA (S. Lingafelter)
<b>WIBF</b>	West Indian Beetle Fauna Project, Bozeman, MT, USA (M. Ivie)

Holotypes of new species described herein are deposited in the USNM and maintained on the online image database of Lingafelter, et al. (2015) following the standards and methods of Lingafelter, et al. (2014). Label data are mostly verbatim, but redundancy among paratypes is minimized by not repeating identical localities from specimens from the same institution. Specimen data are grouped in alphabetical order by provinces (which are not repeated for brevity). Haiti records are listed after Dominican Republic Records. Species description format follows Lingafelter and Micheli (2009).

Specimens were photographed with a Zeiss AxioCam HRC camera attached to a Zeiss Discovery.V20 stereomicroscope™ with a PlanApo™ 0.63X objective and Dolan-Jenner MI-150 Fiber Optic Illuminators™ with gooseneck fiber optic and ring light attachments. Image stacking was achieved by a combination of Axiovision™ and Adobe Photoshop CS6™ software.

## Results and discussion

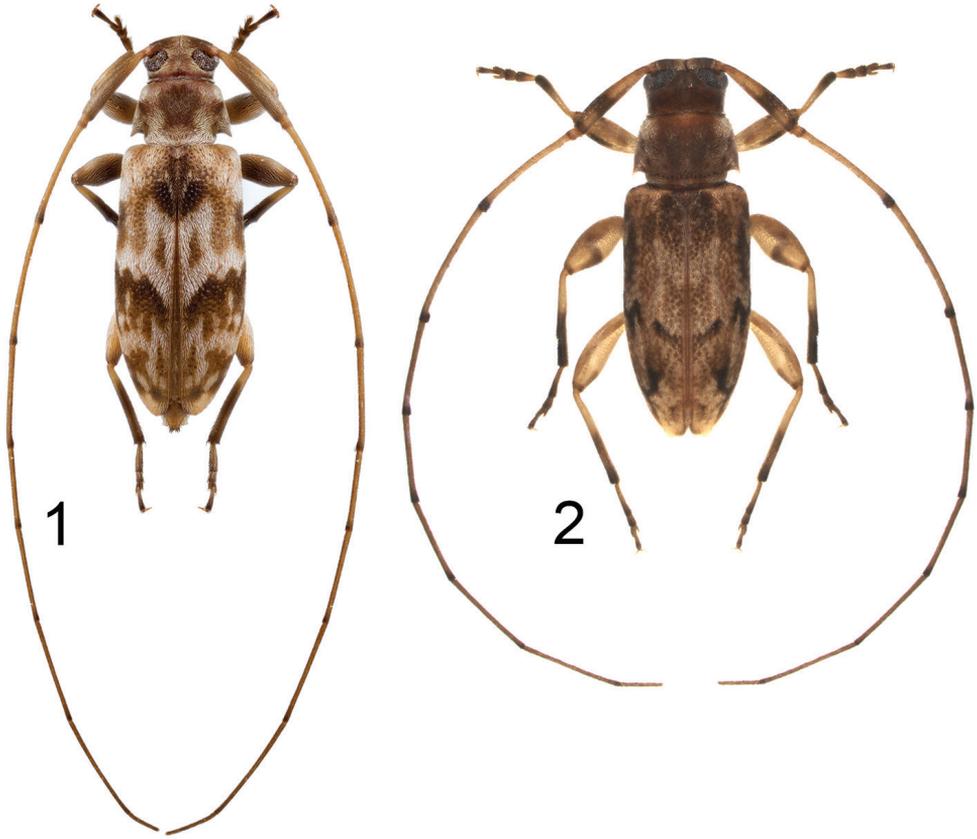
### *Urgleptes puertoricensis* Gilmour, 1963

Figs 1, 8b, 15

**Diagnosis.** This species can be distinguished easily by the mostly dark brown scape, slightly flavous at the base (in *U. sandersoni* the scape is darkened apically with a subapical pale ring). This species is most similar to the highly variable *U. sandersoni* by the elytral maculae (most specimens have a darkened periscutellar region and a zigzag pubescent fascia extending from the lateral margin obliquely toward the middle combined with variable subapical maculae). The posthumeral macula never attains the base in *U. puertoricensis*, whereas in *U. sandersoni* this macula originates basally and extends along the epipleuron.

**Redescription.** *Measurements:* body length: 3.1–4.7 mm; body width: 1.1–1.5 mm; elytral length: 2.1–3.2 mm; elytral width: 0.6–0.8 mm; pronotal length: 0.6–0.9 mm; pronotal width: 1.0–1.4 mm; body length/pronotal length: 4.9–5.1; elytral length/elytral width: 3.7–4.1; pronotal length/pronotal width: 0.6.

*Head:* covered in moderately dense, ashy, appressed setae, becoming denser on genae and eye margins; setae light brown at vertex suture. *Antenna:* with exception of apical antennomeres being mostly dark, antennomeres 3–7 flavous, covered with moderately dense, appressed, dark pubescence; dark annulate at apices. Antennal apices with thickened bristle-like setae along mesal surface of third and fourth segments. Antennae extending beyond elytral apices by 4–6 segments. Antennal scape basally flavous, transitioning to brown; covered in fine gold pubescence apically. Scape extend-



**Figures 1–2.** Dorsal habitus photographs of described species of *Urgleptes*. **1** *U. puertoricensis* Gilmour  
**2** *U. sandersoni* Gilmour.

ing to posterior one-fourth of pronotum. *Eye*: lower eye lobe about twice the height of upper eye lobe; lobes connected by 5–7 rows of ommatidia in most specimens. Upper eye lobes separated by little more than greatest width of scape. *Mouthparts*: frontoclypeal margin with two long, black setae aligned with edge of upper eye lobe. Clypeus without pubescence; labrum pallid with sparse, translucent setae; and 4–6 long, suberect, black setae two-thirds length of those found at frontoclypeal margin.

*Thorax*: pronotum broadly rounded at sides to posteriorly directed, short, acute tubercle on posterior fourth of each side; constricted along posterior fifth behind lateral tubercles; constriction demarcated with row of large, separate punctures across disc, continuing behind base of tubercles and down sides (partially obscured by dense white pubescence); no other distinct punctures visible. Dense, white anterolateral pubescence converging posteromedially around brown pubescent fascia of variable width. Lateral tubercles covered in dense, white pubescence extending ventrally to proepimeron. No distinct calli present on pronotal disc. Pronotal integument mostly brown but darker beneath brown pubescent fascia along posterior constriction and base of

lateral tubercles; anterior pronotal collar distinctly dark brown. Prosternum smooth, impunctate, covered with uniform, translucent pubescence. Prosternal process narrow between procoxae (less than one-fifth width); greatly expanded behind procoxae. Mesosternum smooth, impunctate, covered with uniform, translucent pubescence. Mesosternal intercoxal process slightly broader than prosternal process, just less than one-fourth width of mesocoxa. Metasternum smooth, impunctate, covered with uniform, appressed, ashy-white to translucent pubescence. Integument of ventral sclerites mostly light brown, becoming dark brown at sides. Scutellum brown with nearly black posterior edge (some specimens posteriorly fringed with white pubescence); broadly rounded posteriorly. *Elytra*: moderately densely, coarsely punctate (some specimens with punctures more pronounced than others); punctures partially obscured by dense, appressed, mottled pubescence; elytra lacking tubercles and erect setae. Integument mostly light brown, with exception of darker brown maculae and corresponding dark brown pubescent fasciae. Periscutellar region dark brown to black (sometimes with medial, white pubescence parallel to suture). This region often surrounded by light brown integument covered in dense, white pubescence reaching slightly variable dark brown submedial epipleural macula that is mostly covered in white and brown pubescence. Elytron with dark macula as follows: pubescent zigzag fascia extending from lateral margin obliquely towards middle, not quite attaining suture; with two posteriorly directed parallel fasciae (occasionally weakly connected), ending postmedially along elytral disc. Subapical brown macula extending anterolaterally, narrowly branching toward suture (some specimens with branched maculae merged, almost connecting with medial maculation), surrounded by appressed, dense, white pubescence. Elytral apex subtruncate, with outer apical angle more produced posteriorly than sutural angle. *Legs*: femora mostly dark brown with exception of metafemora; slightly flavous basally and subapically, most apparent on metafemora; uniformly covered with pale white to gold pubescence. Tibiae basally flavous, becoming dark brown apically; with thickened postmedial bristle-like setae. Mesotibiae with dorsal concavity apically also lined with bristle-like setae. Tibiae approximately equal in length to femora. Tarsomeres basally flavous, becoming dark brown apically; coated with short, suberect, dark setae and off-white pubescence ventrally on second through fifth segments.

*Abdomen*: ventrites covered with appressed, pale to translucent pubescence. Integument light brown with posterior third of each ventrite noticeably darkened. Fifth ventrite one and one-half times longer than fourth ventrite and fringed with slightly denser off white pubescence.

**Distribution.** This species was originally described from Puerto Rico and has also been recorded from the Virgin Islands (Monné 2015). *Hispaniola* and the Dominican Republic represent new island and country records, respectively, for this species. This species is uncommonly collected but wide ranging (Fig. 15) throughout the Dominican Republic. Most specimens have been collected by beating vegetation from May through July.

**Material examined. DOMINICAN REPUBLIC: Barahona Prov.**, South slope of Sierra Martin Garcia, 530 m, 18°21.012'N, 71°01.765'W, 9 December 2014, S.

W. Lingafelter (USNM, 2); **La Altagracia Prov.**, Parque Nacional del Este, Boca de Yuma entrance, 18°21.904'N, 68°37.087'W, beating vegetation at night, 5 August 1999, M. A. Ivie (WIBF, 2); **La Vega Prov.**, 1 km NW Manabao, 5 June 1994, M. C. Thomas (FSCA); **Monte Cristi Prov.**, 8 km N Villa Elisa, 31 May 1994, M. C. Thomas (FSCA); 13.2 km N Villa Elisa, 2 June 1994, M. C. Thomas (FSCA); **Pedernales Prov.**, 25 km N of Cabo Rojo, 679 m, 18°06.769'N, 71°37.245'W, day collecting, 10 July 2004, Charyn J. Micheli (USNM); Parque Nacional Jaragua, trail to Carlitos, 6 km S of hwy 44, 106 m, 17°48.93'N, 71°28.27'W, beating vegetation, 8 July 2004, Charyn J. Micheli (USNM, 2); Los Tres Charcos, 13 July 1996, M. C. Thomas (FSCA); **PUERTO RICO.**, Guánica Forest, 25–26 July 1969, H. & A. Howden (WIBF, 3).

### *Urgleptes sandersoni* Gilmour, 1963

Figs 2, 8a, h, 9, 16

*Urgleptes haitiensis* Gilmour, 1963: 82, syn. n.

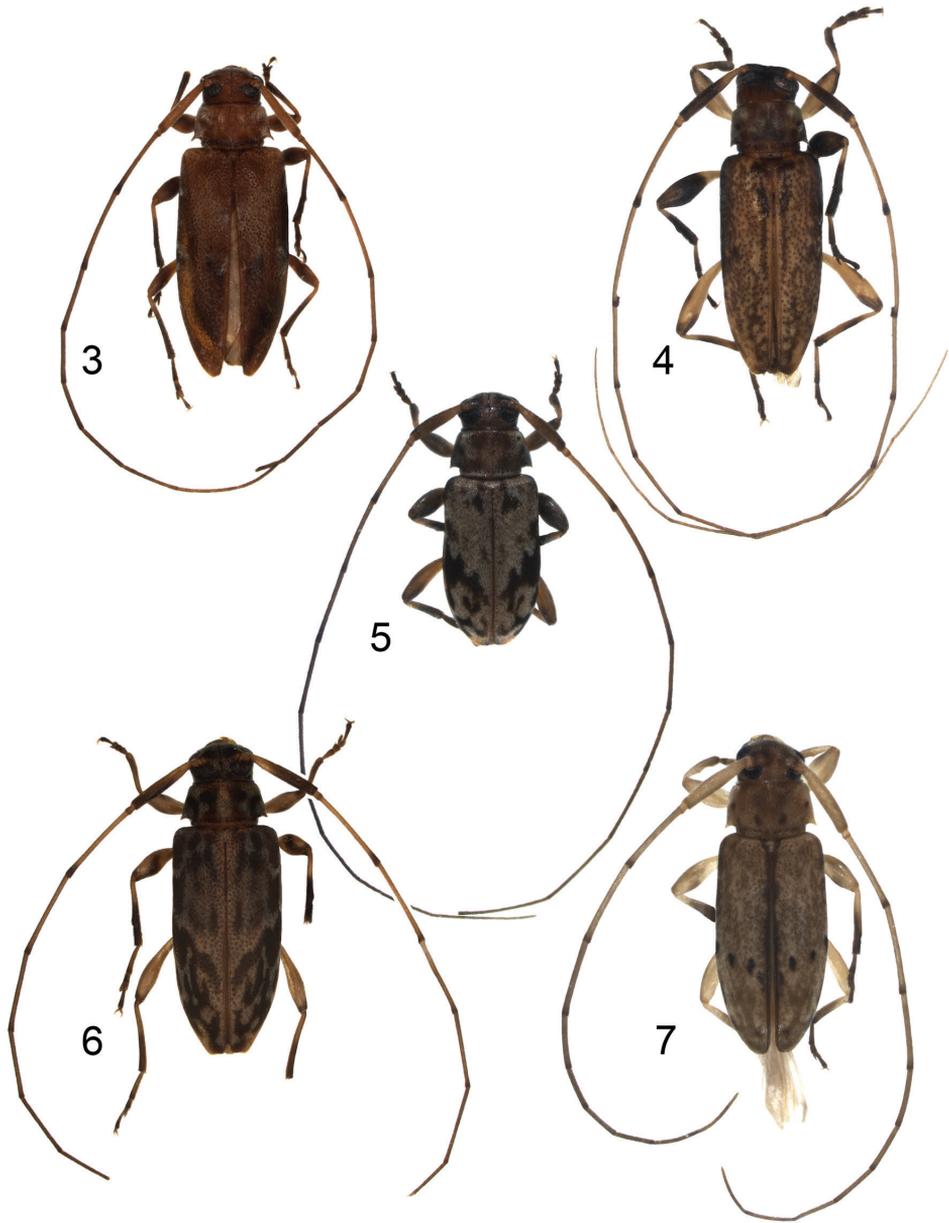
**Diagnosis.** The elytral maculae of this species are more variable than any other species in the genus. As discussed above, *U. sandersoni* is most likely to be confused with *U. puertoricensis*, but they can be distinguished most easily by the scape that is apically darkened with a subapical, flavous ring in *U. sandersoni* (mostly dark brown, without a subapical, pale ring in *U. puertoricensis*.) The presence of dark brown to black maculae at the base of the humeri, often extending through the epipleuron (only occurring posthumeraly in *U. puertoricensis*) may also be used to differentiate between the two. The primarily Lesser Antillean *U. guadeloupensis* (Fleutiaux & Sallé) is much paler and lacks a marmorated pubescent pattern on the elytra (see Remarks for further discussion of this species).

**Redescription.** *Measurements:* body length: 3.3–6.3 mm; body width: 1.2–2.3 mm; elytral length: 2.3–4.6 mm; elytral width: 0.6–1.2 mm; pronotal length: 0.6–1.0 mm; pronotal width: 1.0–1.7 mm; body length/pronotal length: 5.3–6.1; elytral length/elytral width: 4.0; pronotal length/pronotal width: 0.6–0.7.

*Head:* covered in fine vestiture of golden or pale brown appressed hairs; denser along eye margins and antennal tubercles; relatively sparse on occiput and anterior margin of frons. Narrow median-frontal line mostly visible, extending from frons through vertex, and posteriorly to occiput. Frontal-genal line extending from anterior tentorial pits along anterior margin of genae to base of mandible; mostly obscured by dense, golden, appressed pubescence. *Antenna:* mostly pale brown; covered with short, appressed, fine pubescence, not obscuring surface. Antennomeres 1–8 with distinct, narrowly dark brown apices; scape also with second, diffusely dark annula at apical two-thirds; antennomeres 9–11 vaguely darkened apically. Antennae considerably longer than body; extending beyond elytral apices by 4–5 antennomeres; scape extending to posterior margin of pronotum. *Eye:* Lower eye lobe over twice height of upper

eye lobe; extending over half distance between antennal tubercle and frontal margin; lobes connected by 3–4 rows of ommatidia at narrowest point, in most specimens. Upper eye lobes separated by 1.5 times greatest width of scape. *Mouthparts*: frontoclypeal margin sparsely pubescent; lacking pubescent fringe; clypeus without pubescence except for few long setae originating at base. Labrum sparsely pubescent, with 8–10 long, suberect, translucent setae.

*Thorax*: pronotum broadly rounded at sides to posteriorly directed, short, acute tubercles on posterior fourth; constricted along posterior fifth behind lateral tubercles; constriction demarcated with row of large, separate punctures across disc, continuing behind base of tubercles, down sides; pronotum otherwise impunctate except for uniform micropunctures visible only under high magnification. No distinct calli present on disc. Pronotum with uneven vestiture of golden pubescence concentrated at sides of disc, around lateral tubercles, and, often, in two anteromedial spots on disk; elsewhere, pubescence is sparse. Integument mostly light brown, becoming darker at middle of disc, often extending to anteromedial and posteromedial margins. Prosternum smooth, impunctate, covered with uniform, appressed, golden or translucent pubescence. Prosternal process narrow between procoxae (less than one-sixth width) and greatly expanded behind procoxae. Mesosternum smooth, impunctate, covered with uniform, appressed, golden or translucent pubescence. Mesosternal intercoxal process broader than prosternal process, separating mesocoxae by about one-fourth width of mesocoxa. Metasternum smooth, impunctate, covered with uniform, appressed, golden or translucent pubescence. Integument of ventral sclerites mostly light brown, becoming dark brown at sides. Scutellum dark brown with mixture of dark, translucent, and golden pubescence; broadly rounded posteriorly. *Elytra*: densely, coarsely punctate; coated with moderately dense, appressed pubescence; with mottled light and dark appearance; lacking tubercles and erect setae. Highly variable in distribution of maculae and pubescence, often with a correspondence between integumental color and setal color. Nearly all specimens with very dark brown to black periscutellar region (occasionally extending posteriorly along most of suture). This region often surrounded by lighter brown integument covered in gray or translucent pubescence. Nearly all specimens with an oblique narrow post-medial macula extending from near the sutural margin anterolaterally toward lateral margin (sometimes complete, sometimes extending only one-third to one-half across elytral disk). This black macula bordered by white or gray setae. Humeri slightly projecting anterolaterally, usually with black or very dark macula at base and often poorly-demarcated epipleural region. Elytral apex obliquely truncate; lacking spines. *Legs*: femora mostly light yellowish-brown with variably sized dark maculae on mesal and lateral face (most pronounced on mesofemora; least pronounced on metafemora); femora mostly uniformly pubescent with combination of fine, appressed, white, translucent, and dark brown setae. Tibiae light yellowish-brown at base, dark brown to piceous at apical half to two-thirds. Tibiae with setae suberect and more stout, particularly. Mesotibiae with dorsal concavity lined with stout, dark, bristle-like setae. Tarsi, with exception of base of first segment, mostly dark brown to piceous on most specimens.



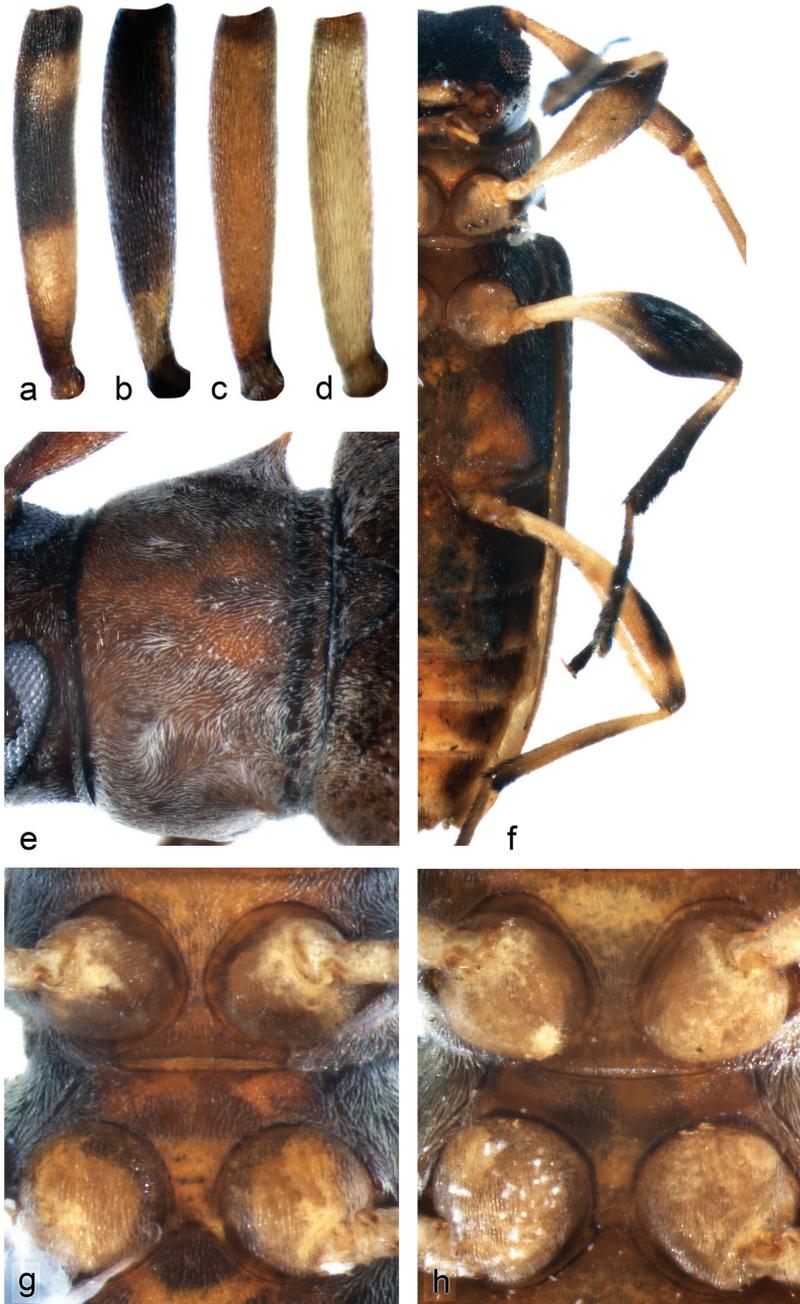
**Figures 3–7.** Dorsal habitus photographs of new species of *Urgleptes*. **3** *U. charynae* Ravin and Lingafelter **4** *U. conjunctus* Ravin & Lingafelter **5** *U. curtipennis* Ravin and Lingafelter **6** *U. marionae* Ravin & Lingafelter **7** *U. obliteratus* Ravin & Lingafelter.

*Abdomen:* ventrites covered with fine, appressed, golden and translucent pubescence; light brown, becoming darker on basal segments and sides. Fifth ventrite distinctly longer than fourth in both sexes; with weak middle notch fringed by longer setae.

**Distribution.** This species was originally described from Puerto Rico. We record it from the Dominican Republic (new country record). This is the most widespread and common species on the island of Hispaniola, having been collected at nearly every sampled locality (Fig. 16). We also record this species for Jamaica (new country record) and Navassa Island which lies between Jamaica and Hispaniola. Specific locality data are included for those islands below.

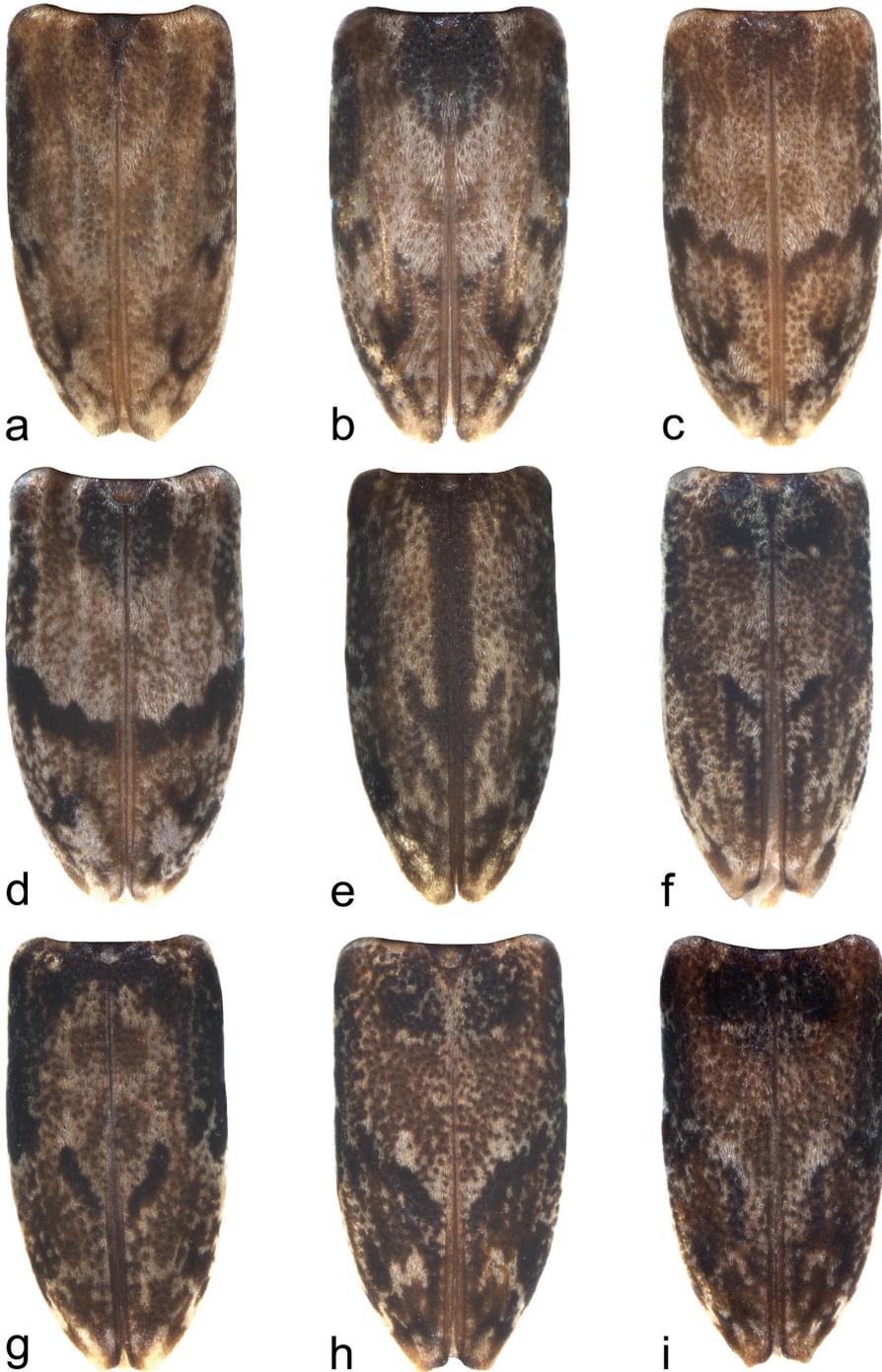
**Remarks.** *Urgleptes sandersoni* and *Urgleptes haitiensis* were each described in Gilmour (1963) on the basis of one specimen; therefore, he was unable to assess intraspecific variation when he defined both species. He stated for *U. haitiensis* that it differs from *U. sandersoni* "in being of a general much darker colour and its marmorated appearance", but shares the pale annulate antennal scape. We have studied hundreds of specimens from Hispaniola and Puerto Rico and found that this is a single, variable species. We demonstrate that the elytral markings vary tremendously (Fig. 9) and without a geographical basis. Figure 9a most closely matches the holotype of *U. sandersoni* (described from Puerto Rico). Figure 9f most closely matches the holotype of *U. haitiensis* (described from Haiti). The scape coloration, however, with the presence of the pale apical annulation in an overall darker apical half, is constant for the species as is the elytral punctation and general coloration of the femora, tibiae, and tarsi, described above. We therefore consider *U. haitiensis* Gilmour (1963: 82) **a new synonym** of *U. sandersoni* Gilmour (1963: 79). This species is most similar to *U. guadeloupensis* (Fleutiaux & Sallé), another highly variable species described from Guadeloupe. According to Gilmour (1963), that species is much paler without a marmorated appearance. Some authors (e.g., Peck 2005) have recorded *U. guadeloupensis* from the Greater Antilles (Cuba) but other authors (e.g., Micheli 2010) concluded it was not present in Puerto Rico. We agree with Micheli's concept of *U. sandersoni*; however, further study and discovery of additional characters may support synonymy of *U. sandersoni* under *U. guadeloupensis*.

**Material examined.** **DOMINICAN REPUBLIC: Barahona Prov.,** 11 km S Barahona, 6–17 May 1985, E. Giesbert (FSCA, 7); Filipinas, 1700 ft, 3–6 May 1985, E. Giesbert (FSCA); same data but 5–6 May 1985 (FSCA); Rd to Polo, S slope, 860 m, 14 July 1996, M. C. Thomas (FSCA, 34); 4.5 km S Barahona, 13 July 1996, M. C. Thomas (FSCA); Paraiso Río Nazaito, 18°00'N, 71°06'W, blacklighting/log picking, 7 July 2004, S. W. Lingafelter (USNM, 2); same data but Charyn J. Micheli (USNM, 3); Filipinas, 625 m, 18°07.339'N, 71°07.152'W, blacklighting/night beating, 7 July 2004, S. W. Lingafelter (USNM, 5); same data but 6 July 2004, C. J. Micheli (USNM); same data but 7 July 2004 (USNM); El Cachote, 970 m, 18°03.295'N, 71°09.778'W, beating, 14 July 2006, S. W. Lingafelter (USNM, 6); Rd to Filipinas, 1700 ft, V–15–1985, J. E. Wappes (WIBF); 11 km S Barahona, V–6–1985, J. E. Wappes (WIBF, 4); same data but V–15, 17–1985 (WIBF); **Dajabón Prov.,** El Pomo Loma de Cabrera, 366 m, 19°26'09.3"N, 71°34'45.3"W, beating/dead wood, 28 June 2010, S. W. Lingafelter (USNM); Los Cerezos, 14 km NW of Río Limpio, 608 m, 19°18'42.9"N, 71°36'36.6"W, fresh cut wood, 29 June 2010, S. W. Lingafelter (USNM, 10); **Elías Piña Prov.,** Sierra de Neiba, 1.5 km E of Military Post 204, SW of Aniceto Martínez,



**Figure 8.** Morphological feature of *Urgleptes* species. **a–d** Scapes of *Urgleptes*: **a** *U. sandersoni* **b** *U. puertoricensis* **c** *U. charynae* **d** *U. obliterated* **e** Detail of posterior row of pronotal punctures characteristic of the genus and dense pronotal pubescence concentrated around lateral tubercles in *U. charynae* **f** Ventral view of *U. conjunctus* emphasizing distinctly dark mesofemora and mesotibiae and very narrow procoxal and mesocoxal processes **g** Narrow procoxal process and broad mesocoxal process for *U. marionae* **h** Broad procoxal and mesocoxal process for *U. sandersoni*.

1597 m, 18°41.644'N, 71°46.457'W, 12 July 2006, S. W. Lingafelter (USNM); Río Limpio, 867 m, 19°14'03.9"N, 71°31'00.9"W, MV lights, 30 June 2010, S. W. Lingafelter (USNM); **Hato Prov.**, Parque Nacional Los Haitises, 6 km SW Sabana de la Mar, 10–20 m, 19°03.494'N, 69°27.302'W, beating, 6 July 2005, C. J. Micheli (USNM, 2); same data but S. W. Lingafelter (USNM, 2); **Independencia Prov.**, Rd 47 between Los Pinos and Ángel Félix, 760 m, 18°36.986'N, 71°46.556'W, 20 June 2005, N. E. Woodley (USNM, 2); **La Altagracia Prov.**, Parque Nacional del Este, Guaraguao, 0–5 m, 18°19.568'N, 68°48.500'W, day collecting, 21 July 2004, C. J. Micheli (USNM); same data but beating, S. W. Lingafelter (USNM); same data but 3 July 2006 (USNM); same data but 8 July 2006 (USNM); same data but 28 June 2005, on *Conocarpus erectus*, N. E. Woodley (USNM); same data but day collecting (USNM); Parque Nacional del Este, Boca de Yuma, 20 m, 18°21.508'N, 68°36.956'W, day collecting, 19 July 2004, C. J. Micheli (USNM, 2); same data but 20 July 2004 (USNM); El Verón, Hoyo Azul, 25–40 m, 18°33.610'N, 68°26.881'W, day collecting, 22 July 2004, C. J. Micheli (USNM, 3); same data but S. W. Lingafelter (USNM, 5); El Verón, Hoyo Azul, 25–40 m, 18°33.805'N, 68°26.543'W, 4 July 2005, N. E. Woodley (USNM); same data but day collecting, 1 July 2005, C. J. Micheli (USNM, 8); same data but 4 July 2005 (USNM, 2); same data but 1 July 2005, S. W. Lingafelter (USNM, 7); same data but UV light and log picking, 7 July 2006 (USNM, 3); Parque Nacional del Este, Boca de Yuma, 20 m, 18°21.508'N, 68°36.956'W, blacklight, 18 July 2004, S. W. Lingafelter (USNM); same data but day collecting, 19 July 2004 (USNM); Punta Cana near Ecological Reserve, 0–5 m, 18°30.477'N, 68°22.499'W, day collecting, 3 July 2005, S. W. Lingafelter (USNM, 5); same data but blacklight (USNM); same data but 29 June 2005 (USNM); same data but beating, 14 June 2005 (USNM, 8); same data but 12–14 June 2005 (USNM); same data but lights, N. E. Woodley (USNM, 4); same data but 2–7 July 2005 (USNM, 2); same data but 12–13 June 2005 (USNM, 5); same data but day collecting, 3 July 2005, C. J. Micheli (USNM, 9); same data but at lights, 26–27 July 2005 (USNM); Punta Cana near Ecological Reserve, 0–5 m, 18°30.477'N, 68°22.499'W, beating, 2 July 2006, S. W. Lingafelter (USNM, 5); same data but 21 July 2006 (USNM, 5); same data but cut wood at night, 5 July 2006 (USNM, 11); same data but at light, 1 July 2006 (USNM); Parque Nacional del Este, valle de la Orqueta, 25 m, 18°22.945'N, 68°46.631'W, beating, 29 June 2005, C. J. Micheli (USNM); same data but N. E. Woodley (USNM); **La Vega Prov.**, vicinity of Manabao, 15 July 1996, M. C. Thomas (FSCA, 6); 10 km E Constanza, 1295 m, beating in pine guava forest, 31 August 1988, M. A. Ivie, T. K. Philips, & K. A. Johnson (FSCA); 1 km NW Manabao, 6 July 1994, M. C. Thomas (FSCA, 4); same data but 4 July 1994 (FSCA, 2); same data but 5 July 1994 (FSCA); Pico Duarte Trail, Ciénaga to Los Tablones, 19°08.222'N, 70°27.736'W, beating, 29 June 2004, C. J. Micheli (USNM, 2); same data but 3000 ft, S. W. Lingafelter (USNM); same data but 3300 ft, 17 July 2004 (USNM); same data but recently fallen tree, 2 July 2010, S. W. Lingafelter (USNM, 2); Parque Nacional José Armando Bermúdez, 10 km along trail W of La Ciénaga near Los Tablones, 990–1100 m, 19°01.753'N, 70°54.654'W, day collecting, 22 June 2005, S. W. Lingafelter (USNM);



**Figure 9.** Morphological series showing major elytral maculae for *U. sandersoni* and its new synonym, *U. haitiensis*. **a** Pattern most similar to *Urgleptes sandersoni* holotype **f** Pattern most similar to *Urgleptes haitiensis* Gilmour holotype.

Rancho Baiguarte Hotel, 527 m, 19°07'36"N, 70°38'39"W, dead branches, 18 June 2010, S. W. Lingafelter (USNM, 5); 9 km NE Jarabacoa, 2000 ft, 8–12 May 1985, E. Giesbert (FSCA, 8); Boca de Yuma entrance, Parque Nacional del Este, 12 m, 18°201.904'N, 68°37.094'W, beating vegetation, 6 August 1999, M. A. Ivie (FSCA); same data but 2 m, at light, 5 August 1999, M. A. Ivie & K. A. Guerrero (FSCA); 6 km E Jima, 4100 ft, 18 May 1985, E. Giesbert (FSCA); 10 km NE Jarabacoa, V–8, 12–1985, J. E. Wappes (WIBF, 5); 2 km E Tireo, 4100 ft, V–8–1985, J. E. Wappes (WIBF); **Monseñor Nouel Prov.**, 19°01'N, 70°31'W, beating, 4 July 2004, S. W. Lingafelter (USNM); **Monte Cristi Prov.**, Reserva Científica Villa Elisa, 183 m, 19°44'46.1"N, 71°15'27.3"W, dead wood, 24 June 2010, S. W. Lingafelter (USNM, 4); **Pedernales Prov.**, 19–20 km N Cabo Rojo, 375 m, 10 July 1996, M. C. Thomas (FSCA, 4); same data but 24 km N, 535 m, 11 July 1996 (FSCA); N of Pedernales border Rd, Río Banano, S of Arroyos, 18°09.291'N, 71°45.540'W, 21 July 1999, Ivie & Guerrero (FSCA); Parque Nacional Sierra de Baoruco, Las Abejas, 1240 m, 18°09.023'N, 71°37.387'W, 09 August 1999, M. A. Ivie (FSCA); Parque Nacional Jaragua, trail to Carlitos ca. 6 km S of hwy 44, 106 m, 17°48.93'N, 71°28.27'W, beating, 8 July 2004, C. J. Micheli (USNM, 7); same data but S. W. Lingafelter (USNM, 4); same data but 16 June 2006 (USNM, 4); Parque Nacional Sierra de Baoruco, Las Abejas, 1150 m, 18°09.011'N, 71°37.342'W, blacklight, night beating, 11 July 2004, S. W. Lingafelter (USNM, 14); same data but 18 June 2005 (USNM, 2); same data but 17 July 2006 (USNM, 10); same data but beating, 11 July 2004, Charyn J. Micheli (USNM, 9); 25 km N of Cabo Rojo, 679 m, 18°06.769'N, 71°37.245'W, day collecting, 10 July 2004, S. W. Lingafelter (USNM, 2); 1 km N of Banano, 290 m, 18°09.258'N, 71°45.384'W, day beating, 12 July 2004, S. W. Lingafelter (USNM); 25 km N of Cabo Rojo, 679 m, 18°06.769'N, 71°37.245'W, beating, 15 July 2006, S. W. Lingafelter (USNM); Parque Nacional Jaragua 3 km S of Los Tres Charcos, 100 m, 17°47.51'N, 71°27.78'W, beating, 16 July 2006, S. W. Lingafelter (USNM, 6); **Peravia Prov.**, 5 km W of Rd to El Río, S of Pedregal, 52 m, 19°05.092'N, 70°35.864'W, 23 June 2005, S. W. Lingafelter (USNM, 3); **Puerto Plata.**, Reserva Científica Isabel de Torres, 704 m, 19°45'55.6"N, 70°42'42.8"W, beating, 23 June 2010, S. W. Lingafelter (USNM, 9); S of Punta Rusia, 39 m, 19°49.32.5"N, 71°13'11.1"W, dead wood, S. W. Lingafelter (USNM, 2); S Pico Isabel de Torres, El Cupey Rd, 258 m, 19°45.214'N, 70°43.6464'W, 30 July 1999, Ivie & Guerrero (FSCA); 14 km W Puerto Plata, 10–11 May 1985, E. Giesbert (FSCA, 2); 14 km W of Puerto Plata, V–11–1985, J. E. Wappes (WIBF); Le Cumbre Rsh. Sta., V–8, 9–1985, J. E. Wappes (WIBF); Imbert, at night, 29 July 1983, R. E. Woodruff (FSCA); **San Pedro Prov.**, Near Juan Dolio, V–13, 18–1985, J. E. Wappes (WIBF, 17); **San Pedro de Macorís Prov.**, 12 km W San Pedro de Macorís, 5–19 May 1985, E. Giesbert (FSCA, 10). **HAITI: Dept. Ouest.**, Morne Guimby, 22 km SE Fonds-Verrettes, 6500 ft, 19 July 1956, B. & B. Valentine (WIBF, 8). **Dept. Sud-Est.**, Massif de la Selle, Morne d'Enfer, 1850 m, 15 May 1984, M. C. Thomas (FSCA, 4); Parc National La Viste, 1 km S Roche Plat, 22 May 1984, M. C. Thomas (FSCA, 4); Furcy (Holotype of *haitiensis*).

***Urgleptes charynae* Ravin & Lingafelter, sp. n.**

<http://zoobank.org/C6C1795B-4F4F-4C5A-BC97-2D6C64D3F497>

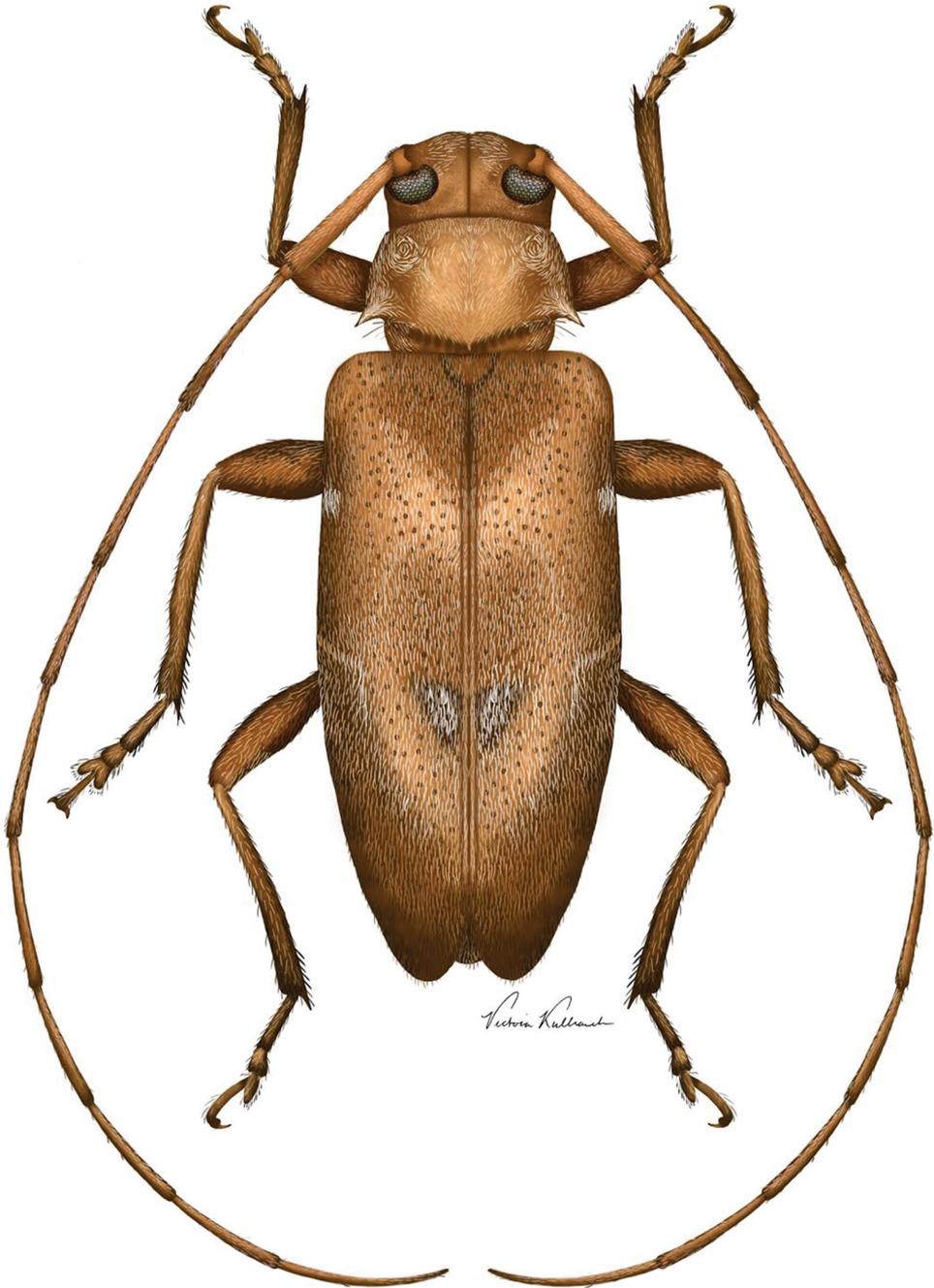
Figs 3, 8c, 10, 17

**Diagnosis.** This species is recognized by the mostly uniform, light ferruginous integument covered by mostly uniform pubescence. The elytra have slightly denser patches of white pubescence postmedially extending across the disk (sometimes forming circular patches). Underneath these pubescent patches, the integument is slightly darkened. The pronotum has dense, white pubescence anterolaterally, extending to the lateral tubercles. The only other species with mostly uniform integument color and mostly lacking dense pubescent patches is *U. obliteratus*. That species is easily distinguished by its much paler integument and typically bold, black, postmedial elytral and pronotal spots. Additionally, *U. charynae* has the scape uniformly brown, slightly darker apically, unlike other species which usually contain a subapical spot or flavous base.

**Description.** *Measurements:* body length: 3.6–5.3 mm; body width: 1.3–1.9 mm; elytral length: 2.5–3.8 mm; elytral width: 0.7–1.0 mm; pronotal length: 0.7–1.0 mm; pronotal width: 1.1–1.6 mm; body length/pronotal length: 5.3–5.4; elytral length/elytral width: 3.9–4.0; pronotal length/pronotal width: 0.6.

*Head:* integument brown, becoming darker at frontoclypeal margin, and apices of antennal tubercles. Covered in vestiture of appressed white pubescence on genae, occiput, and posterior margin of lower eye lobe. *Antenna:* with exception of apical antennomeres being uniform throughout, antennomeres mostly flavous with darkened apices; covered in dense appressed, gold to brown pubescence. Antennal apices with thickened bristle-like setae along mesal surface of third and fourth segments of most specimens. Sixth antennomere shortest, being just under three-fourths length of third antennomere. Antennae extending beyond elytral apices by approximately 5 segments. Antennal scape extending to posterior fourth of pronotum; uniformly light brown, weakly darker at apex; covered in uniform, appressed, gold pubescence. *Eye:* lower eye lobe slightly more than 2× height of upper eye lobe; lobes narrowly connected by about 5 rows of ommatidia in most specimens. Upper eye lobes separated by slightly more than greatest width of lower eye lobe. *Mouthparts:* clypeus pallid; lacking distinct pubescence; and finely punctate. Labrum slightly darker than clypeus; with 7 suberect, dark brown setae; anteriorly fringed with translucent setae. Mandibles light brown, distinctly darkened on apical fourth; with two dark brown setae along lateral margin.

*Thorax:* pronotum broadly rounded at sides to posteriorly directed, short, acute tubercles on posterior fourth; constricted along posterior fifth behind lateral tubercles; constriction demarcated with row of large, separate punctures across disc, continuing behind base of tubercles and down sides; no other distinct punctures visible. Integument mostly brown, slightly darker medially and along posterior constriction; anterior pronotal collar distinctly dark brown. Pronotal disc finely coated in gold pubescence; with anterolateral patches of white pubescent fasciae; surrounding pubescence dense, ashy-white, covering tubercles; sometimes concentrating on posterior constriction behind lateral spines. No distinct calli present on pronotal disc. Prosternum impunc-



**Figure 10.** Digital painting of *Urgleptes charynae* sp. n. (illustrated by Victoria Kulhanek, St. Paul, Minnesota).

tate; covered in dense vestiture of white pubescence. Prosternal process extremely narrow between procoxae, about half width of anterior pronotal collar, and greatly expanded posteriorly. Mesepimeron toward metepisternal apex coated with dense, appressed, white pubescence becoming thinner ventrally. Mesosternal intercoxal process about twice as broad as prosternal process. Integument of ventral sclerites mostly light brown, with margin of coxal cavity darkened. Scutellum brown with darker posterior edge; broadly rounded posteriorly. *Elytra*: moderately dense, coarsely punctate; elytral disc mostly light-ferruginous; dark brown at epipleuron; dark brown postmedially to apex; covered in mottled white-grey to brown pubescence. Periscutellar region slightly raised; coated in ferruginous pubescence; surrounding region weakly concave; with moderately dense, appressed, white-grey pubescence extending from humerus to submedial suture. Epipleural integument mostly dark brown; medially giving rise to discontinuous, oblique, dark brown maculae, each surrounded by distinctly dense, white, appressed, pubescent fasciae. Postmedial pubescence along disc white-grey; integument becoming dark brown to apical third. Elytral apex subtruncate, with outer apical angle slightly more produced posteriorly than sutural angle. *Legs*: femora mostly light-ferruginous; slightly darker laterally, most visibly on mesofemora; uniformly covered with pale-golden pubescence. Tibiae basally flavous-ferruginous; submedially dark brown towards apices with dark brown, postmedial, thickened, bristle-like setae. Mesotibiae with dorsal concavity apically, also lined with bristle-like setae. Tibiae slightly longer than femora; hind legs slightly longer than forelegs. Tarsomeres basally flavous-ferruginous, becoming brown apically; generally coated with short, suberect, dark setae; with off-white ventral pubescence on lobed fourth tarsomere.

*Abdomen*: ventrites covered with moderately dense, appressed, pale pubescence; integument mottled brown, posteriorly lighter, apical margin pallid. Fifth ventrite one and a half times longer than fourth ventrite and fringed with slightly denser golden pubescence.

**Distribution.** Endemic to Hispaniola, this species is known from both the Cordillera Central and southern Sierra de Neiba mountain ranges (Fig. 17) where it has been collected from May through November, at high elevations between 600–2450 m, often in or near pine forests.

**Etymology.** We name this species for our friend and colleague, Charyn Micheli, who collected the holotype and many other specimens in the genus. The epithet is a noun in apposition.

**Type material.** **Holotype** (male): **DOMINICAN REPUBLIC: La Vega Prov.**, Pico Duarte trail below La Participación, 2450 m, 19°02.254'N, 70°58.155'W, day collecting, 1 July 2004, Charyn J. Micheli (USNM); **Paratypes: DOMINICAN REPUBLIC: La Vega Prov.**, 10 km NE of Jarabacoa, 8–12 May 1985, J. E. Wappes (ACMT); Sierra de Neiba, 9.4 km SSW El Cercado, 1973 m, 18°39'18"N, 71°32'51"W, hand collected in meadow near mature pine forest, 18–19 November 2004, C. W. Young, J. E. Rawlins, C. Nunez, V. Verdecia, and W. Zanol (CMNH, 2); 9 km NE of Jarabacoa, 2000 ft, 8–12 May 1985, E. Giesbert (FSCA); 9 km NE of Jarabacoa 8–12 May 1985, E. Giesbert (FSCA, 2); Constanza, 17 July 1996, R. Turnbow (RHTC, 2); 13

km S of Constanza, El Convento Rd, 1450 m, 18°50.915'N, 70°41.059'W, 28 July 1999, M. A. Ivie & K. A. Guerrero (WIBF); 3 km N of Jarabacoa, 25 May 1992, R. Turnbow (RHTC, 2); 1 km N of Tíreo Arriba, 24 May 1992, R. Turnbow (RHTC); 1 km NW Manabao, 6 June 1994, M. C. Thomas (FSCA); 1.4–2.6 km E of Manabao, 5 June 1994, M. C. Thomas (FSCA, 5); 2.6–6.4 km E of Manabao, 4 June 1994, M. C. Thomas (FSCA); Vicinity of La Ciénaga, mercury vapor/UV light, 18 July 1996, M. C. Thomas (FSCA, 3); 1 km NW Manabao 6 June 1994, M. C. Thomas (FSCA); 1.4–2.6 km E of Manabao, 6 June 1994, M. C. Thomas (FSCA); **San Juan Prov.**, San Juan, 7 km N of Arroyo Cano, 1 km S of Los Fríos, 1120 m, 18°52'N, 71°01'W, second growth pine forest, 1 September 1995, J. Rawlins, G. Onore, R. Davidson (CMNH); **Santiago Prov.**, Parque Nacional José Armando Bermúdez, El Rodeo, 1456 m, 19°08'N, 71°02'W, 10 July 1992, M. A. & R. O. Ivie (WIBF).

***Urgleptes conjunctus* Ravin & Lingafelter, sp. n.**

<http://zoobank.org/3334A9B6-0BAB-49A0-95FA-018F86497253>

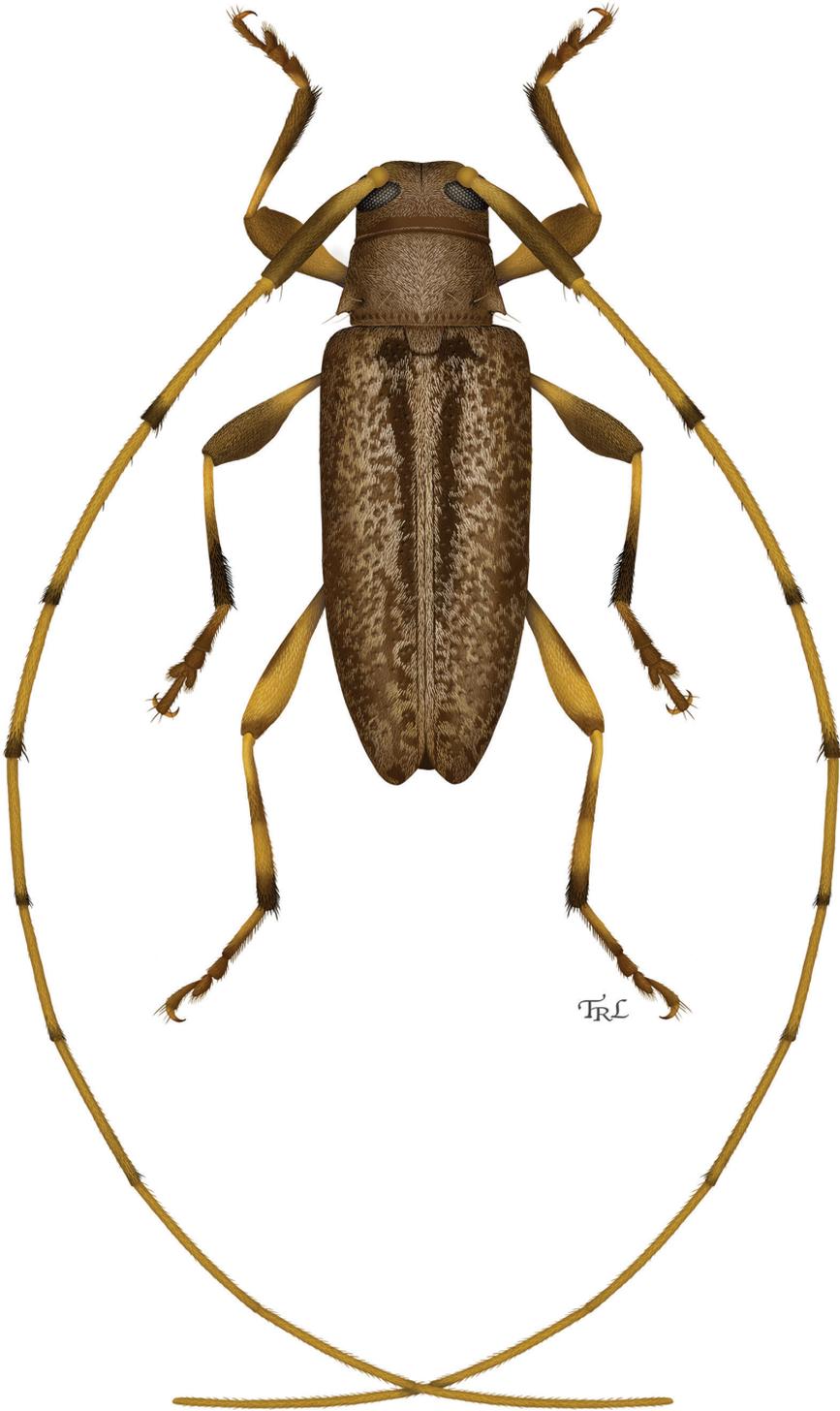
Figs 4, 8f, 11, 18

**Diagnosis.** The coarsely punctate elytra and narrow longitudinal darkened macula running parallel to the suture make this species readily identifiable. The mesofemora and mesotibiae of this species are distinctly darker than in other species. The antennae are most distinct in that the scape is antemedially darker than the base, and the third and fourth segments contain suberect bristle-like, apicomeral setae. Both the procoxal and mesocoxal processes are very narrow in *U. conjunctus* and barely separate the coxae.

**Description.** *Measurements:* body length: 4.4–5.0 mm; body width: 1.5–1.8 mm; elytral length: 3.2–3.7 mm; elytral width: 0.8–0.9 mm; pronotal length: 0.8 mm; pronotal width: 1.2–1.4 mm; body length/pronotal length: 5.6–6.5; elytral length/elytral width: 4.0–4.1; pronotal length/pronotal width: 0.6–0.7.

*Head:* covered in moderately dense, appressed, pale white to golden pubescence; denser at genae, posterior margin of eye lobes and antennal tubercles. Integument mostly dark brown; slightly lighter from vertex of upper eye lobes to occiput. *Antenna:* scape basally flavous, darker submedially to apex; covered with fine, golden pubescence. Remaining antennomeres flavous; covered with moderately dense, brown setae; segments 2–7 acutely darkened at apices; segments three and four with thickened, suberect bristle-like, apicomeral setae; segments 8–11 without darkened apices. Males (most distinct in holotype) have tuft of perpendicular, thickened mesal setae at apex of fourth antennomere. *Eye:* lower eye lobe just over twice height of upper eye lobe; lobes connected by about six rows of ommatidia. *Mouthparts:* clypeus flavous; lightly pubescent basally. Labrum same color as clypeus; strongly apically rounded; with long, suberect, dark brown to gold setae; mandibles brown, darker at apical third.

*Thorax:* pronotum broadly rounded at sides to posteriorly directed, short, acute tubercles on posterior fourth; constricted along posterior fifth behind lateral tubercles; constriction demarcated with row of large, separate punctures across disc, continuing behind



**Figure 11.** Digital painting of *Urgleptes conjunctus* sp. n. (illustrated by Taina Litwak, USDA).

base of tubercles, down sides of pronotum. No distinct calli present on disc. Pronotum anteromedially covered in ashy-white pubescence extending to subapices of lateral tubercles; brown pubescence on middle of disc, extending posteriorly around posterior third of pronotum, partially obscuring row of punctures. Integument mostly brown, slightly darker at middle, extending posterolaterally and around base of lateral tubercles. Ventral surface of lateral tubercles coated in dense, appressed, golden pubescence. Prosternum smooth, impunctate, covered with uniform translucent pubescence. Prosternal process very narrow between procoxae (less than one-eighth width), barely separating them and greatly expanded posteriorly. Mesepimeron dark brown, densely coated with white pubescence, thinner at mesosternum; mesosternal intercoxal process very narrow, barely separating mesocoxae. Metepisternal integument dark brown; coated with dense, appressed, ashy-white pubescence; mostly flavous at metasternum; with moderately dense, translucent to brown pubescence. Scutellum anteriorly dark brown, slightly lighter at apex; pubescence medially expanding along posterior margin. *Elytra*: dense, irregularly spaced, distinct punctures throughout; elytral disc mottled with pallid, brown, and ferruginous pubescence. Periscutellar region slightly swollen, darkened anteriorly flanking scutellum; posteriorly, briefly interrupted by ashy-white pubescence, resuming into single narrow longitudinal darkened macula running parallel to suture, terminating medially (in one specimen this longitudinal macula is postmedially positioned). Humeri with darkened integument and corresponding darkened pubescence extending along epipleuron. Disc mostly brown, covered in dense, appressed, ashy-white to pale pubescence. Apices subtruncate, with outer apical angle slightly more produced posteriorly than sutural angle; sutural apices dark brown, with irregular finger-like projections extending anteriorly, surrounded by mottled pale and brown pubescence. *Legs*: profemora covered in vestiture of translucent to gold setae; mostly flavous; ferruginous submedially to apices both mesally and laterally, narrowly connecting at apex; protibiae basally flavous, becoming brown submedially, covered with gold to brown setae. Mesofemora distinctly, mostly piceous, with exception of flavous base, covered in fine, translucent to gold setae; mesotibiae basally flavous, becoming dark brown apically, covered in moderately dense brown setae. Metafemora mostly flavous; with lateral dark macula submedially to apex; tibiae slightly flavous, darker at apex; both covered in vestiture of fine gold pubescence. Tarsomeres completely dark-ferruginous with exception of slightly basally lighter first tarsomere; generally coated with short, suberect, dark setae.

*Abdomen*: ventrites covered with uniformly weakly dense, appressed, translucent to golden pubescence; integument medially light brown, becoming noticeably darker towards sides. Fifth ventrite 1.5 times length of fourth ventrite.

**Distribution.** Endemic to Hispaniola, this rare species has been collected only in the Sierra de Baoruco mountains in August (Fig. 18).

**Etymology.** The epithet, *conjunctus*, refers to the closely parallel longitudinal macula along the elytral suture.

**Type material. Holotype** (male): **DOMINICAN REPUBLIC: Peravia Prov.**, 36 km. NW. San José de Ocoa, Aug. 9, 1979, L. B. O'Brien (USNM); **Paratypes**: same data as holotype (USNM, 2).

***Urgleptes curtipennis* Ravin & Lingafelter, sp. n.**

<http://zoobank.org/1FAF70B5-06B7-4874-ADBB-5ECD4D15BDC3>

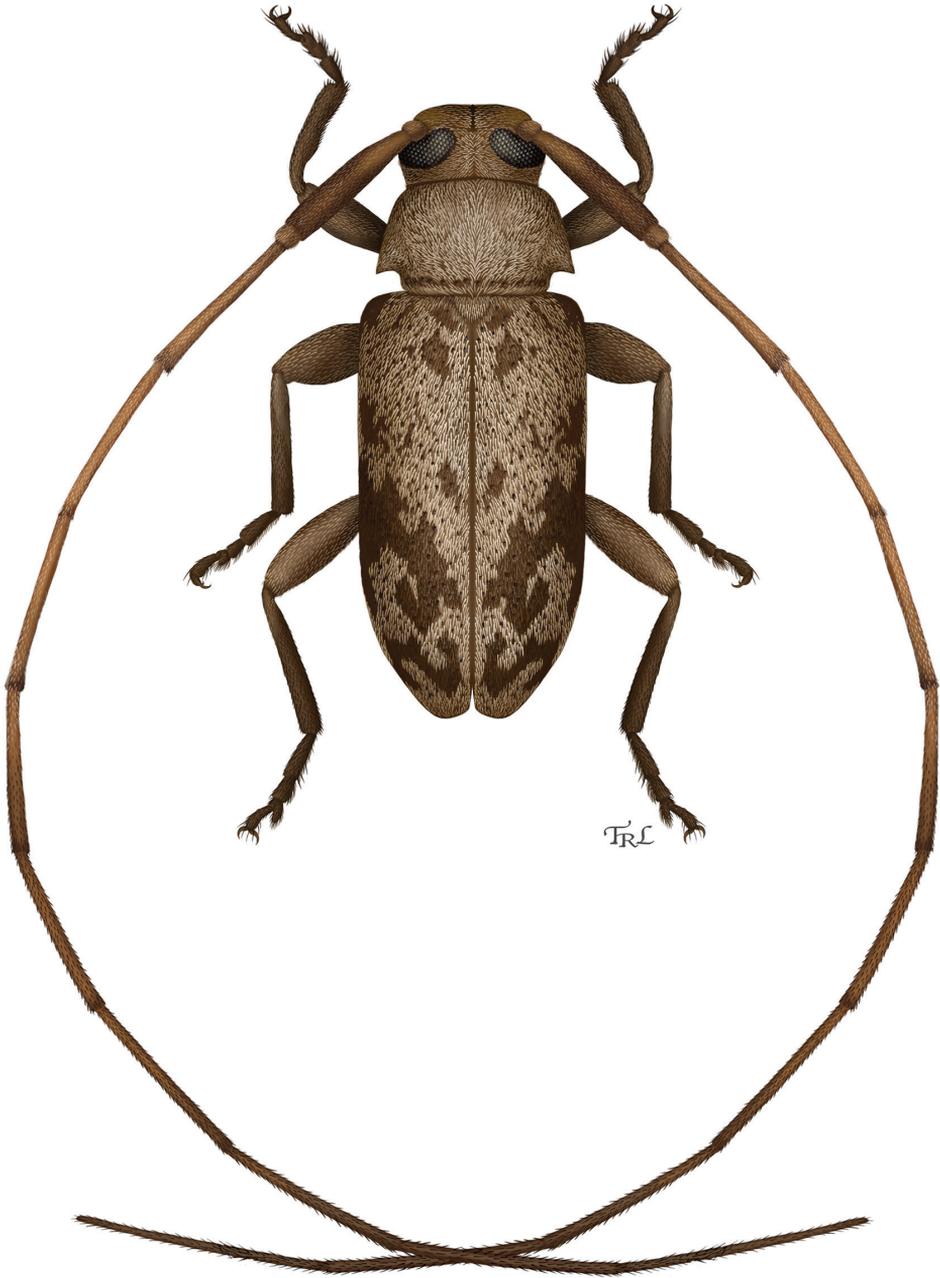
Figs 5, 12, 18

**Diagnosis.** The proportions of this species are distinctive. The elytra are relatively much shorter compared to overall body length than all other Hispaniolan species. Further, the elytral maculations are well defined and contrast strongly from the dense, ashy, white pubescence that is otherwise present. With the exception of the pedicel and third antennomere being mostly flavous and darkened apically, all remaining antennomeres are gradually darker until the distal segments which are mostly uniform in coloration. Unlike *U. sandersoni*, *U. puertoricensis*, and *U. conjunctus*, this species has a light periscutellar region.

**Description.** *Measurements:* body length: 3.3 mm; body width: 1.3 mm; elytral length: 2.2 mm; elytral width: 0.6 mm; pronotal length: 0.7 mm; pronotal width: 1.1 mm; body length/pronotal length: 5.0; elytral length/elytral width: 3.5; pronotal length/pronotal width: 0.61.

*Head:* integument piceous; covered in coarse white pubescence; denser at vertex of antennal tubercles, frons, and occiput; slightly sparser on dorsal face of tubercles. *Antenna:* Scape slightly flavous at base, quickly becoming uniformly brown, covered in dense, fine gold pubescence; antennomeres three and four mostly flavous, narrowly darkened at apices; successive antennomeres mostly ferruginous, gradually darker towards apices; with exception of slightly longer third and tenth antennomeres, segments nearly uniform in length. Antennae considerably longer than body; extending beyond elytral apices by 5–6 antennomeres; scape extending to posterior third of pronotum. *Eye:* Lower eye lobe no more than 1.5 times height of upper eye lobe; extending over half distance between antennal tubercle and frontal margin; lobes connected by 4–5 rows of ommatidia. Upper eye lobes separated by just slightly greatest width of scape. *Mouthparts:* Clypeus weakly concave, ashy-flavous, lacking distinct pubescence; labrum with a few long setae originating at base and anterior fringe of translucent setae.

*Thorax:* pronotum broadly rounded at sides to posteriorly directed, short acute tubercles on posterior fourth; constricted along posterior fifth behind lateral tubercles; constriction demarcated with row of large, separate punctures across disc, continuing behind base of tubercles, down sides. No distinct calli present on disc. Anteromedial fascia of darkened pubescence present; otherwise evenly coated in moderately dense grey-white pubescence. Integument mostly light brown, vaguely darkened at lateral tubercles to apices of spines. Prosternum smooth, impunctate, covered with sparse, gold or translucent pubescence, concentrated at posterolateral margin below lateral spines. Prosternal process narrow between procoxae (about one-eighth width) and greatly expanded behind procoxae. Mesepimeron smooth, impunctate, covered with uniform, appressed, golden or translucent pubescence. Mesosternal intercoxal process almost 2.5 times broader than prosternal process, separating mesocoxae by about one-fourth width of mesocoxa. Metasternum smooth, impunctate, covered with appressed, golden or translucent pubescence, densest at sides, thinning towards middle. Integument of ventral sclerites mostly dark brown, becoming lighter at middle. Scutellum coated in dense, appressed, ashy-white pubescence, making difficult



**Figure 12.** Digital painting of *Urgeleptes curtipennis* sp. n. (illustrated by Taina Litwak, USDA).

to distinguish from elytra; broadly rounded posteriorly. *Elytra*: integument mostly dark brown; moderately punctate; almost completely obscured by uniformly dense, appressed, ashy-grey pubescence. Humeri strongly rounded with darker integument and blackened pubescence. Periscutellar region slightly swollen with two dark brown maculae; one ovate,

flanking scutellum; second, larger macula set posteriorly; neither attaining suture. This region surrounded by dense, appressed, ashy-white pubescence. Elytron with sickle-shaped, post-medial, dark macula, originating at epipleuron and obliquely coiling towards middle. Posteriorly directed branches of this macula not quite attaining suture, ending at subapical, lateral margin. Darkened macula bordered by same appressed, ashy-white pubescence as anterior half. *Legs*: femora mostly ferruginous; flavous at basal third and dorsum; covered in course white setae. Tibia flavous at base; ferruginous submedially; covered in brown, bristle-like setae. Mesofemora covered in brown to gold setae; mostly ferruginous, only flavous at base; basal third of mesotibiae flavous, dark brown submedially to apex; with postmedial concavity full of brown, bristle-like setae. Metafemora mostly flavous, slightly darker at mesal and lateral third to apices; covered in moderately dense pale gold setae. Metatibiae mostly dark brown, dark-flavous at base; covered in translucent to brown bristle-like setae. Tarsi mostly dark brown; covered in suberect, brown setae.

*Abdomen*: ventrites covered with fine, appressed, translucent pubescence, slightly thicker, gold pubescence at sides; integument light brown at middle, becoming darker toward sides. No distinct size difference in length of ventrites, with weak middle notch fringed with longer setae.

**Distribution.** This endemic Hispaniolan species is known only from the holotype that was collected at lights on the northern face of the Sierra de Baoruco mountain range (Fig. 18).

**Etymology.** The epithet, *curtipennis*, refers to the short elytra relative to the overall body length.

**Type material. Holotype** (male): **DOMINICAN REPUBLIC: Independencia Prov.**, Sierra de Baoruco, Rabo de Gato, 18°17.962'N, 71°35.811'W, 490 m, 14–15 Dec 2014, S. W. Lingafelter, UV/MV lights (USNM).

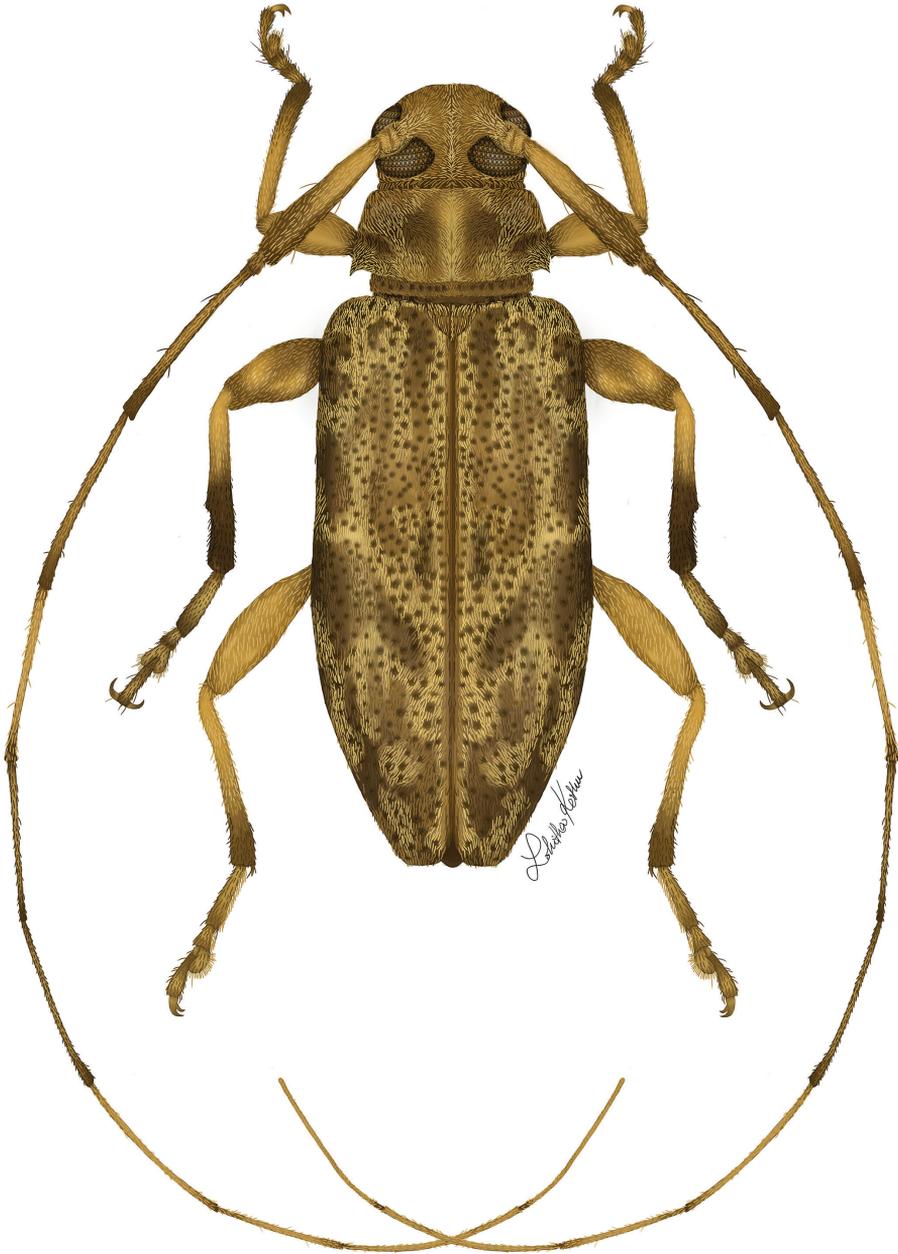
***Urgleptes marionae* Ravin & Lingafelter, sp. n.**

<http://zoobank.org/72996267-F241-41D2-94FD-10C65EA0351C>

Figs 6, 8g, 13, 19

**Diagnosis.** The elytra of this species each have an oblique postmedial macula extending anterolaterally from near the suture to middle lateral margin, somewhat similar to *U. sandersoni*, *U. puertoricensis*, and *U. curtipennis*. However *U. marionae* is unique in that faint, longitudinal, darker maculae are present on the elytra, extending posteriorly from the base, much less defined than in *U. conjunctus*, and there are three irregular, longitudinal fasciae of pale pubescence. The femora are flavous and densely covered in mostly golden pubescence, with the pro- and mesofemora each containing a medially darkened ring along the dorsal and mesal margins. The mesocoxal process in *U. marionae* is much broader than in *U. conjunctus*.

**Description. Measurements:** body length: 4.8–6.3 mm; body width: 1.7–2.2 mm; elytral length: 3.5–4.9 mm; elytral width: 0.8–1.1 mm; pronotal length: 0.8–0.9 mm; pronotal width: 1.4–1.7 mm; body length/pronotal length: 6.4–6.7; elytral length/elytral width: 4.2–4.4; pronotal length/pronotal width: 0.5–0.6.



**Figure 13.** Digital painting of *Urgleptes marionae* sp. n. (illustrated by Lohitha Kethu, Virginia Commonwealth University).

*Head:* integument dark brown, slightly lighter at antennal tubercles; with exception of mostly glabrous genae, covered in dense, appressed, ashy-white pubescence, denser at posterior eye margin. *Antenna:* scape basally flavous, dark brown submedially to apex; covered with fine, translucent pubescence. Antennomeres 3–6 flavous,

darkened apically, with fine gold to brown pubescence; apical segments without dark apices, uniformly light brown; basal segments with thickened, suberect bristle-like, apicomesal setae. *Eye*: lower eye lobe just over twice height of upper eye lobe; lobes connected by about seven rows of ommatidia. *Mouthparts*: clypeus light-flavous; lacking pubescence. Labrum flavous; apically fringed with translucent setae, and posteriorly with long, suberect, dark brown setae; mandibles light-ferruginous, darker at apices.

*Thorax*: pronotum broadly rounded at sides to posteriorly directed, short, narrow, acute tubercles on posterior fourth; constricted along posterior fifth behind lateral tubercles; constriction demarcated with row of large, separate punctures across disc, continuing behind base of tubercles, down sides of pronotum. No distinct calli present on disc. Pronotum dark brown; anteromedially covered in appressed, ashy-white pubescence extending posteriorly; flanked by dark, irregular fascia, surrounded by ashy-white pubescence. Prosternum smooth, impunctate, covered with uniform ashy to golden pubescence. Prosternal process narrow between procoxae (less than one-sixth width) and greatly expanded posteriorly. Mesepimeron dark brown, densely coated with ashy to golden pubescence, thinner at mesosternum; mesosternal intercoxal process moderately broad between mesocoxae, about twice width of prosternal process between procoxae. Metepisternal integument dark brown; coated with dense, appressed, ashy to golden pubescence; light brown at metasternum; with fine translucent pubescence. Scutellum uniformly dark brown; covered in ashy-white pubescence. *Elytra*: light brown; covered with moderately dense punctures, partially obscured by dense, mottled ashy-white to brown pubescence. Periscutellar region slightly swollen, with dark, longitudinal, posteriorly directed, incomplete maculae terminating basally and medially. Base of elytron with dark, lateral, posteriorly directed macula interrupted into thirds; terminal macula posteriorly slanted to, but not attaining sutural margin. Sutural apices dark, with irregular finger-like maculae extending anteriorly, connecting to obliquely transverse macula; surrounded by dense, uniform, ashy pubescence. Apices subtruncate, with outer apical angle slightly more produced posteriorly than sutural angle. *Legs*: pro- and mesofemora covered in translucent to gold setae; integument mostly flavous; light brown submedially to apices both mesally and laterally, narrowly connecting at apex. Protibiae basally flavous, becoming brown submedially, covered with gold to light brown setae; mesotibiae basally flavous, dark brown submedially, covered with dark brown, dense, bristle-like setae. Metafemora covered with fine translucent to gold pubescence; mostly flavous, with vague, lateral, postmedial, light brown spot; apex slightly darker; tibiae basally flavous, dark apically, with brown pubescence. Tarsomeres basally flavous, dark apically; generally coated with short, suberect, dark setae.

*Abdomen*: ventrites covered with fine vestiture of appressed, translucent to golden pubescence; integument dark flavous; fifth ventrite brown, one and one-half the length of the fourth ventrite. Last ventrite weakly concave and fringed with long golden pubescence.

**Distribution.** Endemic to Hispaniola, this species has been collected just east of the Haitian border in the Sierra de Neiba mountains and in the northeast Cordillera Central (Fig. 19).

**Etymology.** We are pleased to name this species after Grace Natalie Marion (1925–2014), grandmother of the first author. The epithet is a noun in apposition.

**Type material. Holotype** (male): **DOMINICAN REPUBLIC: Monseñor Nouel Prov.**, Cabo Vito 19°01.165'N, 70°31.197'W, 4 July 2004, beating, C. J. Micheli (USNM); **Paratype: Elías Piña Prov.**, Sierra de Neiba, 9.3 km SW Hondo Valley, 1901 m, 18°41'31"N, 71°47'03"W, montane forest, *Podocarpus* sp., UV light, 30 April 2006, J. Rawlins, J. Hyland, R. Davidson, C. Young, D. Koenig, J. Fetzner (CMNH).

***Urgleptes obliteratus* Ravin & Lingafelter, sp. n.**

<http://zoobank.org/2310C234-C85F-4F47-9C5D-3A707F18FC79>

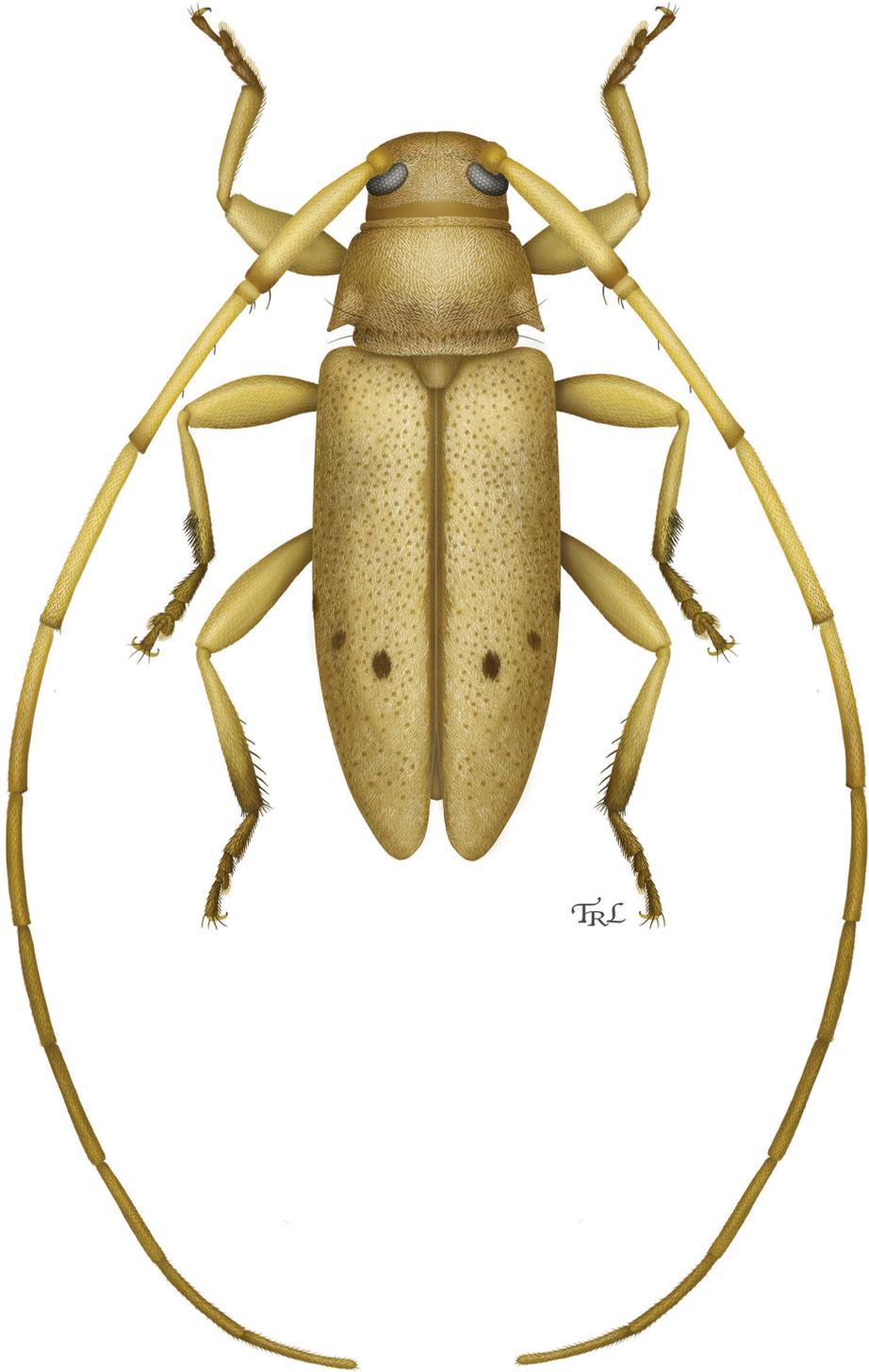
Figs 7, 8d, 14, 19

**Diagnosis.** This species is easily identified by the three dark, circular elytral maculae, originating mediolaterally and extending toward the suture. This dark circular pattern is repeated on the pronotum which usually contains two posteromedial spots, in some specimens, an additional two are located at the base of the lateral tubercles. The elytral suture is narrowly dark brown. Otherwise, the integument is mostly uniform in color, although in *U. obliteratus* it is much paler yellow or flavous than in *U. charynae*. Unlike other species, the scape is uniformly pale, with antennomeres light, gradually becoming darker at apices. The femora are also mostly pale, with the tibiae usually darker postmedially.

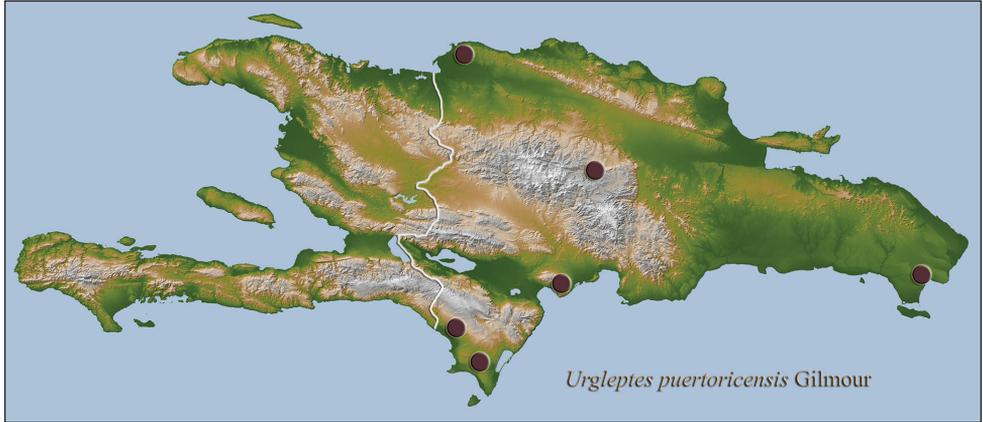
**Description.** *Measurements:* body length: 3.6–4.8 mm; body width: 1.3–1.7 mm; elytral length: 2.5–3.3 mm; elytral width: 0.6–0.8 mm; pronotal length: 0.7–0.9 mm; pronotal width: 1.0–1.6 mm; body length/pronotal length: 5.2–5.4; elytral length/elytral width: 4.0; pronotal length/pronotal width: 0.5–0.6.

*Head:* covered in uniform pale to golden pubescence, denser at posterior margin of eyes and inner eye notch margin. *Antenna:* scape extending to posterior fourth of pronotum; pale-flavous, weakly darker apically; covered in fine, pale to golden pubescence. Remaining antennomeres pallid, darkened apically; covered in brown pubescence, with thickened bristle-like setae at apices; mesal surface of third and fourth segments of most specimens usually with thickened setae. Antennae extending beyond elytral apices by approximately five segments. *Eye:* lower eye lobe about 2.5 times height of upper eye lobe; lobes narrowly connected by about 5 rows of ommatidia in most specimens. Upper eye lobes separated by twice width of upper eye lobe. *Mouthparts:* clypeus pallid; lacking distinct pubescence. Labrum pallid; anteriorly fringed with long, golden setae; and basal, longer, suberect, dark brown setae. Mandibles light brown, distinctly darkened on apical halves.

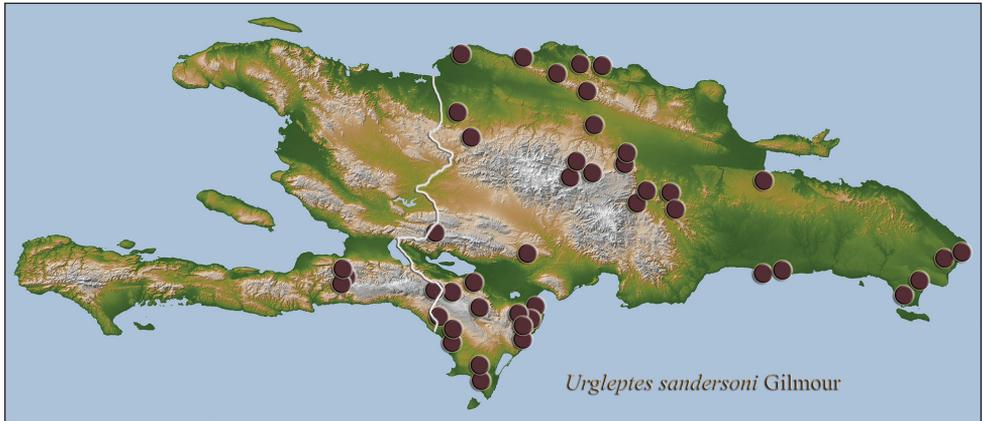
*Thorax:* pronotum broadly rounded at sides to posteriorly directed, short, acute tubercles on posterior fourth; constricted along posterior fifth behind lateral tubercles; constriction demarcated with row of large, separate punctures across disc, continuing behind base of tubercles and down sides; no other distinct punctures visible. Integument mostly light brown; coated in moderately dense vestiture of white pubescence.



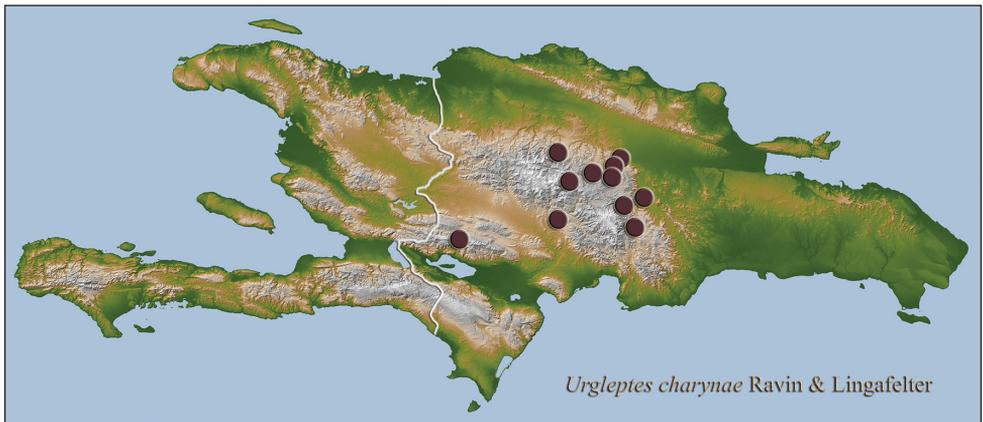
**Figure 14.** Digital painting of *Urgleptes obliteratus* sp. n. (illustrated by Taina Litwak, USDA).



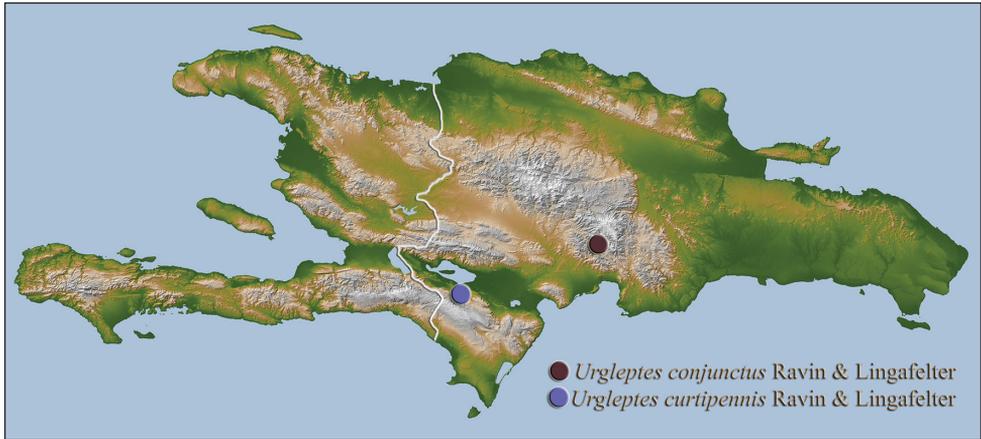
**Figure 15.** Hispaniolan distribution map for *Urgleptes puertoricensis* Gilmour.



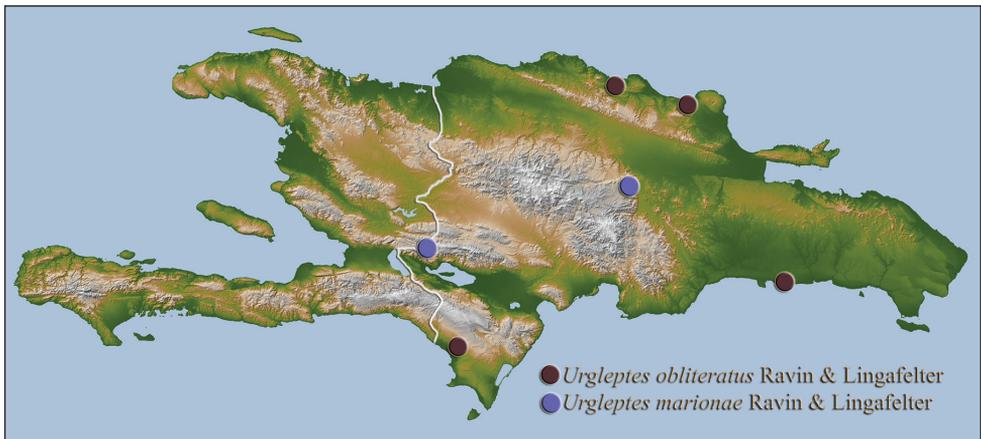
**Figure 16.** Hispaniolan distribution map for *Urgleptes sandersoni* Gilmour.



**Figure 17.** Hispaniolan distribution map for *Urgleptes charynae* sp. n.



**Figure 18.** Hispaniolan distribution map for *Urgleptes conjunctus* sp. n. and *Urgleptes curtipennis* sp. n.



**Figure 19.** Hispaniolan distribution map for *Urgleptes marionae* sp. n. and *Urgleptes obliteratedus* sp. n.

Pronotal disc with dark anterolateral and posteromedial fasciae. No distinct calli present on pronotal disc. Prosternum impunctate; covered in moderately dense white pubescence. Prosternal process extremely narrow and greatly expanded posteriorly; procoxal cavities nearly touching. Mesepimeron toward metepisternal margin coated with dense, appressed, white pubescence becoming thinner ventrally. Mesosternal intercoxal process about 3–4 times broader than prosternal process. Integument of ventral sclerites mostly light brown, with margins of coxal cavities darkened. Scutellum dark brown; with white, longitudinal fascia. *Elytra*: moderately, densely punctate; elytral disc mostly pale-orange with suture dark brown from scutellum to apices. Periscutellar region slightly swollen; coated in white to translucent pubescence extending through-

out disc; epipleuron slightly darker than surrounding region. Elytron with three, dark, distinct, circular maculae, originating mediolaterally, obliquely extending toward, but not reaching suture. Some specimens with faint, irregular macula extending anteriorly from apex but not reaching circular maculae. Elytral apex subtruncate, with outer apical angle slightly more produced posteriorly than sutural angle. *Legs*: femora mostly pallid; uniformly covered with golden to translucent pubescence. Protibiae uniformly pallid; meso- and metatibiae darker apically with thickened, bristle-like setae. Mesotibiae with dorsal concavity apically that is lined with dark, bristle-like setae. Tarsomeres dark brown; coated with long, suberect, dark setae.

*Abdomen*: ventrites covered with fine, appressed, white pubescence; integument mottled brown, posteriorly lighter, apical margin of all ventrites slightly lighter. Fifth ventrite one and a half times longer than fourth. Last tergite strongly narrowed and projecting beyond last ventrite.

**Distribution.** Endemic to Hispaniola, this species has been collected only in low elevation (less than 700 meters) coastal areas of the country (Fig. 19) from May through December.

**Etymology.** The epithet, *obliteratus*, refers to the nearly absent maculae on the elytra, unlike most other species of the genus.

**Type material.** **Holotype** (female): **DOMINICAN REPUBLIC: Pedernales Prov.**, 25 N of Cabo Rojo, 750 meters 18°06.769'N, 71°37.245'W, beating, 11 December 2014, S. W. Lingafelter (USNM); **Paratypes: DOMINICAN REPUBLIC: María Trinidad Sánchez Prov.**, Río San Juan, 19°37'17"N, 70°7'45"W, 20 July 2008, Julien Touroult (JTPC, 2); **Puerto Plata Prov.**, South of Pico Isabel de Torres, El Cupey Rd., 258 m, 19°45.214'N, 70°43.6464'W, 30 July 1999, Ivie & Guerrero (WIBF, 2); **San Pedro de Macorís Prov.**, 12 km W of San Pedro de Macorís, 5–19 May 1985, E. Giesbert (FSCA).

### Key to the species of *Urgleptes* of Hispaniola

- 1 Scape with flavous subapical spot between narrow, darkened apex and broadly darkened postmedial region (Fig. 8a); elytral periscutellar area darkened and contrasting with surrounding region; elytra with obliquely transverse, postmedial dark macula; femora mostly flavous with dark macula both mesally and laterally, most prominent on mesofemora..... ***U. sandersoni***
- Subapical spot absent from scape (Fig. 8b-d); other characters variable..... **2**
- 2(1) Scape mostly uniformly colored (Fig. 8c-d); elytral integument mostly uniformly colored (Fig. 10, 14)..... **3**
- Scape basally flavous (Fig. 8b), darkened apically; elytral integument mottled light and dark (Figs 1, 11, 12, 13)..... **4**
- 3(2) Integument tawny brown; pronotum with dense, white pubescence concentrated on posterior constriction behind lateral tubercles; elytral suture of same color as disc; elytra with postmedial patches of dense white pubescence ex-

- tending across disc; slightly darkened integument underneath patches (Fig. 10)..... ***U. charynae* sp. n.**
- Integument pale; pronotal disc with dark anterolateral and posteromedial fasciae; elytra with darkened suture from scutellum to apices; elytra with three, dark, mediolateral, circular maculae, obliquely extended toward suture (Fig. 14) ..... ***U. obliteratus* sp. n.**
- 4(2) Elytra with longitudinal, dark maculae, extending posteriorly from base (Figs 11, 13)..... **5**
- Elytra without longitudinal macula; with dark, transverse, postmedial macula extending obliquely from lateral margin to suture (Figs 1, 12) ..... **6**
- 5(4) Elytra with faint, posteriorly directed, incomplete maculae at base. Apices of elytra with dark, finger-like maculae extending anteriorly, connecting to obliquely transverse macula. Punctures on elytral disc mostly obscured beneath appressed pubescence. Pro- and mesofemora with dark, lateral and mesal maculae (Fig. 13) ..... ***U. marionae* sp. n.**
- Each elytron with single narrow longitudinal darkened macula running parallel to suture, terminating medially; elytra with moderately dense, distinct punctures, clearly visible beneath pubescence; oblique, transverse macula absent; mesofemora distinctly darker than pro- and metafemora (Fig. 11).....  
..... ***U. conjunctus* sp. n.**
- 6(4) Periscutellar region light; distinctly covered in dense, appressed, ashy pubescence with well-defined, dark, postmedial macula obliquely coiled from lateral margin to middle. Most antennomeres (with exception of third antennomere that is mostly flavous and apically darkened) gradually darker; distal segments mostly uniform in coloration (Fig. 12) ..... ***U. curtippennis* sp. n.**
- Periscutellar region dark with postmedial zigzag fascia obliquely extending towards suture; antennomeres 3–7 flavous, dark annulate at apices (Fig. 1) ...  
..... ***U. puertoricensis***

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# A second species of *Cheleion* from Johor, Malaysia (Coleoptera, Scarabaeidae, Aphodiinae, Stereomerini)

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## Abstract

A new species of the genus *Cheleion* Vårdal & Forshage, 2010, *Cheleion jendeki* **sp. n.**, from Johor, Malaysia is described, illustrated and compared with the type species of the genus, *C. malayanum* Vårdal & Forshage, 2010. Photographs of the two species are presented. The adaptation to inquilinous lifestyle of *Cheleion* is compared with those in other beetle groups and briefly discussed.

## Keywords

*Cheleion*, new species Coleoptera, Scarabaeidae, Aphodiinae, Stereomerini, Malaysia, Oriental Region

## Introduction

Scarabaeoidea (Lamellicornia) represent a distinct, cosmopolitan group of beetles, comprising approximately 2,500 genera and 35,000 species worldwide. They occupy a vast range of various niches, including inquilinous, either myrmecophilous or termitophilous, lifestyles (for a review, see Scholtz and Grebennikov 2005). Among the most peculiar presumably inquilinous scarabs are members of the small, rarely collected tribe Stereomerini of the subfamily Aphodiinae. The 21 presently known species of Stereomerini are currently assigned to nine genera. All representatives of the tribe are allegedly associated with termite nests. Seven of them, *Adebrattia* Bordat & Howden,

1995, *Australoxenella* Howden & Storey, 1992, *Bruneixenus* Howden & Storey, 1992, *Daintreeola* Howden & Storey, 2000, *Danielsonia* Bordat & Howden, 1995, *Pseudostereomera* Bordat & Howden, 1995, and *Stereomera* Arrow, 1905 are restricted to insular southeastern Asia and Australia (Howden and Storey 1992, 2000; Bordat and Howden 1995; Storey and Howden 1996; Maruyama and Nomura 2011). At present, only the genera *Cheleion* Vårdal & Forshage, 2010 and *Rhinocerotopsis* Maruyama, 2009 are known from the Peninsular Malaysia (Maruyama 2009, Vårdal and Forshage 2010). The genus *Cheleion* so far has contains only one species, *C. malayanum* Vårdal & Forshage, 2010, described from Pahang. A second species, *C. jendeki* sp. n., discovered from primary tropical forest of Endau Rompin NP in another Malaysian state, Johor, is described in the present paper.

## Material and methods

The specimens were examined with an Olympus SZ61 stereomicroscope. Measurements were taken with an ocular graticule. The habitus photographs were taken using a Canon MP-E 65mm f/2.8 macro lens with 5:1 optical magnification on bellows attached to a Canon EOS 550D camera. Partially focused images of specimen were combined using Helicon Focus 3.20.2Pro software. External morphology of both species was also examined with a Hitachi S-3700N environmental electron microscope in the Department of Paleontology, National Museum in Prague (in both cases using uncoated specimens). Exact label data are cited for the type material. Our remarks and addenda are found in brackets, separate label lines are indicated by a slash (/), separate labels by a double slash (//). The holotype of the newly described species is deposited in the collection of National Museum, Prague, Czech Republic (NMPC). For comparison, the holotype of *Cheleion malayanum* (deposited in Swedish Museum of Natural History, Stockholm, Sweden) was studied. For morphological terms used in the description we largely follow Howden and Storey (1992) and Vårdal and Forshage (2010).

## Taxonomy

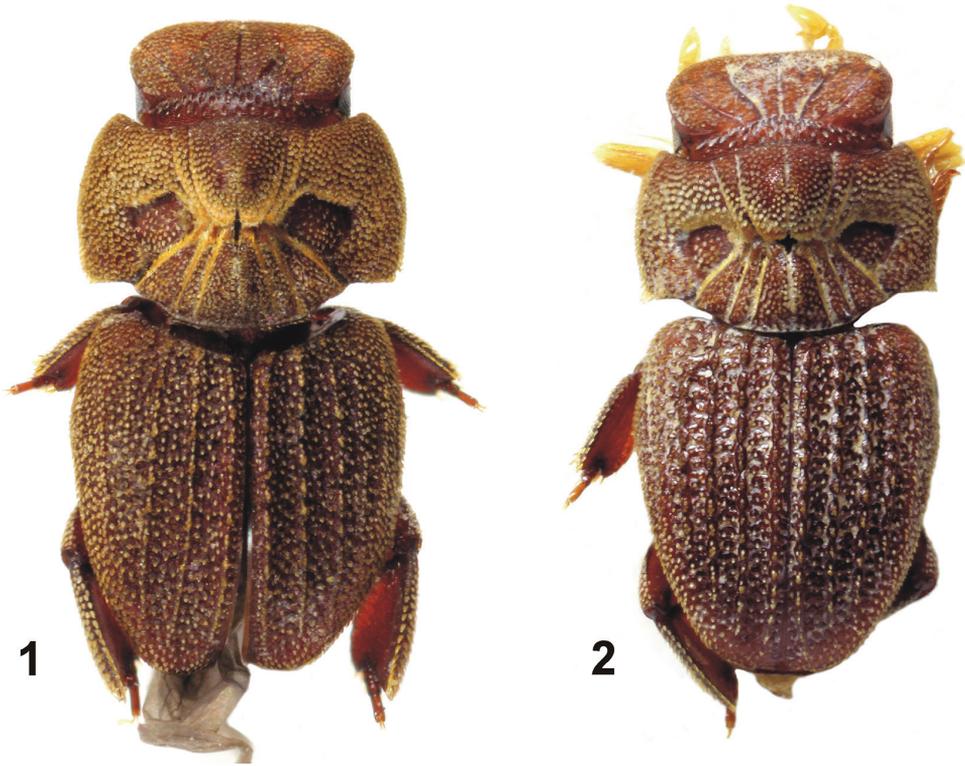
### *Cheleion jendeki* sp. n.

<http://zoobank.org/4DF33FD9-FF5D-47A1-8967-06EAEE42349D>

Figures 1, 3, 5, 7, 9, 11, 13–15, 17

**Type locality.** Malaysia, Johor, Endau Rompin National Park, 02°37'12"N 103°21'00"E, 120–300 m a. s. l.

**Type material.** Holotype: ♀, “Malaysia, Johor / Endau Rompin NP / N2.62, E103.35 / 28-31.v.2013, 120-300 m / E. Jendek & O. Šauša leg. [printed] // *Cheleion jendeki* sp. nov. / HOLOTYPUS ♀ / David Král & Jiří Hájek det. 2015 [red, printed]”.

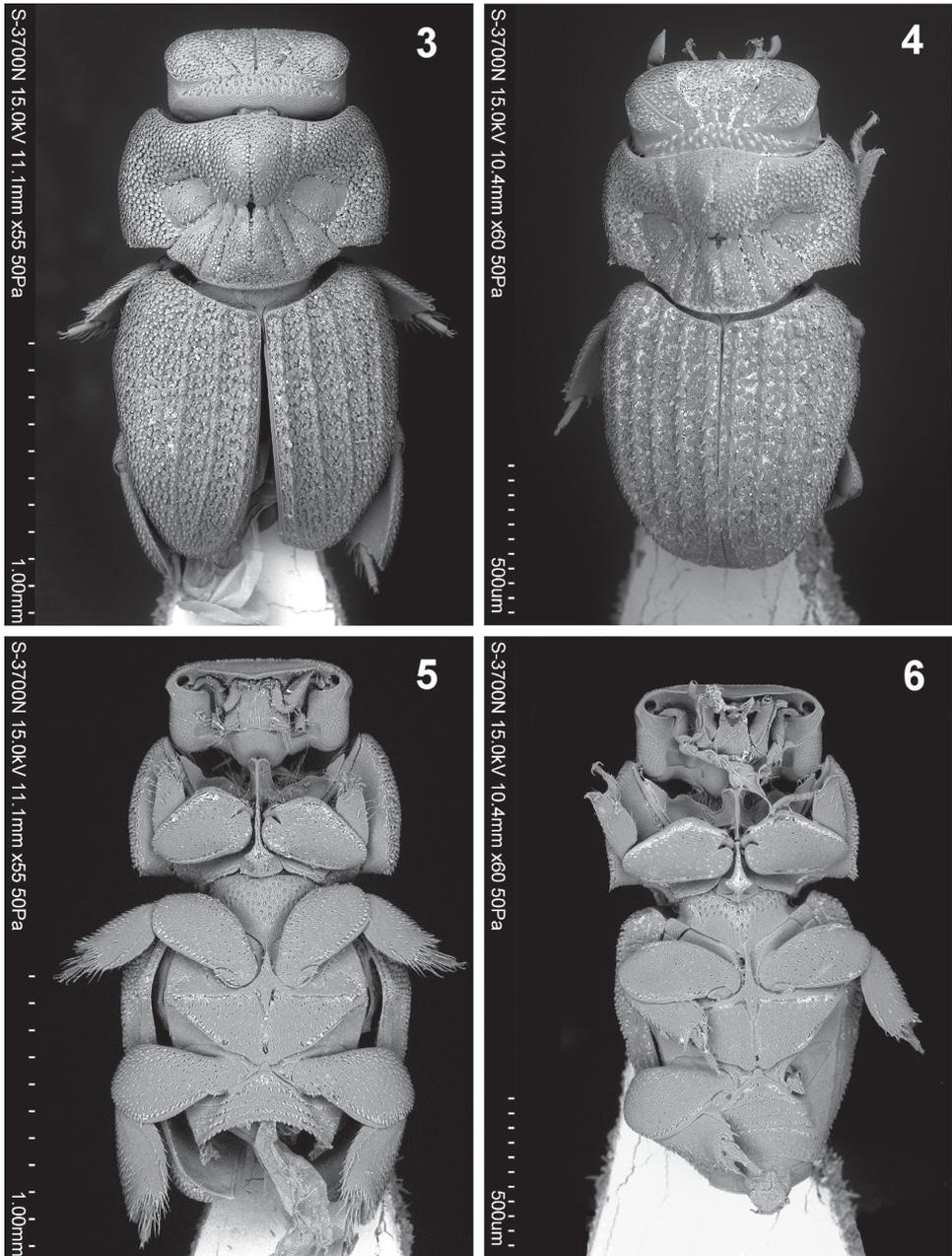


**Figures 1–2.** Habitus of *Cheleion*. **1** *C. jendeki* sp. n. (♀ holotype) **2** *C. malayanum* (♀ holotype; Malaysia, Pahang, Bukit Fraser).

**Description of female holotype.** Slightly convex, integument chestnut brown; head appendages and tarsi amber coloured; whole dorsal surface more or less covered with appressed lanceolate scales (Fig. 1).

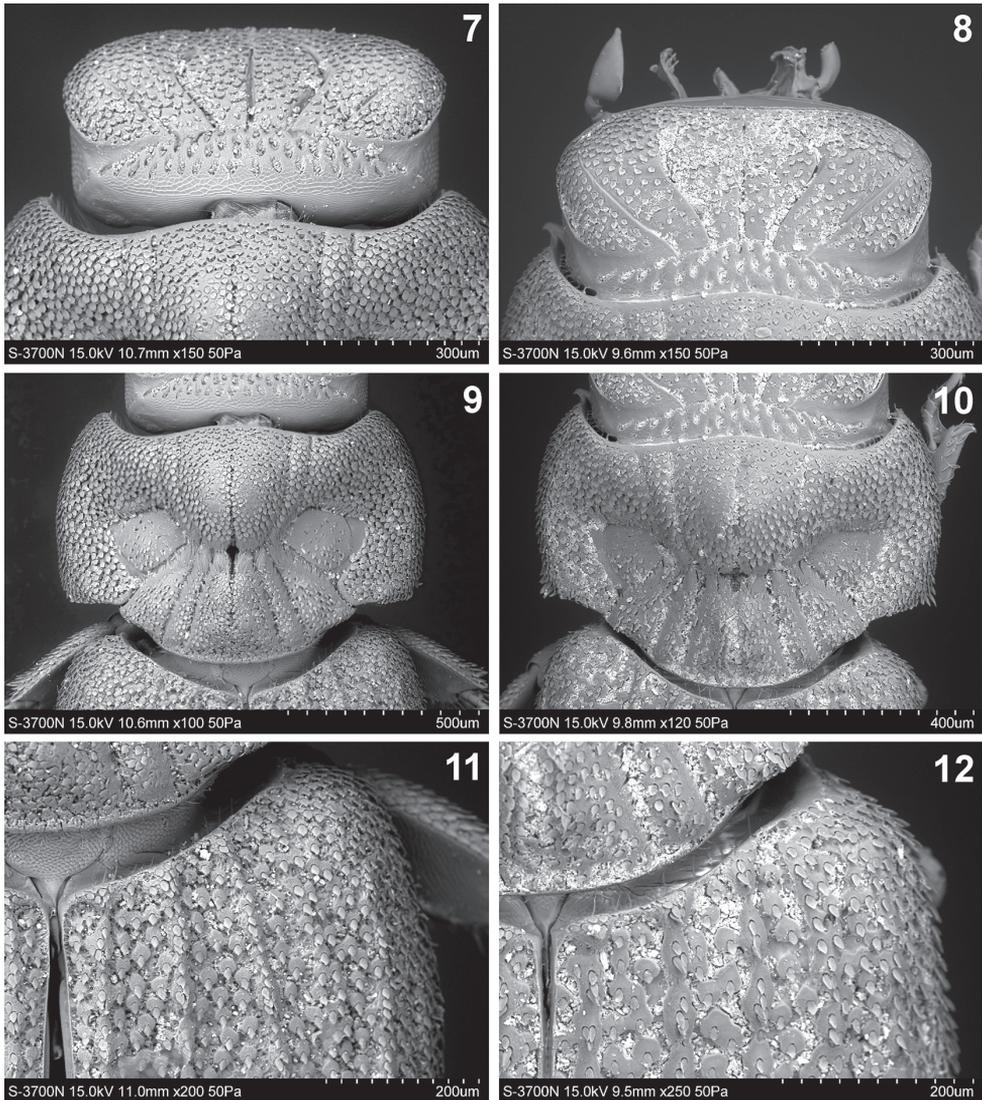
Head (Figs 1, 3, 7) remarkably transverse, subrectangular in dorsal view, clypeus shiny, impunctate, apically pointed and reflexed under head, frons slightly convex with five straight, anteriorly divergent furrows; posterior transverse furrow across head between posterolateral corners of eyes; occiput with numerous small, longitudinal pits. Surface covered with dense appressed, lanceolate, approximately regularly spaced scales, individual scales separated from each other by less than their diameter (Fig. 7). Antennae long, length equal to width of head, with long macrosetae. Maxillary palpi length equal to length of head, with securiform ultimate palpomere. Labial palpi with long macrosetae apically. Eyes small but visible in dorsal view (Fig. 7).

Pronotum (Figs 3, 9, 13) large and transverse, anterior edge shallowly bisinuate, sides regularly, broadly rounded, posterior edge with broad medial protrusion. Pronotal disc with seven furrows medially, converging towards middle in hourglass



**Figures 3–6.** Habitus of *Cheleion*. **3, 5** *C. jendeki* sp. n. (♀ holotype) **4, 6** *C. malayanum* (♀ holotype; Malaysia, Pahang, Bukit Fraser) **3, 4** dorsal view **5, 6** ventral view.

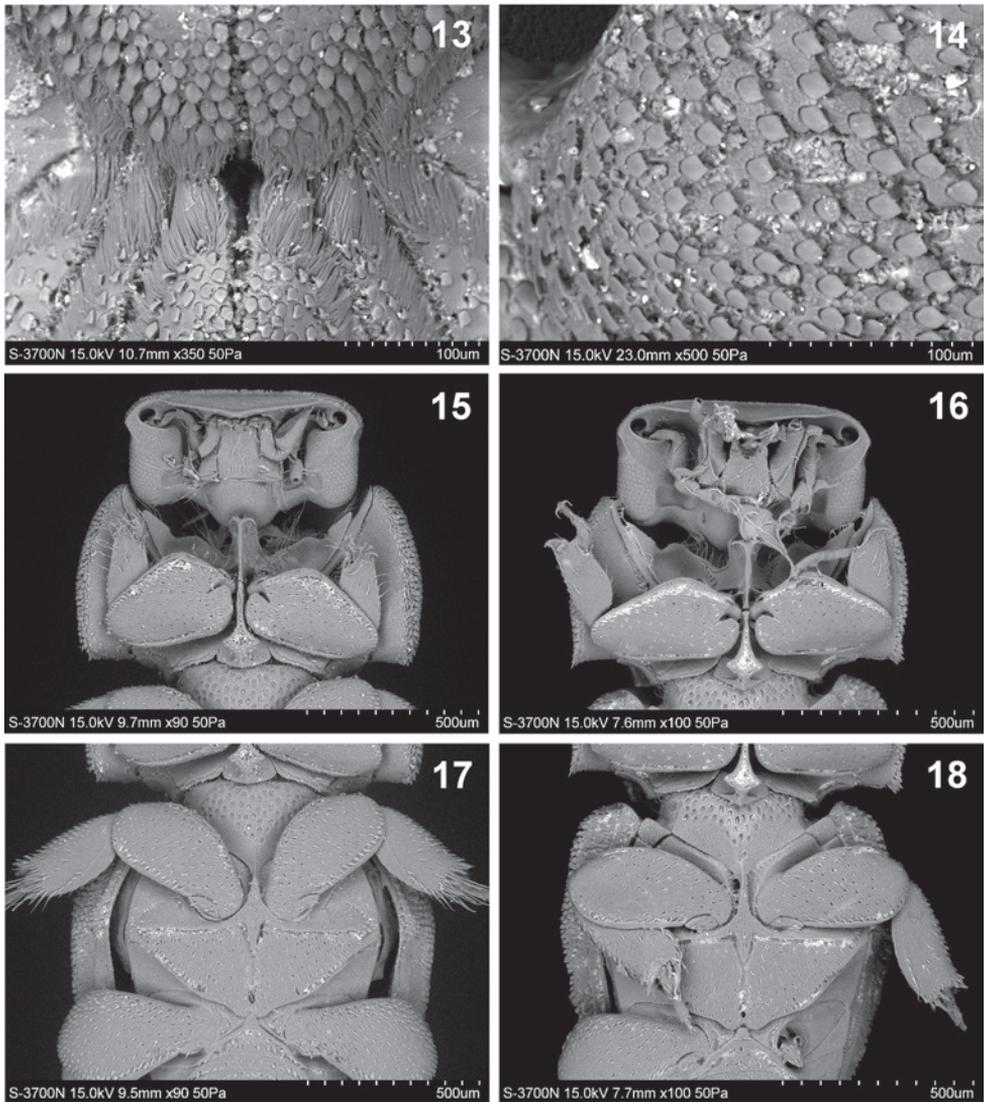
pattern, mid furrow shallower than lateral furrows (Figs 3, 9). Anteromedial disc with distinctly raised knob, posteromedial disc and posterolateral sides with slightly lower, bulbous areas; anterolaterally of the furrows with large, flat elliptical depressions, de-



**Figures 7–12.** Details of *Cheleion*. **7, 9, 11** *C. jendeki* sp. n. (♀ holotype) **8, 10, 12** *C. malayanum* (♀ holotype; Malaysia, Pahang, Bukit Fraser) **7–8** head **9–10** pronotum **11–12** base of right elytron.

lined by furrows. Knob posteriorly and bulbous areas anteriorly with tufts of long dense microtrichiae (= trichomes) (Fig. 13); surface covered with dense appressed, lanceolate, approximately regularly spaced scales, individual scales separated by less their diameter from each other anterolaterally and laterally; scales on knob and bulbous areas smaller and sparser; flat lateral areas with several sparse rather irregularly spaced scales only (Fig. 13).

Scutellar shield triangular, notably small (Fig. 11).



**Figures 13–18.** Details of *Cheleion*. **15, 17** *C. malayanum* (♀ holotype; Malaysia, Pahang, Bukit Fraser) **13–14, 16, 18** *C. jendeki* sp. n. (♀ holotype) **13** detail of tufts of microtrichiae (= trichomes) in centre of pronotum **14** detail of macrosetation on elytral shoulder **15–16** head and prothorax in ventral view **17–18** meso- and metaventrite in ventral view.

Elytra approximately as broad as pronotum and only slightly longer than pronotum and head combined; tapering posteriad, rounded apically. Each elytron with five longitudinal ridges before the lateral edge (Figs 1, 3, 11); ridges of approximately same height, elevated and almost continuous, consisting of longitudinal rows of almost confluent tubercles (Fig. 11); intervals (between ridges) flat, rugose, with irregularly circular pads, each pad bearing lanceolate scale on posterior edge, individual pads sepa-

rated by less their diameter from each other discally, becoming confluent into small rows or groups laterally, especially in humeral area (Figs 11, 14). Epipleura broadly inflexed; posterior two thirds of lateral edge slightly recurved (to allow free movement of metathoracic legs).

Legs short with broad femora and tibiae; tarsi short, tetramerous; claws weak, short, almost straight (Figs 5, 15, 17). Femora shiny, covered with coarse, dense, almost regularly spaced macrosetigerous punctures (Figs 15, 17). Protibiae moderately wide, with finely serrated outer edge and one strong apical lateral tooth, tarsus inserted well before apex (Fig. 15). Meso- and metatibiae broad with finely serrated outer edge and concave apex; each with two inconspicuous terminal spurs and two rows of thick short macrosetae on outer edge (Fig. 17).

Macropterous.

Pygidium exposed, strongly punctate proximally, less strongly apically, with small emargination on proximal pygidial border.

Venter. Prosternal process remarkably elevated, strongly expanded anteriorly and posteriorly (Figs 5, 15); anterior part grooved longitudinally and sinuate apically, posterior part hastate, surface rugose with marginal bead (Fig. 15). Mesoventrite narrow with alutaceous surface (Fig. 17). Metaventral plate flat, triangular, tapering, widest anteriorly, grooved along midline, surface alutaceous, covered with coarse, dense, almost regularly spaced macrosetigerous punctures (Fig. 17).

Five visible abdominal ventrites apparently fused, covered with coarse, dense, almost regularly spaced macrosetigerous punctures.

**Measurements.** Total body length: 1.9 mm, width at broadest point 0.9 mm.

**Differential diagnosis.** The new species is classified in the genus *Cheleion* mainly by the combination of the following characters: strongly tuberculate and rugose body surface, noticeably long antennae, pronotum with distinct anteromedial knob and bulbous areas medially and laterally and hastate posterior prosternal process. *Cheleion jendeki* sp. n. is similar and probably closely related to *C. malayanum*, the only other known species of the genus, but clearly differs mainly as follows:

- lateral longitudinal grooves on head straight (Figs 1, 3, 7) (weakly s-shaped in *C. malayanum* (Figs 2, 4, 8));
- sides of pronotum regularly rounded, maximum width of pronotum in midlength; posterior angles subrectangular (Figs 3, 9, 15) (sides of pronotum more attenuated in basal third, maximum width of pronotum in anterior third; posterior angles obtuse with apparent spiniform scales in *C. malayanum* (Figs 4, 10, 16));
- elytral surface at first sight moderately rugose (Figs 1, 3, 11) (more strongly rugose in *C. malayanum* (Figs 2, 4, 12));
- elytral ridges distinctly elevated (Figs 3, 11) (almost flat in *C. malayanum* (Figs 4, 12));
- elytral ridges continuous, consisting of longitudinal rows of almost confluent tubercles; lateral ridges indistinct (Fig. 3) (rather discontinuous, consisting of tubercles with scanty longitudinal groups of tubercles with scales; all elytral ridges distinct in *C. malayanum* (Fig. 4));



**Figure 19.** Lowland primary tropical forest in Endau Rompin NP, habitat of *Cheleion jendeki* sp. n. (photo E. Jendek).

- pads on elytral intervals separated by less their diameter and mostly arranged as triseriate discally (Fig. 11) (confluent to subconfluent and mostly arranged as biseriate in *C. malayanum* (Fig. 12));
- marginal bead of posterior part of prosternal process rounded apically (Fig. 15) (angulate apically in *C. malayanum* (Fig. 16)).

In spite of clear differences mentioned above, we are aware that only single specimens are known for each *Cheleion* species. In addition, both type localities are placed only about 200 km apart, without any distinct barrier between them. Thus, we cannot exclude the possibility that morphological differences of *C. jendeki* sp. n. represent only an intraspecific variability of *C. malayanum*, but we consider it quite improbable.

**Etymology.** Patronymic; named in honour of our colleague and friend Eduard Jendek (Ottawa, Canada), excellent student in Buprestidae and collector of the holotype.

**Distribution.** So far known only from the type locality in the Johor Province of continental Malaysia.

**Collecting circumstances.** Flight intercept trap exposed inside lowland primary tropical forest (Fig. 19; E. Jendek, pers. comm. 2015).

## Discussion

Virtually nothing is known about the biology of Stereomerini. Beetles were repeatedly supposed to be termitophilous, based on single finding of *Termitaxis holmgreni*

Krikken, 1970 with termites in Peru (Krikken 1970). However this genus no longer belongs to the tribe Stereomerini as it was excluded by Bordat and Howden (1995). All other members of the Stereomerini were usually collected by flight intercept traps (FIT) in primary forests, more rarely they were also sifted or attracted at UV light (Storey and Howden 1996), collected with window trunk traps, or with yellow pan traps (Howden and Storey 2000).

We have not been able to trace any “typical characters” distinguishing myrmecophilous and termitophilous beetles. For example, Crowson (1981) noted that “termitophilous beetles tend to show rather less extreme structural modifications than comparable myrmecophilous ones”, and that “termitophilous beetles do not as a rule develop the elaborate trichomes seen in some of the more specialized myrmecophiles”. It is far beyond the scope of this paper to solve this problem, but we would like to point out several facts that may suggest myrmecophilous association of *Cheleion* and other Stereomerini.

1) There exist numerous well known myrmecophilous aphodiines, especially of the tribe Eupariini (see, e.g., Stebnicka 2009; Maruyama 2010). Those beetles usually live in debris in ant nests, fly well and are frequently collected with FIT or attracted at light.

2) In rather rare cases of presence of trichomes in termitophilous scarabaeids, those structures are not recorded from the pronotum and have a quite different appearance from *Cheleion* (see, e.g., Maruyama 2012a,b).

3) The peculiar structure on the pronotum in *Cheleion*, consisting of a central pit surrounded by numerous long microtrichia (= trichomes), is surprisingly similar to the pronotal structure of myrmecophilous ptnids (see, e.g., Bell and Philips 2008a,b), paussine carabids (Geiselhardt et al. 2007), elytral structures of myrmecophilous chlamidopsine histerids (e.g., Caterino and Degallier 2007), or elytral and abdominal structures of pselaphine (clavigerine) staphylinids (e.g., Nomura 1997, Baňář and Hlaváč 2014).

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# A new species of the genus *Baeoura* from Morocco, with a key to the West Palaearctic species (Diptera, Tipuloidea, Limoniidae)

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## Abstract

The genus *Baeoura* is represented in Morocco by two species, *Baeoura ebenina* Starý, 1981, and *Baeoura staryi* sp. n. The new species is described and illustrated, and a key to the West Palaearctic species of *Baeoura* is presented.

## Keywords

Diptera, Limoniidae, *Baeoura*, new species, Morocco

## Introduction

The genus *Baeoura* Alexander, 1924 belongs to the subfamily Chioneinae. It originally was erected by Alexander (1924) as a subgenus of *Erioptera* Meigen, 1803, with the type species *Erioptera nigrolatera* described by Alexander, 1920. It later was transferred to the genus *Cryptolabis* Osten-Sacken, 1859 (Starý 1981). The genus comprises small species with antennae of 15 articles, a long Rs, the male hypopygium with a single gonostylus, a reduced ovipositor, and eggs which are large and blackened with a smooth surface. The immature stages are aquatic (Mendl and Tjeder 1974).

Worldwide, 70 species of the genus *Baeoura* have been reported, including 43 in the Oriental Region, ten in the Afrotropical Region, four in Australia, four in the East Palaearctic, eight in the West Palaearctic, and a single species in Chile (Oosterbroek 2014). In North Africa, the genus was recorded by Krzemiński and Starý (1984) who described a new species, *B. szadziewskii*, from northeastern Algeria. Two species belonging to the genus *Baeoura* have been collected in northwestern Morocco: *Baeoura ebenina* Starý, 1981, a new record for North Africa, and *Baeoura staryi* sp. n. Thus, in Morocco, the genus *Baeoura* is represented by two species. Here, *Baeoura staryi* sp. n. is described and a key to the West Palaearctic species of *Baeoura* (mostly males) is provided.

## Material and methods

The specimens were collected using an entomological hand net. Genital preparations were made by macerating the apical portion of the abdomen in cold 10% KOH for 12–15 h. After examination, the genitalia were transferred to fresh glycerin and stored in a microvial. The holotype (male in alcohol) is deposited in the collections of the laboratory at Ecology, Biodiversity and Environment, Faculty of Science, University Abdelmalek Essaâdi, Tétouan, Morocco. A paratype male (dry) is deposited in the collection of J. Starý, Olomouc, Czech Republic.

Terminology of morphological features generally follows that of McAlpine (1981).

## Systematic

### Key to West Palaearctic species of *Baeoura* (mostly males)

- 1 Body yellowish brown to brown ..... 2
- Body brownish black to black ..... 6
- 2 Tergite 9 narrowed distally, posterior margin with comparatively narrow median emargination and short truncate lobe on each side; ventral and dorsal lobes of gonocoxite well developed, ventral lobe longer than body of gonocoxite (Fig. 6) ..... 3
- Tergite 9 relatively broad, posterior margin with broad median emargination and projecting corner on each side; ventral lobe of gonocoxite shorter than body of gonocoxite, dorsal lobe indistinct ..... 5
- 3 Gonostylus curved, with broad spatulate apex bearing small sharp tooth, directed backwards; for male and female terminalia, see Mendl and Tjeder (1976), Figs 1–9. Bulgaria, Greece, Romania, Serbia ..... *B. malickyi* Mendl & Tjeder
- Gonostylus more or less S-shaped, pointed at apex ..... 4
- 4 Sc<sub>1</sub> ending beyond fork of Rs; gonostylus slender, gradually narrowed to pointed apex; for male terminalia, see Krzemiński and Starý (1984), Figs 1–4. Algeria ..... *B. szadziewskii* Krzemiński & Starý

- Sc<sub>1</sub> ending just before fork of Rs; gonostylus long, slender, with bulge-shaped extension at about mid-length provided with group of setulae on outer surface, tapered to slender distal half, strongly bent posteriorly, and almost filiform before pointed apex (Fig. 1–9). Morocco .....***B. staryi* sp. n.**
- 5. Gonostylus narrowed just before tip, obtuse at apex; aedeagus dilated in proximal half, spindle-shaped in dorsal aspect, produced into long filament; for male and female terminalia, see Mendl and Tjeder (1974), Figs 2–10. Greece (Crete), Turkey ..... ***B. alexanderi* Mendl & Tjeder**
- Gonostylus narrowed in distal third, beak-shaped, obtuse at apex; aedeagus simple, slender; for male and female terminalia, see Mendl (1986), Figs 1–7. Turkey.....***B. schachti* Mendl**
- 6. Gonostylus with conspicuous, roughly triangular extension at outer base; aedeagus filiform; for male terminalia, see Mendl (1986), Figs 8–10. Spain .....  
.....***B. longefiligera* Mendl**
- Gonostylus and aedeagus of different shape .....7
- 7 Sc<sub>1</sub> ending beyond fork of Rs; proximal section of M<sub>3+4</sub> (before m-cu) subequal in length to or longer than m-cu.....**8**
- Sc<sub>1</sub> ending before fork of Rs; proximal section of M<sub>3+4</sub> (before m-cu) about half length of m-cu; for male and female terminalia, see Starý (1981), Figs 6–10. Portugal, Spain ..... ***B. ebenina* Starý**
- 8 Tergite 9 with short, broad lobe on each side of its posterior margin; for male and female terminalia, see Starý (1981), Figs 1–5. France (Corsica), Italy (Sicily) .....***B. directa* (Kuntze)**
- Tergite 9 with slender projection on each side of its posterior margin; for male and female terminalia, see Mendl (1985), Figs 1–6. Greece (Crete).....  
.....***B. armata* Mendl**

***Baeoura ebenina* Starý, 1981**

**Material examined.** Rif Mts, Chefchaouen Province, Mezine village: 1♂, 2♀♀, Tributary Oued Tazarine, 35°05.670'N/5°21.991'W, 731 m, 11.vi.2013, middle course of the river ; 1♂, 1♀, Daya near Aïn Afersiw, 35°06.069'N/5°20.337'W, 716 m, 11.vi.2013, pond. O. Driauach and B. Belqat leg.

**Distribution.** *Baeoura ebenina* was previously known only from Spain and Portugal (Oosterbroek 2014). We provide the first record for Morocco and North Africa.

**Ecology.** According to Starý (2014), this species is collected near rivers and brooks. In Morocco, we collected adults by sweeping the vegetation around lotic and lentic habitats. One habitat was in the middle of a temporary river with a substrate of stones, gravel, and sand. The wet section was reduced to a thin layer of water, due to the beginning of the dry season and to water being pumped out by countrymen; the current velocity was slow to medium. There was a proliferation of filamentous green algae. Riparian vegetation consisted primarily of *Nerium oleander* and herbaceous vegeta-

tion. A second habitat was a pond surrounded by conifer reforestation, with the edges overgrown by grasses and herbaceous vegetation.

***Baeoura staryi* sp. n.**

<http://zoobank.org/D79FC3AE-DF30-4796-A119-B6902D619945>

Figs 1–9

**Diagnosis.** Body dark brown, patterned with yellow. Tergite 9 narrow distally, with median emargination and short truncate lobe on each side. Gonocoxite with two lobes; dorsal lobe rather short and broad; ventral lobe long and slender. Single gonostylus long, slender, with bulge-shaped extension at about mid-length provided with group of setulae, and filiform before pointed apex.

**Description.** Male: Body dark brown, patterned with yellow. Body length 3.5–3.8 mm, wing length 4.5–4.7 mm.

Head: Dark greyish brown; rostrum obscurely yellow; palpus yellowish brown, with terminal palpomere elongate. Antenna dark brown, with 15 articles, bent backwards, reaching to about anterior margin of thorax. Scape cylindrical; pedicel large, ovoid, much broader than scape. First flagellomere rather long-ovoid, smaller than scape but distinctly larger than other flagellomeres, these diminishing toward apex of antenna. Verticils on flagellomeres sparse and short, not reaching length of respective flagellomere.

Thorax: Pronotum brown dorsally, yellow laterally. Mesonotum dark brown with broad, pale yellow stripe on each side close above wing, from pronotum to scutellum. Scutum with distinct yellow marking near base of wing. Scutellum light yellow, light brown only medially on extreme anterior margin. Pleuron generally greyish brown, light yellow on dorsopleural membrane (part of lateral stripe).

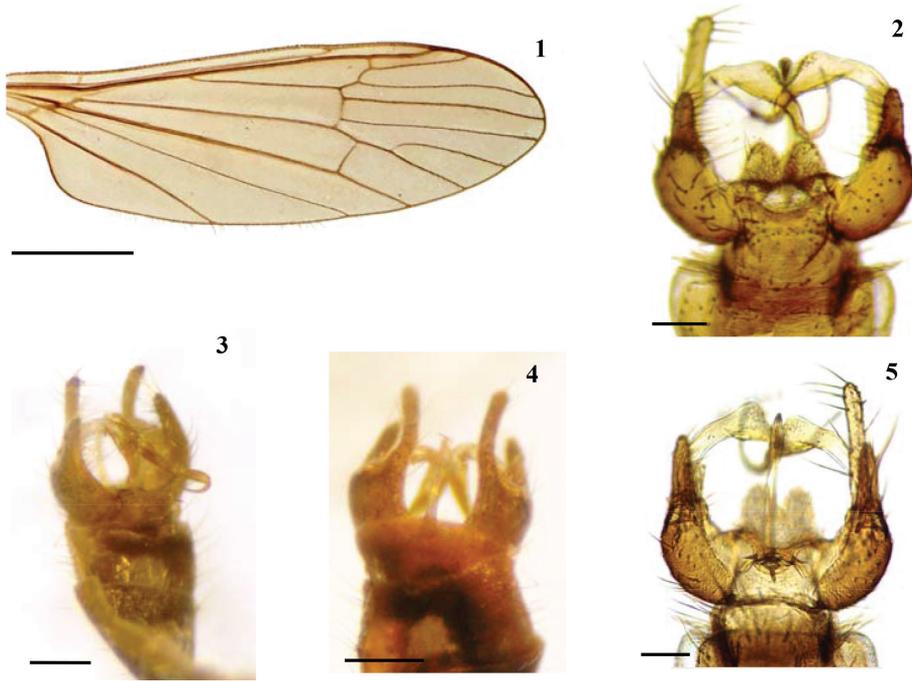
Legs: Anterior coxa brown, middle coxa pale brown, hind coxa yellow. Trochanters yellowish brown. Femora yellowish brown, with darker distal half and blackish brown at distinctly enlarged apex. Tibiae yellowish brown. Tarsi dark brown. Tibiae longer than femora. Legs rather densely and darkly haired.

Wing (Fig. 1): Hyaline with faint yellowish-grey tinge; veins primarily brown. Sc ending just before fork of Rs. Halter rather stout, with white knob.

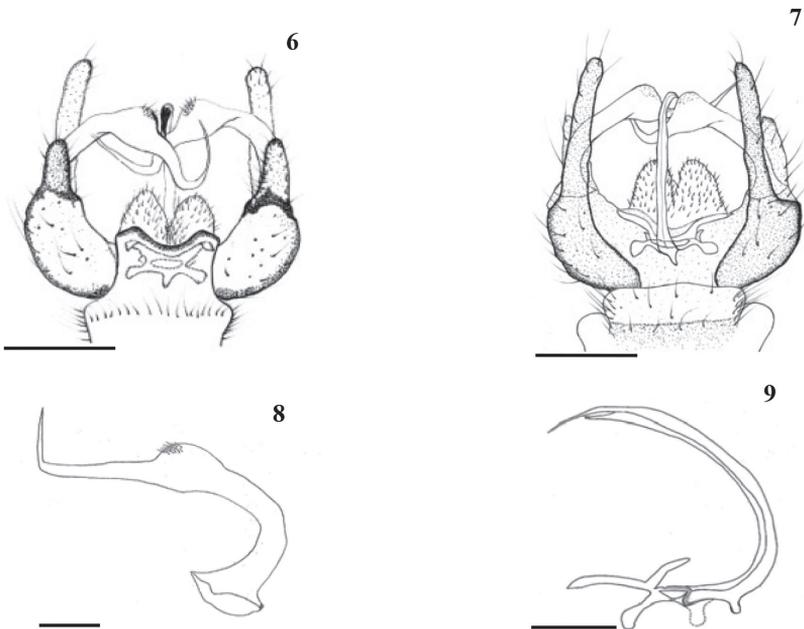
Abdomen: Dark brown dorsally and ventrally, paler laterally.

Male terminalia (Figs 2–7): Yellowish brown. Tergite 9 narrow distally, its posterior margin with median emargination, and with short, truncate lobe on each side of it. Gonocoxite with two lobes; dorsal lobe rather short and broad; ventral lobe long and slender, gently curved dorsally. Single gonostylus of peculiar shape, long, slender, with bulge-shaped extension at about mid-length provided with group of setulae at outer surface, then tapered into slender distal half, strongly bent posteriorly, and almost filiform before pointed apex (Fig. 8). Aedeagus long, slender, curved dorsally (Fig. 9).

Female: Unknown.



**Figures 1–5.** *Baeoura staryi* sp. n. **1** Wing **2, 3** Male terminalia, dorsal view **4, 5** Male terminalia, ventral view. Scale bars: 1 mm (**1**); 0.1 mm (**2–5**); 0.2 mm (**3–4**).



**Figures 6–9.** *Baeoura staryi* sp. n. (holotype male) **6** Male terminalia, dorsal view **7** Male terminalia, ventral view **8** Gonostylus, dorsal view **9** Aedeagus, lateral view. Scale bars: 0.2 mm (**6–7**); 0.1 mm (**8–9**).



**Figure 10.** Oued Jnane Niche, type locality of *Baeoura staryi* sp. n.

**Specimens examined. Holotype.** Male in alcohol, from Morocco, Rif Mts, Chefchaouen Province, Jnane Niche village, toward Jebha, Oued Jnane Niche, 35°17.040'N / 4°51.479'W, 46 m above sea level, 19.iv.2013, O. Driauach and B. Belqat leg.

**Paratype.** Dry, one male, same locality as holotype, 14.vi.2013, O. Driauach and B. Belqat leg.

**Etymology.** This species is named in honor of Dr. Jaroslav Stary (Olomouc, Czech Republic), with our thanks for his help in the identifications of the Moroccan Limoniidae.

**Remarks.** *Baeoura staryi* sp. n. is distinctive in having the ventral lobe of the gonocoxite long and slender, the longest among the West Palaearctic species. In the shape of tergite 9, the new species resembles *B. malickyi* Mendl & Tjeder, 1976, and *B. szadzievskii* Krzemiński & Stary, 1984, but differs from these species especially by the peculiar shape of the gonostylus.

**Distribution and ecology.** Morocco. The species was collected from vegetation by a river on dry, stony ground with small streams, at an altitude of 46 m (Fig. 10).

## Acknowledgements

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# Online database for mosquito (Diptera, Culicidae) occurrence records in French Guiana

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## Abstract

A database providing information on mosquito specimens (Arthropoda: Diptera: Culicidae) collected in French Guiana is presented. Field collections were initiated in 2013 under the auspices of the Center for the study of Biodiversity in Amazonia (CEBA: <http://www.labexceba.fr/en/>). This study is part of an ongoing process aiming to understand the distribution of mosquitoes, including vector species, across French Guiana. Occurrences are recorded after each collecting trip in a database managed by the laboratory *Evolution et Diversité Biologique* (EDB), Toulouse, France. The dataset is updated monthly and is available online. Voucher specimens and their associated DNA are stored at the laboratory *Ecologie des Forêts de Guyane* (Ecofog), Kourou, French Guiana. The latest version of the dataset is accessible through EDB's Integrated Publication Toolkit at [http://130.120.204.55:8080/ipt/resource.do?r=mosquitoes\\_of\\_french\\_guiana](http://130.120.204.55:8080/ipt/resource.do?r=mosquitoes_of_french_guiana) or through the Global Biodiversity Information Facility data portal at <http://www.gbif.org/dataset/5a8aa2ad-261c-4f61-a98e-26dd752fe1c5> It can also be viewed through the Guyanensis platform at <http://guyanensis.ups-tlse.fr>

## Keywords

Occurrence, French Guiana, Neotropics, mosquitoes, diversity

## Introduction

Mosquitoes (Diptera: Culicidae) are probably the most medically important group of arthropods worldwide because of the ability of some species to transmit pathogens to humans (Clements 2011), causing major health issues in some parts of the world. Mosquito-borne diseases are frequent in French Guiana with malaria occurring mainly in inland areas, dengue and chikungunya in urban areas, while many lesser known crypto-arboviruses occur in sylvan and/or rural environments (Chippaux and Pajot 1983). To date, 3,543 valid species of mosquitoes have been described (Harbach 2015) and French Guiana, with 235 species, harbors one of the highest relative species densities of mosquitoes anywhere in the world (Foley et al. 2008, Talaga et al. 2015). Understanding the biology, ecology and distribution of this group is thus of primary importance.

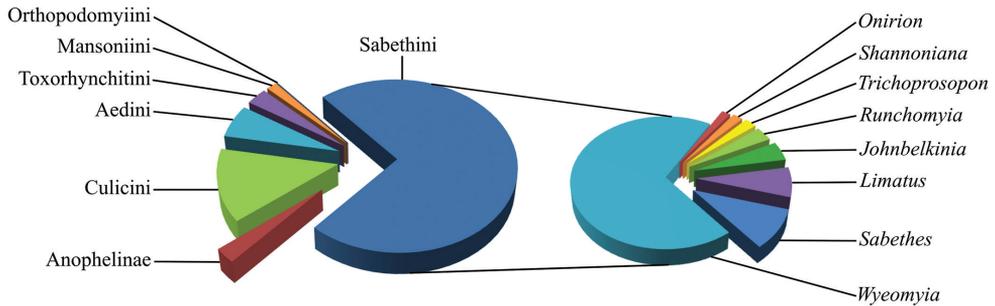
French Guiana is mainly covered by primary rainforest and its inhabitants (*ca.* 250,000) are mostly distributed along the coast (Gond et al. 2011). While some evidence suggests that the Guiana Shield could be an early center of speciation for mosquitoes in the Neotropics (Navarro et al. 2007), the mechanisms explaining the high mosquito diversity in the region remain poorly understood.

This work is an ongoing process and should help to understand mosquito distribution across French Guiana. This database will also be used to disseminate biodiversity information related to future studies on mosquito distribution in French Guiana in general and in medical entomology and ecology in particular. We aim to promote the best practices for recording and sharing biodiversity data within our research community, and highly encourage foreign institutions to do the same. Our goal is to provide data on Guianese mosquitoes and to make available a fast and efficient tool for sharing and tracking reliable information on specimens in the form of an online database.

## Taxonomic coverage

**Description:** This database concerns all mosquito (Diptera: Culicidae) species inhabiting French Guiana. Most specimens have been identified to species level or at least to genus level. The identifications were made by the first author based most of the time on the examination of immature and adult specimens, and by using the latest taxonomic publications on the genus or on the subgenus concerned (e.g. Harbach and Peyton 2000, Motta and Lourenço-de-Oliveira 2000, Zavortink 1979). The validation of species and subspecies is based on “A Catalog of the Mosquitoes of the World (Diptera: Culicidae)” (Knight and Stone 1977) and its supplements (Knight 1978; Ward 1984, 1992; Gaffigan and Ward 1985), and the “Systematic Catalog of Culicidae” (WRBU 2015). The internal classification of the tribe Aedini is based on Wilkerson et al. (2015).

Until now, the database was mostly filled with data from studies conducted on mosquitoes breeding in phytotelmata, which explains why the Sabethini are particu-



**Figure 1.** Taxonomic coverage by tribe (pie chart on the left) with a focus on the distribution of specimens by genus for the tribe Sabethini (pie chart on the right) from the dataset the “Mosquitoes of French Guiana” up to 2015. Because there are no tribes in the Anophelinae, they are represented at the subfamily level on the pie chart.

larly well represented in the current dataset (Fig. 1). Consequently, clades like the Anophelinae, Culicini and Mansoniini are highly underrepresented and the tribes Aedeomyiini and Uranotaeniini are not at all represented (Fig. 1). The dataset presently contains 19 genera and 81 species, including occurrences of twelve species recently recorded in French Guiana (Talaga et al. 2015), namely: *Onirion* sp. cf. Harbach & Peyton (2000), *Sabethes* (*Peytonulus*) *hadrognathus* Harbach, 1995, *Sa. (Pey.) paradoxus* Harbach, 2002, *Sa. (Pey.) soperi* Lane & Cerqueira, 1942, *Sa. (Sabethinus) idiogenes* Harbach, 1994, *Sa. (Sabethes) quasicyaneus* Peryassú, 1922, *Runchomyia* (*Ctenogoeldia*) *magna* (Theobald, 1905), *Wyeomyia* (*Caenomyiella*) sp. cf. Harbach & Peyton (1990), *Wy. (Dendromyia) ypsipola* Dyar, 1903, *Wy. (Hystatomyia) lamellata* (Bonne-Wepster & Bonne, 1919), *Wy. (Miamiya) oblita* (Lutz, 1904), and *Toxorhynchites* (*Lynchiella*) *guadeloupensis* (Dyar & Knab, 1906).

## Taxa include

**Kingdom:** Animalia

**Phylum:** Arthropoda

**Class:** Insecta

**Order:** Diptera

**Family:** Culicidae

**Subfamilies:** Anophelinae, Culicinae.

**Tribes:** Aedeomyiini, Aedini, Culicini, Mansoniini, Orthopodomyiini, Sabethini, Toxorhynchitini, Uranotaeniini.

**Genera:** *Aedeomyia*, *Aedes*, *Anopheles*, *Chagasia*, *Coquillettidia*, *Culex*, *Deinocerites*, *Haemagogus*, *Johnbelkinia*, *Limatus*, *Lutzia*, *Mansonia*, *Onirion*, *Orthopodomyia*, *Psorophora*, *Runchomyia*, *Sabethes*, *Shannoniana*, *Toxorhynchites*, *Trichoprosopon*, *Uranotaenia*, *Wyeomyia*.

## Spatial coverage

**Description:** French Guiana (83,534 km<sup>2</sup>) is a French overseas region situated in South America at the eastern limit of the Guiana Shield. The latter is a mountainous tableland extending, from West to East, across Guyana, Suriname, French Guiana, as well as parts of Colombia, Venezuela and Brazil. The sampling area is delimited by the current administrative boundaries of the territory of French Guiana (Fig. 2). To the East, the Oyapock River delimits the border with Brazil. To the West, the Maroni River delimits the border with Suriname. The territory's borders have not been constant throughout history and a large portion of northern Brazil was disputed between France and Brazil during the 19th century. As a result, the type locality of Counani, French Guiana where the *nomen dubium* *Culex americanus* Neveu-Lemaire, 1902 was described (Belkin et al. 1971) is currently in Brazil. Even though French Guiana is a French overseas region, all occurrences have been recorded under the country "French Guiana" to comply with the ISO 3166-1 standard.

**Geographical methods:** GPS coordinates were obtained using a Garmin GPSmap 60CSx device or higher equivalent of the GPSmap series. The World Geodetic System 1984 (WGS 84) was used as geodetic system and associated with UTM 21-22 N for map projection.

**Coordinates:** 2°5'24"N and 5°50'60"N Latitude; 54°36'36"W and 51°31'48"W Longitude

## Temporal coverage

**Notes:** From October 2013 to present.

## Project description

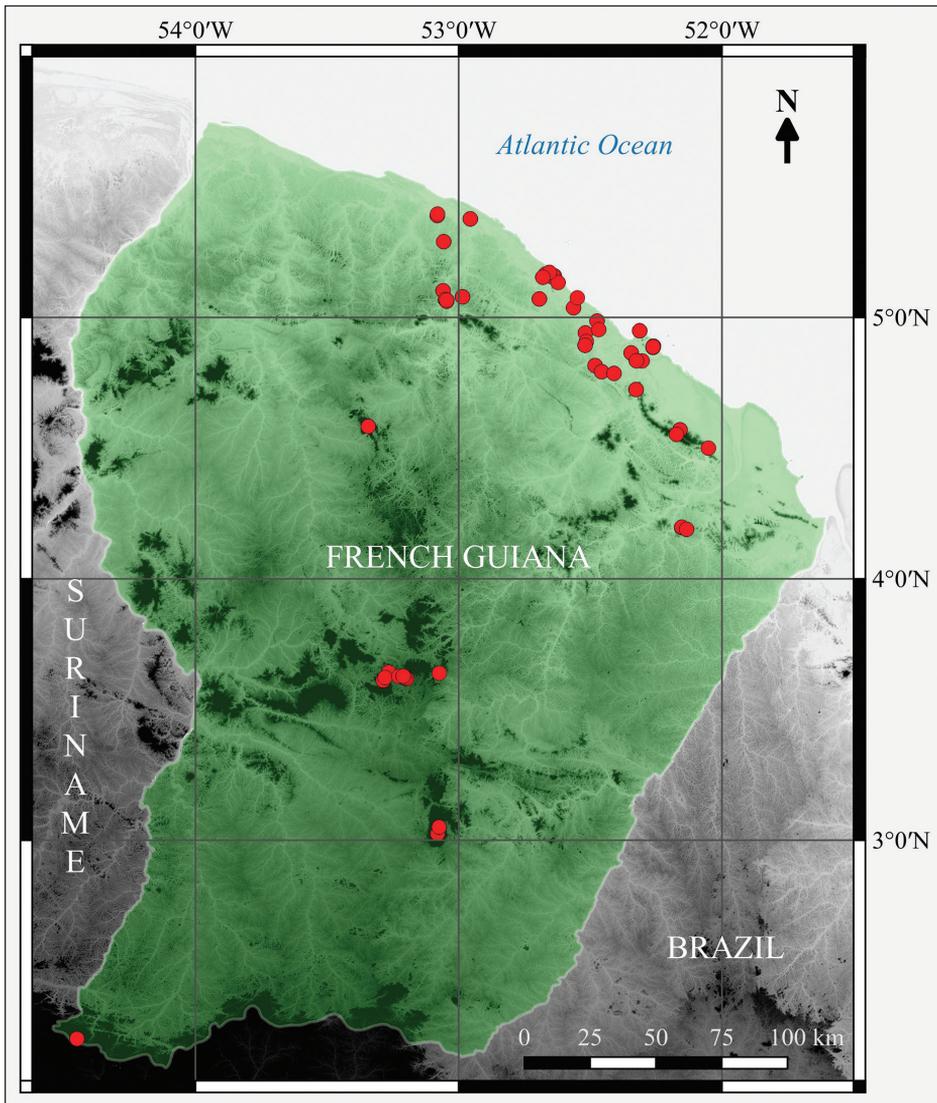
**Title:** Mosquitoes of French Guiana

**Personnel:** Stanislas Talaga

**Study area descriptions:** Collecting trips were conducted in various locations throughout French Guiana ranging from urban to pristine environments.

**Design description:** This database was originally built from studies on mosquito-phytotelm associations at the scale of French Guiana. Immature mosquitoes were collected from at least 30 water-holding structures per phytotelm species, per locality. However, the extent of the sampling area was not standardized between the different localities. The database also contains some records of opportunistically sampled immature and adult mosquitoes conducted by the first author.

**Funding:** Data for this resource have been obtained within the framework of the projects BIOHOPSY and DIADEMA from the CEBA (Center for the study of Biodiversity in Amazonia) and thanks to a PhD fellowship from the *Université Antilles-Guyane* awarded to Stanislas Talaga. CEBA is funded by an *Investissement d'Avenir*



**Figure 2.** Geographical coverage of the dataset (green shade) and collecting localities (red dots) up to 2015.

grant managed by the French *Agence Nationale de la Recherche* (ANR) under grant number ANR-10-LABX-25-CEBA.

## Methods

**Study extent description:** Study sites were located throughout French Guiana.

**Sampling description:** The following techniques were used; however, not all techniques were used at every collecting site and the sampling design may not have been the same at all sites.

Immature container mosquitoes were collected by extracting plant-held water using a great variety of sucking devices in order to fit the great variety of plant structures and water volumes. On some occasions, natural and artificial ovitraps were used, including bamboo stumps, CDC ovitraps and artificial bromeliads installed at ground or canopy level. Immature mosquitoes from larger bodies of water were collected by using a kick net. Adult mosquitoes were attracted in the field by human bait and captured with a butterfly net or with an entomological aspirator when they alighted.

**Processing:** Whenever possible, samples were brought back alive to the laboratory. Immature mosquitoes were individually reared in 2 mL Eppendorf tubes and placed in a climatic chamber at 28 °C to obtain adults. When a sufficient number of adults was obtained, some of them were stored in individual tubes containing 95% ethanol. Fourth instar and pupal skins were also sorted and stored in individual tubes containing 70% ethanol. Laboratory-reared adults and adults issued from field capture were killed by freezing. Three legs from the right side of each specimen were then carefully dissected and kept in a separate vial containing 95% ethanol and stored at -20 °C for further molecular investigations. Adults were mounted on their right side on a pin point attached to a No. 3 stainless steel insect pin and stored in entomological boxes. Specimen codes are based on the name of the collection followed by a unique serial number as proposed by Gaffigan and Pecor (1997). The same code was used for all of the biological material issued from the same specimen. When it was impossible to bring live samples back to the laboratory and rearing was not possible either, specimens were stored directly in 95% ethanol in the field.

Selected specimens were photographed using a Leica DFC450 camera mounted on a Leica MZ16 microscope under a light dome simulating natural light. Images were Z-stacked using the Leica LAS Z-stacking module. Montage pictures and collecting information for each specimen are stored in an online Voseq database (Peña and Malm 2012) managed by the EDB laboratory (Fig. 3) and viewable through the Guyanensis GIS web platform at <http://guyanensis.ups-tlse.fr>, through the Global Biodiversity Information Facility (GBIF) at <http://www.gbif.org/dataset/5a8aa2ad-261c-4f61-a98e-26dd752fe1c5> or alternatively through the local Integrated Publishing Toolkit (IPT) at [http://130.120.204.55:8080/ipt/resource.do?r=mosquitoes\\_of\\_french\\_guiana](http://130.120.204.55:8080/ipt/resource.do?r=mosquitoes_of_french_guiana)

Specimens are initially curated at the Ecofog laboratory by Stanislas Talaga and can be deposited in museums for further taxonomic study.

**Quality control description:** Considering different sources of GPS errors (such as ionosphere delay and signal multipath), we estimate the accuracy of the coordinates to be around 30 meters at a 95% confidence level.

## Data resources

**Dataset title:** Mosquitoes of French Guiana

**Resource:** r=mosquitoes\_of\_french\_guiana

**Character encoding:** UTF-8

**Format name:** Darwin Core Archive (Darwin Core Task Group 2009)

MB10794

*Sabethes hadrognathus* Harbach, 1995  
 authority from [EOL](#)

Specimen name			
Order	Diptera	Subfamily	Culicinae
Family	Culicidae	Tribe	Sabethini
Genus	<i>Sabethes</i>	Subtribe	Peytonulus
Species	<i>hadrognathus</i>	Host org.	
Subspecies		Auctor	
Type species?		don't know	

Locality Information		
Country		
French Guiana		
Specific Locality		
Saül		
Latitude	Longitude	Altitude
3° 38' N	53° 13' W	100

Collector Information		
Code in VoSeq	Collector	Collection date
MB10794	S. Talaga	2015-03-06
Voucher Locality	Voucher	Sex
Ecofog-Kourou	95% EtOH	I
	Voucher Code	Determined By
	MB1#0794	S. Talaga

DNA						
Extraction	Tube					
Extractor						
Date						

Sequence Information						
Region	bp	Amb.	Lab.	Accession	local Blast	ncbi Blast
16SIns	230	0	GenoScre			
COI	654	0	GenoScre			
<a href="#">add seq</a>						

Publication and Notes	
Published in	Notes
	Larval collection - Hollow stem <i>Guadua latifolia</i>



**Figure 3.** Sample data entry of our online database (<http://mosquitoes.ups-tlse.fr> with restricted access) holding the “Mosquitoes of French Guiana” dataset.

**Format version:** 1.0

**Distribution:** [http://130.120.204.55:8080/ipt/resource.do?r=mosquitoes\\_of\\_french\\_guiana](http://130.120.204.55:8080/ipt/resource.do?r=mosquitoes_of_french_guiana)

**Publication date of data:** 2015-06-12

**Language of database:** English

**License of use:** Other

**Date of metadata creation:** 2014-12-10

**Hierarchy level:** Dataset

### Usage rights

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# Two new species of the genus *Nephrotoma* (Diptera, Tipuloidea, Tipulidae) from China with a key to species from Mainland China

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## Abstract

*Nephrotoma liankangensis* **sp. n.** and *N. pseudoliankangensis* **sp. n.** are described from males and females collected from Henan and Yunnan provinces, China. Morphological descriptions and illustrations for the new species are provided. A key to known species from mainland China is provided. Some internal reproductive structures, including male semen pump, female vaginal apodeme and spermatheca, are described and compared. The possible usefulness of these internal reproductive structures for separating related species is analyzed. The type specimens are deposited in the animal specimen room, School of Life Sciences, Anqing Normal University, Anhui Province, China.

## Keywords

Nematocera, crane flies, taxonomy, internal reproductive organ, China

## Introduction

*Nephrotoma* is a large genus in the family Tipulidae. It was originally erected by Meigen (1803) with type species *Tipula dorsalis* (Fabricius, 1781), which is widely distributed in Palaearctic region. This genus is characterized by the following characters: median size; Rs short, cell m1 with or without petiole; ninth tergite covered with small black spines, never completely confused with ninth sternite, has a varied shaped posterior extension; outer gonostylus more or less lobe-shaped, generally flattened, fleshy or partly sclerotized; female cerci longer than hypoalva (Tangelder 1983, 1984). Up to now, 446 species and 29 subspecies of *Nephrotoma* have been reported worldwide, with 78 species recorded from mainland China (Oosterbroek 2015).

During this study of crane fly specimens collected from Henan and Yunnan provinces, China, two new species of *Nephrotoma* were found. Morphological descriptions and detailed illustrations for the new species are provided herein. A key to known species from mainland China is provided. In addition, some internal reproductive structures of the new taxa, including male semen pump, female vaginal apodeme and spermatheca, are described and compared. The possible usefulness of these internal reproductive structures for separating related species is analyzed.

## Material and methods

The specimens examined in this study were collected from Henan and Yunnan provinces by the first author and undergraduates of the School of Life Sciences, Anqing Normal University. The genitalia, including male hypopygium and female ovipositor were removed and soaked in 10% NaOH for 12 hours to clear the muscle for examination. The cleared genitalia were immersed in glycerin jelly, and then examined and drawn using Leica MZ125 (Leica, Germany) stereomicroscope. All measurements were made with the aid of a digital caliper in millimeters (mm). The terminology and methods of description and illustration follow that of Alexander and Byers (1981) and Frommer (1963).

The key was principally constructed from descriptions in the literature without examination of the type species of most of these species, and should be considered preliminary. The characters used in the key rely primarily on the structure of genitalia, the variation of veins and the number of stripes on the prescutum.

## Key to species of the genus *Nephrotoma* from mainland China

- |       |  |   |
|-------|--|---|
| 1     | Prescutum with stripe(s) .....   | 2 |
| –     | Prescutum without stripe.....  | 3 |
| 2 (1) | Prescutum with only one broad stripe, which almost covers the whole prescutum (see Savchenko 1973: p. 164) ..... |   |
|       | ..... <i>N. villosa</i> (Savchenko, 1973) (China: Anhui)   |   |

- Prescutum with more than one stripe ..... 5
- 3 (1) Stigma covered with macrotrichia ..... 4
- Stigma not covered with macrotrichia (see Yang and Yang 1990: p. 477) .....  
..... *N. hypogyna* Yang & Yang, 1990 (China: Yunnan)
- 4 (3) Head and thorax brown with grayish-white pruinosity; wing entirely light  
brown (see Yang and Yang 1993: p. 54).....  
..... *N. guangxiensis* Yang & Yang, 1993 (China: Guangxi)
- Head yellow, thorax brown, without grayish-white pruinosity; wing hyaline,  
tinged with light brown at apex (see Yang and Yang 1993: p. 56) .....  
..... *N. jinxiuensis* Yang & Yang, 1993 (China: Guangxi)
- 5 (2) Prescutum with black stripes..... 6
- Prescutum with stripes not black ..... 7
- 6 (5) Prescutal stripes with velvety black margin..... 29
- Prescutal stripes without velvety black margin ..... 28
- 7 (5) Prescutum with four stripes ..... 8
- Prescutum with three stripes ..... 9
- 8 (7) Male tergite nine without median notch, medially terminated into an obtuse  
lobe (see Yang and Yang 1987b: p. 134, fig. 4B); each flagellomere bicoloured  
(see Alexander 1925: p. 407) .....  
..... *N. rectispina* Alexander, 1925 (China: Hubei, Guizhou)
- Male tergite nine with U-shaped notch; flagellum black throughout..... 10
- 9 (7) Abdomen without dark apical or lateral stripes ..... 11
- Abdomen with dark apical and/or lateral stripes ..... 12
- 10 (8) Male tergite nine produced into two lobes; pleura yellow variegated with pale  
yellow (see Alexander 1949: p. 517).....  
..... *N. quadrinacrea* Alexander, 1949 (China: Hubei, Guangdong)
- Male tergite nine produced into four lobes; pleura entirely light yellow (see  
Alexander 1949: p. 515) ..... *N. progne* Alexander, 1949 (China: Guangdong)
- 11 (9) Male tergite nine projected into four lobes..... 13
- Male tergite nine projected into two lobes ..... 14
- 12 (9) Occiput with mark ..... 17
- Occiput without mark ..... 18
- 13 (11) Caudal margin of male sternite eight with an appendage directed caudally  
(see Yang and Yang 1997: p. 30, Pl. III, fig. 1); abdomen dark brown with  
two to four segments yellow (see Yang and Yang 1997: p. 30) .....  
..... *N. meridionalis* Yang & Yang, 1997 (China: Hainan, Guangxi)
- Caudal margin of male sternite eight without appendage; abdomen uniformly  
coloured ..... 15
- 14 (11) Cell m1 petiolate (see Alexander 1951: p. 1097); male sternite eight without  
produced appendage at caudal margin (see Alexander 1967: Pl. IV, fig. 30) ...  
..... *N. inorata* Alexander, 1951 (China: Xizang; India)
- Cell m1 sessile; male sternite eight with produced appendage at caudal  
margin..... 16

- 15 (13) Occiput without mark (see Yang and Yang 1990: p. 122); male sternite nine without appendage at caudal margin (see Yang and Yang 1990: p. 124, fig. 1A) ..... ***N. sichuanensis* Yang & Yang, 1990** (China: Sichuan)
- Occiput with a linear mark medially; male sternite nine with an appendage bifid and directed caudally (see Tangelder 1984: p. 51, fig. 125; p. 58, fig. 149).....***N. koreana* Tangelder, 1984** (China: Hebei, Heilongjiang, Ningxia; Russia; North Korea)
- 16 (14) Flagellum dark yellow; scutum with spots brown; abdomen dark yellow (see Yang and Yang 1987: p. 243) .....  
..... ***N. qinghaiensis qinghaiensis* Yang & Yang, 1987** (China: Qinghai)
- Flagellum with first flagellomere yellowish brown, the remainder of flagellum brown; scutum with black spots; abdomen blackish brown (see Yang and Yang 1990: p. 480) ..... ***N. qinbaiensis nigraabdomen* Yang & Yang, 1990** (China: Heilongjiang, Inner Mongolia)
- 17 (12) Cell m1 sessile ..... **24**
- Cell m1 petiolate ..... **25**
- 18 (12) Flagellomeres bicoloured, dark brown on enlarged bases, brown on apical portions of each flagellomere (see Alexander 1914: p. 158) .....  
..... ***N. flavonota* (Alexander, 1914)** (China: Zhejiang, Fujian, Hainan; Japan)
- Flagellomeres uniformly coloured ..... **19**
- 19 (18) Flagellum with first flagellomere yellow, the remainder of flagellum black or brown ..... **20**
- Flagellum entirely black ..... **21**
- 20 (19) Inner gonostylus with toothed crest (see Tangelder 1984: p. 85, fig. 277; Yang and Yang 1991: p. 44, fig. 2C)..... **22**
- Inner gonostylus without crest (see Yang and Yang 1990: p. 477, Pl. II, fig. 3)...**23**
- 21 (19) Wing weak brown; prescutum with orange stripes (see Alexander 1949: p. 513)..... ***N. citricolor* Alexander, 1949** (China: Fujian)
- Wing whitish hyaline; prescutum with fuscous stripes (see Matsumura 1916: p. 466)..... ***N. makiella* (Matsumura, 1916)** (China: Fujian, Taiwan)
- 22 (20) Male sternite eight without produced appendage at caudal margin (see Tangelder 1984: p. 85, fig. 272); wing yellowish with dark brown stigma (see Alexander 1935: p. 228) ..... ***N. profunda* Alexander, 1935** (China: Sichuan, Hubei)
- Male sternite eight with produced appendage at caudal margin (see Yang and Yang 1991: p. 44, fig. 2A); wing hyaline with light brown stigma.....  
..... ***N. hunanensis* Yang & Yang, 1991** (China: Hunan)
- 23 (20) Male tergite nine with two horn-shaped processes (see Yang and Yang 1990: p. 477, Pl. II, fig. 2); flagellum with flagellomeres brown except the first yellow.....  
..... ***N. ruiliensis* Yang & Yang, 1990** (China: Yunnan)
- Male tergite nine without horn-shaped processes (Fig. 25); flagellum with flagellomeres black except the first yellow .....  
..... ***N. pseudoliankangensis* sp. n.** (China: Yunnan)

- 24 (17) Vertex with a triangular stripe; inner gonostylus with a spinous lobe at posterior basal portion (see Alexander 1937: p. 22, fig. 26).....  
 ..... ***N. stylacantha* Alexander, 1937** (China: Fujian, Jiangsu)
- Vertex with a thin linear stripe; inner gonostylus without lobe described as above (see Alexander 1941b: Pl. III, fig. 34) .....  
 ..... ***N. alticrista* Alexander, 1941** (China: Sichuan)
- 25 (17) Male tergite nine without notch at caudal margin, medially terminated into an obtuse lobe (see Alexander 1940: Pl. VIII, fig. 7) .....  
 ..... ***N. medioproducta* Alexander, 1940** (China: Zhejiang)
- Male tergite nine with notch in the middle of caudal margin..... **26**
- 26 (25) Male tergite nine with two spinous processes excluding setae (see Sidorenko 1999: p. 112, Pl. 64, fig. 3)..... ***N. sinensis* (Edwards, 1916)** (China: Beijing, Henan, Jiangsu, Shaanxi, Sichuan, Jiangsu, Yunnan, Hainan, Taiwan; Russia; North Korea; South Korea)
- Male tergite nine without spinous process excluding setae (see Alexander 1935a: Pl. IV, fig. 50) ..... **27**
- 27 (26) Pleura yellow with a variable amount of red; male tergite nine with a V-shaped notch in the middle of caudal margin (see Alexander 1935a: Pl. IV, fig. 50)..... ***N. omeiana* Alexander, 1935** (China: Sichuan, Hubei, Taiwan)
- Pleura yellowish brown with a variable amount of white; male tergite nine with a rounded notch in the middle of caudal margin (Fig. 6).....  
 ..... ***N. liankangensis* sp. n.** (China: Henan)
- 28 (6) Scutum uniformly coloured ..... **30**
- Scutum with dark stripe or spot, or with different colours in middle portion ... **31**
- 29 (6) Cell m1 petiolate (see Alexander 1935a: Pl. I, fig. 20; Alexander 1949: p. 519)..... **66**
- Cell m1 sessile (see Alexander 1935c: Pl. I, fig. 15) .....  
 ..... ***N. catenata catenata* Alexander, 1935** (China: Sichuan)
- 30 (28) Abdomen not uniformly coloured, with dark stripe on tergites ..... **32**
- Abdomen uniformly coloured (see Yang and Yang 1991: p. 39) .....  
 ..... ***N. basiflava* Yang & Yang, 1991** (China: Qinghai)
- 31 (28) Occiput without a mark ..... **34**
- Occiput with a mark..... **35**
- 32 (30) Cell m1 sessile (see Alexander 1936a: p. 15) .....  
 ..... ***N. drakanae* Alexander, 1936** (China: Gansu, Inner Mongolia)
- Cell m1 petiolate ..... **33**
- 33 (32) Occiput without a mark; scutellum orange ochreous (see Edwards 1916: p. 266) ..  
 ..... ***N. parva* (Edwards, 1916)** (China: Jiangxi, Guangxi, Guangdong, Taiwan)
- Occiput with triangular black spot; scutellum black (see Edwards 1928: p. 700)..... ***N. distans* Edwards, 1928** (China: Xizang)
- 34 (31) Antennae black throughout; abdomen chiefly black, with fourth, fifth and base of third tergites orange (see Alexander 1941a: p. 405) .....  
 ..... ***N. aurantiocincta* Alexander, 1941** (China: Sichuan, Yunnan)

- Antennae variously coloured but not black throughout; abdomen chiefly yellow, with fourth and fifth tergites not orange.....**36**
- 35 (31) Flagellum with basal three segments yellow (see Yang and Yang 1988: p. 111) ..  
.....***N. catenata guizhouensis* Yang & Yang, 1988** (China: Guizhou)
- Flagellum with basal segments not yellow, or only first segment yellow .... **42**
- 36 (34) Abdomen with seventh segment black ..... **37**
- Abdomen with seventh segment not black ..... **38**
- 37 (36) Cell m1 long-petiolate, longer than m-m (see Alexander 1936b: Pl. I, fig. 2)....  
..... ***N. hainanica* Alexander, 1936** (China: Hainan)
- Cell m1 short-petiolate, shorter than m-m (see Alexander 1935b: Pl. I, fig. 4)..... ***N. biarmigera* Alexander, 1935** (China: Zhejiang)
- 38 (36) Male sternite eight without produced appendage in the middle of caudal margin (see Yang and Yang 1993: p. 55, fig. 2A; Yang and Yang 1991: p. 44, fig. 1A; Yang and Yang 1990: p. 124, fig. 4A)..... **39**
- Male sternite eight with produced appendage in the middle of caudal margin (see Yang and Yang 1995: p. 420, fig. 1; Yang and Yang 1987b: p. 132, fig. 2A)... **40**
- 39 (38) Process of male tergite nine widened basally and narrowed apically (see Yang and Yang 1993: p. 55, fig. 2B) .....  
..... ***N. tianlinensis* Yang & Yang, 1993** (China: Guangxi)
- Process of male tergite nine horn-shaped (see Yang and Yang 1991: p. 44, fig. 1B; Yang and Yang 1990: p. 124, fig. 4B)..... **41**
- 40 (38) Male sternite nine with an appendage directed ventrally in the middle of caudal margin (see Yang and Yang 1995: p. 420, fig. 1) .....  
..... ***N. zhejiangensis* Yang & Yang, 1995** (China: Zhejiang)
- Male sternite nine without appendage (see Yang and Yang 1987a: p. 132, fig. 2A) ..... ***N. geniculata* Yang & Yang, 1987** (China: Inner Mongolia, Hubei, Sichuan, Guizhou)
- 41 (39) Abdominal tergites with median stripe; inner gonostylus without crest (see Yang and Yang 1991: p. 44, fig. 1C).....  
..... ***N. cuneata* Yang & Yang, 1991** (China: Hubei, Hunan)
- Abdominal tergites without median stripe; inner gonostylus with crest (Yang and Yang 1990: p. 124, fig. 4C).....  
..... ***N. xichangensis* Yang & Yang, 1990** (China: Sichuan)
- 42 (35) The first flagellomere not the same colour as remaining flagellomeres of flagellum ..... **43**
- Flagellum with flagellomeres all the same colour..... **44**
- 43 (42) Inner gonostylus with crest ..... **45**
- Inner gonostylus without crest ..... **46**
- 44 (42) Male tergite nine without emargination, or with shallow emargination on caudal margin ..... **53**
- Male tergite nine with U-shaped or V-shaped notch on caudal margin .... **54**
- 45 (43) Crest of inner gonostylus with tooth on dorsal margin ..... **47**

- Crest of inner gonostylus without tooth (see Oosterbroek 1985: p. 268, fig. 103).....***N. hirsuticauda* Alexander, 1924** (China: Heilongjiang, Inner Mongolia, Gansu, Ningxia; Russia; Japan; Mongolia; North Korea)
- 46 (43) Caudal margin of male tergite nine produced into a pair of flattened black lobes, their medial edges coarsely toothed; outer gonostylus with tip curved and subacute, the margin of gonostylus with three or four teeth (see Alexander 1935b: Pl. II, fig. 31) .....***N. nigrostylata* Alexander, 1935** (China: Hubei, Zhejiang, Fujian, Sichuan, Guizhou, Guangxi)
- Caudal margin of male tergite nine, and outer gonostylus not as above .... **48**
- 47 (45) Outer gonostylus abruptly narrowed at apical half; inner gonostylus with a relatively short beak (see Oosterbroek 1985: p. 250, figs. 36, 37).....  
..... ***N. relicta* (Savchenko, 1973)** (China: Heilongjiang, Sichuan, Hubei; Russia; North Korea; South Korea; Mongolia; Finland)
- Outer gonostylus gradually narrowed; inner gonostylus with a relatively long beak (see Oosterbroek 1985: p. 250, figs 34, 35) .....  
..... ***N. parvirostra* Alexander, 1924** (China: Beijing, Hebei, Heilongjiang, Hubei, Sichuan; Russia; Mongolia; South Korea; Japan)
- 48 (46) Abdominal tergites without median stripe (see Alexander 1935b: p. 200).....  
..... ***N. evittata* Alexander, 1935** (China: Sichuan, Yunnan)
- Abdominal tergites with median stripe..... **49**
- 49 (48) Male sternite eight with appendage in the middle of caudal margin (see Yang and Yang 1990: p. 478, Pl. III, fig. 1; Yang and Yang 1987b: p. 131, Pl. I, fig. 1A) ..... **50**
- Male sternite eight without appendage in the middle of caudal margin (see Yang and Yang 1987a: p. 130, fig. 1B; Oosterbroek 1985: p. 271, fig. 111; Alexander 1935a: p. 135)..... **51**
- 50 (49) Male tergite nine with lobes acute apically (see Yang and Yang 1990: p. 478, Pl. III, fig. 2)..... ***N. concava* Yang & Yang, 1990** (China: Gansu)
- Male tergite nine with lobes rounded apically (see Yang and Yang 1987b: p. 131, Pl. I, fig. 1B)..... ***N. hubeiensis* Yang & Yang, 1987** (China: Hubei)
- 51 (49) Male tergite nine with two blunt processes on each side of hind margin (see Yang and Yang 1987a: p. 130, fig. 1C) .....  
..... ***N. xizangensis* Yang & Yang, 1987** (China: Xizang)
- Male tergite nine with two acute processes on each side of hind margin.... **52**
- 52 (51) Occipital mark brown, rounded; abdomen with segments seven to nine dark brown (see Alexander 1914: p. 162); male tergite nine with two spinous processes at caudal margin (see Oosterbroek 1985: p. 271, fig. 112).... ***N. repanda* (Alexander, 1914)** (China: Sichuan; Russia; North Korea; South Korea; Japan)
- Occipital mark black, subtriangular; abdomen with all segments yellow (see Alexander 1935a: p. 134); male tergite nine with two horn-shaped processes at caudal margin (see Alexander 1935a: Pl. IV, fig. 43) .....  
..... ***N. retenta* Alexander, 1935** (China: Sichuan-Xizang border)

- 53 (44) Male tergite nine with process not directed caudally (see Tangelder 1984: p. 40, fig. 81).....***N. libra* Alexander, 1951** (China: Xizang)  
 – Male tergite nine with process directed caudally (see Yang and Yang 1987a: p. 131, fig. 2B; p. 132, fig. 3B) ..... **55**
- 54 (44) Tergite nine dividing into four processes ..... **56**  
 – Tergite nine dividing into two processes ..... **57**
- 55 (53) Vertex with a light brown spot between eyes; male sternite nine with an appendage directed caudally in the middle of hind margin (see Yang and Yang 1987a: p. 132, fig. 3A)..... ***N. didyma* Yang & Yang, 1987** (China: Xizang)  
 – Vertex with a black spot between eyes; male sternite nine without appendage in the middle of hind margin (see Yang and Yang 1987a: p. 131, fig. 2A).....  
 ..... ***N. claviformis* Yang & Yang, 1987** (China: Xizang)
- 56 (54) Inner gonostylus with crest ..... **58**  
 – Inner gonostylus without crest ..... **59**
- 57 (54) Male sternite eight with appendage in the middle of caudal margin..... **67**  
 – Male sternite eight without appendage in the middle of caudal margin..... **68**
- 58 (56) Inner gonostylus produced caudad into a long tail-like portion (see Alexander 1935a: Pl. IV, fig. 44, as *attenuata*); sternite eight without appendage in the middle of caudal margin (see Alexander 1935a: p. 136 as *attenuata*) .....  
 ..... ***N. nigrohalterata* Edwards, 1928** (China: Sichuan, Xizang)  
 – Inner gonostylus without such tail-like portion; sternite eight with an appendage in the middle of caudal margin ..... **60**
- 59 (56) Male sternite eight with appendage in the middle of caudal margin (see Oosterbroek 1985: p. 244, fig. 10) ..... ***N. aculeata* (Loew, 1871)** (China: Heilongjiang, Shanxi; widely distributed in Palaearctic Region)  
 – Male sternite eight without appendage in the middle of caudal margin..... **62**
- 60 (58) Occipital mark dark brown; male sternite nine with appendage in the middle of caudal margin (see Oosterbroek 1985: p. 272, fig. 115).....  
 ..... ***N. virgata* (Coquillett, 1898)** (China: Anhui, Hebei, Hubei, Sichuan, Zhejiang; Russia; North Korea; South Korea; Japan)  
 – Occipital mark black; male sternite nine without appendage in the middle of caudal margin ..... **61**
- 61 (60) Flagellum entirely brown; male sternite eight with a curved appendage directed ventrally at caudal margin (see Yang and Yang 1990: p. 124, fig. 3A).  
 ..... ***N. ocellata* Yang & Yang, 1990** (China: Sichuan)  
 – Flagellum entirely black; male sternite eight with a straight appendage directed caudad at caudal margin (see Oosterbroek 1984: p. 122, fig. 2).....  
 ..... ***N. cornicina cornicina* (Linnaeus, 1758)** (China: as far south as Zhejiang; widely distributed in Palaearctic Region)
- 62 (59) Caudal margin of male tergite nine with two intermediate rounded processes and two spinous processes laterally (see Yang and Yang 1990: p. 124, fig. 2B)..  
 ..... ***N. kunagi* Yang & Yang, 1990** (China: Sichuan)

- Caudal margin of male tergite nine with processes not as above..... 63
- 63 (62) Cell m1 petiolate (see Alexander 1927: p. 182)..... ***N. pleuromaculata* Alexander, 1927** (China: Hubei, Sichuan, Yunnan; India)
- Cell m1 sessile ..... 64
- 64 (63) Intermediate lobes of male tergite nine with apex further produced into a pale triangular point (see Alexander 1935c: Pl. IV, fig. 43).....  
..... ***N. martynovi* Alexander, 1935** (China: Hebei, Heilongjiang, Inner Mongolia; Russia; Mongolia)
- Intermediate lobes of male tergite nine with apex lacking such a point ..... 65
- 65 (64) Male tergite nine with a slender glabrous spine arising from the ventrolateral portion (see Alexander 1937: p. 25, fig. 29, as *brierei*) .....  
..... ***N. scalaris parvinotata* (Brunetti, 1918)** (China: Beijing, Hebei, Shanxi, Shandong, Xinjiang, Inner Mongolia, Gansu, Ningxia, Heilongjiang, Jiangsu, Anhui, Sichuan, Guizhou; Russia; Georgia; Armenia; Azerbaijan; Turkey; Syria; Lebanon; Iran; Kazakhstan; Turkmenistan; Uzbekistan; Tajikistan; Kyrgyzstan; Afghanistan; Mongolia; India; Pakistan)
- Male tergite nine without such a spine arising from the ventrolateral portion (see Oosterbroek 1985: p. 259, fig. 72)..... ***N. pullata* (Alexander, 1914)** (China: Heilongjiang; Russia; North Korea; Japan)
- 66 (29) Male sternite eight with a small compressed lobe at posterior margin (see Alexander 1935a: p. 139)..... ***N. pilata* Alexander, 1935** (China: Sichuan)
- Male sternite eight lacking such a lobe at posterior margin (see Alexander 1949: p. 519)..... ***N. vesta* Alexander, 1949** (China: Guangdong)
- 67 (57) Abdominal tergites black with pale yellow lateral stripes ..... 69
- Abdominal tergites yellow with dark lateral stripes..... 70
- 68 (57) Inner gonostylus without crest..... 71
- Inner gonostylus with crest ..... 72
- 69 (67) Antennae entirely black; male tergite nine terminating in two rounded lobes at caudal margin (see Alexander 1935a: Pl. IV, fig. 49) .....  
..... ***N. biformis* Alexander, 1935** (China: Sichuan)
- Antennae entirely brown; male tergite nine terminating in two acute lobes at caudal margin (see Yang and Yang 1990: p. 481, Pl. V, fig. 2) .....  
..... ***N. joneensis* Yang & Yang, 1990** (China: Gansu)
- 70 (67) Cell m1 petiolate (see Yang and Yang 1987: p. 245) ..... ***N. barbiger* (Savchenko, 1964)** (China: Heilongjiang, Jilin, Gansu, Ningxia, Shanxi; Russia)
- Cell m1 sessile ..... 77
- 71 (68) Male tergite nine with a pair of spinous processes except setae ..... 73
- Male tergite nine without spinous processes except setae (see Oosterbroek 1985: p. 262, fig. 79) ..... ***N. bifusca* Alexander, 1920** (China: Heilongjiang, Hebei, Jilin; Russia; North Korea; South Korea; Japan)
- 72 (68) Cell m1 petiolate ..... 75
- Cell m1 sessile ..... 76

- 73 (71) Male tergite nine projected into a pair of spike-like processes at caudal margin, each with a series of six or seven blackened points along their medial edge (see Savchenko 1973: p. 47) .....74
- Male tergite nine projected into a pair of fingerlike processes at caudal margin, the horn without points described as above (see Yang and Yang 1990: p. 480, Pl. IV, fig. 2)..... ***N. shanxiensis* Yang & Yang, 1990** (China: Shanxi)
- 74 (73) Cell m1 petiolate (see Alexander 1935a: Pl. I, fig. 19).....***N. impigra impigra* Alexander, 1935** (China: Zhejiang, Hubei, Jiangxi, Fujian, Sichuan)
- Cell m1 sessile (see Savchenko 1973: p. 48).....  
.....***N. impigra fulvovittata* (Savchenko, 1964)** (China: Yunnan)
- 75 (72) Male tergite nine terminating in two angular lobes at caudal margin (see Tangelder 1984: p. 74, fig. 235)..... ***N. quadristriata* (Schummel, 1833)** (China: Xinjiang; widely distributed in Palaearctic Region)
- Male tergite nine terminating in two truncated lobes at caudal margin (see Tangelder 1984: p. 49, fig. 115) .....  
.....***N. spicula* Tangelder, 1984** (China: Heilongjiang; Russia; North Korea)
- 76 (72) Inner gonostylus with crest toothed (see Tangelder 1984: p. 77, fig. 245) ....  
.....***N. scurra* (Meigen, 1818)** (China: Gansu, Inner Mongolia; widely distributed in Palaearctic Region)
- Inner gonostylus with crest not toothed (see Tangelder 1984: p. 28, fig. 20; p. 30, fig. 29; p. 38, fig. 73).....**78**
- 77 (70) Male tergite nine terminating in two truncated lobes at caudal margin; inner gonostylus with an angular process on dorsal side (see Mannheims 1967: p. 178, fig. 1).....***N. ligulata* Alexander, 1925** (China: Xinjiang; Russia; Turkmenistan; Uzbekistan; Tajikistan; Kyrgyzstan; Afghanistan; Mongolia; India)
- Male tergite nine terminating in two bluntly rounded lobes at caudal margin; inner gonostylus without process on dorsal side (see Yang and Yang 1987: p. 244, figs. 3B, 3C).....***N. xinjiangensis* Yang & Yang, 1987** (China: Xinjiang)
- 78 (76) Male sternite nine with an appendage directed caudally (see Alexander 1953: p. 332, fig. 3a) .....***N. kaulbacki* Alexander, 1951** (China: Xizang)
- Male sternite nine with an appendage directed ventrally (see Tangelder 1984: p. 28, fig. 16; p. 30, fig. 27) .....**79**
- 79 (78) Abdominal tergites without lateral stripes; male tergite nine separated by a U-shaped notch medially on caudal margin (see Tangelder 1984: p. 30, fig. 30).....***N. perobliqua* Alexander, 1936** (China: Gansu)
- Abdominal tergites with lateral stripes; male tergite nine separated by a V-shaped notch medially on caudal margin (see Tangelder 1984: p. 28, fig. 18).....***N. pjotri* Tangelder, 1984** (China: Xinjiang; Kazakhstan; Uzbekistan; Kyrgyzstan)

## Taxonomy

### *Nephrotoma liankangensis* sp. n.

<http://zoobank.org/50E64607-C1E1-4AD1-88AB-10F98DF3FF37>

Figs 1–19

**Diagnosis.** Antennae with flagellum light brown, pleura light yellow conspicuously patterned with white, abdominal tergites with two black lateral stripes and one brown median stripe, ninth tergite with two rounded lobes which are densely covered with black spines, posterior margin of ninth tergite not concaved at base of lobes.

**Description.** Male (n=2): body length 9.8 mm, wing 10.5 mm, antenna 5.8 mm.

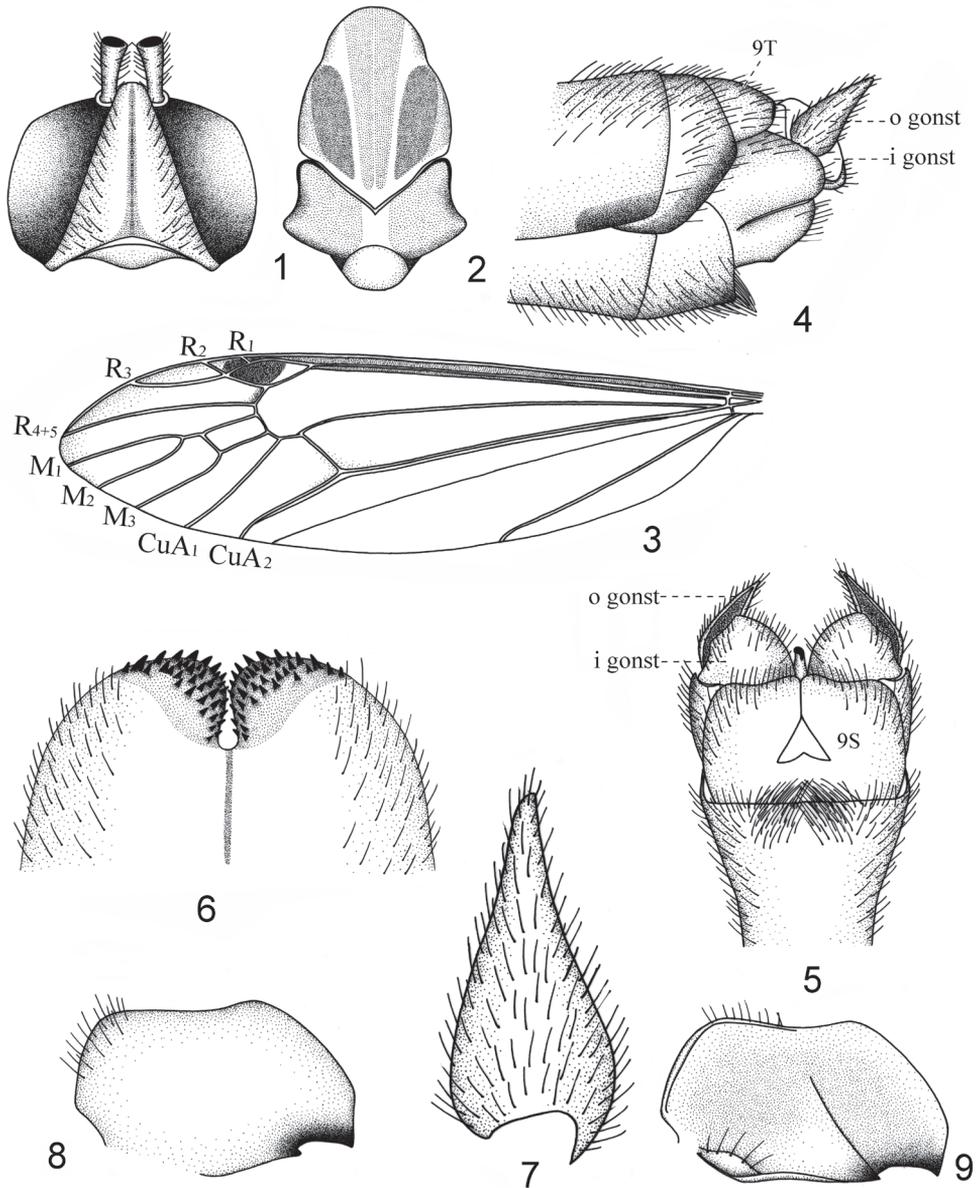
*Nasus* yellow with black setae, palpi black. Antennae relatively long, if bent backward extending to the first abdominal tergite, scape and pedicel yellow, flagellum 10-segmented, with the first flagellomere yellow, with the second to tenth flagellomeres light brown and enlarged at both ends, the basal enlargement black with black setae basally, subequal to the flagellomeres from which they arise. Head yellow, occipital band brown and narrow, along the middle line of occiput (Fig. 1).

*Pronotum* light brown, changing into yellow in middle. Prescutum yellow with three brown stripes, median one expanded apically, not extending to the hind border, lateral stripe straight and rounded apically, extending slight beyond the middle of median stripe (Fig. 2). The median stripe lighter in coloration than lateral one, sometimes divided by a yellow line (Fig. 2). Scutum light brown, each lobe with jet-black anterior border, median area of scutum yellow (Fig. 2). Scutellum yellowish. Postnotum light brown. Pleura yellowish brown, variegated by white on anepimeron, katepimeron, meron and basal laterotergite. Halteres yellowish brown throughout. Legs with coxae and trochanters yellow; femora and tibiae yellow with brown tips; tarsi dark brown. Wings transparent, cells c and sc suffused with brown; stigma oval, dark brown; wing tip narrowed and slightly suffused with light brown. Cell r1 without stigmal trichia, cell m1 petiolate (Fig. 3).

*Abdomen* generally yellow, the first tergite light brown, tergites two to six with a light brown median stripe and two black lateral stripes, sternites two to seven with light brown median stripe, hypopygium chiefly yellowish brown. Male hypopygium (Figs 4, 5) with the ninth tergite having the median notch rounded basally, gradually narrowed to apex, separating the ninth tergite into two rounded lobes, the lobe black and densely covered with black spines (Fig. 6). Outer gonostylus lanceolate, basally widened and gradually narrowed to the end (Figs 4, 5, 7). Inner gonostylus with two black beaks (Figs 8, 9).

*Aedeagal guide* horn-shaped in lateral view, very acute apically (Fig. 10); paramere lamellate, blunt apically (Fig. 10); ventral appendage of aedeagal guide horn-like in lateral view, boot-shaped in dorsal view (Figs 10, 11).

*Semen pump* with posterior immovable apodeme (PIA) narrow, dorsally bent in lateral view (Fig. 13); compressor apodeme (CA) fan-shaped, with an obviously expanded median ridge in lateral view, in a 90° angle with posterior immovable apodeme

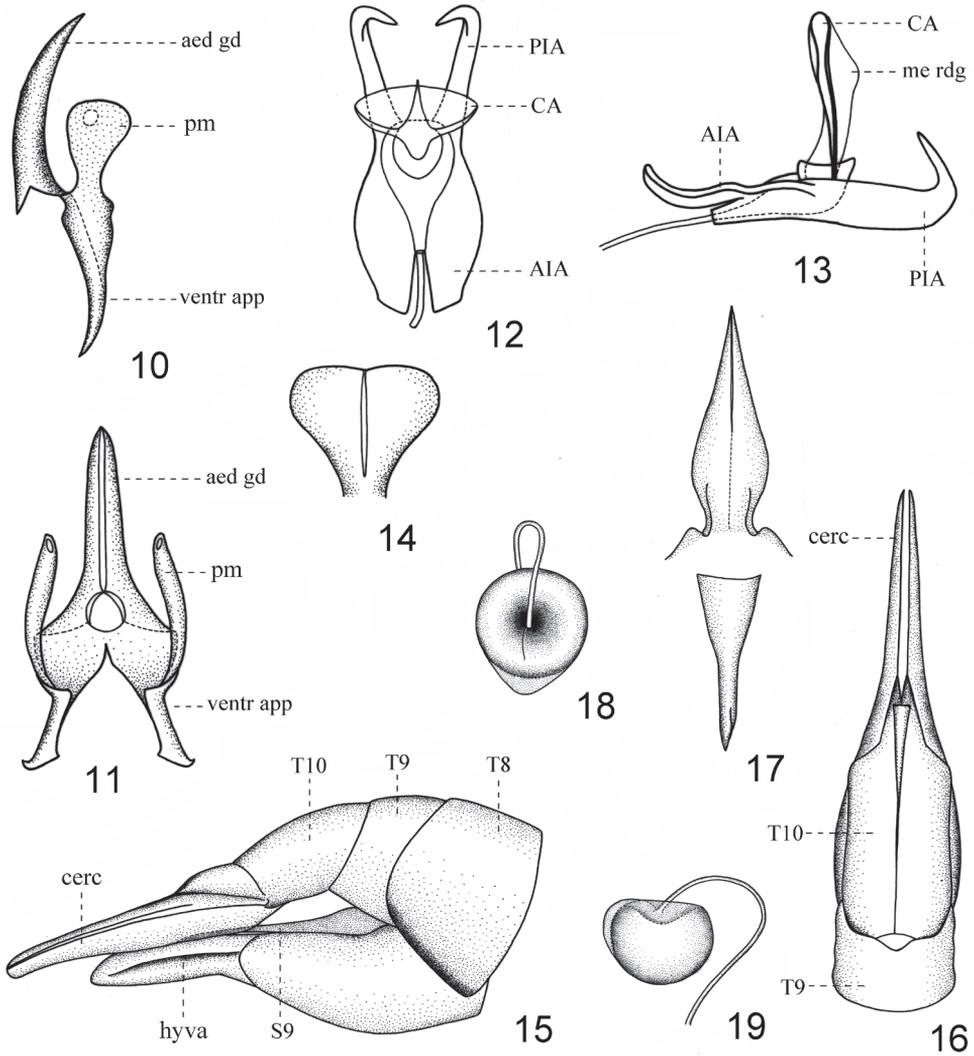


**Figures 1–9.** *Nephrotoma liankangensis* sp. n. **1** head, dorsal view **2** thorax, dorsal view **3** left wing **4** hypopygium, lateral view **5** hypopygium, ventral view **6** ninth tergite, dorsal view **7** outer gonostylus, lateral view **8** inner gonostylus, lateral internal view **9** inner gonostylus, lateral external view. Abbreviations: i gonst = inner gonostylus, o gonst = outer gonostylus, S = stergite.

(Figs 12–14); anterior immovable apodeme (AIA) broader than compressor apodeme, with lateral margins arched and inner margins straight, separated medially (Fig. 12).

Female (n=2): body length 16.2 mm, wing 12.0 mm, antenna 3.2 mm.

The general coloration of head, thorax and abdomen similar to that of male.



**Figures 10–19.** *Nephrotoma liankangensis* sp. n. **10** aedeagal guide, lateral view **11** aedeagal guide, dorsal view **12** semen pump, dorsal view **13** semen pump, lateral view **14** compressor apodeme **15** ovipositor, lateral view **16** ovipositor, dorsal view **17** ninth sternite and vaginal apodeme, dorsal view **18** spermatheca, dorsal view **19** spermatheca, lateral view. Abbreviations: aed gd = aedeagal guide, pm = paramere, ventr app = ventral appendage of aedeagal guide, PIA = posterior immovable apodeme, AIA = anterior immovable apodeme, CA = compressor apodeme, me rdg = median ridge, T = tergite, cerc = cercus, hyva = hypovalva.

*Antennae* relatively short, if bent backward not extending to abdomen, scape and pedicel yellow, flagellum 10-segmented, each flagellomere cylindrical, gradually shorter and slightly enlarged at base, the basal two flagellomeres yellow, three to ten flagellomeres yellowish brown with black at base.

*Ovipositor* yellowish brown, ninth sternite very thin, lanceolate, separated medially (Fig. 17). Sternite ten slightly shorter than cerci, parallel in lateral margins in dorsal

view (Fig. 16). Cerci long, acinacifoliate, widened at basal three fifths, narrowed at apical two fifths, surpassing the end of hypovalva (Fig. 15). Hypovalva simple, extending to nearly three quarters length of cerci (Fig. 15).

*Vaginal apodeme* widened at basal half and gradually tapered to the end, very acute apically (Fig. 17). Spermatheca spherical, brown, well-sclerotized, with membranous angular extension on lateral side (Figs 18, 19).

**Material examined. Holotype** male. Pinned specimen. **China:** Henan Province, Xin County, Liankangshan National Nature Reserve, 18 Jul. 2014, coll. Qiulei Men. **Paratype.** Pinned specimen. **China:** 1 male 2 females, same data as holotype, coll. Wu Zeng.

**Distribution.** China (Henan).

**Etymology.** The specific epithet is a noun ‘*liankang*’ with Latin suffix ‘*ensis*’, referring to the distribution of the new species.

**Remarks.** This new species is similar to *N. pseudoliankangensis*, as discussed below, and another Chinese species, *N. sinensis* (Edwards, 1916), by the coloration of the prescutum and wings, the shape of lobes on the ninth tergite and the shape of inner gonostylus. It can be easily distinguished from the latter by the prescutum not bearing a black spot on anterior portion of the lateral stripe (this black spot present in *N. sinensis* as described by Liu et al. 2009: 43), the ninth tergite without spiny prominence on each side of lobes (this spiny prominence on each side of lobes in *N. sinensis* as illustrated by Sidorenko 1999: 112), and the inner gonostylus broad apically (apical half obviously narrower than that of *N. liankangensis* in *N. sinensis* as illustrated by Sidorenko 1999: 112).

### *Nephrotoma pseudoliankangensis* sp. n.

<http://zoobank.org/5AAE0CD7-E0D8-454E-9EC0-173267C91215>

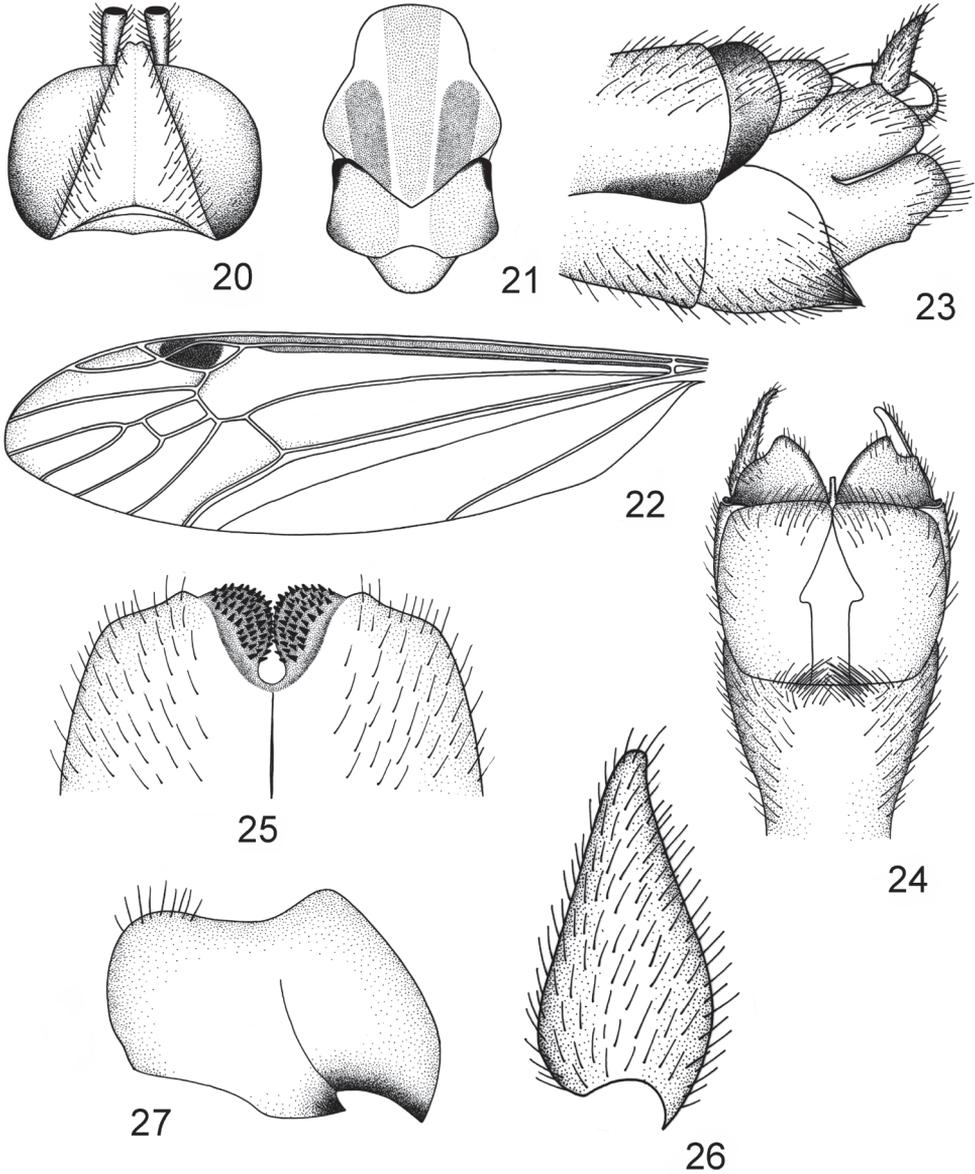
Figs 20–36

**Diagnosis.** General coloration light yellow, antennae with flagellum black except the first flagellomere, pleura white conspicuously patterned with yellow, abdominal tergites with two black lateral stripes and one brown median stripe, ninth tergite with two rounded lobes, posterior margin of ninth tergite slightly concaved at base of lobes.

**Description.** Male (n=2): body length 9.6 mm, wing 11.0 mm, antenna 5.1 mm.

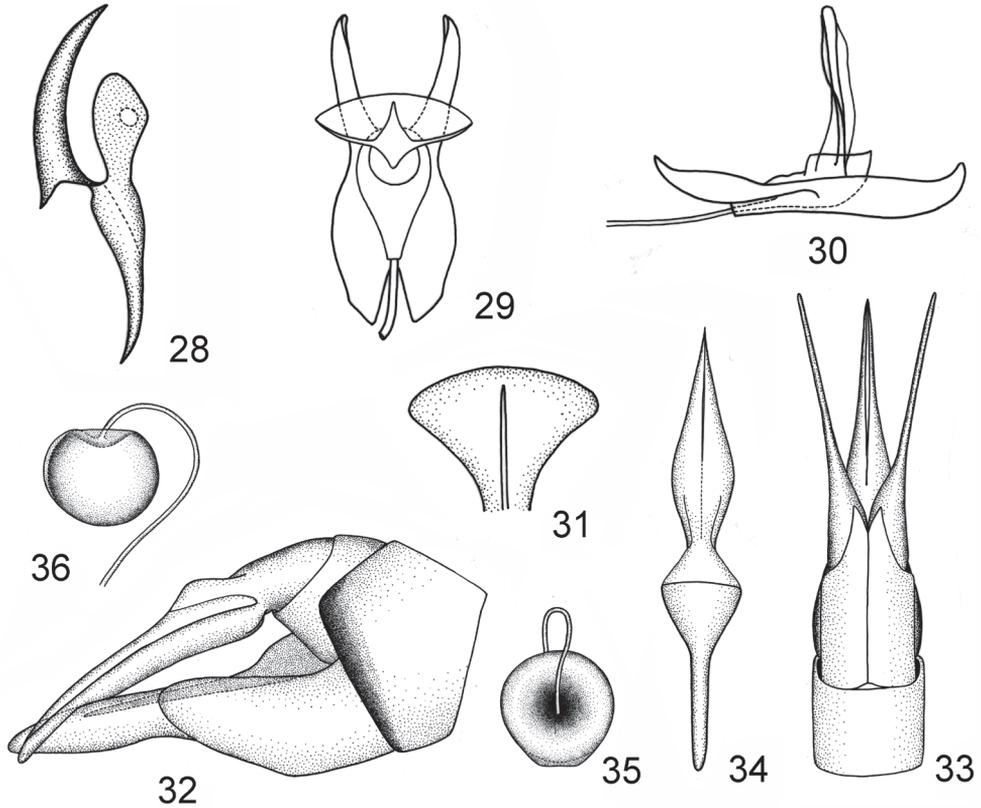
*Nasus* brown with brown setae, palpi black. Antennae relatively long, if bent backward extending to the first abdominal tergite, scape and pedicel yellow, flagellum 10-segmented, with the first flagellomere yellow, with second to tenth flagellomeres black and enlarged at base and apex, each flagellomere with black setae at base, subequal to the flagellomeres where they are found. Head yellow without occipital brand (Fig. 20).

*Pronotum* entirely yellow. Prescutum yellow with three brown stripes, median one percurrent and expanded apically, lateral stripe straight and rounded apically, the area between lateral stripe and lateral border of prescutum suffused with brown (Fig. 21). Scutum light brown, each lobe with jet-black anterior border, median area of scutum yellow (Fig. 21). Scutellum yellowish brown. Postnotum light brown with white median



**Figures 20–27.** *Nephrotoma pseudoliankangensis* sp. n. **20** head, dorsal view **21** thorax, dorsal view **22** left wing **23** hypopygium, lateral view **24** hypopygium, ventral view **25** ninth tergite, dorsal view **26** outer gonostylus, lateral view **27** inner gonostylus, lateral view.

stripe. Pleura white, variegated by yellow on anepisternum and katepisternum. Halteres yellowish brown throughout. Legs with coxae and trochanters yellow; femora and tibiae yellow with brown tips; tarsi dark brown. Wings transparent, cells c and sc variegated with brown; stigma oval, dark brown; wing tip narrowed and slightly suffused with light brown. Cell r1 with five to six stigmal trichiae, cell m1 petiolate (Fig. 22).



**Figures 28–36.** *Nephrotoma pseudoliankangensis* sp. n. **28** aedeagal guide, lateral view **29** semen pump, dorsal view **30** semen pump, lateral view **31** compressor apodeme **32** ovipositor, lateral view **33** ovipositor, dorsal view **34** ninth stergite and vaginal apodeme, dorsal view **35** spermatheca, dorsal view **36** spermatheca, lateral view.

*Abdomen* generally yellow, the first segment yellow with light brown tergite, tergites two to seven with a brown median stripe and two black lateral stripes, the median stripe expanded at hind border, tergite eight entirely brownish black; sternites two to seven with light brown median stripe, hypopygium chiefly yellowish brown. Male hypopygium (Figs 23, 24) with the ninth tergite having the median notch rounded and widened basally, separating the ninth tergite into two rounded black lobes, which densely covered with black spines, almost connected to each other (Fig. 25). Outer gonostylus lanceolate, basally widened and gradually narrowed to the end (Figs 23, 24, 26). Inner gonostylus with two black beaks, the dorsal side of inner gonostylus obviously extended (Fig. 27).

*Aedeagal guide* very similar to that of *N. liankangensis*, with paramere not blunt apically, the dorsal margin slightly arched, the ventral and outer margins forming an obtuse angle (Fig. 28).

*Semen pump* very similar to that of *N. liankangensis*, with posterior immovable apodeme (PIA) not bent directed dorsad at the apex in lateral view (Fig. 30); compressor apodeme (CA) fan-shaped, broader than that of *N. liankangensis* (Figs 29, 31), with median ridge slightly expanded in lateral view, which more degenerated than that of *N. liankangensis* (Fig. 30); anterior immovable apodeme (AIA) more expanded than that of *N. liankangensis* in lateral view (Fig. 30).

Female (n=3): body length 15.8 mm, wing 13.0 mm, antenna 2.5 mm.

The colouration of head, thorax and abdomen similar to those of male.

*Antennae* relatively short, scape and pedicel yellow, flagellum 10-segmented, each flagellomere cylindrical, gradually shorter, the basal two flagellomeres entirely yellow, three to ten flagellomeres yellowish brown with black at base.

*Ovipositor* (Figs 32, 33) very similar to that of *N. liankangensis*, with ninth sternite obviously longer than that of *N. liankangensis* (Fig. 34).

*Vaginal apodeme* widened at basal two fifths, the rest of vaginal apodeme tubular, parallel, acute apically (Fig. 34).

*Spermatheca* spherical, brown, well-sclerotized, with membranous extension truncate (Figs 35, 36).

**Material examined.** **Holotype** male. Pinned specimen. **China:** Yunnan Province, Kunming, Baofeng wetland park, 31 Aug. 2013, coll. Bin Zhang. **Paratype.** Pinned specimen. **China:** 1 male 3 females, same data as holotype.

**Distribution.** China (Yunnan).

**Etymology.** The specific epithet is based on the name of the related species, *N. liankangensis*, with the Latin prefix 'pseudo', referring to the morphological similarity of the new species to *N. liankangensis*.

**Remarks.** This new species is externally similar to *N. liankangensis* by the colouration of head, thorax, abdomen and wings, and the shape of inner and outer gonostyli. It can be easily distinguished from the latter by antennae with the second to tenth flagellomeres black (the second to tenth flagellomeres yellow with basal enlargement black in *N. liankangensis*), the occiput unpatterned (with brown median brand in *N. liankangensis* as shown in Fig. 20), and the inner gonostylus with the dorsal margin obviously extended (just slightly extended in *N. liankangensis* as shown in Figs 8, 9). The new species is also similar to *N. liankangensis* in some internal reproductive organs, but differs from the latter in the female vaginal apodeme widened at basal two fifths, tubular and parallel at apical three fifths (vaginal apodeme widened at basal half and gradually tapered to the end in *N. liankangensis* as shown in Fig. 17), the spermatheca laterally with membranous extension truncate (with membranous extension angular in *N. liankangensis* as shown in Fig. 18), the male aedeagal guide with paramere not blunt apically (apically blunt in *N. liankangensis* as shown in Fig. 10), the semen pump with posterior immovable apodeme not dorsally bent (dorsally bent in *N. liankangensis* as shown in Fig. 13), and compressor apodeme with median ridge slightly expanded in lateral view (median ridge obviously more expanded than that of *N. pseudoliankangensis* in *N. liankangensis* as shown in Fig. 13).

## Discussion

Based on morphological comparison, the characters of the vaginal apodeme, spermatheca and semen pump are uniform in different individuals of *N. pseudoliankangensis* and *N. liankangensis*. However, these structures show noticeable differences between the two species. More comparative morphological study may not only prove a high application value of the characters of these internal reproductive structures in separating relative species, but also prove the roles of these structures for phylogenetic studies as mentioned by Tangelder (1985). Moreover, although used less frequently, the characteristics of female genitalia, especially the vaginal apodeme and ninth sternite, may be helpful to effectively distinguish species in which males are difficult to collect.

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# Ephemeroptera, Plecoptera, and Trichoptera on Isle Royale National Park, USA, compared to mainland species pool and size distribution

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## Abstract

Extensive sampling for aquatic insects was conducted in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT) of Isle Royale National Park (ISRO), Michigan, United States of America, during summer 2013. The island was ice covered until 8,000 to 10,000 years ago and is isolated by 22–70 km distance from the mainland. Two hypotheses were examined: that ISRO EPT richness would be much reduced from the mainland, and that the species colonizing ISRO would be of smaller size than mainland, adults presumably using updrafts to bridge the distance from mainland sources. Data sets were developed for known mainland EPT species and size for those species. The first hypothesis was confirmed with the mainland species pool consisting of 417 EPT, while ISRO is known to support 73 species. Richness of EPT is directly related to the number of specimens examined. Small streams supported five EPT species, while 15–25 species were found in larger streams. Lakeshores had intermediate diversity. The second hypothesis was substantiated for stoneflies, but not for mayflies or caddisflies. Stoneflies apparently are poorer fliers than either of the other two orders.

## Keywords

Isle Royale National Park, Ephemeroptera, Plecoptera, Trichoptera, adult size, regional species pool

## Introduction

Isle Royale National Park (ISRO) is an archipelago of islands located in cold, oligotrophic Lake Superior, Michigan, United States of America (USA). The main island is 72 km long and 14 km wide at its greatest dimensions (Kraft et al. 2010). It is presumed that all macroscopic life was eliminated from the island during the Wisconsinan glacial episodes. The region has been ice free for as much as 10,000 yr. Life repopulated by various means from mainland sources, a distance of 20–22 km from Minnesota, USA and Ontario, Canada or 70 km from the Keweenaw Peninsula of Michigan (Fig. 1). The entire park was assessed for natural resource condition within the past decade and much of what is known about the island and its fauna and flora is contained within Kraft et al. (2010).

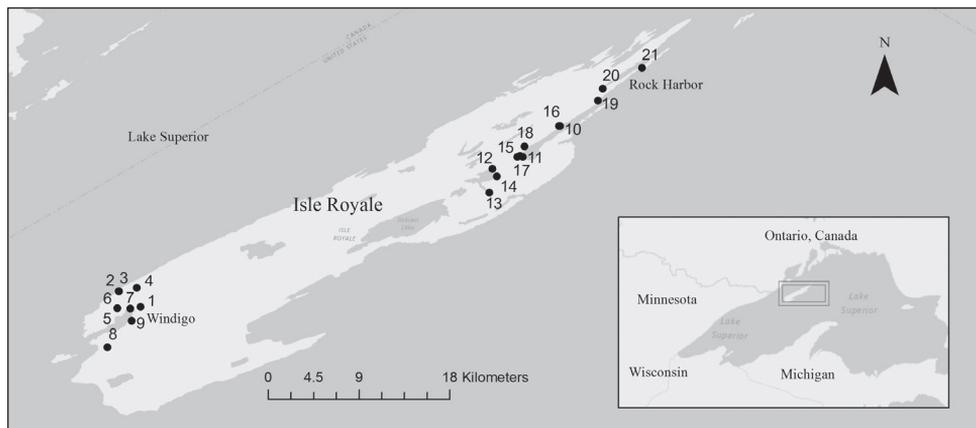
Little is known of the aquatic insects inhabiting the shores, streams, and lakes of ISRO (Bick et al. 1985). At least three ecological studies including aquatic insects have been conducted, but these involved sampling of larvae and genus level identification only, representing government literature and university theses that have not been published (Bowden 1981, Johnson 1980, Toczydlowski et al. 1979). A relatively few specimens of aquatic insects are known from regional museums (DeWalt unpubl. data).

The isolated nature of ISRO and lack of roads on the island make it logistically difficult to inventory. The island may be reached by ferry, personal watercraft, or by plane. It is undeveloped with the exception of a few locations, Windigo in the southwest and Rock Harbor in the northeast (Fig. 1). Waterbodies must then be accessed by foot or by Park Service boat. Few systematic entomologists have visited ISRO due to the expected depauperate nature of the fauna, though some species that currently live on the island will be of interest since they represent relict populations at the southernmost edge of their range. Another reason for studying aquatic insects at ISRO is to understand which species are capable of colonizing the island. Important questions include what species traits allowed them to colonize successfully, and potentially what sources and routes were involved in the colonization.

Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (EPT species) are environmentally sensitive aquatic insects that are routinely used in monitoring of water quality. Their taxonomy and distribution are relatively well known in the Midwest (Burks 1953, DeWalt et al. 2005, DeWalt et al. 2012, DeWalt and Grubbs 2011, Frison 1935, Grubbs et al. 2013, Houghton 2012, Randolph and McCafferty 1998, Ross 1944). This makes EPT an appropriate target for inventories on ISRO.

The EPT species currently living on ISRO most certainly arrived through one or more of several means: direct flight, drifting with debris, as stowaways on boats, or were already present in the lake. Sources of colonization are streams and lakes along the shoreline of Lake Superior in Michigan, Minnesota, Ontario, and Wisconsin. We are assuming that most species would have flown to the island from mainland shoreline sources and that smaller insect species would arrive and establish in greater frequency than larger ones.

Recent work by DeWalt and colleagues has created a 200,000 record EPT specimen dataset within a seven state area of the Midwest, USA. These data have recently



**Figure 1.** Sampling locations on Isle Royale National Park, Michigan, USA, during 2013. Points and numbers indicate sample locations as defined in Table 1.

been used to model the historical distributions of stoneflies (Cao et al. 2013) and through the 21<sup>st</sup> century (DeWalt, unpubl. data). This data set, some recently published records (Houghton 2012), and unpublished data (Klubertanz, pers. comm.) may be used as a tool to build a regional species pool for comparison with ISRO.

The results of our effort to document the EPT species inhabiting the main island of ISRO during 2013 are presented. We hypothesize that the number of EPT species on ISRO is less than that found on the mainland surrounding Lake Superior. In addition, we hypothesize that the size of adult EPT species present on ISRO is smaller than that found on the mainland, suggesting that smaller species are more likely to colonize the island from mainland sources, presumably using prevailing winds.

## Methods

*Inventory.* Inventory of EPT taxa took place over two four-day forays in June and July 2013 (Table 1). Two areas of the island were investigated near access points for ferry service. Our June efforts were concentrated on Lake Superior shorelines and small streams near Windigo in southwestern ISRO (sites 1–9, Table 1, Fig. 1). July efforts concentrated on the same habitats from Rock Harbor in northeastern ISRO to the west end of Moskey Basin (sites 10–21).

Sampling of EPT was conducted in the same manner at each site and continued until no apparently novel taxa were found at a site. Collection of adults was prioritized since species level identification is most straightforward in this life stage. One of the most useful sampling devices for adult EPT ISRO was the beating sheet. The sheet was placed under vegetation at streamside or lakeside and adults dislodged to the sheet. This method was particularly effective when air temperatures were cool, limiting flight of insects after disturbance. Warmer conditions necessitated the use of an aerial



sweepnet. Immature EPT were collected using a rectangular dipnet and by handpicking from substrates. The accumulated debris were examined using a white plastic tray and stream water. All EPT specimens were fixed in 95% EtOH. Non-target taxa were released after sorting. The use of ultraviolet light traps was not possible during either of the two visits due to the low early evening air temperatures.

Specimens were identified to the lowest possible taxonomic level, using current literature, and accessioned into the INHS Insect Collection (INHS-IC). These data are available from the INHS-IC database (<http://inhsinsectcollection.speciesfile.org/InsectCollection.aspx>). Raw specimen data in the form of an Excel comma delimited file are attached as supplementary data.

The relationship between EPT species richness and the number of specimens collected per site was investigated using simple linear regression. This analysis was conducted on untransformed data using VassarStats (Lowry 2015) an internet based statistical package. Data from three samples (sites 12–14 of Table 1) were excluded from this analysis because they were considered incomplete.

*Comparison of ISRO EPT to Mainland.* The mainland list of EPT species was compiled from specimen records whose locations included the Lake Superior border counties of Michigan, Minnesota, and Wisconsin and streams that drained into Lake Superior from Ontario west of  $-84.3^{\circ}$  longitude and south of a line delimited by  $49.3^{\circ}$  latitude. Specimen data were pulled from the INHS-IC database, several other databases compiled by the senior author from 25 region museums, a regional treatment of mayflies (Randolph and McCafferty 1998), additional mayfly records (T. Klubertanz unpubl. data), and other recent literature (Houghton 2012, Blahnik and Holzenthal 2014, Sun and McCafferty 2008). Some of these data are unpublished, so the species list for the mainland is withheld at the owner's request. The ISRO list was compared directly to the mainland list.

*Size of ISRO EPT Species Versus Mainland.* Size of specimens was gathered from the literature, often from original species descriptions. Most useful was the Biodiversity Heritage Library, which has made access to older literature efficient. The measure of size varied greatly between sources. Forewing length was preferred, but often body length was the only measure presented. In some of the oldest literature (e.g., Walker 1852), measurements were provided in "lines". There is no accepted scale for conversion of lines to mm, but a conversion of British lines to 2.12 mm has been offered through <http://www.convertunits.com/from/line/to/mm>. We have applied this conversion to all line measurements and the resultant sizes agree with congeners measured in mm. For all but the largest of EPT species, body length appeared to be a suitable approximation of forewing length. In some instances, no adult measures were available, so length of mature larvae was recorded or measures from species in the same genus were used. Ranges of sizes were often presented in literature sources and were recorded as both minimum and maximum size. Admittedly, some error exists in the sizes recorded, but this appears to be the best that can be done without actually measuring replicates of several hundred species. Literature sources and the type of measure were recorded for all species. Those who wish to use the data set may request a copy from the senior author.

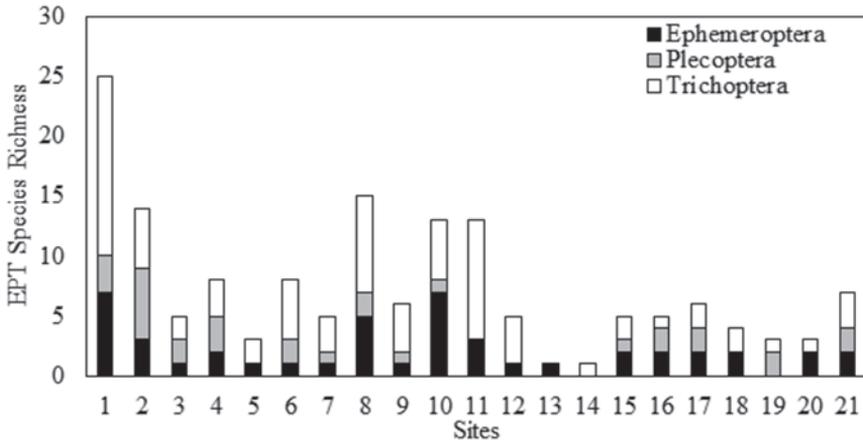
Since we were only assured of a minimum size across the entire data set, this was the measure used for comparative purposes. Both integer and decimal values were present in the literature, so all were converted to the integer form of the value to simplify analysis. Frequency histograms with size classes from 1 to 34 mm were compared for mainland and ISRO species. A Kruskal-Wallis  $k=3$  analysis of ranked data was conducted to compare sizes of orders of EPT on the mainland and on the ISRO (Sokal and Rohlf 1981). In addition, a Mann-Whitney U-test was conducted on mainland versus ISRO adult size for each order (Sokal and Rohlf 1981). All tests of significance were run using Lowry (2015).

## Results

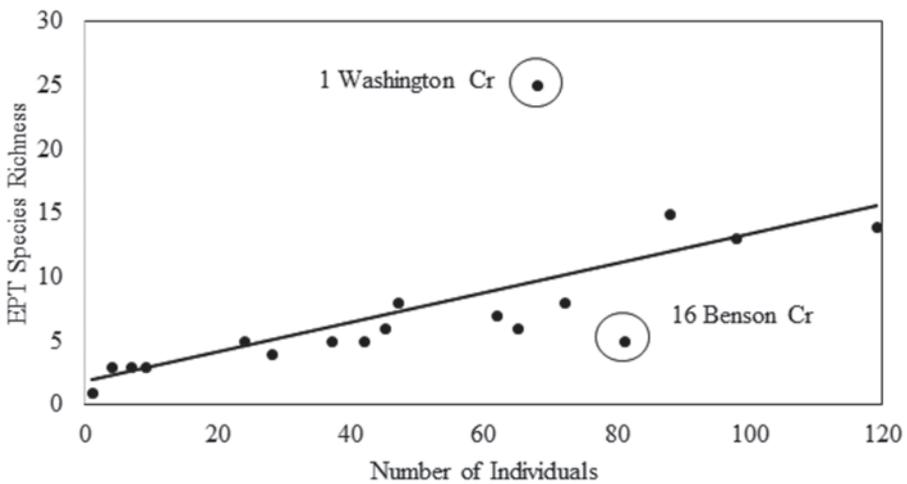
*ISRO EPT Richness and Comparison to Mainland.* Twenty-nine samples were collected from ISRO during 2013, representing 21 locations from opposite ends of the island (Fig. 1, Table 1). These samples produced 983 specimens representing 73 species of EPT (Table 2). The vast majority of EPT species were caddisflies, contributing 42 of the 73 species reported. Mayflies contributed 22 species, while stoneflies contributed only nine. Site EPT richness varied dramatically (Fig. 2). The EPT species richness for completely sampled sites was a linear function of the number of individuals found at the site (simple linear regression,  $R^2=0.45$ ,  $p=0.002$ ,  $n=18$ , Fig. 3). Washington Creek departed greatly from the line-of-best fit (Site 1 of Table 1, Fig. 3). This 5 m wide trout stream is much more diverse compared to other streams sampled during this project, supporting 25 EPT species from a relatively modest number of specimens. The similarly sized Grace Creek (Site 8, Fig. 2) produced only 15 EPT species. Other relatively diverse sites were Lake Superior shorelines at Huginnin Cove (Site 2), Daisy Farm Campground (Site 10), and at Moskey Bay Campground (Site 11). Benson Creek (Site 16 of Table 1) under performed versus predicted richness. This 2 m wide stream produced just five EPT species including two mayflies, two stoneflies, and one caddisfly (Table 2, Fig. 2). Mainland richness was much higher than that found on ISRO, confirming our hypothesis. This trend held for each order sampled, with 417 EPT species being recorded from mainland specimen and literature sources (Fig. 4).

Species richness was predictable in relation to waterbody type and stream size. Streams 1–2 m wide supported a limited EPT fauna, averaging 5.3 species with narrow variability (Fig. 5). Larger streams supported many more species with much higher variation. Lake Superior shorelines, including areas open to the fetch of the lake and those in large protected bays, produced on average 10 EPT species, with relatively low variability.

Most EPT species found on ISRO were rarely encountered, 51 of them being present in only one or two samples of 26 complete samples (Fig. 6). A relatively few species may be considered common on ISRO since they were found in  $>4$  samples. Among these were five species: the caddisfly *Neophylax concinnus* McLachlan, 1871 and the stoneflies *Amphinemura palmeni* (Koponen, 1917), *Leuctra ferruginea* (Walker, 1852), *Nemoura trispinosa* Claassen, 1923, and *Haploperla brevis* (Banks, 1895).



**Figure 2.** Ephemeroptera, Plecoptera, and Trichoptera species richness recovered from Isle Royale National Park sites during 2013. Site numbers correspond to those in Table 1.



**Figure 3.** Relationship of Ephemeroptera, Plecoptera, and Trichoptera species richness to the number of individuals found at 18 sites where full samples were taken on Isle Royale National Park, 2013. Circled points indicate sites that had higher and lower than predicted richness. Diagonal is line-of-best-fit.

We were unable to produce reliable predictions of EPT species richness for ISRO with the number of complete samples at hand. Cumulative richness from complete samples yielded 68 species (Fig. 7). Five additional species from three incomplete samples bring the total to 73 species.

*Size of ISRO EPT Species Versus Mainland.* Mainland EPT were significantly different in size across orders (Kruskal-Wallis,  $H=13.9$ ,  $df=2$ ,  $p=0.0009$ ), with stoneflies having the largest average size at 11.13 mm (Fig. 8). Alternatively, EPT size on ISRO

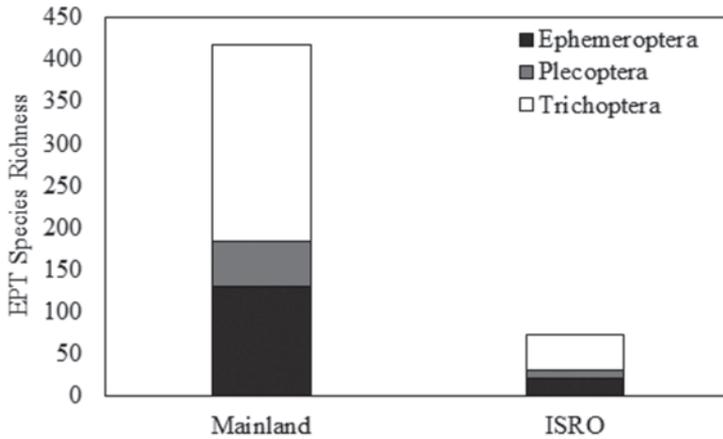




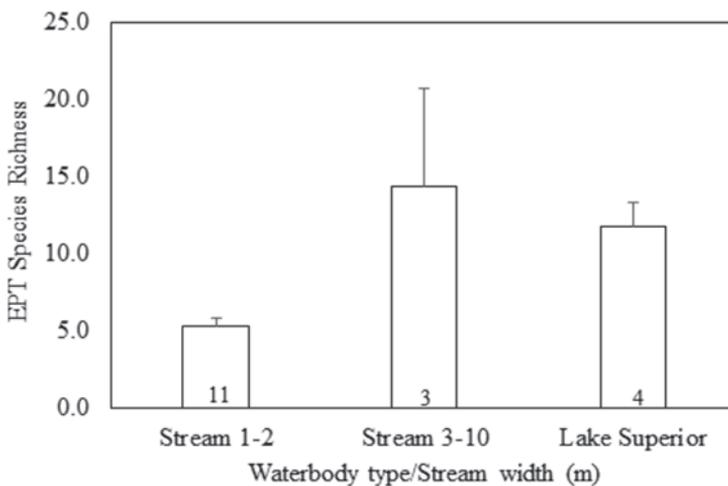
Taxon ↓	Site Number →	1	2	3	4	5	6	7	8	9	10	11	12*	13*	14*	15	16	17	18	19	20	21	Σ
<b>Helicopsychidae-snailcase caddisflies</b>																							
<i>Helicopsyche borealis</i> Hagen, 1861		0	0	0	0	0	0	0	0	0	3	22	0	0	0	0	0	0	0	0	0	0	25
<b>Hydropsychidae-net-spinning caddisfly</b>																							
<i>Chematopsyche</i> sp.		1	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	13
<i>Hydropsyche alhedra</i> Ross, 1939		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Hydropsyche alternans</i> Walker, 1852		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6
<i>Hydropsyche betteni</i> Ross, 1938		0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
<i>Hydropsyche bronita</i> Ross, 1938		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Hydropsyche slossonae</i> Banks, 1905		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Hydropsyche morosa</i> group		6	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	9
<i>Parapsyche apicalis</i> (Banks, 1908)		0	0	0	0	0	7	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	20
<b>Hydroptilidae-microcaddisflies</b>																							
<i>Hydroptila</i> sp.		1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3
<i>Ochrotrichia</i> sp.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Oxyethira</i> sp.		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<b>Lepidostomatidae-lepidostomatid casemaking caddisflies</b>																							
<i>Lepidostoma togatum</i> Hagen, 1861		0	0	0	0	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	0	8
<i>Lepidostoma</i> sp.		0	1	9	5	0	3	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	21
<b>Leptoceridae-longhorned caddisflies</b>																							
<i>Mystacides interjecta</i> (Banks, 1914)		0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	7
<i>Mystacides sepulchralis</i> Walker, 1852		0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	19
<i>Oecetis avana</i> Banks, 1895		7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
<i>Oecetis cinerascens</i> Hagen, 1861		0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
<i>Oecetis osteni</i> Milne, 1934		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
<i>Oecetis</i> sp.		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Triadenodes injustus</i> Hagen, 1861																							
<i>Triadenodes nox</i> Ross, 1941		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
<b>Limnephilidae-northern casemaking caddisflies</b>																							
<i>Anabolia consocia</i> (Walker, 1852)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2

Taxon ↓	Site Number →	1	2	3	4	5	6	7	8	9	10	11	12*	13*	14*	15	16	17	18	19	20	21	Σ
<i>Anabolia sordida</i> Hagen, 1861		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Anabolia</i> sp.		1	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	2	0	0	0	6
<i>Hesperophylax designatus</i> Walker, 1852		0	0	0	0	0	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
<i>Ironoquia parvula</i> Banks, 1900**		0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
<i>Limnephilus moestus</i> Banks, 1908		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
<i>Limnephilus parvulus</i> Banks, 1905		0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
<i>Limnephilus rhombicus</i> Linnaeus, 1758		4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
<i>Limnephilus</i> sp.		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Nemotaulius hostilis</i> Hagen, 1873		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
<i>Platycentropus nadius</i> Say, 1824		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<b>Molannidae-hoodcase making caddisflies</b>																							
<i>Molanna blenda</i> Sibley, 1926		3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	6
<i>Molanna flavicornis</i> Banks, 1914		0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	8
<i>Molanna</i> sp.		0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	3
<b>Philopotamidae-fingernet caddisfly</b>																							
<i>Chironna</i> sp.		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Dolophlodes distincta</i> (Walker, 1852)		0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	9	0	0	0	10
<b>Phryganeidae-giant caddisflies</b>																							
<i>Agrypnia straminea</i> Hagen, 1873		0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	6
<b>Polycentropodidae-trumpetnet caddisflies</b>																							
<i>Nyctiophylax</i> sp.		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
<i>Plectrocnemia cinerea</i> Hagen, 1861		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Polycentropus</i> sp.		0	2	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
<b>Psychomyiidae-trumpetnet caddisflies</b>																							
<i>Psychomyia flavida</i> Hagen, 1861		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<b>Rhyacophilidae-predatory caddisflies</b>																							
<i>Rhyacophila vibox</i> Milne, 1936		2	0	0	0	0	0	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	10
<b>Thremmatidae-thremmatid stonecasc makers</b>																							
<i>Neophylax concinnus</i> McLachlan, 1871		4	1	8	0	0	10	9	3	5	2	0	0	0	0	6	0	0	0	0	0	0	48





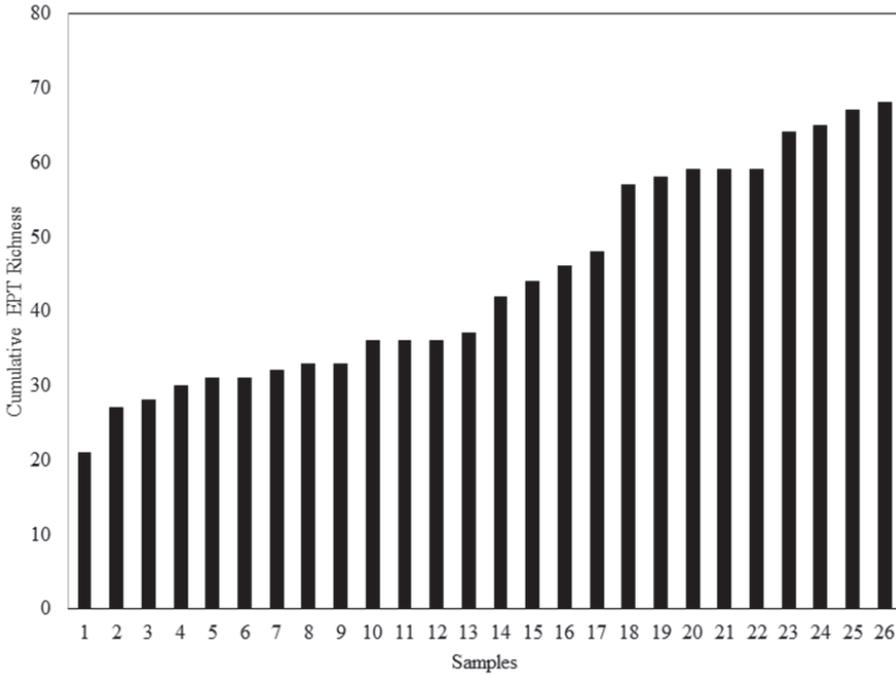
**Figure 4.** Comparison of Ephemeroptera, Plecoptera, and Trichoptera species richness for mainland around Lake Superior versus that found on Isle Royale National Park sites during 2013.



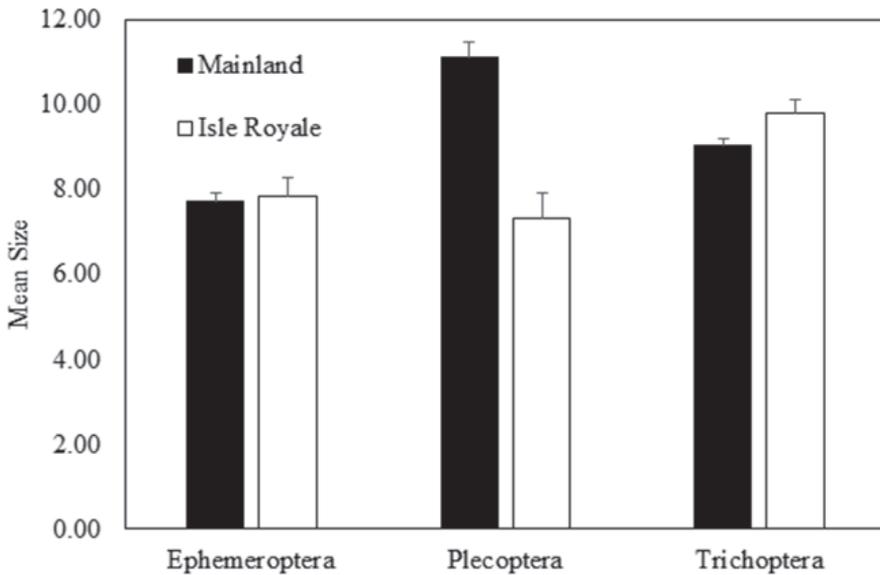
**Figure 5.** Mean site Ephemeroptera, Plecoptera, and Trichoptera species richness by waterbody type and stream size. Sites represented by incomplete samples excluded. Numbers in columns indicate number of sites. Error bars indicated standard error of the mean.

was not significantly different across orders, but the margin was close with the mean size of caddisflies being somewhat larger than other orders (Kruskal-Wallis,  $H=5.7$ ,  $df=2$ ,  $p=0.059$ ) (Fig. 8). With respect to comparisons between sources, mayfly species size between the mainland and ISRO was not significantly different (Mann-Whitney U-test,  $U=1403.0$ ,  $P(1)=0.44$ ,  $P(2)=0.89$ ). A frequency histogram demonstrates that sizes of mayflies overlapped greatly for mainland and ISRO sources (Fig. 9). Stonefly species were significantly smaller on ISRO than they were on the mainland (Mann-

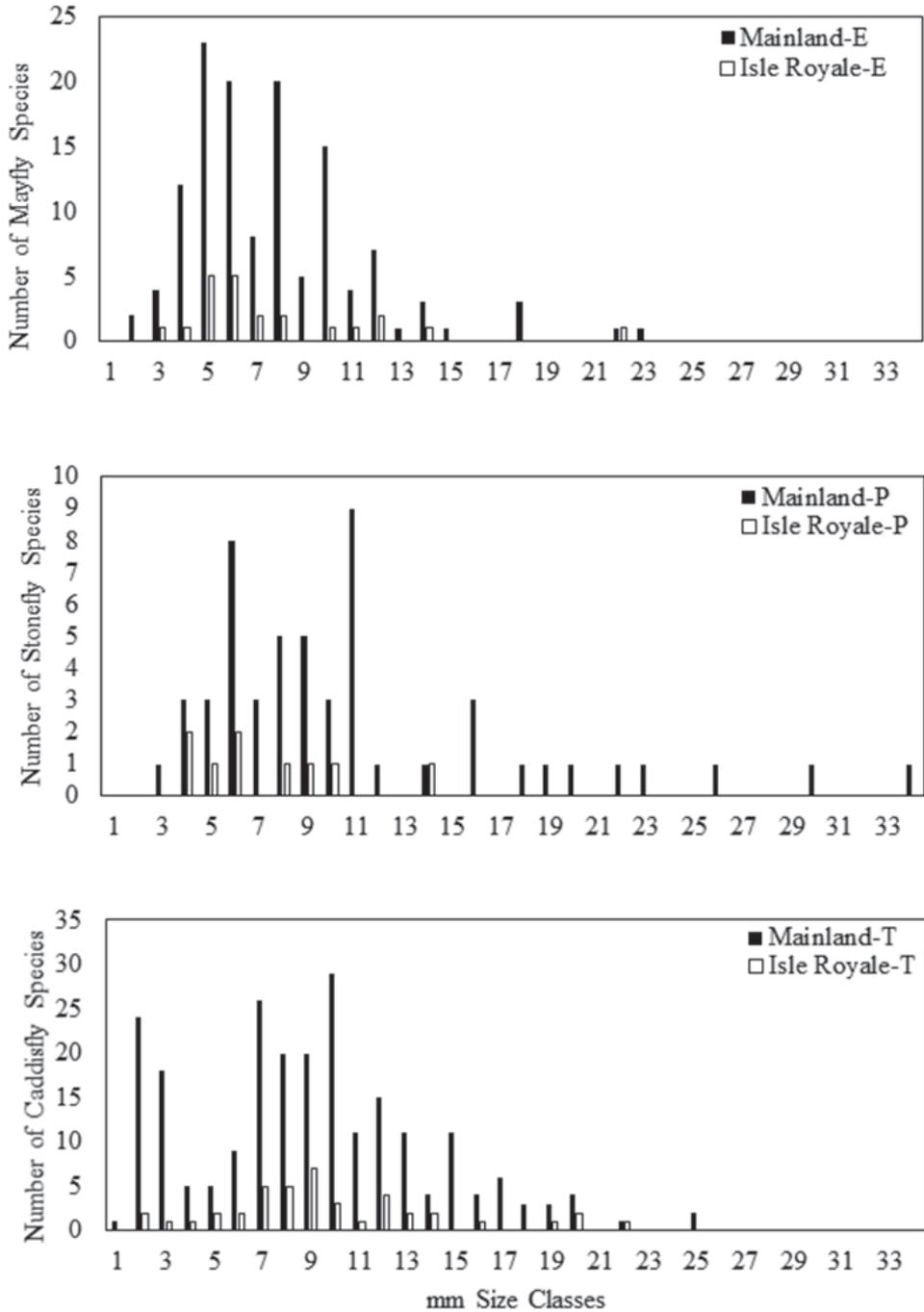




**Figure 7.** Cumulative Ephemeroptera, Plecoptera, and Trichoptera species richness generated from 26 complete samples collected from Isle Royale National Park, 2013.



**Figure 8.** Mean and standard error of minimum size of Ephemeroptera, Plecoptera, and Trichoptera for species inhabiting the Lake Superior mainland and species sampled from Isle Royale National Park lakeshore and streams.



**Figure 9.** Size frequency histogram of Ephemeroptera (E), Plecoptera (P), and Trichoptera (T) species inhabiting Lake Superior mainland and species sampled from Isle Royale National Park lakeshore and streams.

Whitney U-test,  $U=149.5$ ,  $P(1)=0.034$ ,  $P(2)=0.067$ ). Mainland stonefly species ranged 3–34 mm in size, while on ISRO, they ranged 4–14 mm (Fig. 9). Caddisfly species size was not significantly different between sources (Mann-Whitney U-test,  $U=5231.0$ ,  $P(1)=0.239$ ,  $P(2)=0.478$ ) with the size distribution of the two sources being nearly identical (Fig. 9).

## Discussion

Aquatic resources on ISRO, with the current state of sampling, support only 17.5% of the EPT species found on the mainland surrounding Lake Superior (Fig. 4). Since the number of species found in only one or two samples is large (Fig. 6) and the accumulation of species has a steep curve (Fig. 7), we assume that this proportion will rise with greater effort. However, we still expect that <50% of the mainland species will be recovered from ISRO. Caddisflies seemed to be the most effective colonizers of the island, their observed richness being nearly 57.6% of the EPT species recorded to date (Fig. 4). On the other hand, stoneflies seem to be ill suited for traversing the distance from the mainland to ISRO. However, those that colonized ISRO often occurred at many sites (Fig. 6) and often in high abundance.

Small streams on ISRO supported low EPT species richness, while the number of species climbed dramatically in larger streams (Fig. 5). It is probable that many of these small streams freeze into the streambed during the winter, leaving only a few hardy species with egg diapause to overwinter. The larger, species rich streams must continue flowing during winter. Caddisflies and mayflies were most responsible for the increase in species richness of larger streams. Interestingly, Washington and Grace creeks, though being of nearly identical size and gradient, and being geographically close, were quite different in assemblage composition with a Sorensen's Index of Similarity being only 38%.

The shores of Lake Superior supported a moderate diversity of EPT with low variability in the number of species. The communities varied greatly between cold beaches exposed to the fetch of the lake and the protected bays. Exposed lake shores produced many more stoneflies than protected bays, presumably due to the colder water. Caddisflies and mayflies were much more species rich in the protected bays.

*Body Size as a Predictor of ISRO EPT.* Others have studied the evolution of body size of vertebrates on isolated islands as a function of food quality, island area, and interactions with other species (Boyer and Jetz 2010). We are focusing on size as a factor important only in the initial colonization of aquatic insects to ISRO. We suggest that large species may not colonize ISRO successfully and that small species would have an advantage since they could use updrafts from Minnesota, Ontario, or the Keweenaw Peninsula of Michigan to reach ISRO. We have found that the assemblage of stoneflies on ISRO support this hypothesis since they were significantly smaller than on the mainland (Fig. 9). The two largest stonefly species on ISRO, *I. bilineata* (Say,

1824) (9–9.5 mm) and *A. dichroa* (McLachlan, 1872) (14–15 mm), occurred in the lake and presumably have used it to colonize the island. Stoneflies are often considered poor fliers (Stewart and Stark 2002), although there is little direct evidence for this. Malmqvist (2000) found that wing length was positively related to range size and that species with short wings were most likely to be rare and isolated on the landscape. One the mainland, 10–20 large species in the families Perlodidae, Perlidae, and Pteronarcyidae may be present in the same stream. Stoll et al. (2014) found that the presence of fish in the regional species pool was a most important determiner of colonization of restored stream reaches. We suggest that the distance and disruption of normal habitat, e.g. the lake, for larval and adult stonefly species limits most large species from reaching ISRO. One mechanism for limiting flight of large stoneflies is that they fly with the body inclined at a 25–45° angle, conferring considerable drag during flight (DeWalt pers. obs.). The complete absence of truly large stoneflies on ISRO suggests that larger stonefly species do not have the energy reserves or aerodynamics to fly or draft the long distances from the mainland to ISRO.

Mayflies and caddisflies do not support the hypothesis that smaller species are more likely to colonize ISRO (Figs 8, 9). Mayfly wing length has been demonstrated to be positively related to range size, a trait that would increase the possibility of them flying from mainland to ISRO (Malmqvist 2000). Mayflies and caddisflies are generally thought of as stronger fliers than stoneflies. Indeed, anecdotal evidence from weather radar supports the idea that large, burrowing mayflies in the genus *Hexagenia* (Ephemeroidea) fly considerable distances equivalent to that that isolates ISRO from the mainland (Washington Post 2014). The body axis orientation of mayflies and caddisflies is more horizontal during flight; presumably, more power is transferred to forward motion without the drag that stoneflies endure. In addition, an unknown number of mayfly and caddisfly species included in the ISRO taxa list certainly occur within Lake Superior. This would make the habitat from mainland to ISRO more continuous and allow more species of both orders to reach the island. Of course, examination of many more species traits is necessary to determine which factors are most important to the postglacial recolonization of ISRO by all three groups.

*Taxa of Significance.* Most species reported herein have never been reported in the literature from the ISRO and represent a leap in knowledge of the species of aquatic insects that inhabit the park. Some species were of particular interest because of their rarity in the region, their being new state records, or because they have been known in the region under different names until recently. We present an annotated list of those species.

## Ephemeroptera

*Acerpenna macdunnoughi* (Ide, 1937). Several records exist for small streams in Marquette County, Michigan (Randolph and McCafferty 1998) and nowhere else in the state. It was found in both Washington (Site 1) and Grace creeks (Site 8), the latter in abundance.

*Baetis bundyae* Lehmkuhl, 1973. This boreal/tundra species has not been reported from Michigan before (Randolph and McCafferty 1998), but is known from nearby northeastern Minnesota (Lager et al. 1982). This coldwater species was found in a two locations: Huginnin Creek at Huginnin Cove (Site 3) and at a nearby unnamed tributary to Lake Superior (Site 4). This area is kept cold by the lake breezes, producing a southern refuge for the species.

*Callibaetis ferrugineus* (Walsh, 1862). This is the first record of the species for upper Michigan (Randolph and McCafferty 1998). Two nymphs were taken from the outlet of Lake Richie (Site 12) along the Indian Portage Trail.

*Neocloeon triangulifer* (McDunnough, 1931). This species, under the name *Centroptilum triangulifer* (McDunnough, 1931), was only recently added to the Michigan mayfly list, the new records being from Baraga and Marquette counties in the Upper Peninsula (McCafferty 2009). Jacobus and Wiersema (2014) recently moved this species to *Neocloeon*. A large population was taken from the flooded mouth of a small tributary to Lake Superior near Moskey Basin Campground (Site 18).

*Paraleptophlebia praepedita* (Eaton, 1884). This has been rarely collected from Michigan, and only in the lower third of the state (Randolph and McCafferty 1998). It was taken from several tributaries to Moskey Basin (Sites 15-18). This is the first record of the species in northern Michigan.

*Siphonurus phyllis* McDunnough, 1923. This species has never been reported from the state (Randolph and McCafferty 1998). Its presence represents a new state record.

## Plecoptera

*Capnia vernalis* (Newport, 1851). This species is rare in the region. It was found only at the Lake Superior shoreline at Huginnin Cove (Site 2).

*Amphinemura palmeni* (Koponen, 1917). It is not surprising that this species was found on ISRO. We have listed it here to call attention to a relatively recent synonymy that has occurred. Probably hundreds of specimens exist in North American collections using the name *A. linda* (Ricker, 1952), a junior synonym (Boumans and Baumann 2012). This is apparently the only *Amphinemura* on the island and was found at five small streams (Sites 4, 15–17, 19).

*Arcynopteryx dichroa* (McLachlan, 1872). This Holarctic species is another rarity, being known only from the shores of Lake Superior in the region (Grubbs and Bright 2001). Until recently it was known as *A. compacta* (McLachlan, 1872), but all Nearctic specimens under that name are now referable to *A. dichroa* (Teslenko 2012).

## Trichoptera

*Apatania zonella* Zetterstedt, 1840. This is a new state record for Michigan. Leonard and Leonard (1949) did not report it for the state, but it has been collected from

Lake Superior shores in nearby Minnesota. We collected it from shoreline samples at Daisy Farm Campground (Site 10) and Rock Harbor (Site 21).

*Ironoquia parvula* Banks, 1900. This too is a new state record for Michigan. We collected two of the distinctive (Flint 1960) larvae from a small, white cedar swamp (site 5).

## Acknowledgments

We wish to thank Ryan Maki of the National Park Service, Isle Royale National Park for permits to sample ISRO and for agreeing to wave fees to enter the park. We also thank the following colleagues for providing unpublished data from which to develop the EPT regional species pool available to ISRO for colonization: Dr. Tomas Kluber-tanz, University of Wisconsin-Rock County; Dr. David Houghton, Hillsdale College, Hillsdale Michigan; Dr. Patrick Randolph, University of California, Davis. The compilation of specimen databases was partially funded by the following grants: USA NSF DEB 09-18805 ARRA and a USA DOI-USFWS X-1-R-1.

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## Supplementary material I

### Table S1. Raw specimen data in the form of an Excel comma delimited file

Authors: R. Edward DeWalt, Eric. J. South

Data type: occurrence

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