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Five new species of the *Stenus indubius* group (Coleoptera, Staphylinidae) from China

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Abstract

Five new species of the *Stenus indubius* group from China are described: *S. cangshanus* **sp. n.** from Yunnan Province, *S. hewenjiae* **sp. n.** from Sichuan Province, *S. taiyangshanus* **sp. n.** from Guangdong Province, *S. yinziweii* **sp. n.** and *S. zhaiyanbini* **sp. n.** from Guizhou Province. Diagnostic characters are illustrated and a key to the species of this group from the Chinese mainland is provided.

Keywords

Coleoptera, Staphylinidae, *Stenus indubius* group, identification key, new species, China

Introduction

Stenus indubius group is a medium Asian group comprising 26 Japanese species (see Naomi 2006, also for a group definition) and ten Chinese species: *S. guniujiangense* Tang & Li, 2005 and *S. paradecens* Tang & Li, 2005 from Anhui Province, *S. zhuxiaoyui* Tang, 2008, *S. pectorifossatus* Tang, 2008 and *S. erlangshanus* Tang, 2008 from Sichuan Province, *S. hui* Tang & Puthz, 2009 from Shaanxi Province, *S. electristigma*

Puthz, 2011, *S. shibatai* Puthz, 2011, *S. shibataianus* Puthz, 2011 and *S. shibataiellus* Puthz, 2011 from Taiwan.

All hitherto known members from the Chinese mainland of the group are brownish to blackish and brachypterous. In this paper, we describe five new species of the group collected in various mountainous areas in South China, three of them with orange spots on elytra, a character also present in Taiwanese species of this group Puthz (2011).

Material and methods

The specimens examined in this paper were collected by sifting leaf litters in forests and killed with ethyl acetate. For examination of the male genitalia, the last three abdominal segments were detached from the body after softening in hot water. The aedeagi, together with other dissected pieces, were mounted in Euparal (Chroma Gesellschaft Schmidt, Koengen, Germany) on plastic slides. Photos of sexual characters were taken with a Canon G7 camera attached to an Olympus SZX 16 stereoscope; habitus photos were taken with a Canon macro photo lens MP-E 65 mm attached to a Canon EOS40D camera.

The type specimens treated in this study are deposited in the following public and private collections:

NMB Museum of Natural History Basel, Switzerland
NSMT National Museum of Nature and Science, Tokyo
SHNU Department of Biology, Shanghai Normal University, P. R. China
SMNS Staatliches Museum für Naturkunde Stuttgart, Germany
cKish private collection T. Kishimoto, Tokyo
cPut private collection V. Puthz, Schlitz, Germany
cSch private collection M. Schülke, Berlin
cSmet private collection A. Smetana, Ottawa
cWat private collection Y. Watanabe, Tokyo

The measurements of proportions are abbreviated as follows:

BL body length, measured from the anterior margin of the clypeus to the posterior margin of abdominal tergite X
FL forebody length, measured from the anterior margin of the clypeus to the apex of the elytra (apicolateral angle)
HW width of head including eyes
PW width of pronotum
EW width of elytra
PL length of pronotum
EL length of elytra, measured from humeral angle
SL length of elytral suture

Taxonomy

Key to the species of the *Stenus indubius* group from mainland China

1 Pronotum without median longitudinal furrow; elytra with surface weakly uneven; punctation of pronotum and elytra well delimited; abdominal segments IV–VI with tergites and sternites completely fused without joint suture (*Hypostenus*) **2**

– Pronotum with median longitudinal furrow; elytra with surface very uneven; punctation of pronotum and elytra more or less rugose and confluent; abdominal segments IV–VI with tergites and sternites distinctly separated (*Hemistenus*) **3**

2 Body size larger (BL: 4.3–4.8 mm), elytra shorter (EL/EW =0.86–0.93). Habitus: Fig. 2 in Tang and Li (2005); sexual characters: Figs 7–10 in Tang and Li (2005) ..... ***S. guniujiangensis*** **Tang & Li, China: Anhui**

– Body size smaller (BL: 3.3–3.5 mm), elytra longer (EL/EW = 0.96–1.01). Habitus: Fig. 1 in Tang and Li (2005); sexual characters: Figs 3–6 in Tang and Li (2005) ..... ***S. paradecens*** **Tang et Li, China: Anhui**

3 Elytra bicolored with orange marks..... **4**

– Elyra unicolored without marks..... **6**

4 Body size smaller (BL: 3.8 mm, FL: 1.8 mm); elytra with vague orange marks. Habitus: Figs 5, 6; sexual characters: Figs 33–39..... .....***S. taiyangshanus*** **sp. n., China: Guangdong**

– Body size larger (BL ≥ 4.2 mm, FL ≥ 1.9 mm); elytral marks well delimited....**5**

5 Elytral marks larger, ranging from 3/5 to 4/5 as long as and 1/2 to 2/3 as broad as the respective elytron. Habitus: Figs 7, 8; sexual characters: Figs 40–50. BL : 4.3–4.7 mm.....***S. yinziweii*** **sp. n., China: Guizhou**

– Elytral marks smaller, ranging from 1/3 to 1/2 as long as and 1/3 to 2/5 as broad as the respective elytron. Habitus: Figs 9, 10; sexual characters: Figs 51–61. BL : 4.2–5.1 mm.....***S. zhaiyanbini*** **sp. n., China: Guizhou**

6 Head broader, 1.24 times as wide as elytra; punctation of head especially in lateral portion sparser, where interstices may be a little larger than half the diameter of punctures; pronotum with short median longitudinal furrow and vorticose rugae. Habitus: Figs 3, 4; sexual characters: Figs 22–32. BL : 3.6–4.2 mm.....***S. hewenjiae*** **sp. n., China: Sichuan**

– Head narrower, no more than 1.19 times as wide as elytra; punctation of head denser, interstices in lateral portion smaller than half the diameter of punctures; pronotum with short to very long median longitudinal furrow without distinct vorticose rugae **7**

7 Pronotum with very long median longitudinal furrow extending along all of midline; elytra as long as wide; punctation of abdominal tergites III–VIII extremely dense. Habitus: Fig. 1 a in Tang et al. (2009); sexual characters: Fig 2 a, Figs 3 a–c in Tang et al. (2009). BL : 3.8–4.7 mm..... .....***S. hui*** **Tang& Puthz, China: Shaanxi**

– Pronotum with median longitudinal furrow shorter, not extending along all of midline; elytra shorter than wide; punctation of abdominal tergites III–VII not extremely dense **8**

8 Punctation of head denser; pronotal and elytral punctation less rugose and less confluent; elytral disc relatively even with less distinct impressions and suture slightly convex. Habitus: Figs 1, 2; sexual characters: Figs 11–21. BL : 3.6–4.2 mm ..... ***S. cangshanus* sp. n., China: Yunnan**

– Punctation of head less dense; pronotal and elytral punctation more rugose and more confluent; elytral disc uneven with distinct, deep impressions and suture strongly convex **9**

9 Abdominal punctation denser, interstices on abdominal tergites III–VII distinctly smaller than half the diameter of punctures; posterior margin of male abdominal sternite VII without emargination. Habitus: Fig 2 in Tang and Zhao (2008); sexual characters: Figs 9–13 in Tang and Zhao (2008). BL: 4.0–4.2 mm ..... ***S. pectorifossatus* Tang, China: Sichuan**

– Abdominal punctation sparser, interstices on abdominal tergites III–VII smaller than half the diameter of punctures; posterior margin of male abdominal sternite VII with slight median emargination **10**

10 Body larger (BL: 3.8–4.2 mm); median longitudinal furrow and impressions on pronotum very deep. Habitus: Fig 3 in Tang and Zhao (2008); sexual characters: Figs 14–18 in Tang and Zhao (2008) .... ***S. erlangshanus* Tang, China: Sichuan**

– Body smaller (BL: 3.0–3.7 mm); median longitudinal furrow and impressions on pronotum relatively shallow. Habitus: Fig 1 in Tang and Zhao (2008); sexual characters: Figs 4–8 in Tang and Zhao (2008)..... ..... ***S. zhuxiaoyui* Tang, China: Sichuan**

***Stenus cangshanus* Tang & Li, sp. n.**
urn:lsid:zoobank.org:act:CA82E0DC-0E4E-4299-A495-4D8658871B53
http://species-id.net/wiki/Stenus_cangshanus
Figs 1, 2, 11–21

Type material. Holotype. China: Yunnan: male, glued on a card with labels as follows:"China: Yunnan Prov., Dali City, Cang Shan, alt. 2300 m, 10.VII.2010, Liang TANG Leg." "Holotype / *Stenus cangshanus* / Tang & Li" [red handwritten label] (SHNU). **Paratypes.** 3 males and 5 females, same data as for the holotype (SHNU); 1 female, Dali, 1600–2000 m, 5–8.VII.1990, L. & M. Bocák (NMB); 1 female, Cangshan mountains, 25.38N, 100.09E, 2600–3100m, 5–6.VI.1993, Vít Kubán (NMB); 1 female, Dali, Cangshan mountains, 2700 m, 17.VII.1995, Bolm (NMB); 1 male, 1 female, Laohu Shan, 2200 m, Dali Shi, 3.IX.1992, Y. Watanabe (cWatanabe, cPut); 1 male, Zhonghe Feng 2200 m, Diancang Shan Mts., Dali Shi, 4.IX.1993, Y. Watanabe (cWatanabe); 1 male, Zhonghe Feng, 2540 m, Diancang Shan Mts, 28.X.1995, S.

Figures 1, 2. Habitus of *Stenus cangshanus* in dorsal and ventral view. Scale = 1 mm.

Uéno & N. Xiao (cWat); 1 female, above Dali, 2700–2900 m, 14.IV.1999, W. Schawaller (SMNS); 4 males, Dali Bai Nat. Aut: Pref., Diancang Shan, 4 km W Dali old town,, 25°41.4'N, 100°06.7'E, 2900–3000 m, E slope with devasted forest and old pine forest, mushrooms, 31.VIII.2003, M. Schülke (C03–20) (cSch, cPut); 3 males, 3 females, ibidem, 31.VIII.2003, A. Smetana (C143) (cSmet, cPut); 1 male, 1 female, 3 km W Dali, Diancang Shan, 25°41.1'N, 100°06.8'E, 2600–2650 m, 30.VIII.2093, A. Smetana (C 141) (cSmet); 1 male, 3 km W Dali, Diancang Shan, 2750 m, 25°41.1N, 100°06.8'E, 1.IX.2003, A. Smetana (C 144) (cSmet).

Description. Brachypterous; body blackish, anterior margin of labrum, antennae, maxillary palpi and legs yellowish brown.

BL: 4.2–4.8mm; FL: 2.0–2.2 mm.

HW: 0.84–0.94 mm, PL: 0.69–0.78 mm, PW: 0.66–0.73 mm, EL: 0.72–0.78 mm, EW: 0.77–0.87 mm, SL: 0.50–0.54 mm.

Head 1.07–1.12 times as wide as elytra; interocular area with deep longitudinal furrows, median portion convex, slightly extending beyond the level of inner eye margins; punctures round, partly confluent, slightly larger and sparser on median area than those near inner margins of eyes, diameter of large punctures about as wide as apical cross section of antennal segment II; interstices faintly reticulated, much smaller than half the diameter of punctures except those along the midline of the convex median portion, which may be as wide as diameter of punctures. Antennae, when reflexed, extending a little before posterior margin of pronotum; relative length of antennal segments from base to apex as 12.0: 7.5: 16.5: 10: 11: 7.5: 8: 5: 5.5: 6: 7.5. Paraglossa oval.

Pronotum 1.05–1.09 times as long as wide; disk uneven, with distinct median longitudinal furrow, two impressions in anterior half, transverse impression in the middle, and two impressions in posterior half; punctures rugose and confluent, of similar size as those of head; interstices reticulated, more or less smaller than half the diameter of punctures except those at the bottom of longitudinal furrow, which could be larger.

Elytra 0.89–0.93 times as long as wide, distinctly constricted at base; lateral margins, with slight concavity at about half, gently divergent posteriad; disk moderately uneven with distinct longitudinal humeral impression, distinct postero-lateral impression and long sutural impression, suture moderately convex; punctation and interstices similar to those of pronotum.

Legs with hind tarsi 0.72 times as long as hind tibiae, tarsomeres IV distinctly bilobed.

Abdomen cylindrical; distinct paratergites absent, but rudimentary lateral border present, tergites and sternites distinctly split at about posterior eighth; posterior margin of tergite VII with palisade fringe; punctures of abdominal tergites III–VIII round to elliptic, gradually becoming smaller posteriad; interstices smaller than half the diameter of punctures, with relatively faint microsculpture on tergites III–VII and distinct reticulation on tergites VIII–X.

Male. Sternite VII with inconspicuous emargination at middle of posterior margin and a shallow impression before it; sternite VIII (Fig. 11) with semi-circular emargination at middle of posterior margin; sternite IX (Fig. 12) with very long apicolateral projections, posterior margin less serrate; tergite X (Fig. 13) with posterior margin convex. Aedeagus (Figs 14, 15) robust; expulsion hooks (Fig. 17) relatively small; parameres extending a little beyond apex of median lobe, almost straight, swollen in apical third, with two groups of setae on inner side (Fig. 16): 5 apical setae and 9 subapical setae.

Female. Abdomen broader than that in male; sternite VIII (Fig. 18) inconspicuously prominent at middle of posterior margin; tergite X (Fig. 19) slightly broader than that of male; sclerotized spermatheca as in Figs 20, 21.

Distribution. China (Yunnan Province: Mt. Cang Shan).

Diagnoses. In general facies and body size, the new species resembles *S. hui* Tang, 2009, *S. pectorifossatus* Tang, 2008 and *S. erlangshanus* Tang, 2008, but it may be distinguished by the characters listed in the key, particularly by the different sexual characters.

Etymology. The specific name is derived from "Cangshan", the type locality of this species.

***Stenus hewenjiae* Tang & Li, sp. n.**
urn:lsid:zoobank.org:act:0C303377-2124-4D17-BC89-7488C496EAFB
http://species-id.net/wiki/Stenus_hewenjiae
Figs 3, 4, 22–32

Type material. Holotype. China: Sichuan: male, glued on a card with labels as follows:"China: Sichuan Prov., Mt. Emei, Xixiangchi, alt. 2100 m, 29.VII.2009, He & Tang Leg." "Holotype / *Stenus hewenjiae* / Tang & Li" [red handwritten label] (SHNU). **Paratypes.** 2 females, same data as for the holotype (SHNU); 1 female, Mt. Emei, Leidongping, 2400 m, 2.XI.1995, S. Uéno (cWat); 1 female, ibidem 2390 m, 4.X.1996, S. Nomura (NSMT); 1 male, ibidem 2310-2350 m, 5.X.1996, S. Nomura (NSMT); 1 female, Mt. Emei, above Xuedongping, 8.X.1997, T. Kishimoto (cKish).

Description. Brachypterous; head blackish, labrum, pronotum, elytra and abdomen dark brown, anterior margin of labrum, antennae, maxillary palpi and legs yellowish brown.

BL: 3.6–4.2mm; FL: 1.8–2.1 mm.

HW: 0.83–0.90 mm, PL: 0.67–0.73 mm, PW: 0.58–0.70 mm, EL: 0.65–0.71 mm, EW: 0.67–0.77 mm, SL: 0.49–0.54 mm.

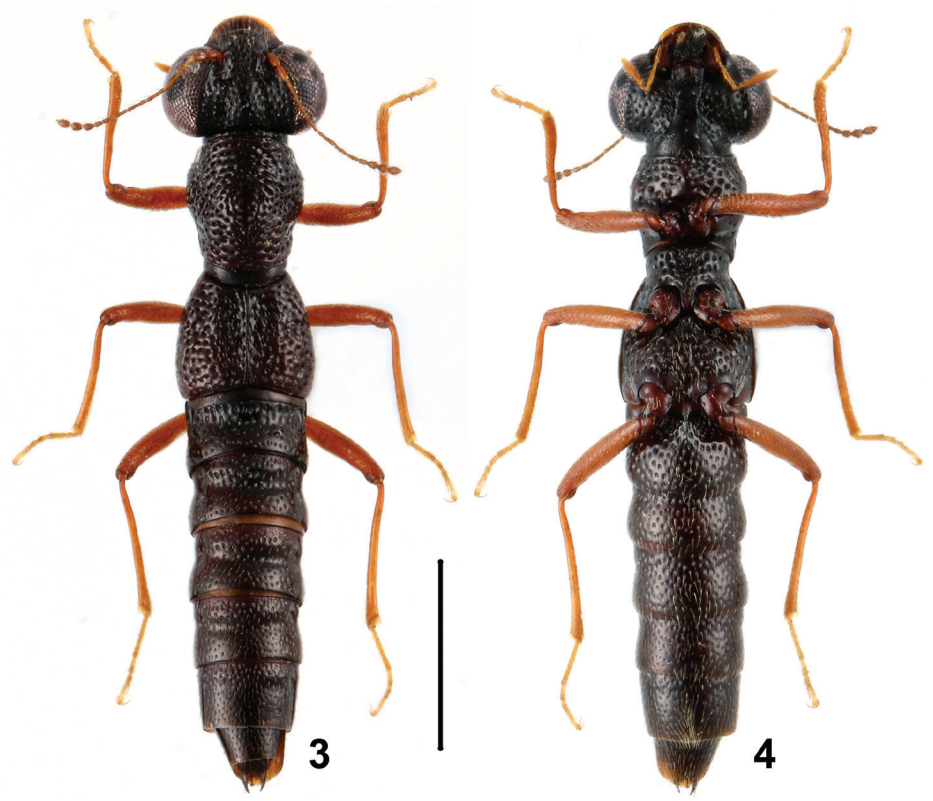
Head 1.18–1.24 times as wide as elytra; interocular area with deep longitudinal furrows, median portion convex, slightly extending beyond the level of inner eye margins; punctures round, mostly well delimited, slightly larger and sparser on median area than those near inner margins of eyes, diameter of large puncture about as wide as basal cross section of antennal segment II; interstices faintly reticulated, smaller than half the diameter of punctures except those along the midline of convex median portion and on the bottom of lateral furrows, which could be more or less larger. Antennae, when reflexed, extending a little before posterior margin of pronotum; relative length of antennal segments from base to apex as 10: 7.5: 15.5: 9.5: 9: 6: 6: 4: 4.5: 5: 7.5. Paraglossa oval.

Pronotum 1.05–1.13 times as long as wide; disk uneven, with distinct short median longitudinal furrow, transverse impression each in anterior half and in the middle, and two indistinct impressions in posterior half; punctures of similar size as those of head, rugose and confluent, forming vorticose rugae surrounding the longitudinal furrow; interstices indistinctly microsculptured, more or less smaller than half the diameter of punctures except those on the bottom of longitudinal furrow, which may be larger.

Elytra 0.92–0.97 times as long as wide, distinctly constricted at base, lateral margins with slight concavity in the middle, gently divergent posteriad; disk uneven with long deep longitudinal humeral impression and sutural impression, indistinct posterolateral impression, suture strongly convex; punctation and interstices similar to those of pronotum.

Hind tarsi 0.69 times as long as hind tibiae, tarsomeres IV distinctly bilobed.

Abdomen cylindrical; distinct paratergites absent, but rudimentary lateral border present, tergites and sternites distinctly split at about posterior eighth; tergite VII with palisade fringe; punctures on abdominal tergites III–VIII round to elliptic, gradually



Figures 3, 4. Habitus of *Stenus hewenjiae* in dorsal and ventral view. Scale = 1 mm.

becoming smaller posteriad; interstices on tergites III–VI faintly microsculptured and on tergites VIII–X distinctly microsculptured.

Male. Sternite VII with posteromedian portion slightly flattened; sternite VIII (Fig. 22) with semicircular emargination at middle of posterior margin; sternite IX (Fig. 23) with very long apicolateral projections, posterior margin serrate; tergite X (Fig. 24) with posterior margin truncate. Aedeagus (Figs 25, 26) slender; expulsion hooks (Fig. 28) large; parameres extending distinctly beyond apex of median lobe, bisinuate, folded at apical third, with about 25 setae on inner side (Fig. 27).

Female. Abdomen broader than that in male; sternite VIII (Fig. 29) inconspicuously prominent at middle of posterior margin; tergite X (Fig. 30) slightly emarginated at posterior margin; sclerotized spermatheca as in Figs 31, 32.

Distribution. China (Sichuan Province: Mt. Emei Shan).

Diagnoses. This new species can be easily distinguished from allied species by the characters listed in key.

Comment. Dr. Puthz has a very similar (undescribed) species of the *indubius*-group from Mt. Emei, Leidongping.

Etymology. This species is named in honor of Ms. Wen-Jian He, wife of the first author, who collected some of the specimens of the new species.

***Stenus taiyangshanus* Tang & Li, sp. n.**
urn:lsid:zoobank.org:act:1116E69D-64A5-45DC-990C-DC42E20BEEA1
http://species-id.net/wiki/Stenus_taiyangshanus
Figs 5, 6, 33–39

Type material. Holotype. China: Guangdong: male, glued on a card with labels as follows:"China: Guangdong Prov., Longmen County, Taiyangshan Mt., 16.VIII.2010, Liang Tang leg." "Holotype / *Stenus taiyangshanus* / Tang & Li" [red handwritten label] (SHNU). **Paratype.** 1 female, same data as for the holotype (SHNU).

Description. Brachypterous; body blackish, anterior margin of labrum, antennae, maxillary palpi and legs yellowish brown, each elytron with a vague elongate orange spot near lateral side.

BL: 3.8mm (the length of the immature female paratype with strongly contracted abdomen is not included); FL: 1.8 mm.

HW: 0.78–0.83 mm, PL: 0.62–0.67 mm, PW: 0.56–0.60 mm, EL: 0.64–0.67 mm, EW: 0.64–0.71 mm, SL: 0.45–0.48 mm.

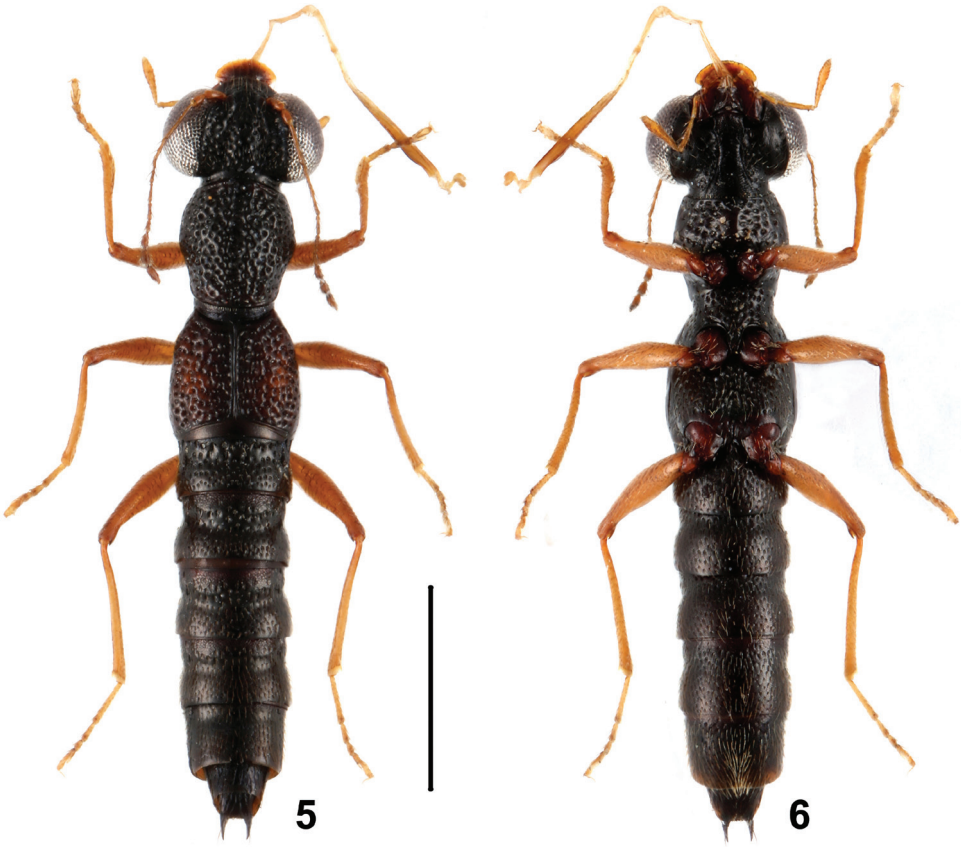
Head 1.17–1.23 times as wide as elytra; interocular area with deep longitudinal furrows, median portion convex, slightly extending beyond the level of inner eye margins; punctures round, partly confluent, slightly larger and sparser on median area than those near inner margins of eyes, diameter of large punctures about as wide as basal cross section of antennal segment II; interstices faintly reticulated, much smaller than half the diameter of punctures except those on vertex and behind basiantennal tubercles, which may be much larger. Antennae, when reflexed, extending a little after posterior margin of pronotum; relative length of antennal segments from base to apex as 11: 7: 16: 8.5: 10: 7.5: 7: 5: 5.5: 5.5: 9. Paraglossa oval.

Pronotum 1.10–1.12 times as long as wide; disk slightly uneven, with distinct median longitudinal furrow, two indistinct impressions in anterior half, indistinct transverse impression in the middle, and two indistinct impressions in posterior half; punctures moderately rugose and confluent, of similar size as those of head; interstices, especially those on the bottom of median longitudinal furrow distinctly reticulated, more or less smaller than half the diameter of punctures except those on the bottom of median longitudinal furrow, which may be larger.

Elytra 0.95–1.01 times as long as wide, distinctly constricted at base, lateral margins with slight concavity at about half, gently divergent posteriad; disk slightly uneven with shallow longitudinal humeral impression, shallow postero-lateral impression and shallow sutural impression, suture moderately convex; punctation and interstices similar to those of pronotum.

Hind tarsi 0.7 times as long as hind tibiae, tarsomeres IV distinctly bilobed.

Abdomen cylindrical; distinct paratergites absent, but rudimentary lateral border present; tergite VII with palisade fringe; punctures on abdominal tergites III–VIII round to elliptic, gradually becoming smaller posteriad; interstices smaller to little larger than half the diameter of punctures, with relatively faint microsculpture throughout abdominal tergites.



Figures 5, 6. Habitus of *Stenus taiyangshanus* in dorsal and ventral view. Scale = 1 mm.

Male. Sternite VII with posteromedian portion slightly flattened; sternite VIII (Fig. 33) with shallow emargination at middle of posterior margin; sternite IX (Fig. 34) with very long apicolateral projections, posterior margin serrate; tergite X (Fig. 35) with posterior margin slightly emarginated. Aedeagus (Figs 36, 37) robust, with setae at sclerotized apex of median lobe; expulsion hooks (Fig. 39) large; parameres extending distinctly beyond apex of median lobe, bisinuate, folded at apical fifth, with 21 setae on inner side (Fig. 38).

Female. Abdomen broader than that in male; sternite VIII inconspicuously prominent at the middle of posterior margin; tergite X slightly emarginated at posterior margin; sclerotized spermatheca can't be observed in immature female and thus it can't be illustrated here.

Distribution. China (Guangdong Province: Mt. Taiyang Shan).

Diagnoses. This new species can be easily distinguished from related species by vague undelimited elytral spots and small body size.

Etymology. The specific name is derived from "Taiyangshan", the type locality of this species.

***Stenus yinziweii* Tang & Li, sp. n.**
urn:lsid:zoobank.org:act:74C97C73-989D-42FF-8019-22F10210EC09
http://species-id.net/wiki/Stenus_yinziweii
Figs 7, 8, 40–50

Type material. Holotype. China: Guizhou: male, glued on a card with labels as follows:"China: Guizhou Prov., Suiyang County, Kuankuoshui N. R., Gongtonggou, alt. 1530–1550m, 7–8.VI.2010, Lu, Yin & Zhai leg." "Holotype / *Stenus yinziweii* / Tang & Li" [red handwritten label] (SHNU). **Paratypes.** 1 male and 6 females, same data as for the holotype (SHNU); 7 males and 12 females, same locality, 12–13. VI.2010, Lu, Yin & Zhai leg. (1 pair in cPut, rest in SHNU)

Description. Brachypterous; body blackish, anterior margin of labrum, antennae, maxillary palpi and legs yellowish brown, each elytron with a large elongate orange spot, which is 3/5 to 4/5 as long as and 1/2 to 2/3 as broad as the respective elytron.

BL: 4.3–4.7mm; FL: 2.2–2.4 mm.

HW: 0.91–0.98 mm, PL: 0.73–0.82 mm, PW: 0.66–0.71 mm, EL: 0.75–0.83 mm, EW: 0.76–0.87 mm, SL: 0.52–0.55 mm

Head 1.10–1.20 times as wide as elytra; interocular area with deep longitudinal furrows, median portion convex, slightly extending beyond the level of inner eye margins; punctures round, partly confluent, slightly larger and sparser on median area than those near inner margins of eyes, diameter of large puncture about as wide as apical cross section of antennal segment II; interstices faintly reticulated, much smaller than half the diameter of punctures except those along the midline of convex median portion, which may be larger. Antennae, when reflexed, extending a little after posterior margin of pronotum; relative length of antennal segments from base to apex as 12: 7: 21: 10.5: 10.5: 8.5: 8.5: 6: 6: 6.5: 9. Paraglossa oval.

Pronotum 1.10–1.16 times as long as wide; disk moderately uneven, with distinct median longitudinal furrow, two shallow impressions in anterior half, shallow transverse impression in the middle, and two shallow impressions in posterior half; punctures slightly rugose and partially confluent, slightly larger than those on head; interstices, especially those on the bottom of median longitudinal furrow distinctly reticulated, more or less smaller than half the diameter of punctures except those on the bottom of median longitudinal furrow which may be much larger.

Elytra 0.95–0.98 times as long as wide, distinctly constricted at base, lateral margins with slight concavity at about half, gently divergent posteriad; disk uneven with distinct longitudinal humeral impression, distinct postero-lateral impression and long, deep sutural impression, suture convex; punctation and interstices similar to those of pronotum.

Hind tarsi 0.72 times as long as hind tibiae, tarsomeres IV distinctly bilobed.

Abdomen cylindrical; distinct paratergites absent, but rudimentary lateral border present, tergites and sternites split apically; tergite VII with palisade fringe; punctures on abdominal tergites III–VIII round to elliptic, gradually becoming smaller posteriad;

Figures 7, 8. Habitus of *Stenus yinziweii* in dorsal and ventral view. Scale = 1 mm.

interstices smaller than half the diameter of punctures, with relatively faint reticulation on tergites III–VII and distinct reticulation on tergites VIII–X.

Male. Sternite VII with posteromedian portion slightly flattened; sternite VIII (Fig. 40) with semicircular emargination at middle of posterior margin; sternite IX (Fig. 41) with very long apicolateral projections, posterior margin serrate; tergite X (Fig. 42) with posterior margin broadly rounded. Aedeagus (Figs 43, 44) slender; expulsion hooks (Fig. 46) relatively small; parameres extending a little beneath apex of median lobe, almost straight, with about 6 setae on inner side of apical portion (Fig. 45).

Female. Abdomen broader than that in male; sternite VIII (Fig. 47) inconspicuously prominent at middle of posterior margin; tergite X (Fig. 48) slightly emarginated at posterior margin; sclerotized spermatheca as in Figs 49, 50.

Distribution. China (Guizhou Province : Kuankuoshui).

Diagnoses. This new species closely resembles *S. zhaiyanbini* sp. n. and both of them live in the same nature reserve, but it may be distinguished from the latter species by larger size of the elytral marks and different sexual characters.

Etymology. This species is named in honor of Mr. Zi-Wei Yin, collector of the new species.

***Stenus zhaiyanbini* Tang & Li, sp. n.**
urn:lsid:zoobank.org:act:5345D8F0-E45B-442D-8186-831F0F04C7AF
http://species-id.net/wiki/Stenus_zhaiyanbini
Figs 9, 10, 51–61

Type material. Holotype. China: Guizhou: male, glued on a card with labels as follows:"China: Guizhou Prov., Suiyang County, Kuankuoshui N. R., Baishagou, alt. 750–900m, 5.VI.2010, Yin & Zhai leg." "Holotype / *Stenus zhaiyanbini* / Tang & Li" [red handwritten label] (SHNU). **Paratypes.** 9 males and 21 females, same locality, 2–5.VI.2010, Lu, Yin & Zhai leg. (1 pair in cPut, rest in SHNU)

Description. Brachypterous; body blackish, anterior margin of labrum, antennae, maxillary palpi and legs yellowish brown, each elytron with a large oval orange spot, which is 1/3 to 1/2 as long as and 1/3 to 2/5 as broad as the respective elytron.

BL: 4.2–5.1 mm; FL: 1.9–2.4 mm.

HW: 0.83–1.03 mm, PL: 0.68–0.82 mm, PW: 0.60–0.74 mm, EL: 0.69–0.84 mm, EW: 0.69–0.88 mm, SL: 0.49–0.57 mm.

Head 1.14–1.21 times as wide as elytra; interocular area with deep longitudinal furrows, median portion convex, reaching the level of inner eye margins; punctures round, partly confluent, slightly larger and sparser on median area than those near inner margins of eyes, diameter of large punctures about as wide as apical cross section of antennal segment II; interstices hardly reticulated, much smaller than half the diameter of punctures except those along the midline of convex median portion, which may be larger. Antennae, when reflexed, extending a little after posterior margin of pronotum; relative length of segments from base to apex as 11.5: 7.5: 22: 12.5: 11: 9: 8.5: 6.5: 6.5: 6.5: 7.5. Paraglossa oval.

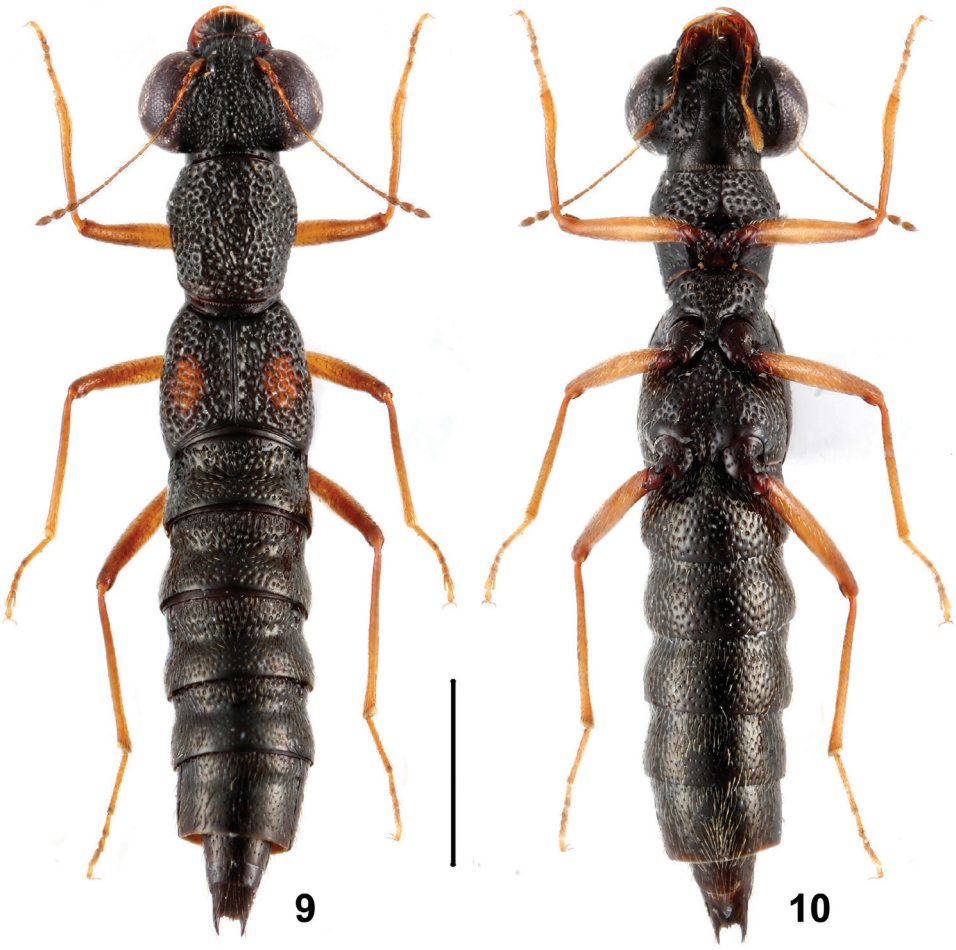
Pronotum 1.10–1.15 times as long as wide; disk uneven, with distinct median longitudinal furrow, two impressions in anterior half, transverse impression in about the middle, and two impressions in posterior half; punctures slightly rugose and partially confluent, slightly larger than those on head; interstices faintly reticulated, more or less smaller than half the diameter of punctures.

Elytra 0.94–1.01 times as long as wide, distinctly constricted at base, lateral margins, with slight concavity at about half, gently divergent posteriad; disk uneven with shallow longitudinal humeral impression, shallow postero-lateral impression and long, deep sutural impression, suture convex; punctation little larger than that of pronotum and interstices clearly microsculptured.

Hind tarsi 0.69 times as long as hind tibiae, tarsomeres IV distinctly bilobed.

Abdomen cylindrical; distinct paratergites absent, but rudimentary lateral border present, tergites and sternites split apically; tergite VII with palisade fringe; punctures on abdominal tergites III–VIII round to elliptic, gradually becoming smaller posteriad; interstices smaller than half the diameter of punctures, with relatively faint reticulation on tergites III–VII and distinct reticulation on tergites VIII–X.

Male. Sternite VII with posteromedian portion slightly flattened; sternite VIII (Fig. 51) with semicircular emargination in the middle of posterior margin; sternite



Figures 9, 10. Habitus of *Stenus zhaiyanbini* in dorsal and ventral view. Scale = 1 mm.

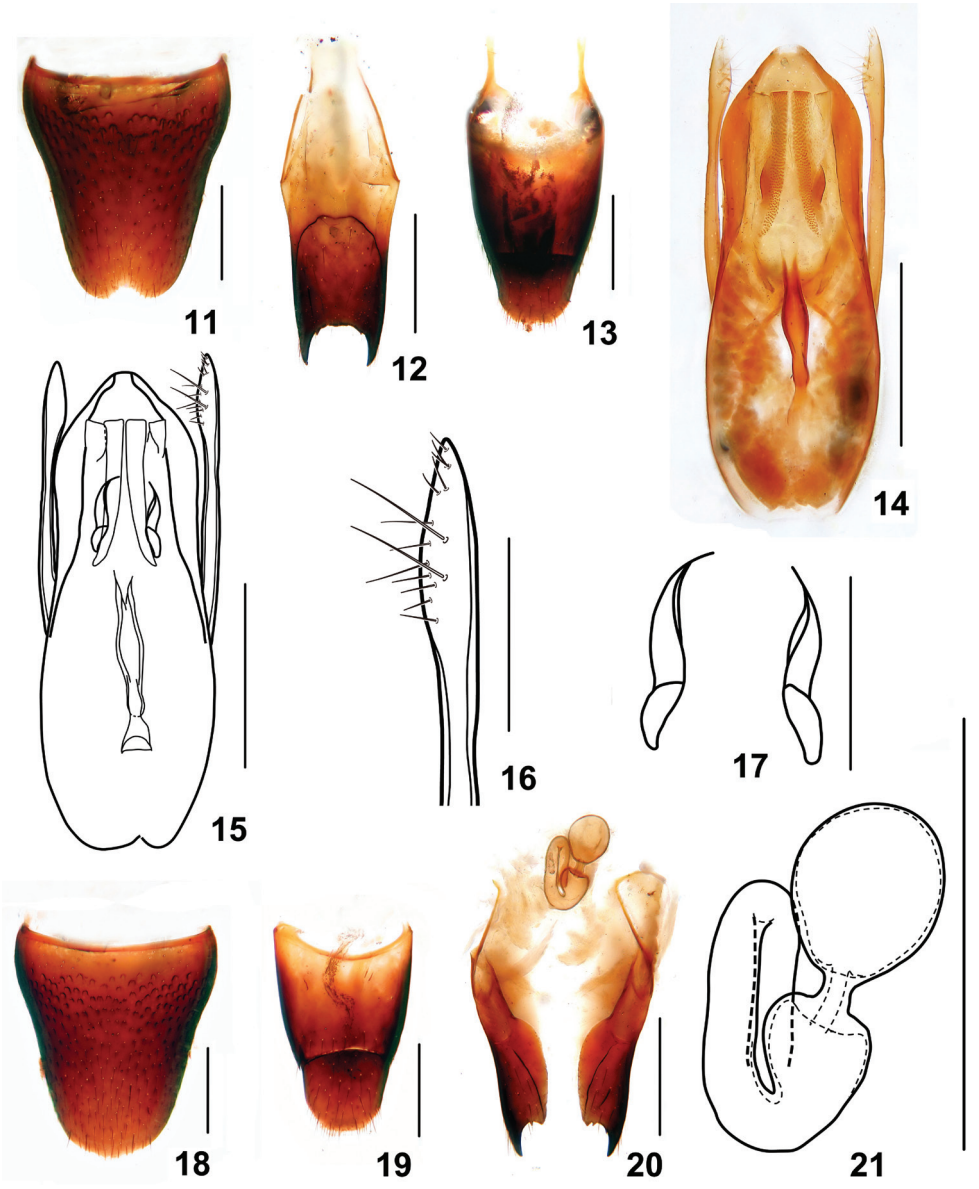
IX (Fig. 52) with very long apicolateral projections, posterior margin serrate; tergite X (Fig. 53) with posterior margin slightly emarginated. Aedeagus (Figs 54, 55) slender; expulsion hooks (Fig. 57) relatively small; parameres extending a little beneath apex of median lobe, bended to inner side, with about 10 setae on inner side of apical portion (Fig. 56).

Female. Abdomen broader than that of male; sternite VIII (Fig. 58) inconspicuously prominent at middle of posterior margin; tergite X (Fig. 59) slightly emarginated at posterior margin; sclerotized spermatheca as in Figs 60, 61.

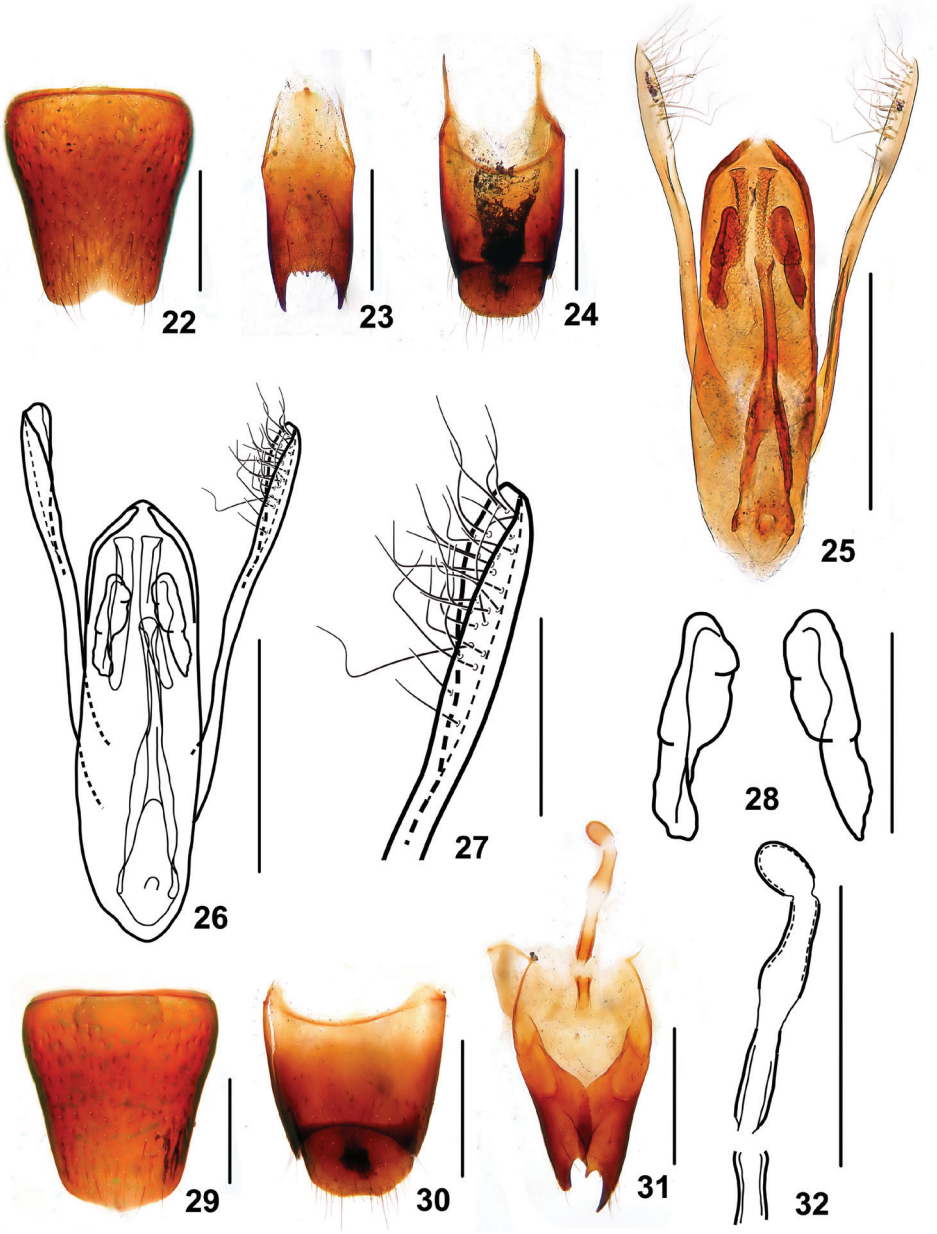
Distribution. China (Guizhou Province : Kuankuoshui).

Diagnoses. This new species closely resembles *S. yinziweii* sp. n. in most aspects, except in smaller elytral marks and different sexual characters.

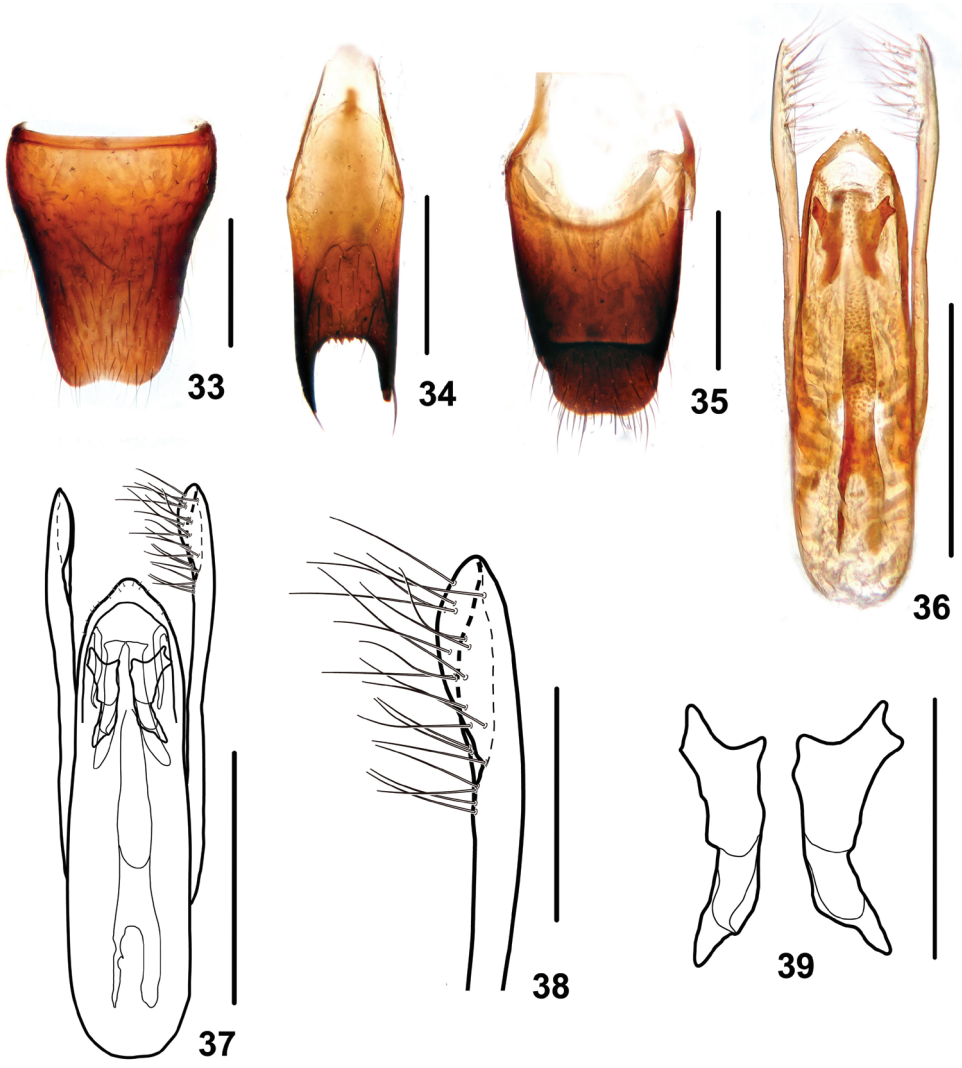
Etymology. The specific name is dedicated to Mr. Yan-Bin Zhai, collector of the new species.



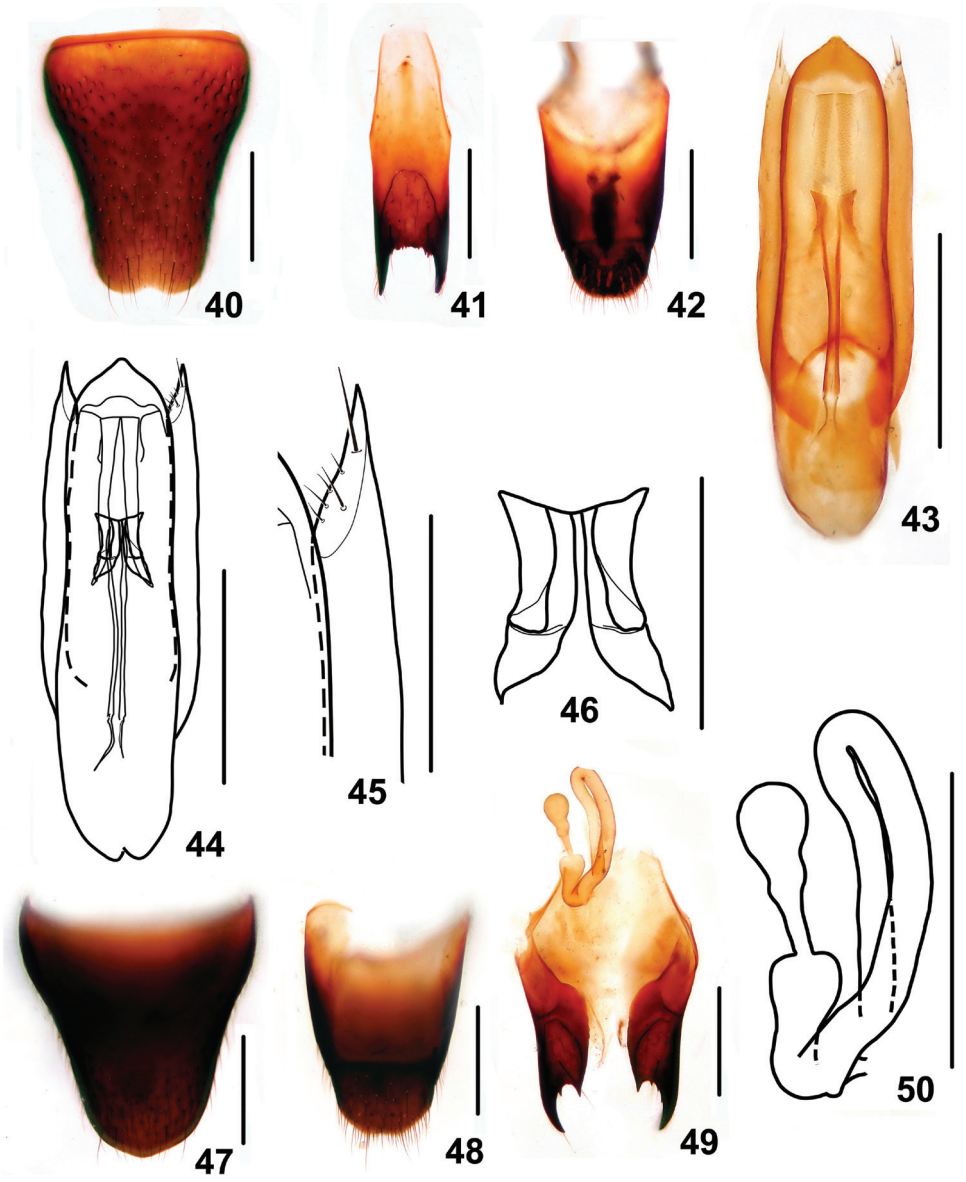
Figures 11–21. *Stenus cangshanus*. **11** male sternite VIII **12** male sternite IX **13** male tergites IX, X **14, 15** aedeagus **16** apical portion of paramere **17** expulsion hooks **18** female sternite VIII **19** female tergites IX, X **20** valvifers and spermatheca **21** spermatheca. Scales = 0.1 mm (**16, 17**), scales = 0.25 mm (**11–15, 18–21**).



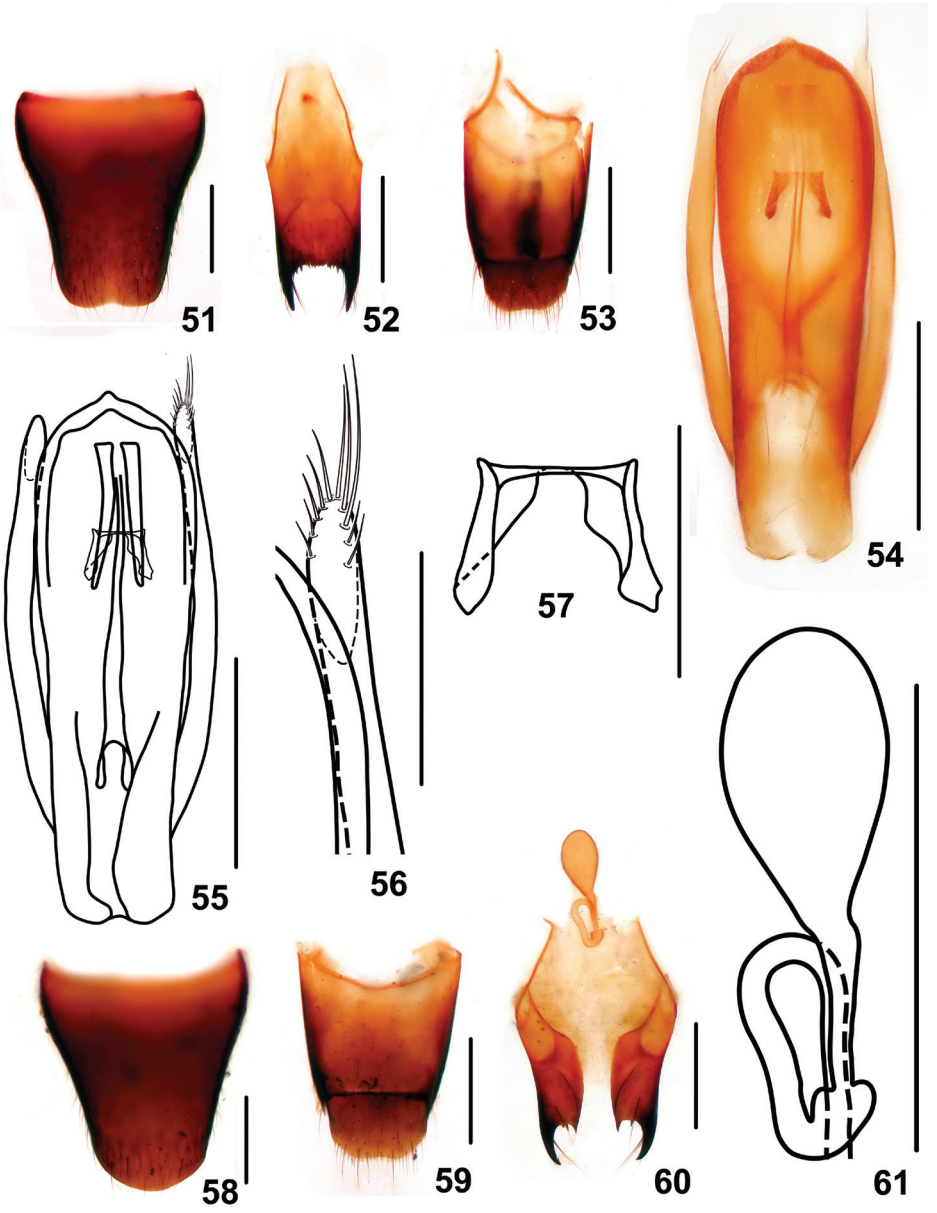
Figures 22–32. *Stenus hewenjiae*. **22** male sternite VIII **23** male sternite IX **24** male tergites IX, X **25, 26** aedeagus **27** apical portion of paramere **28** expulsion hooks **29** female sternite VIII **30** female tergites IX, X **31** valvifers and spermatheca **32** spermatheca. Scales = 0.1 mm (27, 28), scales = 0.25 mm (**22–26, 29–32**).



Figures 33–39. *Stenus taiyangshanus*. **33** male sternite VIII **34** male sternite IX **35** male tergites IX, X **36, 37** aedeagus **38** apical portion of paramere **39** expulsion hooks. Scales = 0.1 mm (38, 39), scales = 0.25 mm (**33–37**).



Figures 40–50. *Stenus yinziweii*. **40** male sternite VIII **41** male sternite IX **42** male tergites IX, X **43, 44** aedeagus **45** apical portion of paramere **46** expulsion hooks **47** female sternite VIII **48** female tergites IX, X **49** valvifers and spermatheca **50** spermatheca. Scales = 0.1 mm (**45, 46**), scales = 0.25 mm (**40–44, 47–50**).



Figures 51–61. *Stenus zhaiyanbini*. **51** male sternite VIII **52** male sternite IX **53** male tergites IX, X **54, 55** aedeagus **56** apical portion of paramere **57** expulsion hooks **58** female sternite VIII **59** female tergites IX, X **60** valvifers and spermatheca **61** spermatheca. Scales = 0.1 mm (**56, 57**), scales = 0.25 mm (**51–55, 58–61**).

Acknowledgements

We dedicate this paper to our friend Mr. Yan-Bin Zhai, a graduated student in our lab, who accidentally died during a collecting trip on 25th April 2011; we would like to express our sincere gratitude to dear Dr. V. Puthz (Germany) for his constant guidance on our study of Chinese Steninae and to all the collectors mentioned in the paper. The research was supported by the National Natural Science Foundation of China (No. 31101659 and No. 31172134), the National Natural Science Foundation of Shanghai (No. 10ZR1421600) and the Innovation Program of Shanghai Municipal Education Commission (No. 12YZ077).

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Taxonomic study on *Lathrobium* Gravenhorst (Coleoptera, Staphylinidae, Paederinae) from Longwangshan Mountain, East China

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Abstract

Species of the genus *Lathrobium* Gravenhorst from Longwangshan Mountain, Zhejiang, East China are studied. A total of five species are recognized, among which three are described here as new: *L. lingae* **sp. n.**, *L. longwangshanense* **sp. n.** and *L. uncum* **sp. n.**, one species was unidentified and the female of *L. tianmushanense* Watanabe is newly reported. All of these species are illustrated and keyed.

Keywords

Coleoptera, Staphylinidae, taxonomy, *Lathrobium*, new species, key, Longwangshan, China

Introduction

To the present, a total of 625 species of the genus *Lathrobium* Gravenhorst have been known worldwide, 64 of them from China (Löbl and Smetana 2004 and subsequent papers). Longwangshan Mountain (at. 30°24'N, 119°27'E) in the south of the Anji County forms the Tianmushan mountain range and Mt. West Tianmushan stand 9.5 kilometers apart. Only two species of *Lathrobium* have been recorded by Watanabe

(1999) from West Tianmushan Mountain, but no members of the genus have been reported yet from Longwangshan Mountain, Zhejiang Province, East China.

In recent years, we made several collecting trips to the Longwangshan Mountain, and obtained a lot of *Lathrobium* specimens. On the basis of the examination, four species were recognized and one species was unidentified, among which three were revealed to be new, and the female of *L. tianmushanense* Watanabe was newly discovered. The purpose of this paper is to describe and illustrate the *Lathrobium* species of Longwangshan Mountain, and to provide an identification key to *Lathrobium* species of Longwangshan Mountain and West Tianmushan Mountain.

Material and methods

All specimens were collected from the leaf litter of the forest floor by sifting. They were killed with ethylacetate and then dried. Dissections were done in water. The genital organs and other dissected parts were mounted in Euparal (Chroma Gesellschaft Schmidt, Koengen, Germany) on plastic slides that were placed on the same pin as the specimen. Photos were taken by a Canon EOS 40D Camera with an MP–E 65 mm Macro Lens or by a Canon G9 Camera mounted on an Olympus CX31 microscope. The type specimens are deposited in the Insect Collection of Shanghai Normal University (SNUC).

The following abbreviations are used in the text, with all measurements in millimeters:

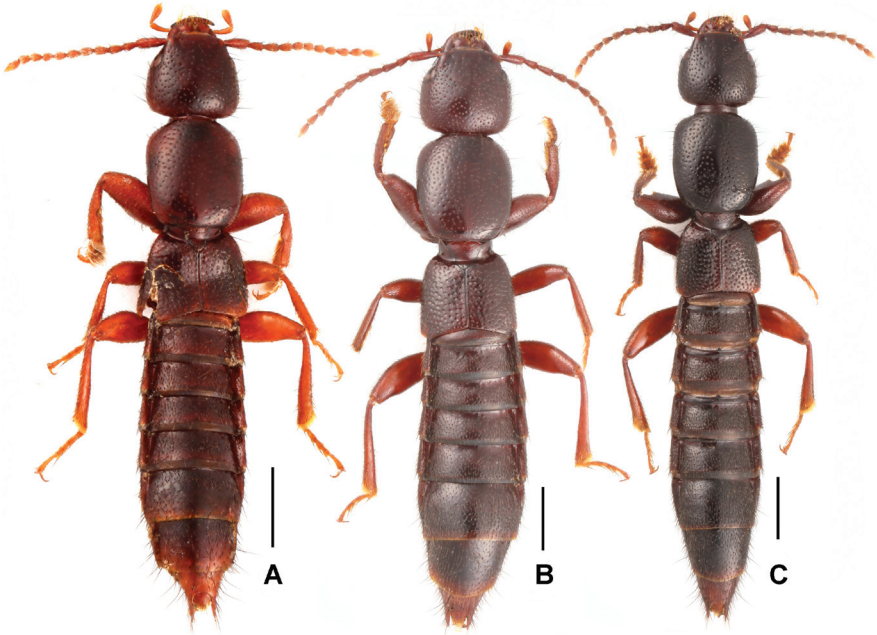
BL	length of the body from the labral anterior margin to the anal end
HL	length of the head from the clypeal anterior margin to the head base
HW	maximum width of the head
PL	length of the pronotum along the midline
PW	maximum width of the pronotum
EL	length of the elytra from the apex of the scutellum to the elytral posterior margin

Taxonomy

***Lathrobium lingae* sp. n.**
urn:lsid:zoobank.org:act:741943E9-A379-42E0-807D-811A596FCE88
http://species-id.net/wiki/Lathrobium_lingae
Figs 1A, 3

Type locality. Longwangshan Nature Reserve, Zhejiang Province, East China

Type material (1 ♂)**.** Holotype: ♂, labeled '**CHINA:** zhejiang Prov. / Anji County / Longwang Mt. / 25.iv.2006, alt. 950–1,200 m / Rui-Fen Ling leg.'.



Figures 1. Male habitus of *Lathrobium* spp., **A** *L .lingae* **B** *L. longwangshanense* **C** *L. tianmushanense.* Scales: 1.0 mm.

Description. Measurements and ratios (holotype): BL 6.88, HL 1.00, HW 1.11, PL 1.27, PW 1.15, EL 1.36, HL/HW 0.91, HW/PW 0.96, HL/PL 0.79, PL/PW 1.11, EL/PL 0.71.

Male (Fig. 1A). Body brown with paler apex, legs reddish brown, antennae reddish brown to yellowish brown.

Head quadrate; posterior angles broadly rounded; postgenae weakly convex ventrally; integument with coarse and moderately dense punctation; eyes reduced.

Pronotum slightly stocky, slightly broader than head; punctation sparser than that of head; interstices shining, lacking microsculpture.

Elytra at suture distinctly shorter than pronotum; wider than long; punctation well-defined; and hind wings completely reduced.

Abdomen with dense pubescence; sternite VII (Fig. 3A) with short dark modified setae on postero-median semicircular impression; sternite VIII (Fig. 3C) with triangular emargination and with short dark modified setae on deep impression; sternite IX (Fig. 3B) asymmetrical; aedeagus (Fig. 3D, 3E) with conspicuously long, slender ventral process and twisted dorsal sclerites.

Female. Unknown.

Distribution. East China (Zhejiang: Longwangshan Mountain).

Etymology. The species is named after Rui-Fen Ling, who collected the type specimens.

Remarks. The new species is close to *L. fengae* in similar general form. *Lathrobium lingae* differs especially by the male sternite VII with deeper impression, male sternite VIII with regularly triangular apico-median emargination, and aedeagus with gracile

ventral process and single dorsal sclerite. *Lathrobium fengae* has the male sternite VII with shallower impression, male sternite VIII with irregular apico-median emargination, and aedeagus with broad ventral process and two dorsal sclerites.

Lathrobium longwangshanense sp. n.

urn:lsid:zoobank.org:act:FFAABDE9-CA6B-4DD8-971D-41BC9898C0E0
http://species-id.net/wiki/Lathrobium_longwangshanense
Figs 1B, 4

Type locality. Longwangshan Nature Reserve, Zhejiang Province, East China

Type material (1 ♂). Holotype: ♂, labeled '**CHINA:** zhejiang Prov. / Anji County / Longwang Mt. / 25.iv.2006, alt. 950–1,200 m / Yong-Yin Wang leg.'.

Description. Measurements and ratios (holotype): BL 9.56, HL 1.51, HW 1.58, PL 1.81, PW 1.59, EL 1.32, HL/HW 0.95, HW/PW 0.95, HL/PL 0.83, PL/PW 1.09, EL/PL 0.73.

Habitus as in Fig. 1B. Externally similar to *L. lingae*, except for the lighter average coloration, the somewhat larger body size, the denser punctation on the head and the pronotum.

Male. Sternite VI (Fig. 4A) with tufted pubescence same length as concavity; sternite VII (Fig. 4B) with weak emargination; sternite VIII (Fig. 4C) with darkish setae on impression and basal angle of asymmetrical triangular emargination with dense point-like seta; sternite IX (Fig. 4D) slightly acute anteriorly; aedeagus (Fig. 4E, 4F) with distinct long ventral process and twisted dorsal sclerites.

Female. Unknown.

Distribution. East China (Zhejiang: Longwangshan Mountain).

Etymology. The species is named after its type locality.

Remarks. The new species is similar in most respects to *L. tianmushanense*, but it differs in having relatively stout body, HL/PL being more than 0.80, male sternite VI with tufted pubescence at concavity and aedeagus with longer twisted dorsal sclerites. In *L. tianmushanense*, the body is relatively slender, HL/PL is more than 0.73, the male sternite VI has the concavity lacking pubescence and the dorsal sclerites of the aedeagus are much shorter.

Lathrobium tianmushanense Watanabe

http://species-id.net/wiki/Lathrobium_tianmushanense
Figs 1C, 5

Lathrobium tianmushanense Watanabe, 1999: 249

Type locality. West Tianmushan Mountain, Zhejiang Province, East China

Material studied (3 ♂♂, 4 ♀♀). 1 ♂, 1 ♀, labelled '**CHINA:** zhejiang Prov. / Anji County / Longwang Mt. / Qianmutian / 27.v.2009, alt. 1,300 m, / Yuan, Liu, Feng & Yin leg.'. 1 ♂, 3 ♀♀, same label data, but '29.v.2009'.

Rescription. For detailed male description of male see Watanabe (1999: 249).

Female. BL 8.06–8.34; Measurements and ratios: HL 1.17, HW 1.32, PL 1.55, PW 1.36, EL 1.02, HL/HW 0.89, HW/PW 0.97, HL/PL 0.76, PL/PW 1.14, EL/PL 0.88.

Slightly smaller than male; posterior margin of tergite VIII (Fig. 5G) weakly asymmetrical; sternite VIII (Fig. 5H) distinctly pointed in the middle; tergite IX (Fig. 5I) (not separated from X) with long and acute lateral processes; tergite X (Fig. 5I) slightly shorter than tergite IX.

Distribution. East China (Zhejiang: Longwangshan and Tianmushan Mountains).

Remarks. *Lathrobium tianmushanense* is closest to *L. cooter*i from Zhejiang by sharing a similar general form. It can be readily separated by the male sternite VI with modified setae at the concavity and male sternite VIII with relatively regular emargination. While *L. cooteri* has the male sternite VI lacking sexual characters and male sternite VIII possess an irregular emargination.

***Lathrobium uncum* sp. n.**

urn:lsid:zoobank.org:act:FBC72B91-DE34-49D0-9918-A486421C9F48

http://species-id.net/wiki/Lathrobium_uncum

Figs 2A, 6

Type locality. Longwangshan Nature Reserve, Zhejiang Province, East China

Type material (7 ♂♂, 5 ♀♀)**.** Holotype: ♂, labeled '**CHINA:** zhejiang Prov. / Anji County / Longwang Mt. / 25.iv.2006, alt. 950–1,200 m / Tang Liang leg.'. Paratypes: 7 ♂♂, 5 ♀, same label data as holotype; 1 ♂, 4 ♀♀, same, but 'Qianmutian / 27.v.2009, alt. 1,300 m/ Yuan, Liu, Feng & Yin leg.'.

Description. Measurements and ratios: BL 5.35–5.93. Holotype: HL 0.78, HW 0.81, PL 1.02, PW 0.82, EL 0.72, HL/HW 0.97, HW/PW 0.98, HL/PL 0.77, PL/PW 1.25, EL/PL 0.70.

Habitus as in Fig. 2A. Externally similar to *L. lingae*, except for the lighter average coloration, the somewhat smaller body size and the sparser punctation on the head and the pronotum.

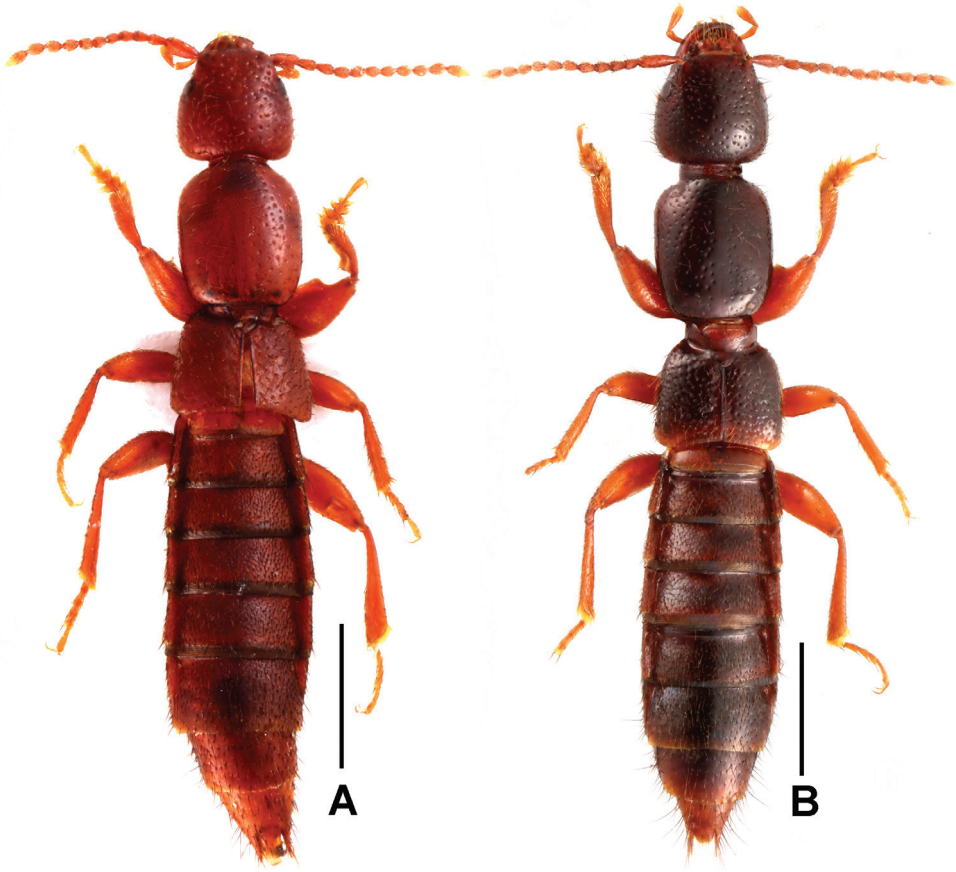
Male. Sternite VII (Fig. 6A) with a group of coarse setae at middle; sternite VIII (Fig. 6B) with half elliptical median emargination, two rows of modified setae in large but faint apical impression and another row along the posterior margin; sternite IX (Fig. 6C) with cuttle-bone-shaped impression; aedeagus (Fig. 6D, 6E) with a hook-shaped ventral process.

Female. Tergite VIII (Fig. 6F) with posterior margin saliently curved; sternite VIII (Fig. 6G) weakly convex posteriorly and with inconspicuous micropubescence; tergite IX (Fig. 6H) (not separated from X), with long lateral processes; tergite X relatively short.

Distribution. East China (Zhejiang: Longwangshan Mountain).

Etymology. The specific name '*uncum*' (Latin adjective) means 'hooked'.

Remarks. The new species and *L. tamurai* from Zhejiang share many features, particularly the general form. They can be readily distinguished by the male sternite VII

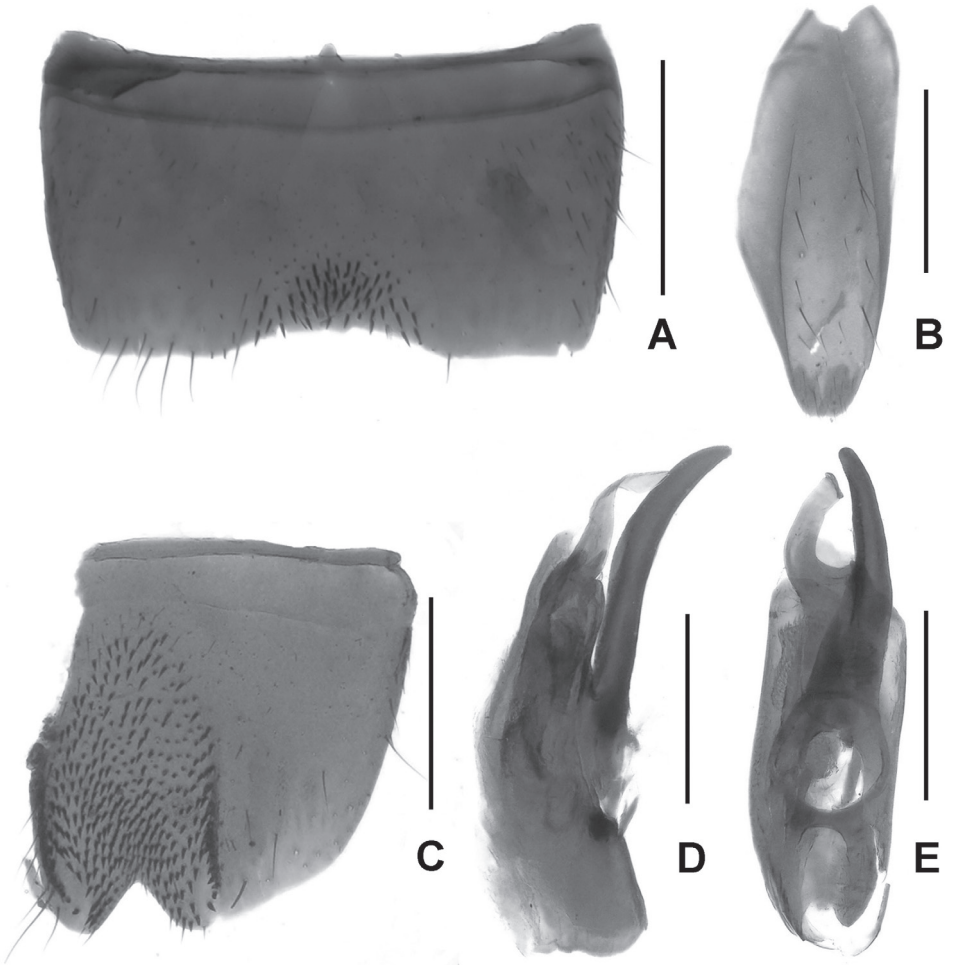


Figures 2. Male habitus of *Lathrobium* spp., **A** *L. uncum* **B** *Lathrobium* sp. indet. Scales: 1.0 mm.

lacking an impression and with several modified discal setae, male sternite VIII with two rows of modified setae in large but faint apical impression and another row along the posterior margin, and slender aedeagus with the ventral process being hook-shaped in *L. uncum*, whereas in *L. tamurai*, the male sternite VII has the impression evenly covered with modified setae on each side of the median part; the male sternite VIII has a horseshoe-shaped impression with dense modified setae; and the robust aedeagus has a straight ventral process.

***Lathrobium* sp. indet.**
Figs 2B, 7

Material studied (3 ♂♂, 3 ♀♀)**.** 3 ♂♂, 3 ♀♀, labelled '**CHINA:** Zhejiang Prov / Anji County / Longwang Mt. / Qianmutian / 25.v.2009, alt. 1300 m / Yuan, Liu, Feng & Yin leg.'.



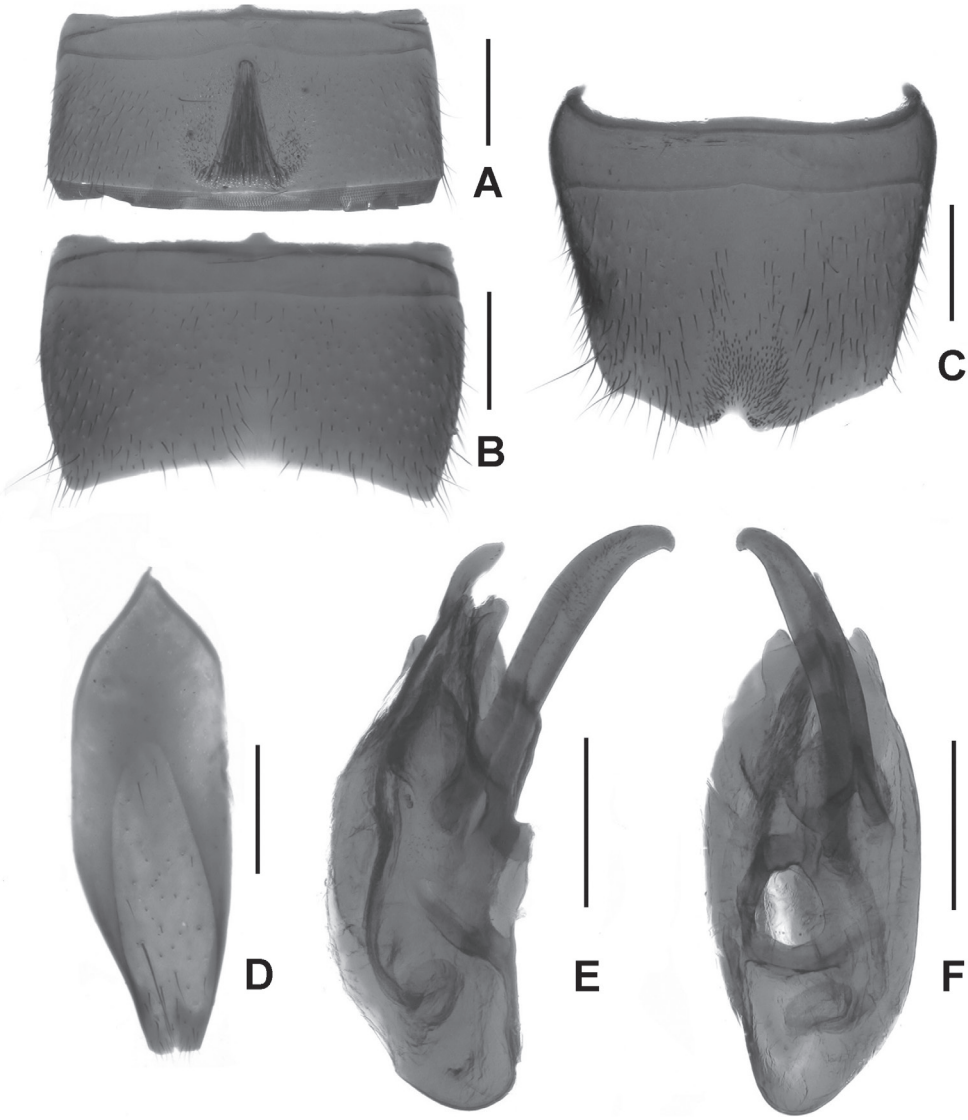
Figures 3. *Lathrobium lingae*. **A** male sternite VII **B** male sternite IX **C** male sternite VIII **D** aedeagus in lateral view **E** aedeagus in ventral view. Scales: 0.5 mm.

Description. Measurements and ratios: BL 6.43–6.65. Holotype: HL 0.78, PL 1.12, PW 0.93, EL 0.74, HL/HW 0.95, HW/PW 0.96, HL/PL 0.74, PL/PW 1.20, EL/PL 0.66.

Habitus as in Fig. 2B. Externally similar to *L. lingae*, except for the somewhat smaller body size and the more oblong pronotum.

Male. Sternite VII (Fig. 7A) with conspicuously modified setae at weak impression; sternite VIII (Fig. 7B) with approximately elliptic impression and furnished with numerous peg-setae, emargination irregularly shaped; sternite IX (Fig. 7C) anisomerous; aedeagus (Fig. 7D, 7E) with broad ventral process and two apical gracile dorsal sclerites.

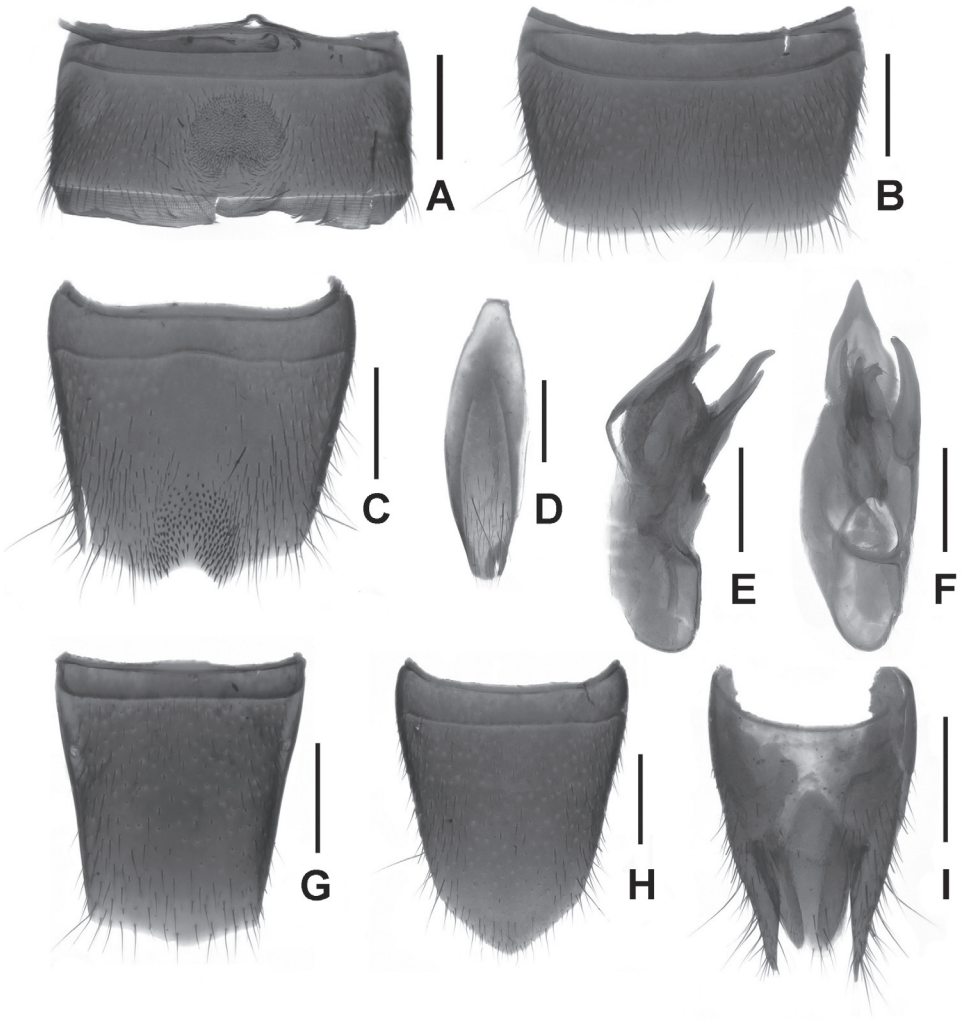
Female. Posterior margins of tergite VIII (Fig. 7F) indistinctly asymmetrical and sternite VIII (Fig. 7G) obtusely produced at middle; tergite IX (Fig. 7H) not separated clearly and its lateral processes acute apically; tergite X relatively short.



Figures 4. *Lathrobium longwangshanense*. **A** male sternite VI **B** male sternite VII **C** male sternite VIII **D** male sternite IX **E** aedeagus in lateral view **F** aedeagus in ventral view. Scales: 0.5 mm.

Distribution. East China (Zhejiang: Longwangshan Mountain).

Remarks. The species resembles *L. rougemonti* Watanabe from Zhejiang by sharing the similar form, male sternite VII with weak impression and male sternite VIII with many dark setae in the large impression, but that of aedeagus typically with two closer dorsal sclerites. In *L. rougemonti*, aedeagus have two widely separated dorsal sclerites. The original description of *L. rougemonti* is based on the holotype from West Tianmushan Mountain. The type was not examined, but based on the description and

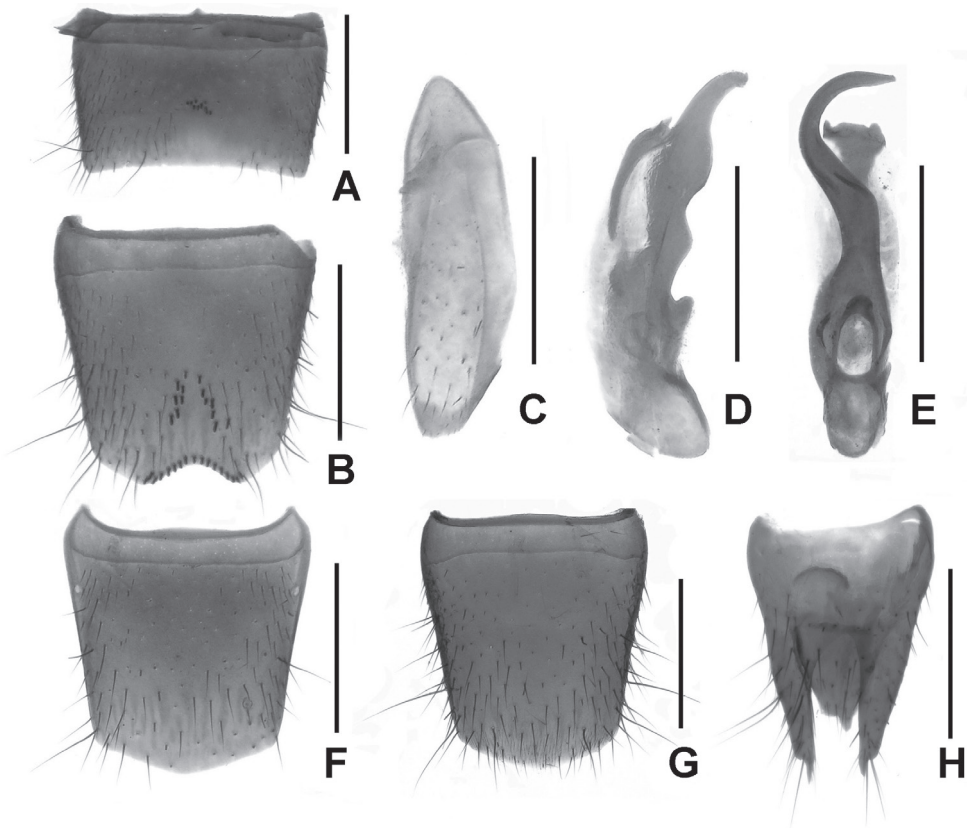


Figures 5. *Lathrobium tianmushanense*. **A** male sternite VI **B** male sternite VII **C** male sternite VIII **D** male sternite IX **E** aedeagus in lateral view **F** aedeagus in ventral view. **G** female tergite VIII **H** female sternite VIII **I** female tergite IX–X. Scales: 0.5 mm.

the illustration (habitus, male abdominal apex and aedeagus) provided by Watanabe (1999), there is still doubt whether the population from Longwangshan represents a new species. As intermediate form exists, it will be necessary to study the type material of *L. rougemonti* for clarification. (Assing pers. comm.)

A key to the *Lathrobium* species from Longwang – West Tianmu Mountains

1 Length of body larger than 9 mm **2**
– Length of body no more than 7 mm **3**

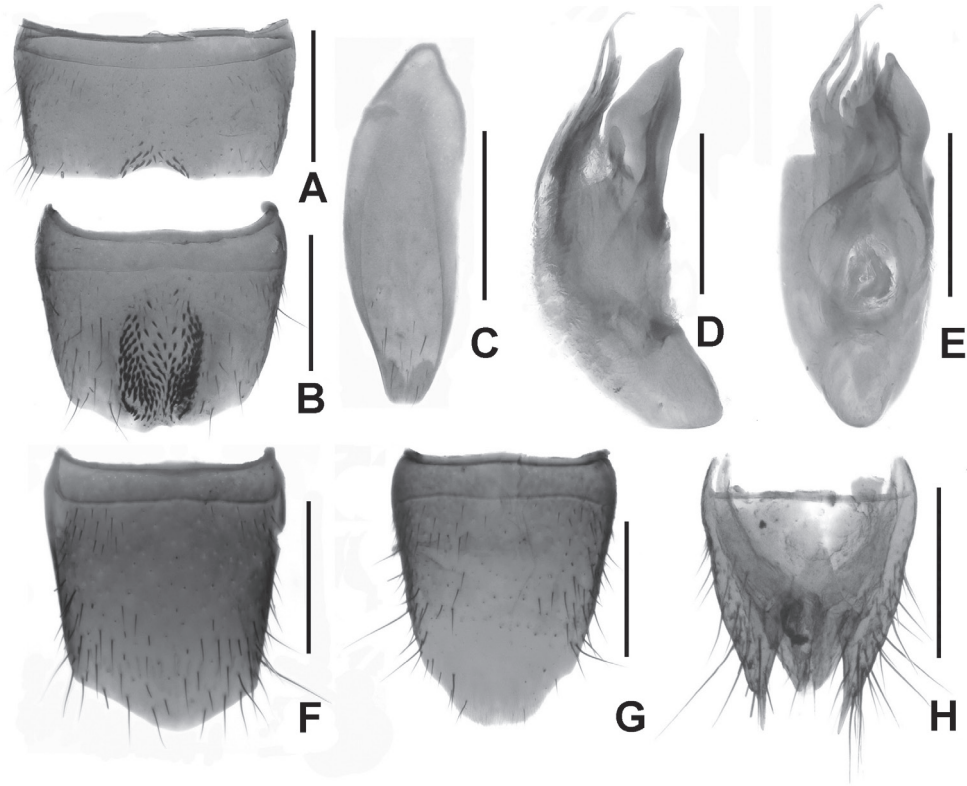


Figures 6. *Lathrobium uncum*. **A** male sternite VII **B** male sternite VIII **C** male sternite IX **D** aedeagus in lateral view **E** aedeagus in ventral view. **F** female tergite VIII **G** female sternite VIII **H** female tergite IX–X. Scales: 0.5 mm.

2 Relatively slender (Fig. 1C), HL/PL no more than 0.75; male sternite VI (Fig. 5A) lacking tuft of pubescence at concavity; aedeagus (Fig. 5E, 5F) with short ventral process. Posterior margin of female tergite VIII (Fig. 5G) weakly asymmetrical; female sternite VIII (Fig. 5H) distinctly pointed in the middle ..... ***L. tianmushanense*** **Watanabe**

– Relatively stout (Fig. 1B), HL/PL more than 0.80; male sternite VI (Fig. 4A) with tuft of pubescence at concavity; aedeagus (Fig. 4E, 4F) with long ventral process. Female unknown ..... ***L. longwangshanense*** **sp. n.**

3 Light brown (Fig. 2A); male sternite VII (Fig. 6A) with modified discal setae; male sternite VIII (Fig. 6B) with sparse modified setae in shallow impression; aedeagus (Fig. 6D, 6E) elongate and with hook-shaped ventral process. Female sternite VIII (Fig. 6G) with inconspicuous micropubescence posteriorly..... ***L. uncum*** **sp. n.**



Figures 7. *Lathrobium* sp. indet.. **A** male sternite VII **B** male sternite VIII **C** male sternite IX **D** aedeagus in lateral view **E** aedeagus in ventral view. **F** female tergite VIII **G** female sternite VIII **H** female tergite IX–X. Scales: 0.5 mm.

– Brown (Fig. 1A); male sternite VII (Fig. 3A) with modified setae at postero-median margin; male sternite VIII (Fig. 3C) with dense modified setae in deep impression; aedeagus (Fig. 3D, 3E) robust and not as above. Female sternite VIII without micropubescence posteriorly (*L. lingae* female unknown)..... **4**

4 Male sternite VII (Fig. 3A) with deep apico-median impression; male sternite VIII (Fig. 3C) with regular triangular emargination; aedeagus (Fig. 3D, 3E) with single dorsal sclerite ..... **L. lingae sp. n.**

– Male sternite VII with shallow apico-median impression; male sternite VIII with irregular emargination, aedeagus with two dorsal sclerites .... ***L. rougemonti* Watanabe**.

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RESEARCH ARTICLE

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Description of the species of *Dicoelothorax* Ashmead (Chalcidoidea, Eucharitidae) and biology of *D. platycerus* Ashmead

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Abstract

Descriptions of the adults of the two species of *Dicoelothorax* Ashmead, *D. parviceps* and *D. platycerus*, and the eggs, planidia and pupae of *D. platycerus* Ashmead are provided. Females of *D. platycerus* deposit their eggs on the underside of leaves of *Pseudabutilon virgatum* (Cav.) Fryxell (Malvaceae). The host of *D. platycerus* is *Ectatomma brunneum* Smith (Formicidae: Ectatomminae).

Keywords

Dicoelothorax, eggs, planidia, pupae, host ant, host plant

Introduction

Eucharitidae are parasitoids of pupae of Formicidae (Hymenoptera: Aculeata) (Clausen 1940, Heraty 2002), females lay their eggs away from the host within the tissues of certain plants and the active first-instar larva, termed a planidium, must make its way back to the ant nest where it can attack the brood (Heraty and Barber 1990).

Dicoelothorax was established by Ashmead (1899), but without a type species. Ashmead (1904) later designated *D. platycerus* as the type species. Heraty (2002) provides a detailed diagnosis and description of the genus, and a morphological phylogenetic analysis placing this genus within a Neotropical *Kapala* clade that are all parasitoids of poneromorph ants. A sister group relationship with *Lasiokapala* Ashmead, 1899 was

proposed based on the broad, angulate postgenal margin and the absence of a postmarginal vein (Heraty 2002).

This genus includes two species distributed in the Neotropical region: *D. parviceps* Cameron (Argentina, Brazil, Colombia and Guyana) and *D. platycerus* Ashmead (Argentina, Bolivia and Brazil). The original descriptions of these species are vague and short, and there is no clear differentiation of species. Based on the collections examined and our new material, we were able to differentiate both species. Herein we provide new descriptions and diagnoses. Also, *D. platycerus* was collected in northwestern Argentina, and information on life history, immature stages, and a new host association are included.

Materials and methods

Dicoelothorax platycerus were collected at San Vicente, Tucumán (26°25'36"S, 65°15'41"W; 740 m altitude) on March 12, 2009 on *Pseudabutilon virgatum* (Cav.) Fryxell (Malvaceae). Eggs were found on the underside of the leaves. Five females of *D. platycerus* were collected in the field and provided twigs with leaves, fruits, and flowers of different species of plants in 10 × 3.5 cm plastic tubes to monitor oviposition habits. Leaves of *P. virgatum* with eggs were placed into a cylindrical glass container of 10 × 10 cm with dampened cotton until emergence of the first instar (planidium). The planidia and some eggs were preserved in ethanol. Planidia were cleared in 10% KOH and both larvae and eggs slide-mounted in Hoyer's medium.

Three nests of *Ectatomma brunneum* Smith (Formicidae: Ectatomminae) that were in close proximity to the adult collection and oviposition site were excavated. Adults, brood, and debris were collected into plastic containers. Adults and immature stages were then sorted from the debris, examined for parasitism, and subsequently returned to the containers to allow further development of immatures. The immature stages were examined once daily until all parasitoids or ants emerged from the cocoons.

Images were obtained using GT-VISION® ENTO-VISION software operating on a Leica M16 zoom lens linked to a JVC KY-F75U 3-CCD digital video camera; and LEICA APPLICATION SUIT (version 3.5.0) software operating on a Leica MZ12 linked to a Leica DFC295 digital video camera. Images were enhanced with COREL PHOTOPAINT and COREL DRAW (version 15); and some images processed with DEEP FOCUS (Stuart Ball).

Specimens studied are deposited in the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina (MACN); Instituto Fundación Miguel Lillo, Tucumán, Argentina (IFML); University of California, Riverside, California, USA (UCRC); and American Museum of Natural History, New York, USA (AMNH). Notes and detailed illustrations of the type material housed at the National Museum of Natural History, Washington (USNM) and the Natural History Museum, London (BMNH) were made available by J. Heraty (UCRC).

Morphological terms are from Heraty (2002) and Heraty and Darling (1984), with details on sculpture from Eady (1968) and Harris (1979).

Taxonomy

***Dicoelothorax parviceps* Cameron**
http://species-id.net/wiki/Dicoelothorax_parviceps
Figs 1–5

D. parviceps Cameron, 1913: 117–118; De Santis, 1979: 107; De Santis, 1980: 211; Heraty, 2002: 130. Type female in BMNH 5.364 [examined], UCRC_ENT 310015.

Description. Distinguished from *D. platycerus* by the mesosoma and frenal processes having distinct, widely spaced longitudinal striae (Figs 2, 5); dorsal concavity of mesoscutum and scutellum smooth medially (Fig. 2); frenal processes in dorsal view distinctly tapered with apex narrowly rounded (Figs 2, 5); venation yellow with stigma pale brown; scutellar processes of male white and straight in lateral view, and 1.6× as long as scutellum (Figs 4, 5).

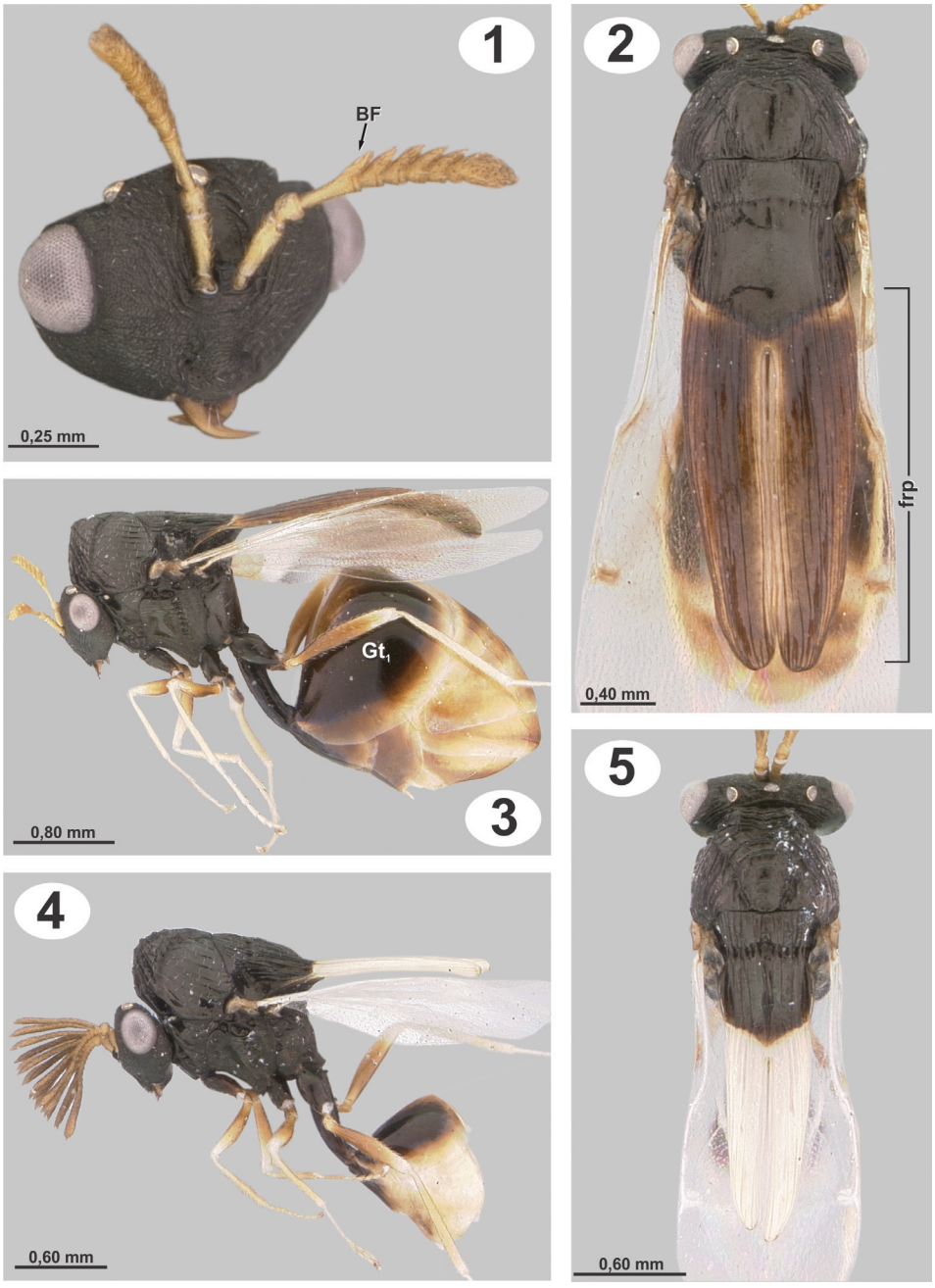
Female. Length 3.8 mm. Head, mesosoma, coxae, petiole and Gt_1 except distal part black; basal ¾ of femora, frenal processes, distal part of Gt_1 and rest of terga brown; antenna yellowish to light brown; rest of legs and distal limits of terga yellowish. Wings slightly infuscate, venation yellow, stigmal vein pale brown (Fig. 3).

Head 1.7× as broad as high. Frons and face granulate, weakly strigose, with small and scattered setae (Fig. 1). Eyes separated by 2.3× their height. Malar space as long as height of eye. Antenna with 8 segments; scape 2.9× as long as broad, broader apically, smooth, with a few scattered setae. Length of flagellum 0.9× height of head, basal flagellomere (homologous to F1+F2; Heraty 2002) as long as scape (BF, Fig. 1), following flagellomeres serrate, clava rounded (Fig. 1).

Mesosoma. Midlobe of mesoscutum elevated anteriorly, with short, thin, decumbent and scattered setae; striate-rugose on anterior face of mesoscutum, sidelobes longitudinally striate, midlobe dorsally smooth and concave (Figs 2, 3). Axilla and scutellar disc smooth and concave dorsally, scutellar disc longitudinally striate laterally. Scutoscutellar sulcus (SSS) weakly crenulate dorsally; deeply invaginated and smooth laterally. In dorsal view, frenal processes tapering toward narrowly rounded apex, with longitudinal striae distinct and widely spaced; processes 3.8× as long as maximum width and 2.1× as long as scutellum (frp, Fig. 2), in profile curved over gaster. Upper half of mesepisternum and mesepimeron longitudinally striate. Hind coxa semiglobose, 1.9× as long as broad; with weak longitudinal striae and scattered, thin setae. Hind femur densely setose. Forewing 2.8× as long as broad; stigmal vein slender and perpendicular to wing margin, 3.3× as long as broad; postmarginal vein indistinct but present and about as long as stigmal vein (Fig. 2).

Metasoma. Petiole 4.1× as long as broad, 1.8× as long as hind coxa and 1.2× as long as hind femur; First gastral tergite (Gt_1) smooth and without setae (Gt_1, Fig. 3).

Male. Length 2.4 mm. Similar to female except for following. Antenna brown, frenal processes and venation completely white; Gt_1 and following segments yellowish (Figs 4, 5); forewing hyaline. Head 1.3× as long as high. Eyes separated by 2.1×



Figures 1–5. *Dicoelothorax parviceps* **1** head and antenna (female, sublateral) **2** mesosoma (female, dorsal) **3** habitus (female) **4** habitus (male) **5** mesosoma (male, dorsal).

their height. Malar space 0.9× as height of eyes. Antenna pectinate; scape shorter than female, 2.4× as long as broad; branch of basal flagellomere 0.9× as long as height of head, following flagellomeres with branches progressively decreasing in length (Fig.

4). Mesoscutal depression rugose (Fig. 5); axilla and scutellar disc narrower than mesoscutum and with longitudinal striae. SSS deeply crenulate dorsally. Frenal processes smaller than female; frenal processes 4.3× as long as maximum width, 1.6× as long as scutellum; spines straight in lateral view (Figs 4, 5). Mesepisternum and mesepimeron with weak striae. Hind coxa 1.8× as long as broad. Petiole 3.4× as long as broad, 2.0× as long as hind coxa.

Biology of *D. parviceps*. Unknown.

Material examined. COLOMBIA. Vichada, P. N. Tuparro, 16.vi.2000, Sharkey, UCRC_ENT 161564 (1 female, UCRC); same location and data, UCRC_ENT 92180 (1 male, UCRC).

***Dicoelothorax platycerus* Ashmead**
http://species-id.net/wiki/Dicoelothorax_platycerus
Figs 6–31

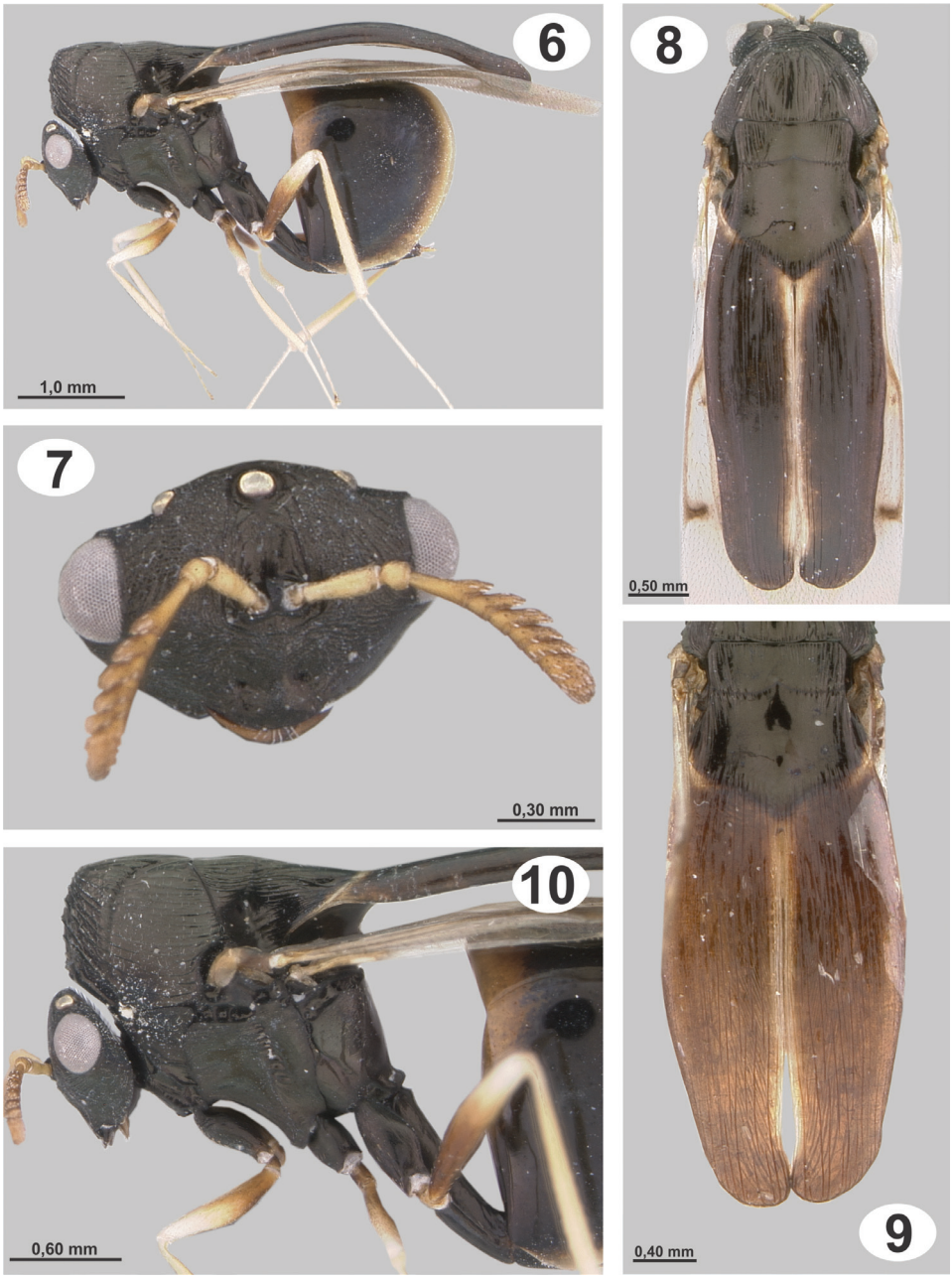
D. platycerus Ashmead, 1904: 470–471; De Santis, 1979: 107; De Santis, 1980: 211; Heraty, 2002: 130, figs 113–119 (lectotype and paralectotype). Type females in USNM, http://www.chalcidtypes.com/default.asp?Action=Show_Types&Single_Type=True&TypeID=878 [examined]

Description. Distinguished from *D. parviceps* by the mesosoma and frenal processes having fine closely-spaced longitudinal striae, closer and more slightly raised in female (Figs 8, 9, 12, 14); dorsal concavity of mesoscutum and scutellum smooth or weakly striate medially (Figs 8, 9); frenal processes in dorsal view widened medially and narrowing only slightly to apex, which is almost the same width as their base and broadly rounded (Figs 8, 9); venation brown; scutellar processes of male yellowish with diffuse black longitudinal band medially and apex black, slightly curved in lateral view, and almost twice as long as scutellum (Figs 12, 14).

Female. Length 3.0–4.5 mm. Head, mesosoma, coxae, petiole and Gt_1 except distal part black; flagellum, basal ¾ of femora, frenal process, distal part of Gt_1 and rest of terga brown but with processes sometimes completely black; scape, pedicel and rest of legs and distal limits of terga yellowish (Figs 6, 8, 9). Wings slightly infuscate, venation brown.

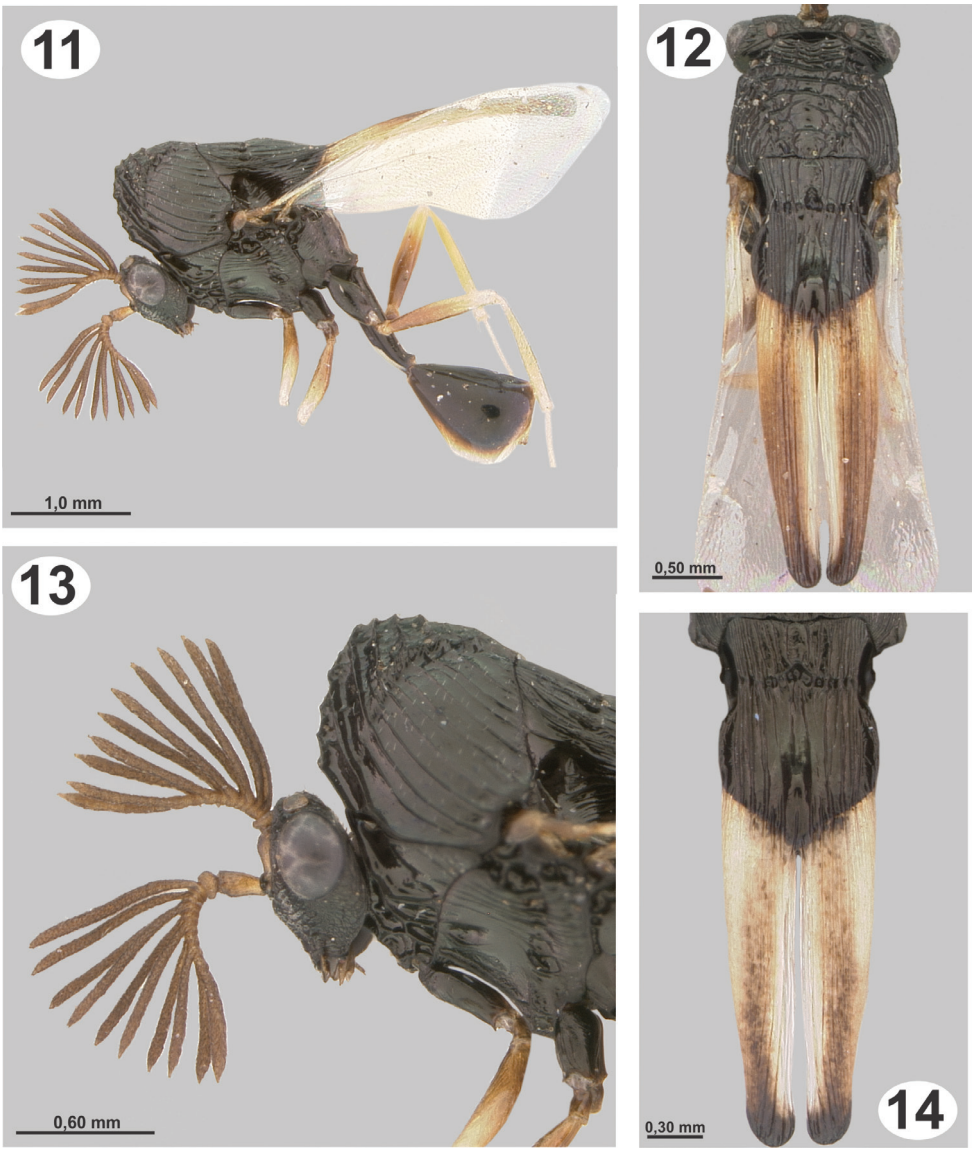
Head 1.4–1.5× as broad as high. Frons and face granulate, weakly strigose, with small and scattered setae or without setae (Fig. 7). Eyes separated by 2.3–2.7× their height. Malar space 0.8–1.2× as long as height of eyes. Antenna with 8 segments; scape 2.4–2.8× as long as broad, slightly broader apically, smooth, with a few scattered setae. Length of flagellum 0.7–0.9× height of head, basal flagellomere 0.8–1.2× as long as scape, basal flagellomere ranging from serrate to clavate, following flagellomeres serrate, clava rounded (Fig. 7).

Mesosoma. Midlobe of mesoscutum elevated anteriorly, with short, thin, decumbent and scattered setae; striate-rugose on anterior face, sidelobes longitudinally stri-



Figures 6–10. *Dicoelothorax platycerus* (female) **6** habitus **7** head and antenna (sublateral) **8** mesosoma (dorsal) **9** scutellum (dorsal) **10** mesosoma (lateral).

ate, modlobe dorsally smooth or weakly striate and concave (Figs 6, 10). Axilla and scutellar disc smooth and concave dorsally, scutellar disc longitudinally striate laterally. SSS weakly crenulate dorsally and deeply invaginated and smooth laterally (Figs



Figures 11–14. *Dicoelothorax platycerus* (male) **11** habitus **12** mesosoma (dorsal) **13** head and mesoscutum (lateral) **14** scutellum (dorsal).

8, 9). In dorsal view, frenal processes widened medially and tapering only slightly to apex, apically almost the same width as their base and broadly rounded, with longitudinal striae slightly marked and closely spaced; processes 3.1–3.5× as long as maximum width and 2.4–2.7× as long as scutellum (Figs 6, 8, 9); in profile, curved over gaster. Upper half of mesepisternum and mesepimeron longitudinally striate. Hind coxa semiglobose and elongate, 1.7–2.1× as long as broad; with weak longitudinal striae and scattered, thin setae (Fig. 10). Hind femur densely setose. Forewing

2.3–2.5× as long as broad; stigmal vein slender and perpendicular to wing margin, 1.9–2.2× as long as broad; postmarginal vein indistinct and less than half as long as stigmal vein (Fig. 8).

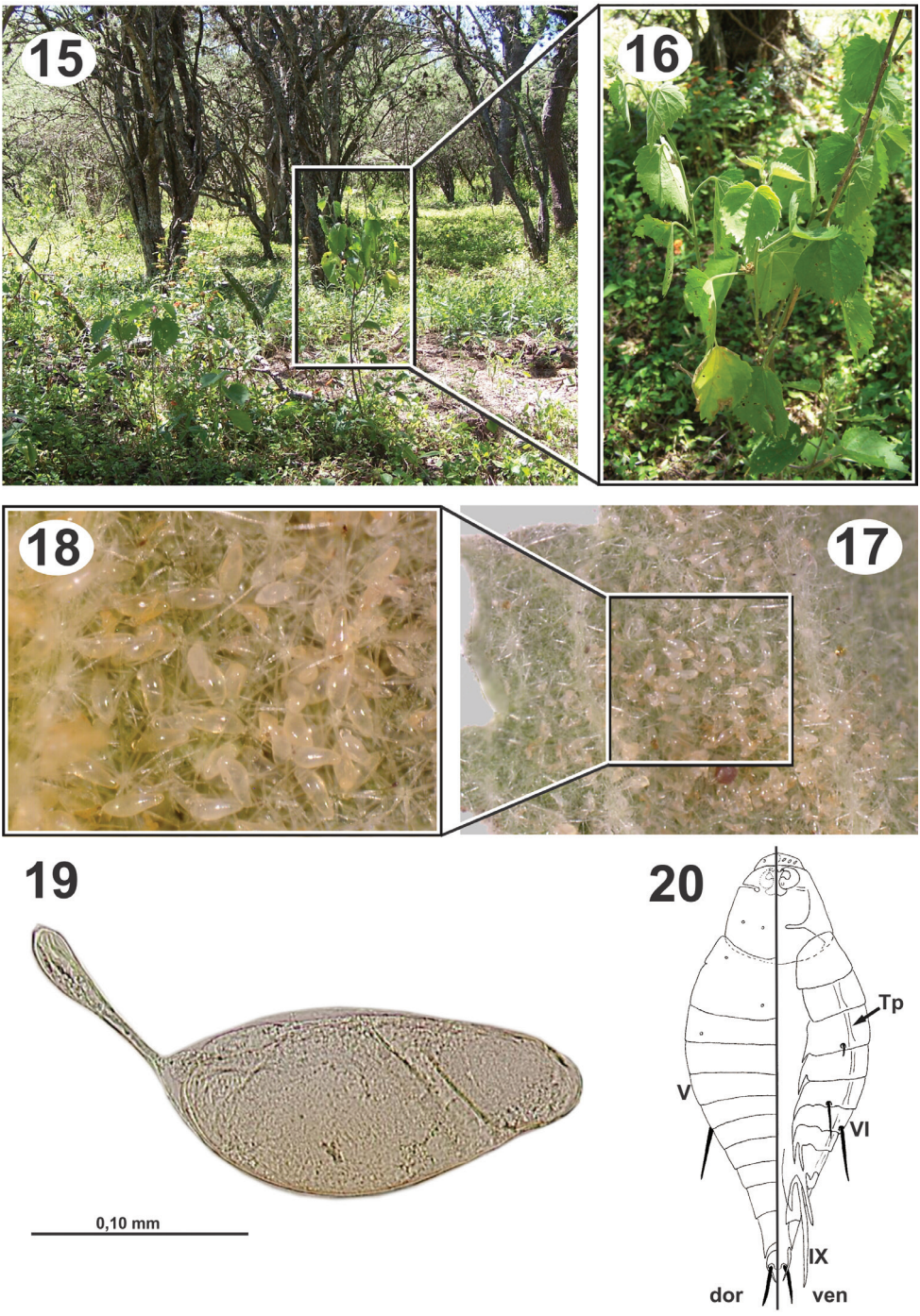
Metasoma. Petiole 3.6–4.1× as long as broad, 1.7–2.0× as long as hind coxa and 1.2–1.3× as long as hind femur; Gt_1 smooth and without setae (Figs 6, 10).

Male. Length 3.0–3.8 mm. Similar to female except for following. Antenna brown, frenal processes yellowish with a diffuse black longitudinal band medially and apex black, this band can be extended laterally and covering almost entire surface, or it can be reduced to a narrow medial line (Figs 11, 12, 14); wing venation white, forewing hyaline. Head 1.5–1.6× as long as high. Eyes separated by 2.2–2.4× their height. Malar space 0.7–0.9× as height of eyes. Antenna pectinate; scape shorter than female, 1.8–1.9× as long as broad; basal flagellomere 0.9–1.0× as long as height of head, following flagellomeres with branches progressively decreasing in length (Fig. 13). Mesosoma with striae stronger than female, mesoscutal depression rugose (Fig. 12); axilla and scutellar disc narrower than mesoscutum and with longitudinal striae; scutellum with a small depression anterior to union of processes (Figs 12, 14). SSS deeply crenulate dorsally. Frenal processes narrowing toward apex; 3.7–4.4× as long as maximum width, 1.7–2.1× as long as scutellum (Figs 12, 14); in profile, uniformly and slightly curved over gaster. Hind coxa 1.8–2.1× as long as broad. Petiole 3.8–4.3× as long as broad, 1.7–2.1× as long as hind coxa. Gaster smaller than female.

Eggs. Length of egg body 0.18 mm and caudal stalk 0.08 mm (Fig. 19). Undeveloped eggs are whitish and translucent with a smooth chorion, slightly flattened dorsally and convex ventrally, with a caudal stalk that is about half the length of the egg body. The egg is similar to other Eucharitinae as described by Heraty and Darling (1984).

Planidium. As described for other Eucharitinae by Heraty and Darling (1984), but distinguished as follows: length 0.09 mm, width 0.05 mm (Fig. 20); pleurostomal spine not observed; anterior pair of placoid sensilla connected to lateral margin by single line of weakness, dorsal cranial spines absent; ventral transverse process of cranium fingerlike; tergopleural line (Tp) separating pleural and dorsal tergites present on tergites TII–VIII; TI and TII fused dorsally, with two pair of small setae dorsally; TIII with one pair of setae ventrally and one pair dorsally; TV with one pair of stout setae ventrally, reaching to TVII; TVI with one pair of stout setae lateral to Tp; TIX entire and with two long lateral processes ventrally reaching to middle of caudal cerci; TXII with lateral processes reaching to almost the middle of caudal cerci; caudal cerci stout (Fig. 20).

Pupa. Length: 5.4–6.7 mm (Figs 26–31). The pupa are similar to the description by Pérez-Lachaud et al. (2006a) for *Kapala izapa* Carmichael, but differ as follows: with blunt conical projections on each sidelobe of mesoscutum (Figs 27, 29); one pair of conical and pointed projections in the axilla; undeveloped frenal processes broad and flattened; gaster with raised ridges along metasomal tergites, the first tergite with lateral and ventral projections, and following segments with dorsal, lateral and ventral



Figures 15–20. Biology and immature stages of *Dicoelothorax platycerus* **15** habitat **16** *Pseudabutilon virgatum* **17** underside leaf of *P. virgatum* with eggs **18** magnified area with eggs **19** egg **20** planidium.

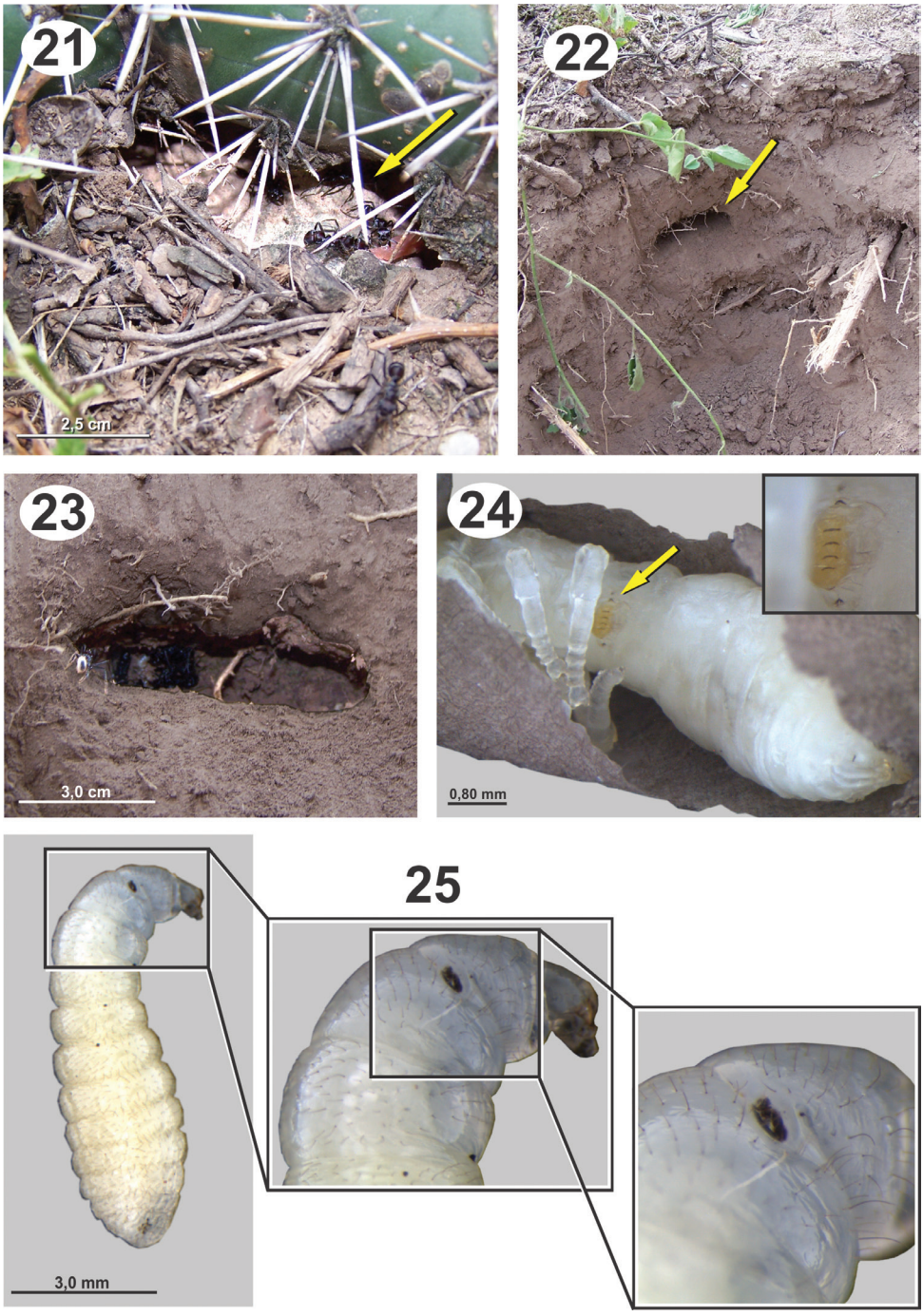
projections. The larval exuvium was attached to the terminal segments of the gaster (Figs 28, 30, 31). Pupation occurs inside of the ant cocoon (Fig. 26).

Habitat and location. Specimens were collected in San Vicente (Tucumán, Argentina). In this region it is common to find *Aspidosperma quebracho-blanco* Schlecht. (Quebracho blanco), *Cassia*, *Cercidium* sp. (Brea), *Cereus validus* Haworth, *Harrisia pomanensis* (F.A.C.Weber) Britton & Rose, *Jodina rhombifolia* Hooker et Arnott (Sombra de toro), *Opuntia* sp. (Tuna, Quimilo), and *Prosopis* sp. (Algarrobo). This vegetation corresponds to the chaco serrano ecoregion (*sensu* Digilio and Legname 1966). The host plant, *Pseudabutilon virgatum*, was widely distributed, but the specimens associated with *Dicoelothorax* were collected in a forest of *Prosopis* sp., 12 meters north of the road (Fig. 15).

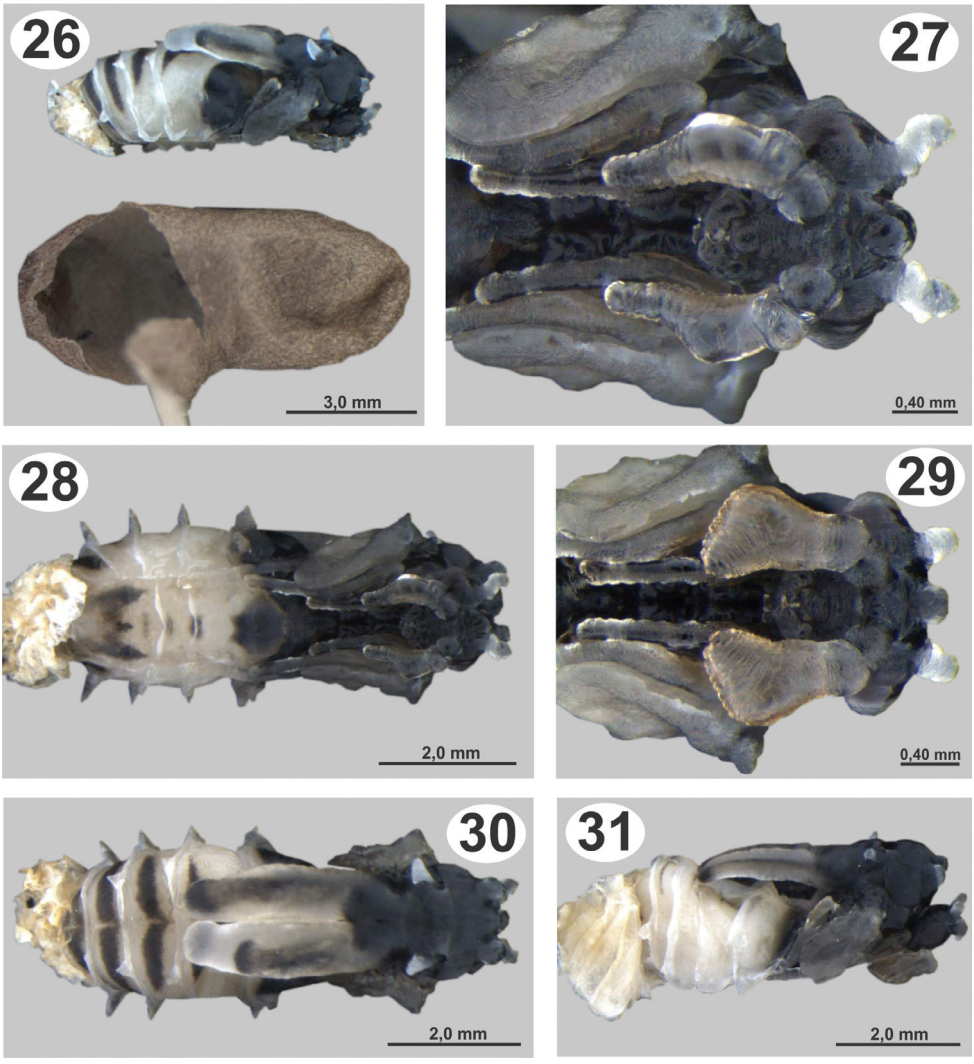
Host Plant. *Pseudabutilon virgatum* is a ligneous shrub that grows not more than 1 m in height, persists year round, and blooms in the humid seasons (spring-summer); its leaves are ovate and marginally serrate and last to the beginning of the cold season (May-June) (Fig. 16).

Host ants. *Ectatomma brunneum* workers were observed and sampled from under the plants with *Dicoelothorax*. In a radius of about 4m, we found three ant nests (H1–H3). The disposition of chambers and general structure of nests are similiar to those observed by Lapola et al. (2003). Nests had 1 to 3 openings at ground level, without any structure elevated above the surface (Fig. 21). Chambers from which the immature stages were extracted were found at a depth of 10 to 13 cm (Figs 22, 23). In two of those nests we found immature stages of ants and parasitoids; in the other (H3) we only found a chamber with a collection of arthropods suggesting that it was a food cache. Nest H1 contained 17 cocoons and 2 larvae, and nest H2 had 97 larvae and no cocoons.

Life History of *D. platycerus*. Collections of adults of *D. platycerus*, *P. virgatum*, and ant nests were made in 2009 (March 12) and 2010 (March 27 and April 3). Females placed in plastic tubes were observed ovipositing on the undersides of the leaves of *P. virgatum* (Figs 17, 18). A single gravid female oviposited about 40 eggs per 1 mm^2 between the spicules forming the pubescence on the underside of leaves (Figs 17, 18). Numerous mites were observed on the leaves, and oviposition under the dense network of spicules appears to be a protection against egg predators. Eggs hatched within 10 days; however, many of the remaining eggs contained mature planidia that did not hatch. First instars (planidia) are very mobile and have a propensity to jump. Larvae presumably attach phoretically to foraging ants under the host plant and get carried back to the ant nest where they attack the ant larvae (Clausen 1941). Of two pupae of *D. platycerus* obtained in H1, one male emerged 12 days after the nest was excavated; whereas the other pupa (female) did not emerge (Figs 26–31). The percentage of parasitism ranged from 6.2% in H2 to 21% in H1. In nest H1, 17 cocoons were recovered, with two pupae of *D. platycerus* (1 female and 1 male) and 2 ant prepupae parasitized by second instars of *D. platycerus* (Fig. 24). In nest H2, 97 larvae were recovered with 6 parasitized by planidia (Fig. 25).



Figures 21–25. Biology and immature stages of *Dicoelothorax platycerus* **21** nest entrace of *Ectatomma brunneum* (opening indicated) **22** brood chamber (indicated) **23** brood chamber magnified **24** prepupa parasitized (2nd instar larva indicated and magnified) **25** ant larva parasitized (attached planidium magnified).



Figures 26–31. Pupae of *Dicoelothorax platycerus* **26** pupa extracted with ant cocoon (female, lateral) **27** head (female, ventral) **28** pupa in ventral view (female) **29** head (male, ventral) **30** pupa in dorsal view (female) **31** pupa in lateral view (male).

Discussion. *Ectatomma brunneum* was reported as the ant host for an unidentified species of *Kapala* (Eucharitidae: Eucharitini) in French Guiana, (Lachaud et al. 2011). It is noteworthy that the same ant species is the primary host for at least two different eucharitid genera. Similarly, *Ectatomma tuberculatum* (Olivier) can be attacked by three different eucharitid genera, *Dilocantha*, *Isomerala* and *Kapala* (Pérez-Lachaud et al. 2006b).

Material examined. ARGENTINA. Salta, Tartagal, xii.1971, UCRC_ENT 305490 and UCRC_ENT 305491 (2 males, AMNH). Salta, Güemes, 7.ii.1983, UCRC_ENT

305492 (1 female, AMNH); same location and data, UCRC_ENT 305493 (1 male, AMNH). Salta, Cabeza de Buey, 24°47'36"S, 64°01'57"W, 15–16.iii.2007, J.&J. Heraty & J. Torréns, UCRC_ENT 305494 (1 female, UCRC); same location and data, UCRC_ENT 305495 and UCRC_ENT 305496 (2 males, UCRC); same location and data, UCRC_ENT 305497, UCRC_ENT 305498 and UCRC_ENT 305499 (3 males, IFML). Salta, Cabeza de Buey, 24°47'36"S, 64°01'57"W, 19.ii.2008, P. Fidalgo, UCRC_ENT 305500 (1 female, MACN); same location and data, UCRC_ENT 305501 (1 male, MACN). Salta, Lumbreras, 25°12'19"S, 64°54'34"W, 14.iii.2009, J. Torréns, UCRC_ENT 305502 (1 female, IFML). Tucumán, San Vicente, 26°25'36"S, 65°15'41"W, 12.iii.2009, J. Torréns, UCRC_ENT 305503 and UCRC_ENT 305504 (2 females, IFML); same location, 27.iii.2010, J. Torréns, ex. Pupa of *Ectatomma* brunneum UCRC_ENT 305505 (1 female, IFML); same location and data, UCRC_ENT 305506 (1 male, IFML); same location, 03.iv.2010, J. Torréns, ex. pupa of *Ectatomma brunneum*, UCRC_ENT 305507 (1 male, IFML).

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RESEARCH ARTICLE

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Two new species of *Quedius* Stephens, subgenus *Raphirus* Stephens from Yunnan, Southwest China (Coleoptera, Staphylinidae, Staphylinini)

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Abstract

Two new species of the genus *Quedius* Stephens collected from Nabanhe Nature Reserve, Yunnan Province, *Q. nabanhensis* **sp. n.** and *Q. maoxingi* **sp. n.**, are described and illustrated. Keys to the *multipunctatus* group and *intricatus* group of *Quedius* species of Yunnan are provided. A map of the collecting sites is given.

Keywords

Coleoptera, Staphylinidae, Staphylinini, *Quedius*, key, Yunnan, Southwest China, new species

Introduction

To date, about 50 species of the genus *Quedius* Stephens, 1829 have been known from Yunnan Province, China (Herman 2001 and subsequent papers: Smetana 2002,

2004, 2008a, 2008b, 2008c, 2009, 2011). Among them, four species belong to the *multipunctatus* species group (*Q. chrysogonus* Smetana, 1997a, *Q. puetzi* Smetana, 1998, *Q. viridimicans* Smetana, 2009 and *Q. michaeli* Smetana, 2009) and two to the *intricatus* species group (*Q. rivulorum* Smetana, 2002 and *Q. torrentum* Smetana, 2002), both species groups from the subgenus *Raphirus* (Smetana 1995). The recent expedition to Nabanhe Nature Reserve, south Yunnan Province, brought two new species of the genus, which are described below: *Q. nabanhensis* sp. n. and *Q. maoxingi* sp. n. Both of them are placed in the subgenus *Raphirus* Stephens, 1829: the former to the *multipunctatus* group and the latter to the *intricatus* group. Both new species are here described and illustrated. Keys to the species of *Quedius* from Yunnan belonging to the *Multipunctatus* and *Intricatus* species groups species are provided. A map (Fig. 16) of the collecting sites is given. Holotypes and most of the paratypes are deposited in the Insect Collection of Shanghai Normal University, Shanghai, P. R. China. Two paratypes of *Q. nabanhensis* is deposited in the collection of Dr. Aleš Smetana (Ottawa, Canada).

Methods

The specimens were collected by sifting from wet moss on rocks in streams. They were killed with ethyl acetate and dried. The sternites, tergites and aedeagi were mounted in the Euparal on plastic slides. The habitus photos were taken with a Canon 40D camera. The photos of the sternites, tergites and aedeagi were taken with a Canon G9 camera mounted on an Olympus SZ61 stereoscope.

Measurements

Body length: measured from the anterior margin of the labrum to the end of abdomen;
Forebody length: measured from the anterior margin of the labrum to the elytral apices;
Head length: measured from the apical margin of the head capsule to its posterior margin;
Head width: Maximal width of the head across eyes;
Eye length: longitudinal length of the eye in dorsal view;
Tempora length: length of the tempora in dorsal view;
Pronotum length: measured from the front margin of the pronotum to its posterior margin along the imaginary median line;
Pronotum width: width of the pronotum across its widest part;
Elytral width: width of the elytra at base;
Elytral length at suture: measured from the apex of the scutellum to the apex of suture;
Elytral length at lateral margins: measured from the humeral angle to the elytral apex.

Descriptions

***Quedius nabanhensis* sp. n.**
urn:lsid:zoobank.org:act:39047DBA-1AD7-44D0-9C0F-CBB27EB8A71B
http://species-id.net/wiki/Quedius_nabanhensis
Figs 1–8

Type material. Holotype. CHINA: Yunnan Prov.: male, Jinghong City, Nabanhe Nature Reserve, Bengganghani, Huazhulianshan, alt. 2,300 m, 29-IV-2009, Jia-Yao HU & Zi-Wei YIN leg. Paratypes. 3 males, 3 females, same data as holotype.

Description. Body length: 8.0–8.6 mm; forebody length: 4.1–4.3 mm.

Body (Fig. 1) shiny, head, pronotum and elytra bright metallic green, abdomen black and iridescent; appendages yellowish brown, antennae slightly darkened from base toward apex.

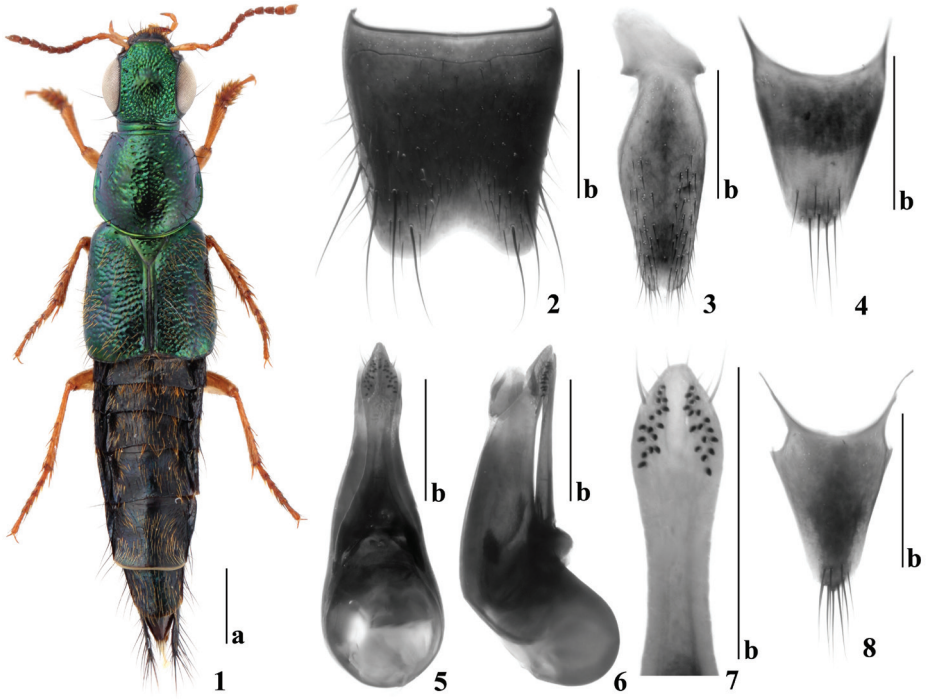
Head slightly wider than long (ratio 1.18); eyes large and convex, tempora distinctly shorter than eyes from above (ratio 0.18); dorsal surface of head with coarse and dense punctation, becoming finer toward vertex and clypeus; surface with fine and dense microsculpture of transverse waves, becoming almost meshed anterior to vertex. Antennae slightly widened apicad, segments III slightly longer than II, segments IV–IX longer than wide, gradually becoming shorter, segments X about as long as wide, last segment as long as two preceding segments combined.

Pronotum about as long as wide; dorsal rows each with seven to eight coarse punctures, forming irregular row; sublateral rows each expanded into irregular group of seven to ten punctures; some distinctly finer punctures scattered among coarse punctation; surface with fine and dense microsculpture of transverse waves. Scutellum with nine to fourteen fine punctures, with fine microsculpture of transverse waves. Elytra at base about as wide as pronotum at widest point, at suture slightly shorter (ratio 0.84), at lateral margins slightly longer (ratio 1.35) than pronotum at midline; punctation coarse and dense, almost confluent and forming transverse rugae; pubescence yellowish-golden; surface without microsculpture. Wings fully developed.

Abdomen with tergite VII bearing distinct whitish apical seam of palisade fringe; punctation moderately fine and dense; pubescence black, each tergite with some scattered golden pubescence; surface with fine and dense microsculpture of transverse waves.

Male. First four segments of protarsus distinctly dilated. Sternite VIII (Fig. 2) with four long setae on each side, with wide, shallow, arcuate medioapical emargination. Sternite IX (Fig. 3) slightly notched in medioapical emargination, with two differentiated apical setae. Tergite X (Fig. 4) with several apical setae. Aedeagus (Figs 5–7) with median lobe gradually narrowed into cone-shaped apex; paramere not reaching apex of median lobe, in ventral view distinctly narrowed at middle and slightly widened near apex; with two apical setae, two similar setae and one long seta at each lateral margin below apex; underside of paramere with sensory peg setae arranged into two longitudinal areas, each with 16–17 peg setae.

Female. First four segments of protarsus similar to those of male, but distinctly less dilated. Tergite X (Fig. 8) with several apical setae.



Figures 1–8. *Quedius nabanhensis* sp. n. **1** habitus **2** male sternite VIII **3** male sternite IX **4** male tergite X **5** aedeagus in ventral view **6** aedeagus in lateral view **7** apical portion of underside of paramere **8** female tergite X. Scale bars: a = 1mm, b = 0.5mm.

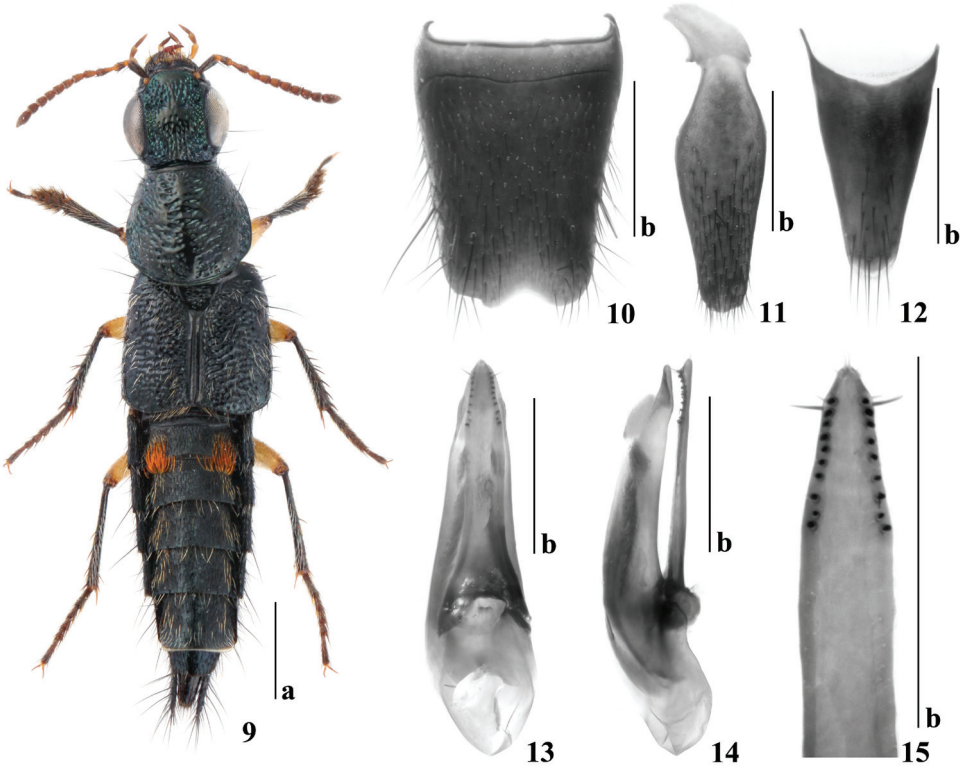
Distribution. Known only from the type locality (Southwest China: Yunnan Province).

Remarks. *Quedius nabanhensis* is closest to *Q. xeno* Smetana, 1997b, the species known from Northern Vietnam based on the female holotype only, due to the similar form and color of the body in both species. The new species can be distinguished from *Q. xeno* by the larger size (8.0–8.6 mm), the scutellum with several punctures and by the female tergite X (Fig. 8) with several apical setae. *Quedius xeno* is smaller (6.6 mm), the scutellum lacks punctures and the female tergite X bears with two setae.

Etymology. The specific epithet is derived from the type locality.

***Quedius maoxingi* sp. n.**
urn:lsid:zoobank.org:act:8EB20BBE-E5E1-468F-9F27-FA5BAA78B815
http://species-id.net/wiki/Quedius_maoxingi
Figs 9–15

Type material. Holotype. CHINA: Yunnan Prov.: male, Jinghong City, Nabanhe Nature Reserve, Guomenshan, alt. 1,200 m, 8-V-2009, Jia-Yao HU & Zi-Wei YIN leg.



Figures 9–15. *Quedius maoxingi* sp. n. **9** habitus **10** male sternite VIII **11** male sternite IX **12** male tergite X **13** aedeagus in ventral view **14** aedeagus in lateral view **15** apical portion of underside of paramere. Scale bars: a = 1mm, b = 0.5mm.

Description. Body length: 6.8 mm; forebody length: 3.4 mm.

Body (Fig. 9) shiny, head, pronotum and elytra dark metallic blue, abdomen black and iridescent; maxillary and labial palpi brown with basal segments slightly paler; antennae brown, first segments and apical halves of following two segments black; legs black with femora and front coxae yellowish.

Head slightly wider than long (ratio 1.12); eyes large and convex, tempora distinctly shorter than eyes seen from above (ratio 0.18); dorsal surface of head with coarse and dense punctation; clypeus and vertex lacking punctures; surface with fine and dense microsculpture of transverse waves, becoming almost meshed anterior to vertex. Antennae slightly widened toward apex, segments II and III subequal in length, IV and V slightly longer than wide, segments VI–X about as long as wide, last segments about as long as two preceding segments combined.

Pronotum about as long as wide; dorsal rows irregular, each with 16 coarse punctures, each row expanding into group of punctures posteriorly; sublateral rows each expanded into irregular group of nine to ten coarse punctures; some distinctly finer punctures scattered among coarse punctation; with many dense and fine punctures

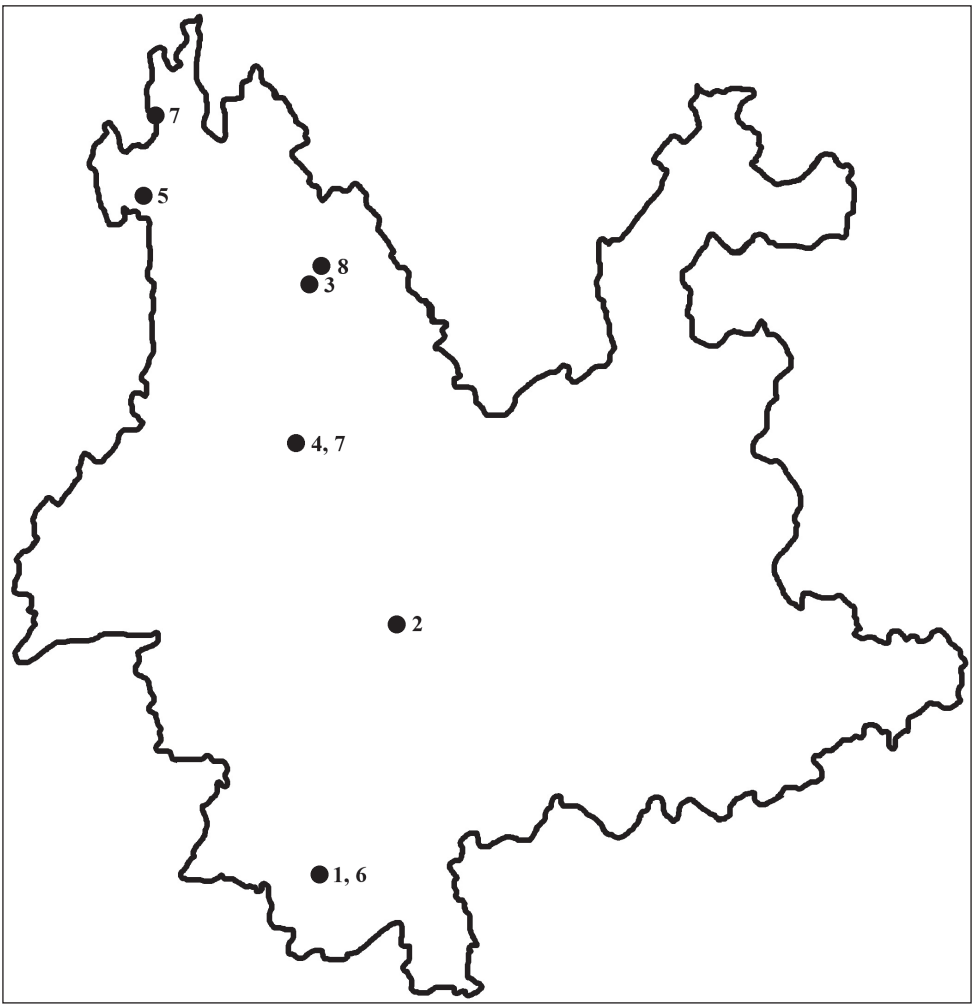


Figure 16. Map showing the collecting sites of the *multipunctatus* group and *intricatus* group of *Quedius* in Yunnan Prov. **1** *Q. nabanhensis* sp. n. **2** *Q. chrysogonus* Smetana **3** *Q. puetzi* Smetana **4** *Q. viridimicans* Smetana **5** *Q. michaeli* Smetana **6** *Q. maoxingi* sp. n. **7** *Q. torrentum* Smetana **8** *Q. rivulorum* Smetana.

bearing whitish hairs in wide strip along lateral margin; surface with fine and dense microsculpture of transverse waves. Scutellum with 14 punctures, with fine microsculpture of transverse waves. Elytra at base about as wide as pronotum at widest point, at suture slightly shorter (ratio 0.74), at sides slightly longer (ratio 1.26) than pronotal midline; punctation coarse and dense, on disc forming transverse rugae; pubescence dark, intermixed with whitish hairs, particularly on lateral portion of each elytron; surface without microsculpture. Wings fully developed.

Abdomen with tergite VII bearing distinct whitish apical seam of palisade fringe; punctation moderately fine and dense; tergite III with distinct tuft of golden-reddish

tomentose pubescence on each lateral portion; pubescence black at middle portion, with some whitish hairs at both lateral portions and at apical margin of each tergite; surface with fine and dense microsculpture of transverse waves.

Male. First four segments of front tarsus distinctly dilated. Sternite VIII (Fig. 10) with two long setae on each side, with wide, shallow, arcuate medioapical emargination. Sternite IX (Fig. 11) simply rounded in medioapical emargination, without differentiated setae. Tergite X (Fig. 12) with five long setae near posterior margin and several shorter setae anterior to them; Aedeagus (Figs 13–15) with median lobe gradually narrowed into cone-shaped apex; paramere extending slightly beyond apex of median lobe; with two setae at apex, two slightly shorter setae and one distinctly longer seta at each lateral margin below apex; underside of paramere with sensory peg setae forming two regular longitudinal rows, each with nine or ten peg setae.

Female. Unknown.

Distribution. Known only from the type locality (Southwest China: Yunnan Province).

Remarks. *Quedius maoxingi* is closest to *Q. barbarossa* Smetana, 2002 due to similar form and color of the body. The new species can be distinguished from *Q. barbarossa* by the pronotum with some finer punctures scattered among coarse punctation, the scutellum with several punctures and by the aedeagus with symmetrical paramere (Fig. 15). *Quedius barbarossa* lacks fine punctures scattered among coarse punctation, its scutellum lacks punctures and the aedeagus bears distinctly asymmetrical paramere.

Etymology. The species is named in honor of Maoxing Tian (Administration of Nabanhe River Watershed National Nature Reserve) who helped a lot during our collection in Yunnan.

Key to the *multipunctatus* species group of *Quedius* (*Raphirus*) from Yunnan Province, China

1 Scutellum with several punctures; pubescence of abdominal tergites not uniform, bearing some golden hairs intermixed with black ones ..... ***Q. nabanhensis* sp. n.**

– Scutellum impunctate; pubescence of abdominal tergites uniform, black or yellowish golden **2**

2 Pubescence of abdominal tergites black..... **3**

– Pubescence of abdominal tergites yellowish golden **4**

3 Head and pronotum with dark green metallic lustre, elytra brilliant dark green; head with microsculpture gradually changing from transverse to meshed on anterior half ..... ***Q. chrysogonus* Smetana**

– Head and pronotum with bronze-green metallic lustre, elytra brilliant bronze-green; head with microsculpture barely changing from transverse to meshed on anterior half..... ***Q. puetzi* Smetana**

4 Pronotum with sublateral rows each expanded into irregular group of seven or eight punctures; sensory peg setae of underside of paramere forming two separate longitudinal rows..... ***Q. viridimicans*** **Smetana**

– Pronotum with sublateral rows each expanded into irregular group of ten to twelve punctures; sensory peg setae of underside of paramere forming apical field below apex of paramere, then extended posteriad as a row along each lateral margin..... ***Q. michaeli*** **Smetana**

Key to the *intricatus* species group of *Quedius* (*Raphirus*) from Yunnan Province, China

1 Femora entirely yellowish; scutellum with several punctures .... ***Q. maoxingi*** **sp. n.**

– Apices and dorsal edge of femora black; scutellum impunctate **2**

2 Abdominal tergite III with a tuft of golden-reddish tomentose pubescence on each lateral portion; sensory peg setae of underside of paramere forming a dense subapical field, with about 50 peg setae..... ***Q. torrentum*** **Smetana**

– Abdominal tergite III without tufts of golden-reddish tomentose pubescence; sensory peg setae of underside of paramere forming two irregular longitudinal rows, each with 11 and 13 peg setae..... ***Q. rivulorum*** **Smetana**

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We thank Aleš Smetana (Ottawa, Canada) for help in obtaining some references and in identification. Mao-Xing Tian (Yunnan, China) helped in many ways during our collection in Yunnan. Zi-Wei Yin (Shanghai, China) collected some of the specimens and commented on a previous version of the manuscript. We are also grateful to the two anonymous reviewers for critically reading the manuscript and providing useful comments. The present study is supported by the National Natural Science Foundation of China (No. 31172134 and No. 31101659).

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Cuban *Calisto* (Lepidoptera, Nymphalidae, Satyrinae), a review based on morphological and DNA data

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Abstract

The Cuban species of *Calisto* are reviewed based on the morphology of adult and immature stages, as well as DNA sequences of six genes (COI, EF1α, *wingless*, GAPDH, RpS5, CAD). A new species, *Calisto occulta* **sp. n.**, is described from the northeastern Cuban mountains. *Calisto smintheus* Bates, 1935 and *C. bruneri,* Michener 1949 are revised and revalidated. A new status, the species level, is proposed for *C. brochei,* Torre 1973, *C. muripetens,* Bates 1939 and *C. bradleyi,* Munroe 1950. The immature stages of *C. smintheus*, *C. brochei*, and *C. occulta* are described for the first time, and those of *C. herophile,* Hübner 1823 are redescribed. Useful morphological characters for adults are the shape and conspicuousness of androconial patch, the number and relative size of white dots on underside of hindwing, the shape of aedeagus, the shape of digitiform projection of genitalia valve, the shape and relative size of tegumen and uncus, the relative size of female genitalia, the height of sterigmal ring dorsal crown of the latter, and the relative size of corpus bursae and ductus bursae. For the immature stages, the most important characters are the color pattern of head capsule, the number and width of longitudinal lines of body, in the larvae; and the color pattern and the absence or presence of dorsal ridges on the abdomen of pupae. The phylogenetic relationships between the Cuban *Calisto* species are

quite robust and well-supported; however, conflict between mitochondrial and nuclear datasets was detected in *C. brochei*, *C. muripetens* and to a lesser degree in *C. bradleyi*.

Keywords
Taxonomy, speciation, DNA, habitat, distribution, life cycle, immature stages, Greater Antilles

Introduction

The genus *Calisto* Hübner, 1823 is endemic to the West Indies and is the only representative of the subfamily Satyrinae (Nymphalidae) in the area. Lamas (2004) listed 42 *Calisto* species, 37 of them from Hispaniola and the remainder present on Cuba, Jamaica, Puerto Rico, Anegada Island and Bahamas. Until late the 1960s, the taxonomy of the Cuban species was relatively stable with most of the original names retained after several works (Bates 1935; 1939; Clench 1943; Michener 1949; Munroe 1950; Torre 1952; 1954; 1968). However, Brown and Heineman (1972) treated all Cuban species as *Calisto herophile* Hübner, 1823 and *Calisto sibylla* Bates, 1934 without giving any taxonomic reason, a decision criticized soon by Munroe (1972). The majority of subsequent authors (Alayo and Hernández 1987; Smith et al. 1994; Lamas 2004) have maintained this unjustified treatment. Núñez (2009) supported the use of original names until an in-depth review of the Cuban and Bahamian species takes place.

Several factors delayed the clarification of Cuban *Calisto* taxonomy, of which the most important is the cryptic nature of most species, with adults showing little morphological differences. Also, some of the few useful adult characters have received poor attention by researchers, *e.g.* shape and conspicuousness of androconial patch, the structure of male and female genitalia; whereas others have been overused or misused, *e.g.* shape of red spot at underside of forewing cell, number and relative size of white dots at underside of hindwing. Characters of immature stages of most species remained unavailable until the present work. They have proven to be useful in the taxonomy of Hispaniolan members of genus (Sourakov and Emmel 1995, Sourakov 1996, 1999).

In the present work, we review the Cuban species of *Calisto* and describe a new species from the northeastern Cuban mountains. Several taxonomic changes based on both morphological and molecular evidence are proposed. Detailed diagnoses are provided for each species. The male and female genitalia of all Cuban species are fully illustrated and described. A key for all species known from Cuba is also provided. Natural history notes, including new localities, habitat, nectar sources, and description of immature stages, are compiled for all Cuban *Calisto*. DNA sequencing is used here for the first time in the taxonomy of Cuban *Calisto*. Only *C. herophile* was included recently in a DNA barcoding study involving the Hispaniolan, Jamaican and Puerto Rican species of *Calisto* (Sourakov and Zakharov 2011). Here we sequenced six molecular markers, one mitochondrial (COI) and five nuclear genes (EF1α, wingless, GAPDH, RpS5 and CAD), in order to clarify the status and relationships of all known Cuban taxa.

Materials and methods

Collection and rearing of immature stages

Eggs were obtained by confining females to plastic jars of 5 oz. After being laid, the eggs remained untouched (no measures were taken) until larvae hatched. Egg collection data: *C. herophile*– Pinar del Río, Sierra del Rosario, Rangel, 19–20 April 2009, *C. occulta*– Holguín, Moa, Yamanigüey, 25 September 2009, *C. smintheus smintheus* – Santiago de Cuba, Gran Piedra, near Estación BIECO, 25 February 2011, *C. smintheus brochei* – Guantánamo, Baracoa, northern slope of Monte Iberia, 3–4 May 2011. Larvae were maintained at ambient temperature, humidity and photoperiod in Havana. For all species, two introduced common grass species, *Zoysia japonica* and *Cynodon dactylon*, were used daily as substitute host plants. Width and height of head capsules and length of larvae, at first instar, were measured with an ocular micrometer having 0.01 mm of precision mounted in a Carl Zeiss Stemi 2000 stereoscopic microscope. Length of last instar larvae and pupae were measured with a metric ruler of 1 mm of precision.

Dissections, characters & descriptions

Wings were cleared with sodium hypochlorite, Eosin–Y tinged and mounted in Euparal. Genitalia and other body parts were treated with hot 10% potassium hydroxide (KOH) solution and the cleaned material was stored in glycerine.

Morphological characters for adults were those traditionally used in previous studies on *Calisto*. For wing pattern, we follow Smith et al. (1994), Jonhson and Hedges (1998), and Núñez (2009). For male genitalia, we follow the terms used by Núñez (2009) and for the female genitalia those detailed by Johnson et al. (1987). Species descriptions and the key are based primarily on fresh specimens. Recently collected individuals show all details of color pattern, mainly those important on the under surface of the wings, which fade relatively fast after death (Smith et al. 1994; Sourakov in Johnson and Hedges 1998). For immature stages, the characters given by Sourakov and Emmel (1995) and Sourakov (1996; 1999) were used. The nomenclature for the longitudinal lines of larvae was after Dethier (1940) except for the para–dorsal for which case the subdorsal line was used.

DNA analysis

Two butterfly legs per individual were preserved either desiccated or immersed in ethanol. Total DNA was extracted from legs using the DNEasy extraction kit (QIAGEN). Six molecular markers including one mitochondrial (COI) and five nuclear genes (EF1α, wingless, GAPDH, RpS5 and CAD) were amplified using previously published primers and protocols (Wahlberg and Wheat 2008). DNA sequencing was carried out by the company Macrogen-South Korea. Sequence editing and alignment

were done manually in the program BioEdit v7.0.5 (Hall 1999). Voucher photos are available at the Nymphalidae Systematics Group database (http://nymphalidae.utu.fi/db.php) and DNA sequences have been submitted to GenBank (Annex 1).

Genetic distances were calculated using the program MEGA4 (Tamura et al. 2007) using the Kimura 2-Parameter model and the Pairwise Distance Calculation analysis for the partial sequence of COI gene, following the DNA barcoding approach (Hebert et al. 2003; Hebert et al. 2004). Phylogenetic analyses were carried out in the program MrBayes v3.1 (Ronquist and Huelsenbeck 2003) and executed through the CIPRES web portal (http://www.phylo.org/sub_sections/portal/). The data were partitioned by gene and analyzed as independent partitions. Due to conflicting results, we chose to analyze the mitochondrial and nuclear genes separately. We imposed the GTR+G sequence evolution model to every partition based on the Log Likelihood values and the Akaike Information Criteria (AIC) calculated using the FindModel portal (http://www.hiv.lanl.gov/content/sequence/findmodel/findmodel.html). Two independent MCMC analyses with four simultaneous chains (one cold and three heated) on each analysis were run for 10 million generations and the sampling of trees was set to every 1000 generations. Convergence of the two runs was determined by the stationary distribution plot of the log likelihood values against number of generations and confirmed by the average standard deviation of split frequencies which in all the cases were lower than 0.05. We discarded the first 1000000 generations as burn-in and trees were summarized under the 50 percent majority rule method.

Repository abbreviations

AMNH	American Museum of Natural History, New York, USA.
CZACC	Instituto de Ecología y Sistemática, Havana, Cuba.
CMNH	Carnegie Museum of Natural History, Pittsburgh, USA
CUIC	Cornell University Insect Collection, Ithaca, USA
MFP	Museo Felipe Poey, Havana, Cuba.
FZC	Private collection of Fernando de Zayas, Havana, Cuba.
MCZ	Museum of Comparative Zoology of Harvard, Cambridge, MS, USA

Type material of Cuban and Bahaman *Calisto* deposited at Museum of Comparative Zoology, Harvard, except *Calisto smintheus muripetens* Bates 1939, was reviewed through pictures available on Internet by the E–Type Initiative (Perkins et al. 2005).

Other abbreviations

dl	discal line
FW	forewing
HW	hindwing

Annex 1. GenBank accession numbers to sequenced genes of Cuban and Hispaniolan (outgroup) *Calisto* specimens used in present study.

	Species	**Voucher code**	**Collection locality**	**coi**	**ef1a**	**wingless**	**gapdh**	**rps5**	**cad**
Outgroup	*Calisto arcas*	NW149-16	DOMINICAN REPUBLIC: La Vega Province, 22 km SE of Costanza, Hwy 41	JN881877	JN881759	JN881855	JN881811	JN881829	JN881779
	Calisto chrysaoros	DR017	DOMINICAN REPUBLIC: La Ciénaga, La Vega	JN881878	JN881760	JN881856	JN881812	JN881830	JN881780
	Calisto confusa	DR016	DOMINICAN REPUBLIC: La Ciénaga, La Vega	JN881879	JN881761	JN881857	JN881813	JN881831	JN881781
	Calisto obscura	DR080	DOMINICAN REPUBLIC: Boca de Yuma, Parque Nac. del Este	JN881880	JN881762	JN881858	JN881814	JN881832	JN881782
	Calisto pulchella	DR003	DOMINICAN REPUBLIC: Puerto Plata	GQ357225	GQ357292	GQ357357	GQ357467	GQ357596	JN881783
	Calisto bradleyi	PM07-06	CUBA: El Taburete, Sierra del Rosario	JN881881	JN881763	JN881859	JN881815	JN881833	JN881784
	Calisto bradleyi	PM07-24	CUBA: Base norte Mogote Dos Hermanas	JN881882	JN881764	JN881860	JN881816	JN881834	JN881785
	Calisto bradleyi	PM07-25	CUBA: Base norte Mogote Dos Hermanas	JN881883	-	JN881861	JN881817	JN881835	JN881786
	Calisto bradleyi	PM07-26	CUBA: Base norte Mogote Dos Hermanas	JN881884	JN881765	JN881862	JN881818	JN881836	JN881787
	Calisto brochei	PM07-03	CUBA: Ladera norte Monte Iberia, cerca de antiguo campamento minero	JN881885	JN881766	JN881854	-	JN881828	JN881788
	Calisto brochei	PM15-03	CUBA: South of Tetas de Julia, Monte Iberia	JN881871	-	-	-	-	-
	Calisto brochei	PM07-20	CUBA: Estación La Zoilita	JN881886	JN881767	JN881863	JN881819	JN881837	JN881789
	Calisto bruneri	PM07-15	CUBA: Cayo Grande, Moa	JN881887	JN881768	JN881846	-	-	JN881790
	Calisto bruneri	PM07-16	CUBA: Cayo Grande, Moa	JN881888	JN881769	JN881847	-	-	JN881791
	Calisto bruneri	PM07-17	CUBA: Yamanigüey	JN881889	-	-	-	-	JN881792
	Calisto bruneri	PM07-21	CUBA: Estación La Zoilita	JN881890	JN881770	JN881864	JN881820	JN881838	JN881793
	Calisto herophile apollinis	PM13-01	BAHAMAS: New Providence I., Prospect Ridge Natl. Pk.	JN881872	-	-	-	-	-
	Calisto herophile apollinis	PM13-02	BAHAMAS: New Providence I., Prospect Ridge Natl. Pk.	JN881873	-	-	-	-	-
	Calisto herophile herophile	CP19-16	CUBA: La Habana	JN881874	-	-	-	-	-

	Species	Voucher code	Collection locality	coi	ef1a	wingless	gapdh	rps5	cad
	Calisto herophile herophile	PM07-07	CUBA: Río Guajaibón, La Habana	JN881891	-	-	-	-	JN881794
	Calisto herophile herophile	PM07-12	CUBA: Loma del Gato, Sierra del Cobre	JN881892	-	JN881848	-	-	JN881795
	Calisto herophile herophile	PM07-22	CUBA: Estación La Zoilita	JN881893	JN881771	JN881865	JN881821	JN881839	JN881796
	Calisto herophile herophile	PM15-06	CUBA: Camino de La Melba, Moa	JN881894	-	JN881849	-	-	JN881797
	Calisto israeli	PM07-01	CUBA: Ladera norte Monte Iberia, cerca de antiguo campamento minero	JN881895	JN881772	JN881866	JN881822	JN881840	JN881798
	Calisto israeli	PM07-02	CUBA: Morones, cerca de La Melba	JN881896	JN881773	JN881867	JN881823	JN881841	JN881799
	Calisto israeli	PM07-27	CUBA: Antiguo campamento minero Meseta de El Toldo	JN881875	-	-	-	-	-
	Calisto muripetens	PM07-08	CUBA: Carso de Buenos Aires	JN881897	-	-	-	-	JN881800
	Calisto muripetens	PM07-11	CUBA: Carso de Buenos Aires	JN881898	-	JN881868	JN881824	JN881842	JN881801
	Calisto muripetens	PM15-02	CUBA: Pico San Juan	JN881876	-	-	-	-	-
	Calisto occulta	PM07-04	CUBA: Tetas de Julia	JN881899	JN881774	-	JN881825	JN881843	JN881802
	Calisto occulta	PM07-10	CUBA: Tetas de Julia	JN881900	-	-	-	-	JN881803
	Calisto occulta	PM07-18	CUBA: Yamanigüey	JN881901	JN881775	JN881869	JN881826	JN881844	JN881804
	Calisto occulta	PM07-19	CUBA: Yamanigüey	JN881902	JN881776	JN881850	-	-	JN881805
	Calisto occulta	PM07-23	CUBA: Yamanigüey	JN881903	JN881777	JN881851	-	-	JN881806
	Calisto smintheus	PM07-05	CUBA: Alrededores de La Platica	JN881904	JN881778	JN881870	JN881827	JN881845	JN881807
	Calisto smintheus	PM07-09	CUBA: Ladera sur Pico Regino	JN881905	-	-	-	-	JN881808
	Calisto smintheus	PM07-13	CUBA: Loma del Gato, Sierra del Cobre	JN881906	-	JN881852	-	-	JN881809
	Calisto smintheus	PM07-14	CUBA: Loma del Gato, Sierra del Cobre	JN881907	-	JN881853	-	-	JN881810

NSB	Nipe–Sagua–Baracoa
pdl	postdiscal line
stl	subterminal line(s)
M_1–M_2	interspace between median (M) veins 1 and 2
M_2–M_3	interspace between median (M) veins 2 and 3
M_3–Cu_1	interspace between median (M) vein 3 and cubital (Cu) vein 1
Rs–M_1	interspace between Radial sector (Rs) and median (M) vein 1
UN	under side
UP	upper side
UNFW	under side of forewing
UNHW	under side of hindwing
UPFW	upper side of forewing
UPHW	upper side of hindwing

Results

***Calisto israeli* Torre, 1973**
http://species-id.net/wiki/Calisto_israeli
Figs 1–3, 25, 32, 40, 48, 56, 57, 60–62, 66

Calisto israeli Torre 1973: 3, Alayo and Hernández 1987: 41, Núñez 2009: 49
Calisto israel Smith et al. 1994: 57, misspelling
Calisto sibylla smintheus Lamas 2004: 207

Diagnosis. *Calisto israeli* can be separated from all its congeners by the large, triangle shaped patch of white scales at the middle portion of the inner margin at UNHW.

Description. FWL: 24–26 mm ♂, 25–27 mm ♀. Male UPFW uniform brown except basal two thirds of costa and androconial patch, dark brown almost black (Fig. 1). Androconial patch extending diagonally between posterior margin of cell and 2A vein to beyond M_3 origin, outer and posterior margins rounded, about three fifths the length of FW (Fig. 32). Female UPFW with basal three fifths and outer margin dark brown, outer two fifths pale brown (Fig. 2). Male UPHW uniform dark brown, costa pale brown. Female UPHW dark brown at anterior two thirds, posterior third pale brown. UN of wings brown mixed with ochre and, in less extent, pale yellow scales mostly at basal half (Figs 3, 25); interspace of stl pale brown mixed with pale yellow scales. UN lines of wings without external edge of pale scaling, only white scales on outer edge of pdl at posterior half of wing. UNFW without red on cell and white scaling below cell to posterior margin. Post discal area on UNHW with four white dots at Rs–M_1, M_1–M_2, M_2–M_3, dot at M3–Cu_1 if present very small; middle of UNHW posterior margin with a large triangular patch of white scales; post discal area heavily suffused with white scales. HW anal lobe entirely black at UN. Male genitalia heavily sclerotized, tegumen approximately 0.7 the length of uncus, with dorsum nearly flat (Fig. 40); uncus stout and slightly arched, tapering gradu-

Figures 1–12. Cuban *Calisto* adults. **1** *C. israeli* ♂ upper side, Guantánamo, Baracoa, Monte Iberia, al sur de las Tetas de Julia **2** *C. israeli* ♀ upper side, same locality **3** *C. israeli* ♂ under side **4** *C. smintheus* ♂ upper side, Granma, Sierra Maestra, La Platica **5** *C. smintheus* ♀ upper side, Granma, Bartolomé Masó, ladera sur Pico Regino **6** *C. smintheus* ♂ under side **7** *C. brochei* ♂ upper side, Guantánamo, Baracoa, ladera norte Monte Iberia **8** *C. brochei* paratype ♀ upper side, Oriente (currently Guantánamo), Cupeyal **9** *C. brochei* ♂ under side **10** *C. bruneri* ♂ upper side, Holguín, Sierra de Cristal, cerca de Estación La Zoilita 400 m. **11** *C. bruneri* ♀ upper side, Holguín, Moa, Cayo Grande **12** *C. bruneri* ♂ under side.

ally to apex, base slightly protruding, subquadrate; digitiform projection of valve straight with ventral margin slightly concave; aedeagus swollen at base in lateral view, near straight with a small left curve at basal half in dorsal view. Female genitalia large (Fig. 48); dorsal crown very tall; corpus bursae broad, approximately 0.8 the length of ductus bursae.

Type material. Holotype ♀: Oriente (currently Guantánamo), Cupeyal 730 m, 20°26'57"N, 75°03'38"W, V/1971, I. García. CZACC, examined. Paratypes 2 ♂, 5 ♀: same data as for holotype except VI/1971, genitalia ♀ in glycerin. CZACC, MFP, examined.

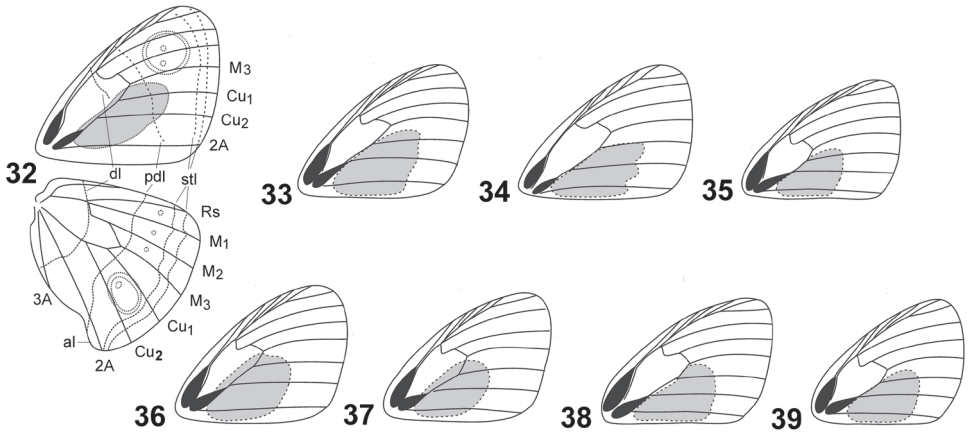
Additional material. 10 ♂, 6 ♀. **Holguín:** Morones, cerca de La Melba 250 m, 20°26'22"N, 74°49'14"W, 22/V/2007, N. Fernández, genitalia in glycerin, DNA

Figures 13–24. Cuban *Calisto* adults. **13** *C. muripetens* ♂ upper side, Cienfuegos, Pico San Juan **14** *C. muripetens* ♀ upper side, Sancti Spiritus, Topes de Collantes **15** *C. muripetens* ♂ under side **16** *C. occulta*, new species, holotype ♂ upper side, Guantánamo, Baracoa, Monte Iberia plateau, Tetas de Julia **17** *C. occulta*, new species, paratype ♀ upper side, same locality **18** *C. occulta*, new species, holotype ♂ under side **19** *C. bradleyi* ♂ upper side, Pinar del Río, base norte mogote Dos Hermanas **20** *C. bradleyi* ♀ upper side, same locality **21** *C. bradleyi* ♂ under side **22** *C. herophile* ♂ upper side, Matanzas, Varadero, Varahicacos **23** *C. herophile* ♀ upper side, Artemisa, Sierra del Rosario, El Taburete **24** *C. herophile* ♂ under side.

voucher PM07–02 (M002) (1 ♂); antiguo campamento minero Meseta de El Toldo 800 m, 20°27'20"N, 74°54'02"W, IV/2008, E. Pérez, genitalia in glycerin, DNA voucher PM07–27 (M046) (3 ♂). **Guantánamo:** Baracoa, Monte Iberia, campamento ladera norte 600 m, 20°29'25.5"N, 74°43'51.3"W, 18/V/2007, R. Núñez, slide RNA162(wings), DNA voucher PM07–01 (M001) (1 ♂); Baracoa, Monte Iberia, ladera sur cerca de la cima 675 m, 20°27'23.9"N, 74°44'27.9"W, 20/V/2007, R. Núñez, genitalia in glycerin, slides RNA170 (legs & labial palpus)/171(wings) (2 ♂); Baracoa, Monte Iberia, Tetas de Julia 650 m, 20°27'47"N, 74°45'13.3"W, 20/V/2007, R. Núñez, genitalia ♂ in glycerin, slides RNA160/164 (wings)/172/173 (legs & labial palpus)/176(androconial scales) (2 ♂, 2 ♀); Baracoa, Monte Iberia, al sur de las Tetas de

Figures 25–31. Live adults of Cuban *Calisto*. **25** *C. israeli* **26** *C. smintheus* **27** *C. brochei* **28** *C. bruneri* **29** *C. occulta*, new species **30** *C. bradleyi* **31** *C. herophile*.

Julia 430 m, 20°27'47"N, 74°45'13.3"W, 20/V/2007, R. Núñez, slides RNA168(legs & labial palpus) (1 ♂, 1 ♀); Baracoa, Monte Iberia, ladera norte 385 m, 20°29'53"N, 74°43'48"W, 1/V/2011, R. Núñez (3 ♀). CZACC.



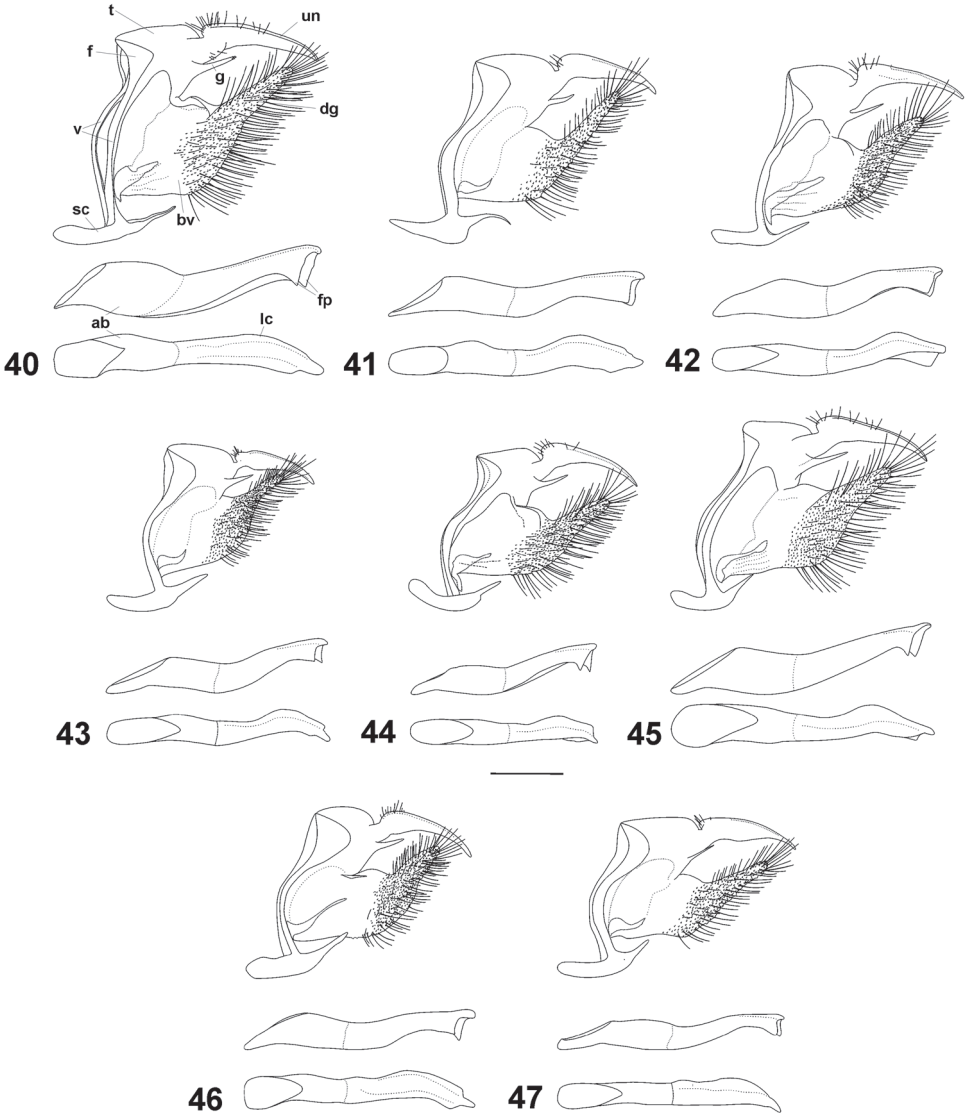
Figures 32–39. Shape and location of androconial patch, under side lines, ocelli, white dots and realted veins in Cuban species of *Calisto*. **32** *C. israeli* **33** *C. smintheus* **34** *C. brochei* **35** *C. bruneri* **36** *C. muripetens* **37** *C. occulta*, new species **38** *C. bradleyi* **39** *C. herophile* Abbreviations: al– anal lobe, dl– discal line, pdl– postdiscal line, stl– subterminal lines, M_1– median vein 1, M_2– median vein 2, M_3– median vein 3, Cu_1– cubital vein 1, Cu_2– cubital vein 2, Rs– radial sector.

Distribution. Collected specimens of *Calisto israeli* come from several localities in the middle and western parts of the NSB mountains, from Monte Iberia plateau 25 km west to Cupeyal (Figs 56, 57). The species has also been recorded from Sierra de Cristal, 1230 m, during the last management plan of Pico Cristal National Park (ENPFF 2010), extending its known distribution almost 50 km west compared to previous records. Species is probably present on the eastern half of NSB whenever its habitat is preserved.

Immature stages. Eggs are laid loose, are near spherical in shape and ivory white in color.

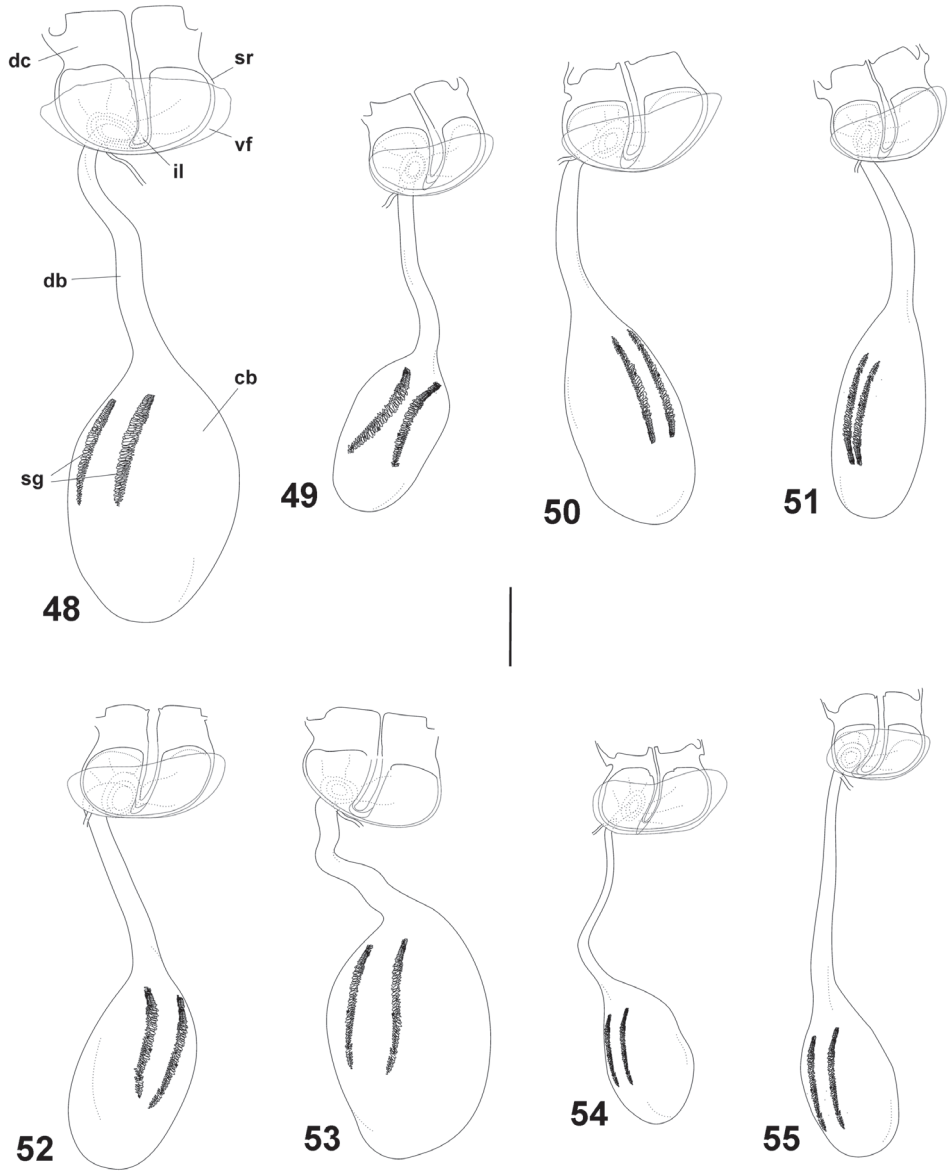
Habitat and biology. The species inhabits several variants of evergreen and rainforests and, to a lesser extent, scrub forests (charrascales) of the NSB Mountains at altitudes between 250 and 1230 m (Figs 60–62). Individuals can be found mainly on forest paths and clearings both sunny and shady. Núñez (2009) recorded 28 individuals along 1.5 km of old mining roads. At Pico Cristal, during an ascent from the foothills to the top, 356 individuals of this species were recorded (ENPFF 2010). Although its life story is unknown, the species seems to be associated with climbing grasses like some of its Hispaniolan congeners (Smith et al. 1994; Schawrtz and Wetherbee 1996). In different visits to Monte Iberia plateau, the senior author found the species abundant only at sites where two climbing grass species, *Arthrostylidium pinifolia* and *Chusquea* sp., dominated the lower strata of the rainforest (Fig. 61). The only mating pair observed was found on May 2011, 3:30 pm, at one of the sites covered by grasses mentioned above.

Remarks. The distinctive pattern of *Calisto israeli* permits a straightforward separation of the species from all its congeners, mostly based on a white triangular patch on the middle posterior margin at UNHW and the lack of red in cell at UNFW.



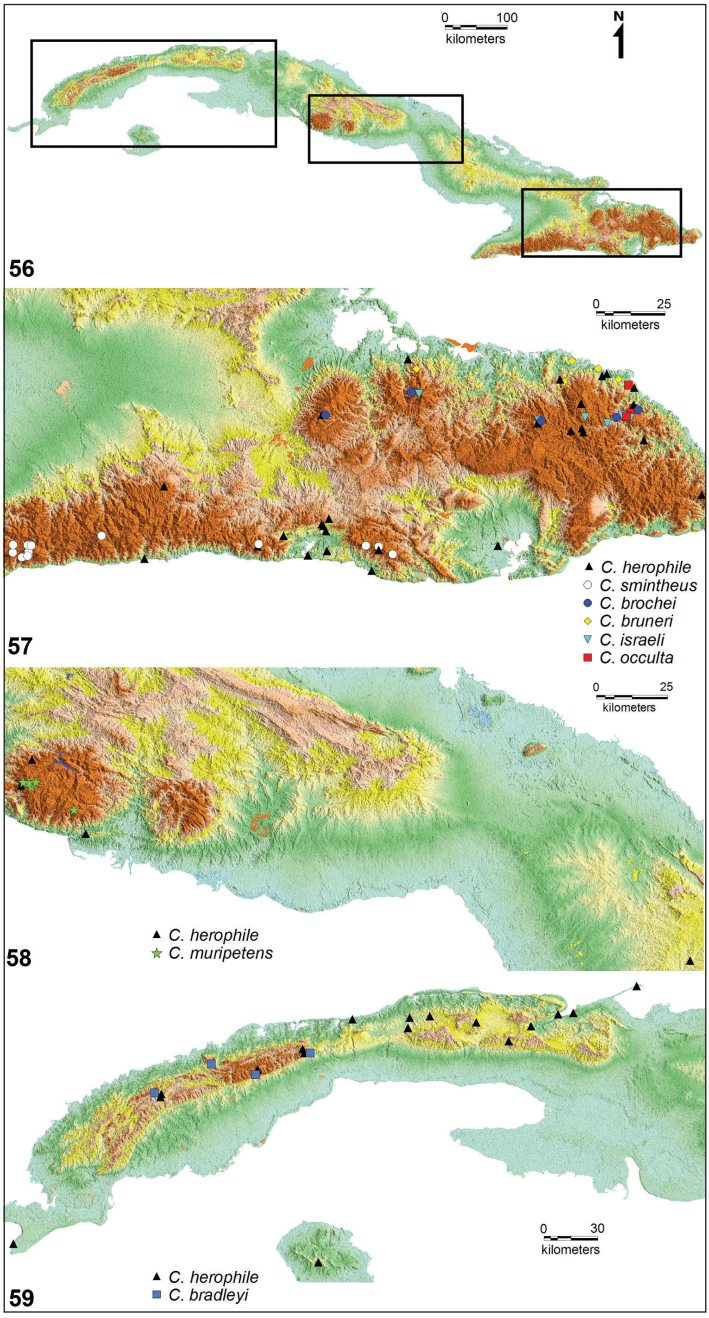
Figures 40–47. Male genitalia of Cuban *Calisto* from top to bottom: main body in lateral view aedeagus in lateral view and aedeagus in dorsal view. **40** *C. israeli* **41** *C. smintheus* **42** *C. brochei* **43** *C. bruneri* **44** *C. muripetens* **45** *C. occulta* new species **46** *C. bradleyi* **47** *C. herophile* Abbreviations: **un** uncus **t** tegumen **f** lateral fold of uncus **g** gnathos **v** vinculum **sc** saccus **dg** digitiform projection of valve **bv** base of valve **ab** aedeagus base **fp** flattened processes **lc** left curves. Scale bar 0.5 mm.

Nuclear DNA analysis grouped *C. israeli* along with *C. smintheus* and *C. brochei* in a branch separated from the remainder of the Cuban taxa (Fig. 66), although the mitochondrial COI dataset suggests an earlier branching event of the *C. israeli* lineage in the phylogeny, placing it as sister to the rest of Cuban *Calisto*. Moreover, the

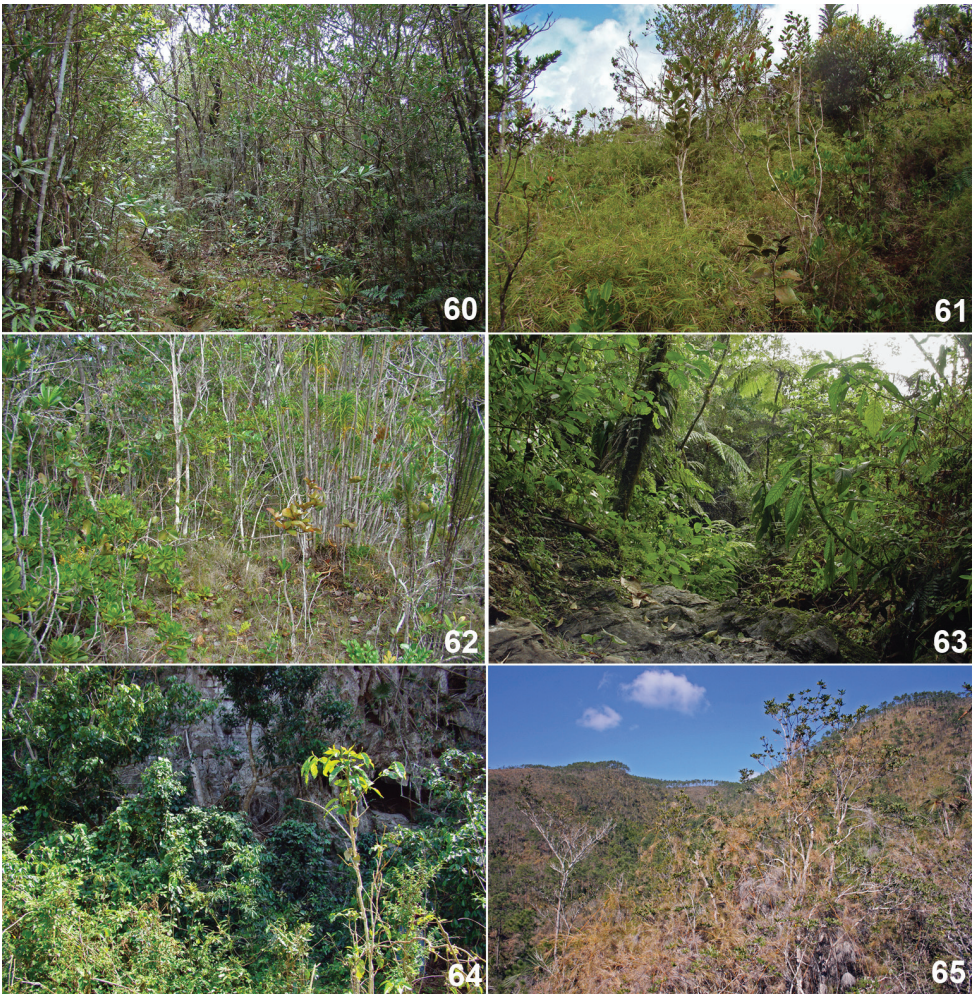


Figures 48–55. Female genitalia of Cuban *Calisto*, ventral view **48** *C. israeli* **49** *C. smintheus* **50** *C. brochei* **51** *C. bruneri* **52** *C. muripetens* **53** *C. occulta*, new species **54** *C. bradleyi* **55** *C. herophile*. Abbreviations: **dc** dorsal crown **st** sterigmal ring **vf** ventral fold of sterigmal ring **il** inner loop of sterigmal ring **db** ductus bursae **cb** corpus bursae **sg** signa. Scale bar 0.5 mm.

genetic distances regarding the COI sequence support the recognition of *C. israeli* as a valid species since the minimum distance to the closely related *C. smintheus* is 9.01% while the average divergence percentages from other congeneric species is higher than 5%.



Figures 56–59. Geographical distribution of Cuban species of *Calisto*. **56** Location of four Cuban major mountains ranges **57** Right rectangle in figure 56, distribution of *C. israeli*, *C. brochei*, *C. bruneri*, *C. occulta*, new species, and *C. herophile* at Nipe– Sagua– Baraoca mountain range, north, and *C. smintheus* and *C. herophile* at Sierra Maestra range, south **58** Central rectangle in figure 56, distribution of *C. muripetens* and *C. herophile* at Guamuhaya mountain range, central Cuba **59** Left rectangle in figure 56, distribution of *C. bradleyi* and *C. herophile* at Guaniguanico mountain range, western Cuba.



Figures 60–65. Habitat of Cuban *Calisto*. **60** Rainforest path at north slope of Monte Iberia plateau, 600 m, habitat of *C. israeli*, *C. brochei*, and *C. occulta*, new species **61** Path dominated by climbing grasses, *Arthrostylidium pinifolia* and *Chusquea* sp., at north slope of Monte Iberia plateau, 400 m, preferred situation by *C. israeli*, *C. occulta*, new species, is also present but not abundant **62** Scrub forest (charrascal) at Yamanigüey, habitat of *C. bruneri*, *C. occulta*, new species, and in lesser degree of *C. israeli* **63** Lower strata of rainforest at Aguada de Joaquín, Sierra Maestra, habitat of *C. smintheus* **64** Secondary forest at base of limestone hill, mogote, at Viñales valley, habitat of *C. bradleyi* **65** Dry scrub on serpentine soil at Cajálbana, habitat of *C. bradleyi*.

***Calisto smintheus* Bates, 1935, stat. rev.**
http://species-id.net/wiki/Calisto_smintheus
Figs 4–6, 26, 33, 41, 49, 56, 57, 63, 66–74

Calisto smintheus Bates 1935: 242
Calisto delos Bates 1935: 243, Michener 1943: 6, Schwartz and Hedges 1991: 136

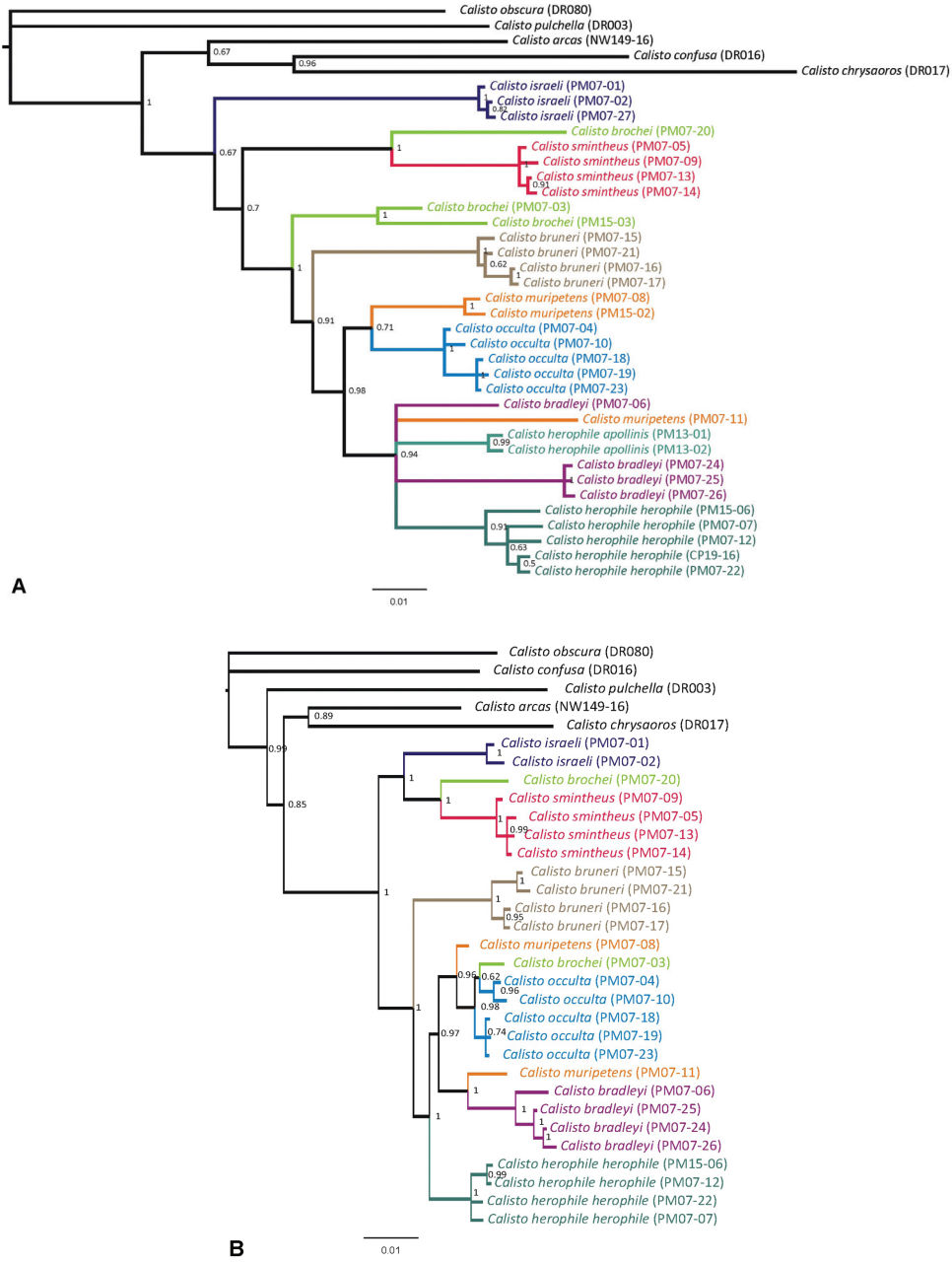


Figure 66. A Phylogenetic hypothesis based on a Bayesian analysis of COI data **B** Phylogenetic hypothesis for Cuban *Calisto* based on five nuclear gene regions. For both figures, numbers to the right of nodes give the posterior probability of the node. Lineages leading to species are coloured.

Calisto smintheus smintheus Bates 1939: 3, Michener 1943: 6, Munroe 1950: 226, Torre 1952: 62, Torre 1954: 120, Torre 1968: 18, Núñez 2009: 56
Calisto smintheus delos Torre 1968: 19
Calisto biocellatus Torre 1968: 22
Calisto sibylla smintheus Brown and Heineman 1972: 51, Fontenla and Rodríguez 1990: 8, Smith et al. 1994: 57, Lamas 2004: 207
Calisto sibylla delos Brown and Heineman 1972: 51, Smith et al. 1994: 57, Lamas 2004: 207

Diagnosis. *Calisto smintheus* requires comparison with some of its cogeners. Within Cuba, the more similar species is *C. brochei*, but *C. smintheus* adults are larger on the average (19–25 mm of FWL versus 16–22 mm in *C. brochei*), have a reddish suffusion around anal lobe at the UPHW, and are darker and more brightly colored at UN of wings. The androconial patch has a rounded outer margin in *C. smintheus*, but it is sinuous, forming three rounded lobes in *C. brochei*. Almost all other Cuban relatives except *C. israeli*, are paler and have fewer white dots at the post discal area on UNHW. *Calisto herophile* has also four white dots at UNHW, but is paler and smaller on the average, 14–21 mm versus 19–25 mm in *C. smintheus*. Outside Cuba, the Bahamian *C. sibylla* lacks red at the UNFW cell and the reddish suffusion at anal lobe; and in general, is a paler species. The Hispaniolan *C. confusa* Lathy, 1899, *C. hysius* (Godart [1824]) and *C. obscura* Michener, 1943, and *C. pauli* Johnson & Hedges, 1998 are superficially similar but all are distinctly smaller (13–18 mm) than *C. smintheus*.

Description. FWL: 19–25 mm ♂ & ♀. Male UPFW dark brown except darker, almost black, androconial patch and postdiscal area adjacent to androconial patch and tornus, pale brown (Fig. 4). Androconial patch distinct except at base anterior limit, approximately triangular with outer margin rounded, anterior margin not entering into cell, about one half the length of FW (Fig. 33). Female UPFW dark grayish brown at basal two thirds, outer third pale grayish brown (Fig. 5). UPHW dark grayish brown at anterior two thirds, pale grayish brown at posterior third; anal lobe ferruginous, occupying apical half of posterior margin in some specimens. UN of wings brown heavily mixed with reddish and, toward base, pale yellow scales; apex of both wings and basal to pdl of **HW** with a dark wine hue (Figs 6, 26). Outer edge of pdl with bright yellow scaling. Post discal area at UNHW with four white dots at Rs–M_1, M_1–M_2, M_2–M_3, and M3–Cu_1, the last one slightly displaced toward outer margin and smaller, sometimes absent in rubbed specimens. Male genitalia with tegumen about two thirds the length of uncus, rounded at posterior half (Fig. 41); uncus gradually tapering toward apex, arched at apical third; digitiform projection of valvae slender and long, straight at both margins; aedeagus sinuated with a left curve both at basal and apical half. Female genitalia with dorsal crown tall (Fig. 49); corpus bursae broad, about two thirds the length of ductus bursae.

Type material. Holotype ♂: Sierra del Cobre, Loma del Gato 3000 ft, 20°00'33"N, 76°02'16"W, 25–30/IX/1935, S. C. Bruner. MCZ, examined. Paratypes 8 ♂, 4 ♀:

same data as for holotype except 2700–3300 ft, S. C. Bruner, genitalia ♂ & ♀ in glycerin. MCZ, CZACC, examined.

Calisto delos Bates 1935: holotype ♂, Ote (currently Santiago de Cuba), Pico Turquino, Loma Cordero (actually Cardero) 4000–6000 ft, 1 August 1935, J. Acuña; paratype ♂, Pico Turquino, Julio 22 de 1922, S. C. Bruner & C. H. Ballou, EEA Cuba No. 1652. MCZ, examined.

Calisto biocellatus Torre 1968: holotype ♂, Turquino, Pico Cuba 1872 m, 19°59'8.4"N, 76°50'32.3"W, VI/1963, F. de Zayas, P. Alayo & I. García; allotype ♀: same data as for holotype. CZACC, examined.

Additional material. 88 ♂, 33 ♀. **Granma:** Bartolomé Masó, La Platica 850 m, 20°00'54.1"N, 76°53'28.4"W, 26/XI/2007, R. Núñez, slide RNA175(androconial sclaes), DNA voucher PM07–05 (3 ♂); same data as for anterior except V/2008 (2 ♂). **Santiago de Cuba:** Aguada de Joaquín 1300 m, 20°00'50.4"N, 76°50'24.8"W, 20–27/I/2005, A. García, A. Barro & R. Núñez, genitalia ♂ in glycerin, slides RNA238(wings)/243(legs & labial palpus) (2 ♂, 1 ♀); same data as for anterior except 30/XI/2007, R. Núñez, genitalia ♀ in glycerin, slide RNA190(wings) (2 ♂, 1 ♀); Sierra Maetra, Pico Joaquín 5300 ft, 19°59'16"N, 76°53'31"W, 18/V/1948, J. Ferrás (3 ♂); ladera sur Pico Regino 1500 m, 20°00'38"N, 76°50'9"W, 29/XI/2007, R. Núñez, genitalia ♀ in glycerin, DNA voucher PM07–09 (M010) (1 ♂, 1 ♀); Sierra Maestra, 29/X/1941, J. Acuña (1 ♂); Turquino, June 1963, P. Alayo, slide RNA208(wings) (5 ♂); same data as for anterior except F. de Zayas, P. Alayo & I. García (1 ♀); Pico Turquino 1972 m, 19°59'23.7"N, 76°50'11.9"W, 18/X/1966, I. García, slide RNA275(legs & labial palpus) (10 ♂, 4 ♀); same data as for anterior except XII/1967, slides RNA225 (wings)/227(legs & labial palpus) (1 ♂, 1 ♀); same locality as for anterior, X/1985, M. G. Casanova, genitália ♀ in glycerin (1 ♂, 2 ♀); Ote (currently Santiago de Cuba), Turquino, Pico Cuba 1872 m, 19°59'8.4"N, 76°50'32.3"W, VI/1963, F. de Zayas, P. Alayo & I. García, genitalia ♂ & ♀ in glycerin, slides RNA186(androconial scales)/189/204/212(wings)/203/230/266 (legs & labial palpus) (10 ♂, 1 ♀); same locality as for anterior, 17/I/2002, A. Barro & R. Núñez (1 ♀); Ote (currently Santiago de Cuba), Sierra del Cobre, Loma El Gato 2600 ft, 20°00'33"N, 76°02'16"W, 24–30 September 1935, J. Acuña, S. C. Bruner & L. C. Scaramuzza (1 ♂, 1 ♀); same locality as for anterior, VIII/1942, Hno Crisogono (2 ♂); same locality as for anterior, 6/IX/1951, S. L. de la Torre, slide RNA228(wings) (8 ♂, 3 ♀); same locality as for anterior, 17–20 June 1952, F. de Zayas & P. Alayo (3 ♂); same locality as for anterior, 19 June 1952 (3 ♂); same locality as for anterior, 20 June 1952, slide RNA273(legs & labial palpus) (1 ♂); same locality as for anterior, 11/VIII/2008, E. Oliva, genitalia in glycerin, DNA vouchers PM07–13 (M030) & PM07–14 (M031) (2 ♂); same locality and date as for anterior, E. Fonseca (1 ♂); Ote (currently Santiago de Cuba), Caney, Gran Piedra 1100 m, 20°00'31"N, 75°37'3"W, Junio 1954, F. de Zayas & P. Alayo (1 ♀); same locality as for anterior, 23/IV/1955, P. Alayo, genitalia ♂ & ♀ in glycerin (2 ♂, 2 ♀); Ote (currently Santiago de Cuba), Caney, Gran Piedra, El Olimpo 900 m, 20°00'41"N, 75°39'42"W, 22 Mayo 1955, F. de Zayas & P. Alayo, slide RNA234(wings) (1 ♀); same data as for anterior except 26 Abril 1956, genitalia ♂ in glycerin, slides RNA192/221(wings) (4 ♂, 2 ♀); same data as for anterior except VIII/1960, genitalia

♀ in glycerin, slides RNA185(androconial scales)/188/219/251(wings)/216/276(legs & labial palpus) (8 ♂, 3 ♀); same locality as for anterior, VI/1962, P. Alayo, F. de Zayas & I. García (1 ♂); same locality as for anterior, 19/XII/1965 (4 ♂, 1 ♀); same locality as for anterior, 6/X/1966, I. García, genitalia ♀ in glycerin, slide RNA274(legs & labial palpus) (3 ♂, 3 ♀); same locality as for anterior, VIII/1986 (1 ♀); Gran Piedra, base Gran Piedra 1200 m, 16/III/2008, R. Núñez (4 ♂); Gran Piedra, pinar detrás Estación BIOECO 1100 m, 24/II/2011, R. Núñez (1 ♀); same data as anterior except ex ova, emerged 17/V/2011 (1 ♀). MFP, CZACC.

Distribution. Species is restricted to the Sierra Maestra. It has been recorded from Pico Mogote (Fontenla 2006) in the east to 140 km west at La Platica (Figs 56, 57). Besides anterior literature data, species has been recorded from La Bayamesa, Granma province (Fontenla 2005).

Immature stages. Egg & oviposition – Eggs are glued to substrate, spherical in shape and ivory white in color becoming beige with irregular orange brown spots a day after laid. Time to hatch 8 days (n=1).

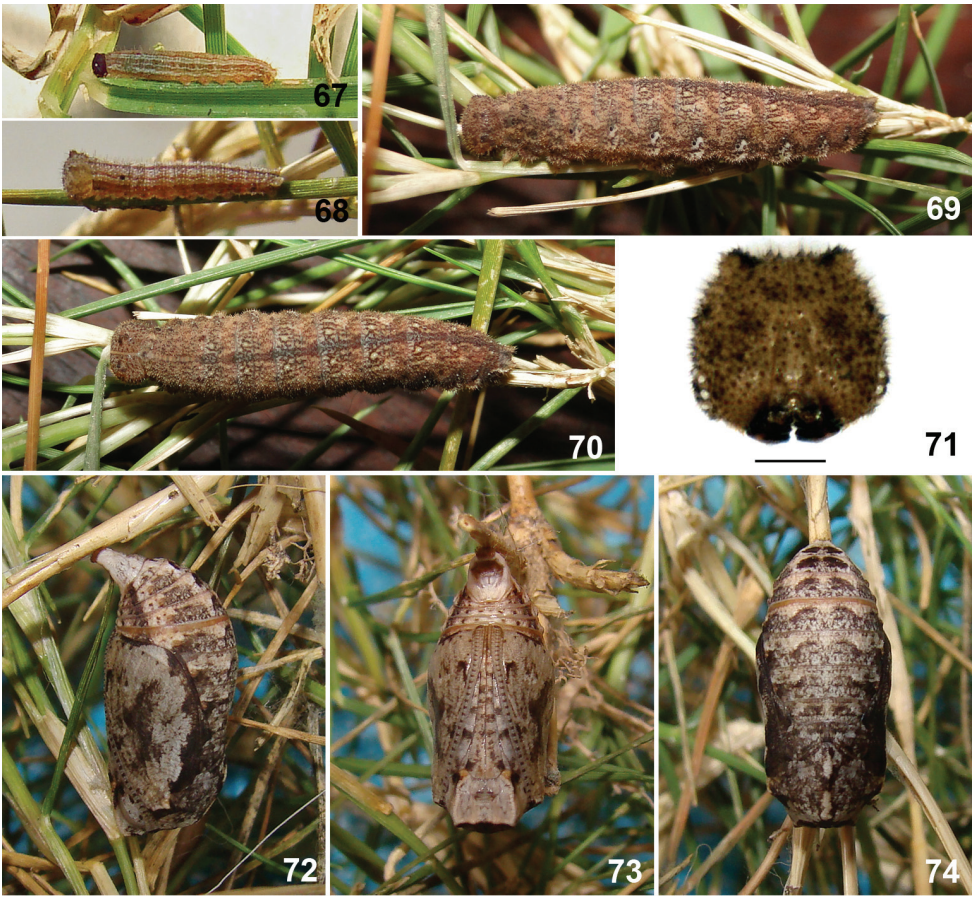
First instar larva (Fig. 67) – Head capsule dark brown, almost black, with a bronze gloss and with two short horns on top. Body beige, greenish white on sides after fed on host leaves, with a dorsal line and four pairs of longitudinal pale orange brown lines: subdorsal, suprastigmatal, stigmatal, and infrastigmatal. Suprastigmatal line more greenish and the thinnest one, remainder lines more brownish and broader but subdorsal thinner than stigmatal and infrastigmatal lines. Dimensions (n=1): head capsule width 0.61 mm, head capsule height 0.64 mm, initial total length 2.9 mm, final total length 4.2 mm. Duration (n=1): 15 days.

Second instar with beige brown head capsule with slightly darker marks, body pattern similar to first but with a pair of dots, one at each subdorsal line, at metathorax that is present in remainder instars (Fig. 68). Instars from third and fourth with the same pattern of fifth, described below, but paler, with lines less contrasting, subdorsal and suprastigmatal lines straighter and the stigmatal and infragstigmatal lines distinct.

Fifth instar larva (Figs 69–71) – Head capsule beige regularly speckled with numerous dark brown dots; horns reduced; sides with two pairs of dark brown spots, each pair almost equidistant between them and to dorsal and ventral edges; mandibles black; X– mark of epicranium obsolete, represented only by a small rounded spot at apex of each arm, slightly darker than background. Body pale brown with brown striations; dorsum of each segment with darker "butterfly" like mark formed by small brown striations; lines slightly darker than background, except subdorsal which is pale yellow, lines becoming diffuse toward thorax; each abdominal segment with a transverse ashy gray band at beginning from dorsum to near suprastigmatal line and edged anteriorly by a brown dot at each end; dorsal line edged at beginning of each abdominal segment by two pale yellowish beige dots; a dark brown dot above subdorsal line on metathorax; subdorsal lines thinner than dorsal line, wavy, closer to dorsal line at middle of each segment, ending on caudal tails; suprastigmatal lines wavy following the wave pattern of subdorsal ones with dark brown dot above it near mid way to subdorsal, above it on each segment one pair of diffuse brown dots, one central, larger,

and other near posterior margin; stigmatal and infrastigmatal lines diffuse mixed; area behind and below whitish, the latter crossed the infrastigmatal line. Dimensions (n=1): head capsule width 2.55 mm, head capsule height 2.58 mm, initial total length 14 mm, final total length 22 mm. Duration (n=1): 19 days.

Pupa (Figs 72–74) – Head and wing sheaths pale gray; antennae and leg sheaths with regular discontinuous pattern of dark brown dots; a pair of ventral black dots on eyes and another at sides of appendages near abdomen; wing sheaths edged at dorsum by an irregular dark brown large spot at middle; dorsum of thorax and abdomen pale gray with diffuse dark brown striations heavier at sides of dorsal ax forming a large spot on each side; abdomen with a dark brown line on sides, abdomen with a transverse ridge with a pair of more prominent crests on dorsum of segments 1 to 6; last abdominal segment long, stout, cremaster area enlarged, broad. Two days before emergence the dark brown extends covering almost entire thorax, extending gradually



Figures 67–74. Immature stages of *Calisto smintheus*. **67** First instar **68** Second instar **69** Fifth instar, lateral view **70** Fifth instar, dorsal view **71** Fifth instar head capsule, scale bar 1 mm. **72** Pupa, lateral view **73** Pupa, ventral view **74** Pupa, dorsal view.

until occupying entire surface before emergence. Dimensions (n=1): total length 11 mm, maximum width 4.5 mm. Duration (n=1): 12 days.

Habitat and biology. Throughout its range, the species inhabits evergreen and rainforests at altitudes between 800 m and 1500 m (Fig. 63). It is also found in cloud forest above 1500 m, and at the cloud scrub around Pico Turquino, 1972 m and Cuba highest peak. Individuals can be found in interior of forests but also at its edges. The species seems to prefer relatively well preserved areas but occasionally can be found at places with secondary vegetation. At La Platica village, Turquino massif, Sierra Maestra, the species was observed in shady places of gardens nearby forest, whereas, at Gran Piedra, it was found inside 25 year old pine plantations. Adults were observed feeding on flowers of *Bourreria laevis*, *Palicourea alpina*, *Pavonia fruticosa*, *Mikania micrantha*, and *Stachyterpheta cayenensis* in rainforest near La Platica.

Two females were observed when laid eggs singly at underside of leaves near midday. The host, *Ichnanthus mayarensis*, is the first one recorded for the Cuban species of the genus. This small grass is common at forest understory, sometimes abundant along paths, of rainforests in the Turquino Massif. Larvae eat the entire corion after hatching and feed at night remaining inactive during the day in lower parts of the plant. Larvae accepted both substitute host plants. First instar was 15 days long and all other were 9 days long each. Prepupal period was one day long and pupal stage extended for 12 days. Immature development takes 80 days and five larval instars.

Remarks. *Calisto smintheus* and *C. herophile* are the only members of the genus inhabiting the Sierra Maestra. Their altitudinal ranges overlap between 800 and 1100 m, however, *C. herophile* is rare in places where *C. smintheus* is present and vice versa. Munroe (1950) mentioned the possibility of hybridization between them but there is no evidence available from present work to confirm it. The phylogenetic inferences and genetic distances agree on the establishment of *C. smintheus* as a single species with a minimum divergence of no lower than 5% from other Cuban *Calisto* taxa. The close phylogenetic relationship between *C. smintheus* and *C. brochei* is discussed below.

***Calisto brochei* Torre, 1973, stat. n.**
http://species-id.net/wiki/Calisto_brochei
Figs 7–9, 27, 34, 42, 56, 57, 60, 66, 75–82

Calisto smintheus brochei Torre 1973: 6, Núñez 2009: 56
Calisto sibylla smintheus Fontenla and Rodríguez 1990: 8, Lamas 2004: 207

Diagnosis. *Calisto brochei* is similar to *C. smintheus* but is smaller on average, lacks the reddish suffusion at the anal lobe in the UPWH, and is paler and less brightly colored at UN of wings (see more details below *C. smintheus*). *Calisto brochei* has four white dots on UNHW and the androconial patch trilobed at the outer margin whereas *C. bradleyi*, *C. occulta*, sp. n., and *C. muripetens* have only three white dots and have dif-

ferent shaped androconial patches, the first species with a single rounded lobe at apex, and the other two without lobes at the outer margin. *Calisto herophile* also resembles *C. brochei,* but it is paler and has a smaller androconial patch without lobes at the outer margin. From *C. sibylla*, *C. brochei* differs by its darker coloration, the presence of red in cell at the UNFW, and the three lobes at the outer margin of androconial patch. The Hispaniolan *C. confusa*, *C. hysius* and *C. obscura* are superficially similar but are smaller on the average (13–17.5 mm of FWL), and have straighter white edged lines at UNHW. *Calisto pauli* possesses a similar wing pattern but its female genitalia has a terminal production a middle of dorsal crown, absent in *C. brochei*, and its male genitalia has the uncus and tegumen flattened, they are slightly rounded in *C. brochei*. Also, the uncus is shorter in *C. brochei* and the aedeagus has two prongs at apex, there are four in *C. pauli*.

Description. FWL: 16–22 mm ♂, 20–22 mm ♀. Male UPFW dark brown except darker, almost black, androconial patch, outer third slightly paler (Fig. 7). Androconial patch distinct, dark brown almost black, approximately triangular with outer margin waved forming three usually distinct lobes, anterior margin not entering into cell, about one half the length of FW (Fig. 34). Female UPFW dark brown at basal two thirds, outer third pale brown (Fig. 8). UN background brown moderately mixed with pale reddish and pale yellow scaling basal to pdl and apex of both wings (Figs 9, 27). Outer edge of pdl with pale yellow scaling. Post discal area at UNHW with four white dots at Rs–M_1, M_1–M_2, M_2–M_3, and M3–Cu_1, the last one smaller, sometimes absent in rubbed specimens. Male genitalia with tegumen about two fifths the length of uncus, rounded at posterior half (Fig. 42); uncus gradually tapering and arched toward apex, base subquadrated; digitiform projection of valvae heavy and moderately long, ventral margin concave; aedeagus straight at basal half and with a left curve at apical half. Female genitalia with dorsal crown tall (Fig. 50); corpus bursae broad, about the same length of ductus bursae.

Type material. Holotype ♀: Oriente (currently Guantánamo), Cupeyal 730 m, 20°26'57"N, 75°03'38"W, VI/1971, I. García. CZACC, examined. Paratypes 1 ♂, 5 ♀: same data as for holotype, genitalia ♀ in slide. CZACC, MFP, examined.

Additional material: 12 ♂, 6 ♀. **Holguín:** Ote (currently Holguín), Pinares de Mayarí 800 m, 20°28'8"N, 75°48'52"W, 16/X/1966, I. García, slide RNA269(wings) (1 ♀); Mayarí, camino de La Zoilita 250 m, 20°38'N, 75°29'W, IX/1986, R. Rodríguez, genitalia ♀ in glycerin (1 ♂, 1 ♀); Sierra de Cristal, cerca de la Estación La Zoilita 400 m, 20°37'41.7"N, 75°29'08.1"W, 15–20/II/2010, R. Núñez, DNA voucher PM07–20 (M037) (1 ♂). **Guantánamo:** same data as for holotype, genitalia ♀ in glycerin, slides RNA224/246/257/261(wings)/277(legs & labial palpus) (3 ♂, 2 ♀); Baracoa, Monte Iberia, campamento ladera norte 600 m, 20°29'25.5"N, 74°43'51.3"W, 18/V/2007, R. Núñez, slide RNA169(wings), DNA voucher PM07–03 (M003) (2 ♂); same data as for anterior except 2/V/2011, ex ova, emerged 9/VIII/2011 (1 ♂, imperfect); Baracoa, Monte Iberia, al sur de las Tetas de Julia 430 m, 20°27'58.6"N, 74°46'9.2"W, 20/V/2007, R. Núñez, slides RNA249(wings)/250(legs & labial palpus), DNA voucher PM15–03 (M049) (1 ♂); Baracoa, Monte Iberia,

ladera norte 385 m, 20°29'53"N, 74°43'48"W, 1/V/2011, R. Núñez (3 ♂, 1 ♀). CZACC.

Distribution. *Calisto brochei* is present in several localities in the middle and western NSB mountains, from Monte Iberia plateau to more than 100 km west at Pinares de Mayarí at Nipe plateau (Figs 56, 57). The species is probably present along NSB wherever its habitat is preserved.

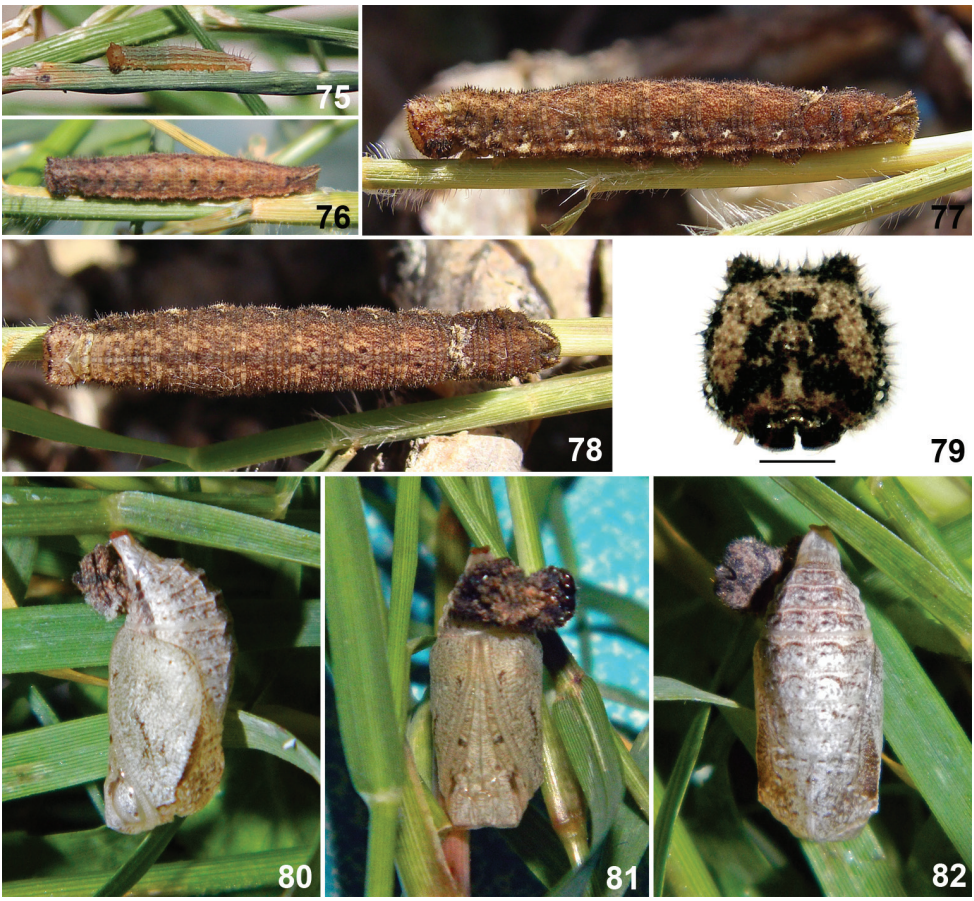
Immature stages. Egg & oviposition – Eggs are glued to substrate. Color is pale yellow with slight greenish tint becoming beige with irregular orange brown spots a day after being laid. Eggs are near spherical, diameter 1.0–1.1 mm, height 0.8–1.0 mm (n=9). Time to hatch 7 to 8 days (n=9).

First instar larva (Fig. 75) – Head capsule pale orange beige, with two short horns on top. Body beige, pale grayish green after fed on host leaves, with a dorsal line and three pairs of longitudinal pale brown lines: subdorsal, suprastigmatal, and stigmatal. Dorsal, subdorsal and stigmatal lines thinner than suprastigmatal one; suprastigmatal and stigmatal lines are closer between them than remainder lines. Dimensions (n=9): head capsule width 0.65–0.68 mm, head capsule height 0.67–0.71 mm, initial total length 2.7–3.0 mm, final total length 4.2–4.5 mm. Duration (n=9): 11–16 days.

Instars from second to fifth (Fig. 76) with color pattern similar to that of sixth, described below, but with pattern better defined and the following dots: a pair, brown, at end of each abdominal segment, the upper one in contact with the more ventral part of subdorsal lines waves; a dark brown, larger at middle segments, at each abdominal segment on the most dorsal portion of suprastigmatal lines waves, above spiracles.

Sixth instar larva (Figs 77–79) – Head capsule beige regularly speckled with scarce dark brown dots; horns reduced, spotted with dark brown; sides with a dark brown vertical line passing horns to epicranial suture; a dark brown band crossing lower part of frons and curved down at sides to stemmata; sides of clypeus, mandibles and stemmatal areas dark brown, almost balck; X– mark of epicranium dark brown, arms ellipse like and connected by almost indistinct paler lines, lower arms larger. Body pale brown with brown striations; dorsum of each segment with darker diffuse X– marks at sides of dorsal line; lines slightly darker than background, diffuse; a transverse diffuse band at end of each abdominal segment, slightly darker than background; dorsal line edged at beginning of each abdominal segment by two dark brown dots; subdorsal lines wavy, diffuse almost indistinct, closer to dorsal line at middle of each segment; suprastigmatal lines wavy following the wave pattern of subdorsal ones; stigmatal and infrastigmatal lines diffuse, indistinct, area between them and below paler; spiracles dark gray brown surrounded by whitish. Dimensions (n=1): head capsule width 2.62 mm, head capsule height 2.69 mm, initial total length 18.4 mm, final total length 22 mm. Duration (n=1): 15 days.

Pupa (Figs 80–82) – Entirely pale ashy gray minutely speckled with darker gray color heavier dorsolaterally on wing sheats; three pairs of frontal brownish gray dots: one elongated on eyes and two smaller and rounded on sheaths of legs, one at first third and the other at apical third; wing sheaths with a small darker crescent on the middle; a row



Figures 75–82. Immature stages of *Calisto brochei*. 75 First instar **76** Fourth instar **77** Sixth instar, lateral view **78** Sixth instar, dorsal view **79** Sixth instar head capsule, scale bar 1 mm. **80** Pupa, lateral view **81** Pupa, ventral view **82** Pupa, dorsal view.

of small submarginal dots on wing sheats; abdomen with a transverse ridge with a pair of more prominent crests on dorsum of segments 1 to 6, with a brownish gray line on sides; last abdominal segment long, stout, cremaster area large, broad. Two days before emergence eyes turns dark brown extending gradually to occupying entire surface. Dimensions (n=1): total length 10 mm, maximum width 4.3 mm. Duration (n=1): 12 days.

Habitat and biology. The species inhabits several variants of rain and evergreen forests of NSB Mountains at altitudes between 200 and 800 m (Fig. 60). Individuals can be found mainly at shady forest paths.

Larvae eat the entire corion after hatching and feed at night, remaining in the lower parts of grasses during day. *Calisto brochei* larvae did not accept well the two grass species supplied as substitute food and only one of nine larvae survived to pupation. Average duration of each instar was about two weeks each. Prepupal period was two days long and pupal stage extended for 12 days. Immature development took three

months and larvae went through six instars (possibly due to low food quality). Adult emergence occurred at the beginning of the afternoon, between 14:00 and 15:00.

Remarks. Although superficially almost identical, *C. brochei* and *C. smintheus* both possess small consistent differences in the adult stage and are well differentiated in the immature stages. Adults can be separated by the characters given above in the Diagnosis section. Immature stages are more different than adults, with the first instar of *C. smintheus* having the head capsule dark brown, almost black, whereas it is pale orange in *C. brochei*. In the latter species, the pair of dark dots on dorsum of metathorax present from second instar of *C. smintheus* is absent. Pupae are also different, with those of *C. brochei* paler in color pattern whereas in *C. smintheus* have a heavily dark spotted pattern.

Two individuals of *C. brochei* (PM07-03 and PM15-03) are grouped together by the COI sequences (Fig. 66A) and placed as sister to a large clade comprising all other taxa except *C. israeli* and *C. smintheus*. One of these individuals (PM07-03) was also sequenced for nuclear genes, which place it within the new species *C. occulta* (Fig. 66B). Another individual (PM07-20) is the sister to *C. smintheus* based on both sets of markers, but is morphologically different to *C. smintheus*. The existence of hybrids between *brochei* and *occulta* may explain these results. Munroe (1950) hypothesized that populations of *C. smintheus* and *C. herophile* may interbreed. The high mortality rate of *C. brochei* larvae may be due to substitute food used during rearing; however, it could be also an indication of hybridization. It is clear that more individuals of *C. brochei* need to be sequenced in order to discover the general patterns of molecular variation in this species.

***Calisto bruneri* Michener, 1949, stat. rev.**
http://species-id.net/wiki/Calisto_bruneri
Figs 10–12, 28, 35, 43, 51, 56, 57, 60–62, 66

Calisto bruneri Michener 1949: 2, Torre 1952: 62, Torre 1954: 120, Torre 1968: 17, Núñez 2009: 56
Calisto herophile bruneri Alayo and Hernández 1987: 40, Smith et al. 1994: 56, Lamas 2004: 207

Diagnosis. *Calisto bruneri* differs from all other *Calisto* with similar color pattern, brown with red at the UNFW cell, by its pear shaped ocellus at the UNHW, ovoid in the others. *Calisto bruneri* was regarded in the past as subspecies of *C. herophile*; however, besides the character given above, the first has uniformly colored UP of wings and three white dots at UNHW, whereas the second has the apical third of wings paler and four white dots. Their genitalia also differ, that of *C. bruneri* male has valvae with concave ventral margins and a more sinuous aedeagus in dorsal view, and its female genitalia has the ductus and corpus bursae almost equal in length, the ductus is almost twice the length of the corpus in *C. herophile*. The Hispaniolan *Calisto pulchella*

Lathy, 1899, *C. raburni* Gali, 1985, *C. schwartzi* Gali, 1985 and *C. tasajera* González, Schwartz & Wetherbee, 1991 also have pear shaped ocelli but can be easily separated from *C. bruneri*, among other features, by the conspicuous reddish suffusion at the UN of wings that is absent in the latter.

Description. FWL: 16–19 mm ♂, 18–21 mm ♀. UP of wings uniform dark grayish brown almost black, anal lobe with a small black dot (Figs 10, 11). Androconial patch indistinct in fresh specimens, approximately triangular with apex slightly angled, anterior margin not surpassing posterior margin of cell, about two fifths the length of FW (Fig. 35). UNHW background brown mixed with grayish white and, in less extent, pale yellow scales (Figs 12, 28). UNHW ocellus pear shaped and narrow. Post discal area on UNHW with three white dots at M_1–M_2, M_2–M_3, M_3–Cu_1, the first one smaller and sometimes absent in rubbed specimens. Male genitalia with tegumen about two thirds the length of uncus, slightly curved (Fig. 43); uncus broad at basal third, tapering gradually from the middle toward apex, arched at apical third, base with a small ventral notch; valvae base very broad; digitiform projection of valvae narrow and short with ventral margin concave; aedeagus sinuated in dorsal view with a left curve both at basal and apical half, the first one more pronounced. Female genitalia with dorsal crown tall (Fig. 51); corpus bursae somewhat narrow, near equal in length to ductus bursae.

Type material. Holotype ♂: Oriente (currently Holguín), Moa, 20°39'23"N, 74°56'34"W, 24–27 February 1948, F. de Zayas & J. Ferrás. AMNH, not examined. Paratypes 6 ♂, 1 ♀: same data as for holotype (5 ♂, 1 ♀); same locality as for holotype 13–22 April 1945, J. Acuña (1 ♂). MCZ, CFZ, examined.

Additional material. 13 ♂, 9 ♀. **Holguín:** same data as for holotype: (1 ♀); Moa, El Johnson 300 m, 20°35'36.4"N, 74°59'9.9"W, Junio 1954, F. de Zayas & P. Alayo, genitalia in glycerin (1 ♀); same data as for anterior except 5/I/1968, S. L. de la Torre, genitalia ♀ in glycerin, slides RNA161/211/214(wings)/183/215/217(legs & labial palpus) (4 ♂, 3 ♀); Oriente (currently Holguín), Moa, Punta Gorda o Cayo del Medio, 20°37'44"N, 74°51'10"W, 6/I/1968, S. L. de la Torre, slide RNA255(legs & labial palpus) (1 ♀); Moa, Cayo Grande, 20°35'28.9"N, 74°46'52.6"W, 19/I/2009, R. Núñez & E. Oliva, genitalia in glycerin, slides RNA256(legs)/267(FW) (1 ♂); same data as for anterior except 24/I/2009, genitalia ♂ & ♀ in glycerin, slides RNA252/258(legs)/253 (wings)/254(legs & labial palpus), DNA vouchers PM07–15 (M032) & PM07–16 (M033) (4 ♂, 2 ♀); Moa, Yamanigüey 75 m, 20°34'45.9"N, 74°44'10.2"W, 24–27/IX/2009, R. Núñez, DNA voucher PM07–17 (M034) (2 ♂, 1 ♀); Sierra de Cristal, cerca de Estación La Zoilita 400 m, 20°37'41.7"N, 75°29'08.1"W, 15–20/II/2010, R. Núñez, DNA voucher PM07–21 (M038) (2 ♂). CZACC, MFP.

Distribution. *Calisto bruneri* occurs in the western parts of the NSB Mountains (Figs 56, 57). Previous records gave a small distribution area around Moa town, including Punta Gorda, Holguín province, near the coast up to an altitude of 300 m in neighboring hills (Michener 1949; Torre 1968). Its distribution is widened here about 10 km east to Cayo Grande, and 55 km westward to Sierra de Cristal at 450 m of altitude.

Immature stages. Torre (1968) mentioned that females glued eggs to the substrate and that they are spherical and beige with orangish spots.

Habitat and biology. The species inhabits rainforests, scrub forests (charrascales) and pine forests (Figs 60–62). Scrub forests have high levels of sun exposition and water loss, and *C. bruneri* has been observed to spend most time near the ground in the shade of shrubs. At Cayo Grande, Moa, the species was observed taking nectar from flowers of *Scaevola wrightii*, a local endemic shrub. Throughout its range, the species is replaced by *C. herophile* in areas where its habitat has been destroyed, mostly around towns and major roads.

Remarks. Alayo and Hernández (1987) considered *bruneri* a subspecies of *C. herophile* arguing that UNHW ocellus shape was the only difference. Like previous authors (Michener 1949; Torre 1968), Núñez (2009) considered it a valid species. Morphological and molecular support of its species status are discussed below.

DNA analysis of *C. bruneri* (4 specimens, 3 localities) showed an average divergence of 4.68% from *C. herophile* (5 specimens, 5 localities). Indeed *C. bruneri* forms a single well-supported monophyletic clade together with *C. occulta*, *C. muripetens*, *C. bradleyi* and *C. herophile*, and altogether sister to the group *israeli-brochei-smintheus* (Fig. 66). Furthermore, both nuclear and mitochondrial datasets suggest an earlier divergence of *C. bruneri* from sister taxa within the clade, diversifying later in the western part of the NSB Massif. Average COI distances between *C. bruneri* and *C. occulta*, *C. muripetens* and *C. bradleyi* are 4.94%, 5.52% and 5.52% respectively.

***Calisto muripetens* Bates, 1939, stat. n.**
http://species-id.net/wiki/Calisto_muripetens
Figs 13–15, 36, 44, 52, 56, 58, 66

Calisto smintheus muripetens Bates 1939: 3, Michener 1943: 6, Munroe 1950: 226, Torre 1952: 62, Torre 1954: 120, Torre 1968: 20
Calisto sibylla muripetens Fontenla and Rodríguez 1990: 8, Smith et al. 1994: 57, Lamas 2004: 207

Diagnosis. *Calisto muripentens* is similar to several Cuban congeners. From the more similar *C. bradleyi* and *C. occulta*, both with three white dots at the UNHW with the middle one distinctly larger, *C. muripetens* differs by its androconial patch, without the apical lobe present in the first and occupying a larger area of wing than in the second. Their female genitalia are also different, being the corpus bursae smaller in *C. muripetens* than in *C. occulta*, and the dorsal crown taller in the first than in *C. bradleyi*. It differs from *C. smintheus*, *C. brochei*, and *C. herophile*, which have four white dots at the UNHW, by having only three white dots at that part of wings with the one at M_2–M_3 interspace distinctly larger. Other differences with *C. smintheus* and *C. brochei* are detailed in their respective Diagnosis sections. From *C. herophile*, it also differs by the larger area occupied by its androconial patch and its size, larger on the average, 18–22 mm of FWL versus 14–19 mm in males, and 20–23 mm versus 17–21 mm in females. The Hispaniolan *C. confusa*, *C. hysius*, *C. obscura*, and *C. pauli* are superficially similar but are smaller, and have four white dots at the UNHW.

Description. FWL: 18–22 mm ♂, 20–23 mm ♀. Male UPFW uniform grayish brown except androconial patch, dark brown almost black (Fig. 13). Androconial patch distinct from surrounding areas, about one half the length of FW, approximately triangular in shape with apex and outer margin rounded, anterior margin entering into cell (Fig. 36). Male UPHW dark grayish brown, paler at outer third. Female UP of wings uniform grayish brown, paler than male (Fig. 14). UNFW cell red patch variable in size, occupying from apical third to entire cell. Pdl edged by scarce pale yellow scaling. HW background brown mixed with pale yellow and, in less extent, ochre scales (Fig. 15). Post discal area on UNHW with three white dots at M_1–M_2, M_2–M_3, M3–Cu_1, with that on M_2–M_3 larger, smaller dots can gone in rubbed specimens. Male genitalia with tegumen about two thirds the length of uncus, dorsally flat and posteriorly rounded (Fig. 44); uncus gradually tapering and curved from base to apex, base rounded; valvae base broad; digitiform projection of valvae short and stout with ventral margin slightly concave; aedeagus straight at basal two thirds with a left curve at apical third in dorsal view. Female genitalia with dorsal crown tall (Fig. 52); corpus bursae somewhat broad, near equal in length to ductus bursae.

Type material. Holotype ♂: Trinidad Mountains, Buenos Aires 2500–3500 ft, 21°59'13"N, 80°11'20"W, 8–14 May 1936, P. J. Darlington. MCZ, not examined. Paratypes 1 ♂, 2 ♀: same locality as for holotype, 4 May 1932, S. C. Bruner & A. Otero. MCZ, not examined.

Additional material. 11 ♂, 4 ♀. **Cienfuegos:** same locality as for holotype, 16/VI/1967, slide RNA272(wings) (1 ♀); carretera a Pico San Juan, V/1986, J. L. Fontenla, slide RNA268(wings)/284 (legs & labial palpus) (3 ♂); Pico San Juan 1140 m, 21°59'25"N, 80°08'50"W, V/2006, R. Núñez, DNA voucher PM15–02 (M048) (3 ♂); Carso de Buenos Aires 725 m, 21°59'13"N, 80°11'20"W, V/2006, R. Núñez, genitalia ♀ in glycerin, slides RNA197/236(wings), DNA vouchers PM07–08 (M009), PM07–11 (M018) (1 ♂, 1 ♀); ladera norte de Pico Cuevita 900 m, 21°59'13"N, 80°10'18"W, V/2006, R. Núñez, genitalia ♂ in glycerin, slides RNA193(androconial scales)/200(legs & labial palpus)/235 (wings) (1 ♂). **Sancti Spiritus**: Topes de Collantes, Mi Retiro 800 m, 21°53'41"N, 80°01'02"W, V/2002, R. Núñez, genitalia ♂ & ♀ in glycerin, slides RNA166/199/241(wings) /209/210(legs & labial palpus), DNA voucher PM15–01 (M047) (3♂, 2 ♀). CZACC.

Distribution. *Calisto muripetens* is restricted to a few localities in the central Cuban mountains: the Guamuhaya massif, above 750 m and up to 1140 m on Pico San Juan, the highest peak (Figs 56, 58).

Immature stages. Unknown.

Habitat and biology. The species inhabits evergreen forests of the mogotes vegetation complex, limestone hills of vertical slopes, and rainforests, flying mostly in shady places.

Remarks. *Calisto smintheus muripetens* type series was not available for study. Online pictures of MCZ insect type material, last accessed in 9th October 2011, do not include them. However, examination of original description leaves no doubt of its identity. *Calisto muripetens* differs from *C. herophile*, the only other species in its range, by its larger size, darker color pattern and structure of the genitalia of both sexes.

Calisto muripetens is closest to *C. occulta*, a new species described below from NSB, the northeastern Cuban mountain range. Besides differences noted at the Diagnosis section, *C. muripetens* has other differences with *C. occulta*. These include the proportionally larger genitalia of the latter with the aedeagus with an enlarged base, swollen both in dorsal and lateral view.

As with *C. brochei*, two individuals of *C. muripetens* (PM07-08 and PM07-11) did not group together in both the nuclear and the mitochondrial data analyses (Fig. 66). A third individual, PM15-02, groups together with PM07-08 in the COI tree in a clade sister to *C. occulta*. The relationships of PM07-11 are unresolved in the mitochondrial data set being located in an unresolved clade containing *C. herophile s.l.* and *C. bradleyi*; however, this individual is sister to *C. bradleyi* based on the nuclear markers (Fig. 66B). This pattern suggests either hybridization or retained ancestral polymorphisms (see Discussion for further discussion on the potential causes of polyphyletic multiple haplotypes in *Calisto*).

***Calisto occulta* Núñez, sp. n.**
urn:lsid:zoobank.org:act:96685BEF-1929-4005-802D-F5C3C82BD2C4
http://species-id.net/wiki/Calisto_occulta
Figs 16–18, 29, 37, 45, 53, 56, 57, 60–62, 66, 83–89

Calisto sp., Núñez 2009: 56

Diagnosis. *Calisto occulta* is more similar to *C. muripetens* and *C. bradleyi* than other Cuban relatives. Characters separating *C. occulta* from *C. muripetens* are discussed above, at the Diagnosis section of the latter. From *C. bradleyi*, *C. occulta* differs by its darker color, its androconial patch without apical lobe, the slight red suffusion below cell at the UNFW, and its proportionally larger male and female genitalia. From the remainder Cuban species and from Bahaman ones with similar pattern, *C. occulta* can be separated by having fewer white dots at the UNHW (except *C. bruneri*), its proportionally larger male and female genitalia, and the presence of a slight red suffusion below the cell at UNFW. The Hispaniolan *C. confusa*, *C. hysius*, *C. obscura*, and *C. pauli* are superficially similar but are smaller, and have four white dots at the UNHW.

Adult. Male (Figs 16, 18, 29, 37) – FWL: 17–20 mm. *Head*: antennae dark brown, UN pale yellow at basal third and UP orange at club; eyes black, hairy, delimited by a pale yellow band; labial palpi dark brown on UN, pale yellow on UP, middle and basal segments rough. *Thorax*: UPFW uniform grayish brown except androconial patch, dark brown almost black. Androconial patch slightly distinct from surrounding areas, about two fifths the length of FW, approximately triangular in shape with apex rounded, anterior margin entering into cell and apex reaching M_3 origin (Fig. 37). UPHW darker than FW, about the same hue of androconial patch. UNFW brown, slightly posterior to pdl (Figs 18, 29); a red patch in outer half of cell with outer margin edged by dl, patch posterior margin diagonal between anterior and posterior limits of cell; a slight red scal-

ing below cell; dl, pdl and both stl darker than background; basal third of costa and outer edge of pdl with grayish white scales; ocellus black encircled by a pale yellow ring laying M_1–M_3, with two white pupils laying midway between M_1– M_2 and M_2–M_3, the posterior one more basad. UNHW brown mixed with pale yellow and grayish white scales; pdl and stl outer edged with pale yellow scales around ocellus; pdl area with three white dots at M_1– M_2, M_2–M_3 and M_3–Cu_1, with that on the middle greatly enlarged, dots surrounded by scattered whitish lilac scales; ocellus large, broad, laying between Cu_1 and Cu_2, black with a bluish white pupil at base and surrounded by a yellowish ochre ring outer edged by a ferruginous suffusion; tornal lobe slightly developed, black, innerly edge with pale yellow; legs dark brown, inner side of femora pale yellow, tibiae and tarsi white on external side. *Abdomen*: UP dark brown, UN pale yellowish brown. *Genitalia* (Fig. 45): uncus having typical bird's beak shape with a dorsal keel and gradually tapering toward apex, arched at apical half, base protuberant and rounded, separated from tegumen by a single dorsal notch; tegumen hood shaped, dorsally flat but rounded at anterior end, approximately one half the length of uncus, lateral fold narrow, extending ventrally along vinculum; gnathos spine shaped, approximately 0.3 the length of uncus; valvae elongated with a broad base, digitiform projection of valvae stout with a very broad base and slightly concave at venter, extending toward apical third of uncus, joins to main body relatively sclerotized; saccus developed, finger–like at anterior half and flattened, slightly convex, toward venter on posterior half; aedeagus robust and slightly arched ventrad at middle, straight at basal two thirds with a strong left curve at apical third in dorsal view, moderately swollen toward basal half both in lateral and dorsal view, ventrally divided from basal third to bifid terminus, ending in a pair of ventral triangular flattened processes.

Female (Fig. 17) – FWL: 18–21 mm. Similar to male except: UP of wings uniform dark brown; UNFW with red scaling below cell more distinct than in male, below lower limit of cell. *Genitalia* (Fig. 53): large in proportion to body; sterigmal ring rounded and well developed, dorsal crown broad and symmetrical, ring almost entirely covered by a ventral fold slightly sclerotized; inner sterigmal loop large, sclerotized, left arched in ventral view almost reaching anterior margin of ring; ductus bursae originated at left side of sterigmal ring in ventral view, membranous; ductus seminalis arising close to origin of ductus bursae; corpus bursae greatly enlarged, broad, approximately the same length of ductus bursae, signa formed by two parallel columns of numerous transverse rows of small irregular sclerotized processes.

Holotype. ♂: Guantánamo, Baracoa, Monte Iberia plateau, Tetas de Julia 650 m, 20°27'47"N, 74°45'13.3"W, 20/V/2007, R. Núñez, DNA voucher PM07–10 (M017). CZACC.

Paratypes. 7 ♂, 3 ♀: Holguín, Moa, Yamanigüey 75 m, 20°34'46.5"N, 74°45'12.2"W, 24–27/IX/2009, R. Núñez, DNA voucher PM07–23 (M041) (1 ♂, 1 ♀); same data as for anterior except: ex ova, emerged 28/I/2010, DNA voucher PM07–18 (M035) (1 ♂); same data as for anterior except: emerged 31/I/2010, DNA voucher PM07–19 (M036) (1 ♀); same data as for holotype except genitalia ♂ & ♀ in glycerin, DNA voucher PM07–04 (M004) (1 ♂, 1 ♀); Monte Iberia plateau, campamento ladera norte 600 m, 20°29'25.5"N, 74°43'51.3"W, 18/V/2007, R. Núñez,

genitalia in glycerin, slide RNA165(wings) (1 ♂); Baracoa, Monte Iberia, ladera norte 385 m, 20°29'53"N, 74°43'48"W, 1/V/2011, R. Núñez (3 ♂). CZACC.

Etymology. The species name derives from the Latin *occultus* (hidden, reserved) in reference to the cryptic nature of this species that remained hidden between its sympatric congeners until the present work.

Distribution. *Calisto occulta* is known from a few localities from the middle part of the NSB Mountains, from the Monte Iberia plateau 14 km north to near Yamanigüey, in northeastern Cuba (Figs 56, 57). It is probable that *C. occulta* is more widespread in the NSB in areas where its habitat is preserved.

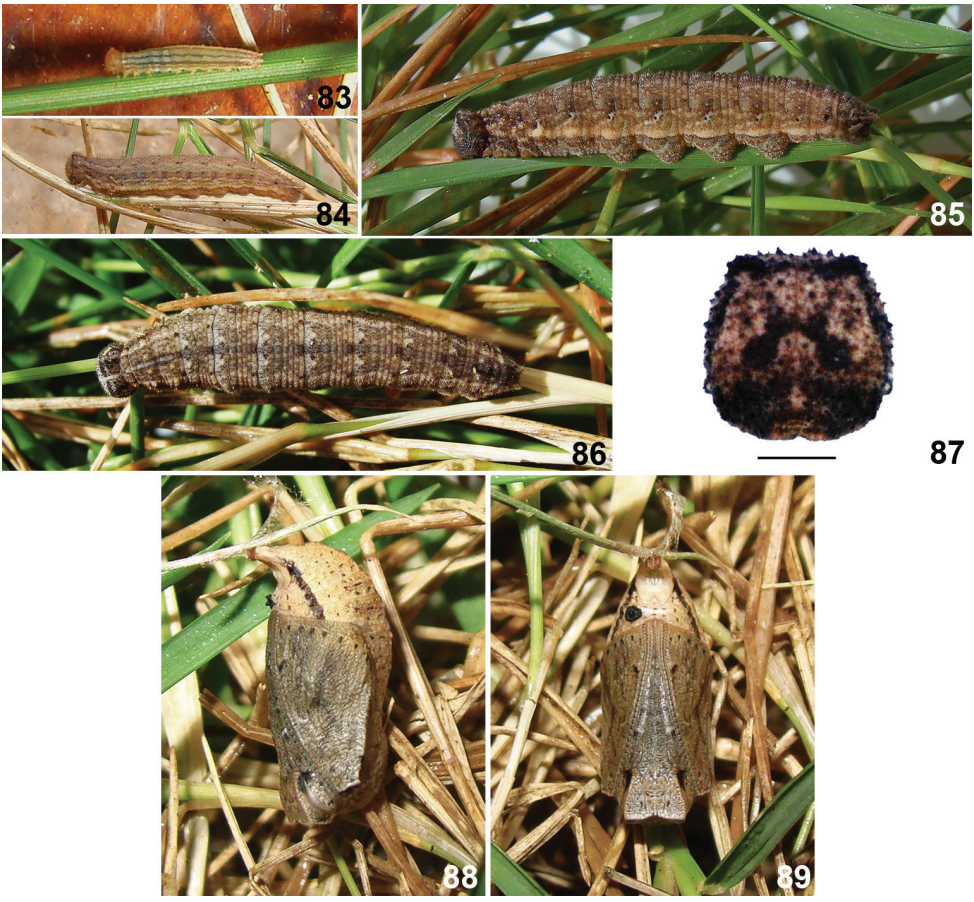
Immature stages. Egg & oviposition – Eggs are glued to substrate, are spherical in shape and ivory white in color becoming beige with irregular orange brown spots a day after being laid. Time to hatch 8 to 9 days (n=7).

First instar larva (Fig. 83) – Head capsule pale orange beige, with two short horns on top. Body beige, bluish white after fed on host leaves, with a dorsal line and three pairs of longitudinal pale brown lines: subdorsal, suprastigmatal, and stigmatal. Dimensions (n=7): head capsule width 0.60–0.62 mm, head capsule height 0.63–0.66 mm, initial total length 2.6–2.7 mm, final total length 3.5–3.8 mm. Duration (n=7): 13–15 days.

Second to fifth instars (Fig. 84) with the color pattern similar to that of sixth, described below, but paler and less contrasting and without the tranversal ashy gray bands.

Sixth instar larva (Figs 85–87) – Head capsule beige brown with numerous dark brown dots, a vertical dark brown line from each side reaching horns and joining at epicranial suture, a dark brown line connecting horns with subdorsal lines, horns much reduced; ventral third dark brown, almost balck, with a small rounded pale beige area at frons near clypeus; mandibles amber brown; X–mark of epicranium black with lower arms longer and rounded at tip. Body pale grayish brown, yellow from above spiracles to above prolegs, ventral side, including prolegs brown; dorsum of each segment with a darker "butterfly" like mark formed by small brown striations; lines slightly darker than background, except subdorsal which is pale yellow; each abdominal segment with a transverse ashy gray band at beginning from dorsum to suprastigmatal line; dorsal line edged at beginning of each segment by two black dots encircled in ashy gray; subdorsal lines thinner than dorsal line, wavy, closer to dorsal line at posterior margin of each segment, ending on caudal tails, with black dots on its upper edge aligned with dots of dorsal and suprastigmatal lines; suprastigmatal lines thin, diffuse, above it on each segment a central white dot encircled in brown and another, brown, near posterior margin; stigmatal lines thinner passing dorsal to spiracles encircled in ashy gray; infrastigmatal line thin and diffuse. Dimensions (n=2): head capsule width 2.41–2.57 mm, head capsule height 2.53–2.68 mm, initial total length 14–16 mm, final total length 22–23 mm. Duration (n=2): 30–35 days.

Pupa (Figs 88–89) – Head and wing sheaths pale brown with a row of black dots at wing sheaths margin; three pairs of frontal black dots: one elongated on eyes and two smaller and rounded on sheaths of legs, one at first third and other nearer to apex; wing sheaths edged on thorax by a brown line; dorsum of thorax and abdomen pale yellow with transverse rows of tiny black dots, density varies between individuals giving a darker or



Figures 83–89. Imatures stages of *Calisto occulta*, new species. **83** First instar **84** Fourth instar **85** Sixth instar, lateral view **86** Sixth instar, dorsal view **87** Sixth instar head capsule, scale bar 1 mm. **88** Pupa, lateral view **89** Pupa, ventral view.

paler appearance to abdomen; abdomen smooth, with a brown line on sides; last abdominal segment long, stout, cremaster area reduced. Three days before emergence color turns brown on dorsum extending gradually to occupying entire surface. Dimensions (n=2): total length 11–12 mm, maximum width 4.5–4.7 mm. Duration (n=2): 18–19 days.

Habitat and biology. The species inhabits the scrub forests (charrascales) of lowlands and rainforests up to 700 m in the NSB mountain range (Figs 60–62). At Yamanigüey scrub, it flies mostly below shrub shadow avoiding the high temperatures of insolated areas.

Larvae eat the entire corion after hatching and feed at night, remaining in the lower parts of grasses during day. *Calisto occulta* larvae did not accept well the two grass species supplied as substitute food and only two of seven larvae survived to pupation after undergoing six instars. Duration of first four instars was about two weeks each whereas fifth and sixth took about three and five respectively. Prepupal

period was two to three days long and pupal stage extended for two and a half weeks. Immature development took up to four months. Adult emergence occurred at the beginning of the afternoon, between 14:00 and 15:00. A mated pair was observed at 3:00 pm Monte Iberia north slope in May 2011.

Remarks. It is remarkable that the closest species to *C. occulta* is *C. muripetens*, an inhabitant of another mountain range. The relationship between them was discussed above. In the following paragraphs we discuss the differences with the remainder Cuban taxa.

Immature stages also support species status. The first instar of *C. occulta* has a pale orange beige head capsule which is almost black in *C. smintheus* and *C. herophile*. The longitudinal lines are fewer more spaced on sides and dorsum in *C. smintheus* and *C. occulta* than in *C. herophile*. Larvae of fifth and sixth instars of *C. occulta* have transverse ashy gray bands at beginning of each segment occupying from dorsum to suprastigmatal line, those lines are absent from *C. herophile* larvae. The subdorsal brown dots at metathorax of *C. smintheus* are absent in *C. occulta*. Pupae also show differences. Those of *C. herophile* have several pair of ridges on dorsum of abdomen and are beige, almost immaculate. In *C. occulta*, the head and thorax are pale grayish brown and the abdomen, that lacks the dorsal ridges, is beige with numerous black dots and a dark brown stripe at sides. As whole, is more spotted than the pupa of *C. herophile* but less than *C. smintheus*. Pupal head and cremaster shape are also different between species. Development time and number of larval instars also differ. The complete development took 60 to 70 days in *C. herophile* and 80 in *C. smintheus* both with five instars and 99 to 120 days and six larval instars in *C. occulta*.

The DNA analyses place all *C. occulta* (5 specimens, 2 localities) together, although the nuclear data placed a specimen of *C. brochei* within the *C. occulta* clade (Fig. 66). Both datasets suggest that *C. occulta* is related to *C. muripetens*, *C. bradleyi* and *C. herophile*, perhaps with *C. muripetens* being the closest relative. The species is separated from *C. herophile* and *C. bradleyi* with an average COI distance of 2.28% and 3.09% respectively, while the average COI divergence within *C. occulta* sampled from two distinct localities is just 0.98%.

***Calisto bradleyi* Munroe, 1950, comb. n.**
http://species-id.net/wiki/Calisto_bradleyi
Figs 19–21, 30, 38, 46, 54, 56, 59, 64–66

Calisto smintheus bradleyi Munroe 1950: 227, Torre 1952: 63, Torre 1954: 121, Torre 1968: 7

Calisto sibylla bradleyi Brown and Heineman 1972: 51, Alayo and Hernández 1987: 41, Fontenla and Rodríguez 1990: 9, Smith et al. 1994: 57, Lamas 2004: 207

Diagnosis. *Calisto bradleyi* resembles *C. muripetens* and *C. occulta* more than its other congeners. It can be separated from these species by the presence of an apical lobe at

the androconial patch, and by having an iridescent blue band edging the black dot of the anal lobe at the UNHW. Other differences were treated in the Diagnosis section of those species. From other Cuban (except *C. bruneri*), Hispaniolan and Bahamian species differs by the same characters and by have fewer white dots at UNHW. Its female genitalia is also diagnostic due to its proportionally smaller size and its thinner dorsal crown. The Hispaniolan *C. confusa*, *C. hysius*, *C. obscura*, and *C. pauli* are superficially similar but are smaller, and have four white dots at the UNHW.

Description. FWL: 17–20 mm ♂, 20–21 mm ♀. UPFW outer third and area anterior to apical half of androconial patch pale grayish brown, basal area anterior to patch darker (Figs 19, 20); costal two thirds and androconial patch dark brown, almost black. UPHW uniform dark brown, slightly paler than androconial. Androconial patch distinct from surrounding areas, approximately triangular with a rounded lobe at apex, not entering into cell, about one half the length of FW (Fig. 38). Lines at UN of wings with little if any pale shade of external side (Figs 21, 30). UNHW background pale brown heavily mixed with ochre scaling basal to pdl. Post discal area on UNHW with three white dots at M_1– M_2, M_2–M_3, M3–Cu_1, with that on M_2–M_3 larger, smaller dots can gone in rubbed specimens. UNHW lobe with a black dot anteriorly edged by a small band of iridescent blue scales. Male genitalia with tegumen about half the length of uncus, tapering gradually toward apex and arched along its length (Fig. 46); uncus strongly arched; digitiform projection of valvae stout, slightly arched toward venter; aedeagus with two sinuations of left side at apical half, the basal one smaller. Female genitalia small (Fig. 54); dorsal crown of sterigmal ring very narrow; corpus bursae small and broad, about two fifths the length of ductus bursae; ductus bursae very thin.

Type material. Holotype ♂: Pinar del Río, Sierra de Rangel (currently Sierra del Rosario), Río Tacoluco (almost surely Río Taco Taco), 3 March 1939, J. C. Bradley. Location unknown, not examined.

Additional material. 14 ♂, 13 ♀. **Pinar del Río:** Viñales 150 m, X/1985, J. L. Fontenla, genitalia ♂ & ♀ in glycerin, slides RNA202(legs & labial palpus)/260(wings) (1 ♂, 2 ♀); no collection data but probably the same same as for anterior, genitalia ♂ & ♀ in glycerin, slides RNA181 (androconial scales) /244/245/262/263/270/271 (wings)/247/ 265/278(legs & labial palpus) (6 ♂, 7 ♀); cuabales ladera sur de Cajálbana 150 m, 22°46'33.1"N, 83°26'22.1"W, III/2002, R. Núñez, DNA voucher PM15–08 (M054), genitalia in glycerin (1 ♀); Viñales, base norte mogote Dos Hermanas 140 m, 22°37'16.4"N, 83°44'40.3"W, 17/IV/2009, R. Núñez & E. Oliva, DNA vouchers PM07–24 (M043), PM07–25 (M044) & PM07–26 (M045) (6 ♂, 3 ♀). **Artemisa**: Pinar del Río (currently Artemisa), Sierra del Rosario, El Taburete 300 m, 22°50'11"N, 82°55'24"W, 9/X/2007, R. Núñez, DNA voucher PM07–06 (M006), genitalia in glycerin (1 ♂).

Distribution. *Calisto bradleyi* occurs in the major mountain range of western Cuba, Guaniguanico, from El Taburete, at Sierra del Rosario, 90 km west to Viñales valley, always at low elevations (Figs 56, 59). The species was previously known only from the type locality, Rangel, and Viñales (Munroe 1950; Fontenla 1987b). Attempts to find it at the type locality were made by Torre (1968) and ourselves without success.

Here we recorded it for the first time from Cajálbana and El Taburete widening its distribution to the eastern most portion of Guaniguanico mountain range.

Immature stages. Unknown.

Habitat and biology. The species inhabits various vegetation types throughout its distribution but can only be found in areas where original elements are still dominant. Habitats include the evergreen forest at El Taburete, the mogote vegetation complex at Viñales, and the dry scrub on serpentine soil at Cajálbana (Figs 64, 65). In Viñales valley, Pinar del Río, the species was flying in the shadow of the base of mogotes (limestone hills of almost vertivcal slopes) appearing occasionally in sunny places. There it was observed feeding on flowers of *Stachyterpheta cayenensis*, *Hyptis verticilla*, and *Urena lobata*, and a mating pair was observed at 3:30 pm in April 2009.

Remarks. The type specimen of *Calisto smintheus bradleyi* is apparently lost. Searching of the type specimen at the different collections mentioned by Munroe (1950), CUIC, AMNH, MCZ, and CMNH, was fruitless. However, based on the examination of original description and since the other only species in its range of distribution, *Calisto herophile*, is rather different, it can be easily identified.

DNA analyses are somewhat ambiguous about the relationships of *C. bradleyi*. The mitochondrial dataset suggests that *C. bradleyi* is paraphyletic with regard to *C. herophile* and one individual of *C. muripetens* (Fig. 66), while the nuclear data place the monophyletic *C. bradleyi* in a clade with *C. occulta* and *C. muripetens*. The COI distance between the sister species *C. herophile* and *C. bradleyi* is 1.91%. Nonetheless, the status of species in both cases is still valid as the molecular phylogenies consistently separate the lineages (Fig. 66). Therefore, we prefer to treat them as separate entities, proposing the species status for *C. bradleyi*, potentially phylogenetically close to *C. herophile*.

***Calisto herophile* Hübner, 1823**

http://species-id.net/wiki/Calisto_herophile

Figs 22–24, 31, 39, 47, 55, 56–59, 66, 90–99

Calisto herophile Hübner 1823: 16, Gundlach 1881: 111, Lathy 1899: 223, Dethier 1940: 14

Satyrus herophile Poey, 1847: 179

Calisto herophile herophile Bates 1935: 242, Michener 1943: 6, Michener 1949: 1, Munroe 1950: 225, Torre 1952: 62, Torre 1954: 120, Torre 1968: 12, Brown and Heineman 1972: 51, Alayo and Hernández 1987: 39, Schwartz and Hedges 1991: 136, Smith et al. 1994: 56, Lamas 2004: 2007, Núñez 2009: 56

Diagnosis. *Calisto herophile* can be separated by its similar congeners in several ways. From *C. smintheus* and *C. brochei*, it differs, among other features, by its paler background color at both sides of wings, the inconspicuousness of its androconial patch and its less sclerotized male genitalia with a shorter uncus and less sinuous aedeagus.

From *C. muripetens*, *C. occulta* and *C. bradleyi*, it differs by having four white dots and paler coloration. Differences with *C. bruneri* are detailed in the Diagnosis section of that species. It is also similar the Bahamian *C. sibylla* but smaller, 14–21 mm of FWL versus 23 mm in *C. sibylla* which also lacks the red in cell at the UNFW present in *C. herophile*. The Hispaniolan *C. confusa*, *C. hysius* and *C. obscura* although similar in size are darker, and have straighter white edged lines at the UNHW. Other Hispaniolan species, *C. pauli*, is similar in size and pattern but has different genitalia including a larger and flattened uncus in males and a terminal production in the dorsal crown of the female genitalia.

Description. FWL: 14–19 mm ♂, 17–21 mm ♀. Male UP of wings dark brown at basal area more or less defined by UN pdl, area outer to pdl distinctly paler (Fig. 22). Androconial patch indistinct in fresh specimens, approximately triangular with apex slightly angled, anterior margin not surpassing posterior margin of cell, about two fifths the length of FW (Fig. 39). Female UP of wings as in male but distinctly paler (Fig. 23). UNHW background pale brown heavily mixed with pale yellow scales (Figs 24, 31). Post discal area on UNHW with four two white dots at Rs–M_1, M_1–M_2, M_2–M_3, M_3–Cu_1 interspaces, the last one, and occasionally the first one too, smaller and sometimes absent in rubbed specimens. Male genitalia with tegumen about two thirds the length of uncus, nearly straight, posterior end rounded (Fig. 47); uncus broad at basal half, tapering gradually from the middle toward apex, arched at apical third; digitiform projection of valvae with ventral margin straight; aedeagus only slightly sinuated in dorsal view, with two small left curves at apical half. Female genitalia with dorsal crown tall (Fig. 55); corpus bursae somewhat broad, about 0.6 the length of ductus bursae.

Type material. Holotype ♂: Cuba, Havannah. Location unknown, not examined.

Additional material. 148 ♂, 76 ♀. **Pinar del Río:** Pinares de Viñales 200 m, 22°35'N, 82°42'41"W, V/1963, P. Alayo & I. García, genitalia in glycerin, slide RNA 223(legs & labial palpus) (1 ♂); Rangel 400 m, 22°45'N, 83°11'W, 2/XI/1966, I. García & S. L. de la Torre (4 ♂); same data as for anterior except I. García, slide RNA196(wings) (1 ♀); same locality and collector as for anterior 21/VII/1967 (9 ♂, 6 ♀); same locality as for anterior, R. Núñez & E. Oliva, 19–20/IV/2009, ex ova, emerged 19/VI/2009 (2 ♂); same data as for anterior except emerged 20/VI/2009 (1 ♀); 22/VI/2009 (1 ♂); 23/VI/2009 (1 ♀); 26/VI/2009 (1 ♂); Viñales 150 m, 22°36'59"N, 82°42'28"W, 21/VII/1967 (6 ♂); same locality as for anterior, X/1985, J. L. Fontenla (2 ♂); Valle de Viñales, 9/I/1974, A. Castiñeiras (1 ♂); carretera a Viñales km 22 200 m, 22°34'29"N, 82°42'11"W, 14/I/1974, A. Castiñeiras (1 ♀). **Mayabeque:** Jaruco, Cueva Don Martin, 23°00'N, 82°01'W, 4/V/1966 (5 ♂); La Habana (currently Artemisa), Guajaibón próximo a Mariel, 23°01'N, 82°40'52"W, 25/V/1967 (1 ♂, 1 ♀); same locality as for anterior, X/2007, R. Núñez, DNA voucher PM07–07 (M008) (1 ♀); Pinar del Río (currently Artemisa), Sierra del Rosario, III/1968, R. González (1 ♂); Pinar del Río (currently Artemisa), Sierra del Rosario, alrededores Estación Biológica 180 m, 22°51'N, 82°55'53"W, 1–10/X/2007, R. Núñez (1 ♂); Sierra del Rosario, El Mulo 200 m, 22°51'29"N, 82°56'54"W, 10/X/2007, R. Núñez (1 ♂). **Isla de La Juventud:** Isla de Pinos (currently Isla de La Juventud), Cerro San Pedro

150 m, 21°42'47"N, 82°51'50"W, 20/X/1966, I. García (2 ♂); Habana (currently Isla de La Juventud), Isla de Pinos (currently Isla de La Juventud), 30/X/1966, I. García (7 ♂, 7 ♀). **Habana:** Cerro, 23°06'27"N, 82°23'20"W, 9/I/1934 (1 ♂); Arroyo Naranjo, 23°01'N, 82°22'W, 5 August 1935, L. C. Scaramuzza (1 ♀); Santiago de Las Vegas, 22°58'N, 82°23'W, 15/VIII/1935, S. C. Bruner, genitalia in glycerin (1 ♀); same locality as for anterior, 5 Marzo 1946, J. Ferrás (1 ♂); same data as for anterior except 19 March 1948 (2 ♂); Cotorro, 23°02'N, 82°16'W, 1/XII/1947, J. T. Sierra (1 ♂). **Mayabeque:** Matanzas (currently Mayabeque), 5 km W Ceiba Mocha 150 m, 22°58'50"N, 81°46'24"W, 8/IX/1940, S. L. de la Torre (1 ♂); La Habana (currently Mayabeque), Madruga, La Jiquima 125 m, 22°53'58"N, 81°50'34"W, 5/X/1948, S. L. de la Torre & J. Ortiz (1 ♀). **Matanzas:** Los Prácticos, 23°02'37"N, 81°34'32"W, 23/VII/1940, S. L. de la Torre (1 ♂); Playa, 23°02'37"N, 81°34'32"W, 11/V/1942, S. L. de la Torre (1 ♀); same data as for anterior except 16/VI/1942, slide RNA242(wings) (1 ♂); same data as for anterior except 29/VIII/1947 (1 ♀); same data as for anterior except 6/X/1947 (1 ♂); same data as for anterior except 26/VIII/1948 (1 ♀); same data as for anterior except 27/VIII/1948 (1 ♂); same data as for anterior except 6/XI/1948 (2 ♂); km 6 Vía Blanca, Playa Mamey, 23°03'06"N, 81°29'41"W, 6/VII/1953, S. L. de la Torre (1 ♀); Varadero, Varahicacos, 23°11'40"N, 81°09'16" W, 17/VI/2008, R. Núñez, slide RNA218(wings), DNA voucher PM15–04 (2 ♂). **Cienfuegos:** Las Villas (currently Cienfuegos), Escambray, Mina Carlota 450 m, 22°03'55"N, 80°09'38"W, 15/VI/1967, genitalia ♂ & ♀ in glycerin, slides RNA207(legs & labial palpus)/206(wings) (3 ♂, 2 ♀); Las Villas (currently Cienfuegos), Escambray, Buenos Aires 700 m, 21°59'13"N, 80°11'20"W, 16/VI/1967, genitalia ♂ & ♀ in glycerin, slides RNA182(androconial scales)/203(legs & labial palpus)/226/232(wings) (9 ♂, 4 ♀); Escambray, Charco Hediondo a 10 km de Aguacate, VIII/1978, L. R. Hernández (1 ♂). **Villa Clara:** Mordazo, 22°38'29"N, 80°26'58"W, V/1934 (1 ♀). **Sancti Spiritus:** Trinidad, La Vigía 200 m, 21°48'48"N, 79°58'34"W, 15/VI/1967 (1 ♂). **Camagüey:** Camagüey, 21°22'51"N, 77°55'01"W, 23/IX/1967, S. L. de la Torre (6 ♂). **Holguín:** Ote (currently Holguín), Pinares de Mayarí 800 m, 20°28'8"N, 75°48'52"W, 16/X/1966, I. García (10 ♂, 5 ♀); same locality as for anterior, VI/1967, P. Alayo (1 ♂, 2 ♀); Moa, El Johnson 300 m, 20°35'36.4"N, 74°59'9.9"W, 5/I/1968, S. L. de la Torre, slide RNA 167(wings) (1 ♂); same data as for anterior except 6/I/1968 (1 ♂); Moa, Quemado del Negro, 22°36'40"N, 74°49'22"W, 6/I/1968, S. L. de la Torre (1 ♂, 1 ♀); same data as for anterior except 7/I/1968, slide RNA281(legs & labial palpus) (3 ♂, 3 ♀); Mayarí, camino de La Zoilita 250 m, 20°38'N, 75°29'W, IX/1986, R. Rodríguez, genitalia in glycerin (2 ♂); Mayarí, El Purio, 20°39'45"N, 75°30'55"W, IX/1986, R. Rodríguez, genitalia ♀ in glicerin, slide RNA220(wings) (2 ♂, 2 ♀); Jaguaní, Arroyo Bueno o La Melba 200 m, 20°26'24"N, 74°48'46"W, VIII/2001, R. Núñez (1 ♂, 1 ♀); antiguo campamento minero Meseta de El Toldo 815 m, 20°27'35"N, 74°53'53"W, V/2008, E. Pérez (3 ♂); Moa, km 1 camino de La Melba, 20°36'12"N, 74°50'20"W, 19/I/2009, R. Núñez, genitalia ♀ in glycerin, slide RNA259(legs & labial palpus), DNA voucher PM15–06 (M052) (1 ♂, 2 ♀); Moa, Yamanigüey 75 m, 20°34'45.9"N, 74°44'10.2"W, 24/I/2009, R. Núñez, slide RNA264(wings), DNA voucher PM157–05 (2 ♂, 1 ♀); ♀), Sierra de

Cristal, cerca de la Estación La Zoilita 400 m (20°37'41.7"N, 75°29'08.1"W), 15–20/II/2010, R. Núñez, DNA voucher PM07-22 (M040). **Santiago de Cuba:** Las Lagunas, 19°59'37"N, 75°47'50"W, 29/VI/1930 (1 ♂); Santa María, 20°05'N, 75°49'W, Julio 1940, slides RNA 177/178(androconial sclaes) (2 ♂, 1 ♀); same locality as for anterior, 18 May 1941, slide RNA180 (androconial scales) (1 ♂); same locality as for anterior, 20 Junio 1943 (1 ♂); same locality as for anterior, 29 Junio 1943 (1 ♂); Marimón, 27 Junio 1942, slide RNA179(androconial scales) (1 ♂); same locality as for anterior 28 Junio 1942, slide RNA205(wings) (1 ♀); Ote (currently Santiago de Cuba), Ciudamar, 19°58'41"N, 75°51'51"W, 22/IX/1950, S. L. de la Torre (1 ♀); Cuabitas (20°03'48"N, 75°48'05"W, 28/IV/1953, S. L. de la Torre (1 ♂); same locality as for anterior XII/1956, P. Alayo (1 ♀); Las Manuelas camino a Baire 420 m, 20°13'09"N, 76°21'52"W, 23/XI/1952, S. L. de la Torre (1 ♂); Pico Turquino 1972 m, 19°59'23.7"N, 76°50'11.9"W, 18/X/1966, I. García (1 ♀); Ote (currently Santiago de Cuba), Loma El Gato 1000 m, 20°00'33"N, 76°02'16"W, VIII/1942, Hno Crisogono (1 ♂); same locality as for anterior, 6/IX/1951, S. L. de la Torre, genitalia ♂ in glycerin (5 ♂, 5 ♀); same locality as for anterior, 17–20 June 1952, F. de Zayas & P. Alayo (1 ♂); same locality as for anterior, 20 June 1952, slide RNA187(wings)/222(legs & labial palpus) (2 ♂); same locality as for anterior, 25–26 Junio 1952, F. Zayas & P. Alayo (1 ♂); same locality as for anterior, 11/VIII/2008, E. Oliva, DNA voucher PM07–12 (M029) (1 ♂, 1 ♀); same locality and date as for anterior, E. Fonseca (1 ♀); Puerto Boniato, 28/XI/1950, S. L. de la Torre (1 ♂); same data as for anterior except 16/V/1953 (1 ♂); zona del Caney, Loma del Ermitaño 430 m, 20°02'38"N, 75°37'3"W, 13/III/1953 (1 ♂); Ote (currently Santiago de Cuba), Caney, Gran Piedra, 20°00'31"N, 75°42'31"W, Junio 1954, F. de Zayas & P. Alayo, slide RNA229(wings) (2 ♀); same locality as for anterior, 23/IV/1955, genitalia in glycerin (1 ♀); same locality as for anterior, VI/1962, P. Alayo, genitalia in glycerin (1 ♀); Juraguá próximo a Santiago de Cuba, 19°55'31"N, 75°38'28"W, 9/I/1968, S. L. de la Torre (1 ♂); alrededores Estación BIOECO Gran Piedra 1000 m, 20°00'31"N, 75°37'3"W, 16–18/XI/2005, R. Núñez (1 ♀); same data as for anterior except 8/III/2008, genitalia ♀ in glycerin (1 ♂, 1 ♀); same locality as for anterior, 14/VIII/2008, E. Oliva (1 ♂); km 19 carretera Gran Piedra, 12/III/2008, R. Núñez (1 ♂); Gran Piedra, El Olimpo, campamento forestal "Las Marianas", 13/III/2008, R. Núñez, DNA voucher PM15–07 (M053) (2 ♂). **Guantánamo:** Ote (currently Guantánamo), Guantánamo, 20°01'N, 75°12'W, 26/XI/1950, S. L. de la Torre & P. Alayo (1 ♀); Ote (currently Guantánamo), Baracoa, Loma La Farola, 1/V/1968, S. L. de la Torre (2 ♂, 1 ♀); Ote (currently Guantánamo), Cupeyal 730 m, 20°26'57"N, 75°03'38"W, VI/1971, I. García (2 ♂); Piedra La Vela 650 m, 20°24'45"N, 74°56'51"W, VII/2001, R. Núñez (2 ♂); Piedra La Vela, Loma El Mulo 615 m, 20°25'27"N, 74°54'32"W, VII/2001, R. Núñez (1 ♂); río Jaguaní, Vázquez Abajo 560 m, 20°25'15"N, 74°54'33"W, Cuchillas del Toa, Boca de Jaguaní 130 m, 20°22'46"N, 74°41'36"W, VIII/2001, R. Núñez (1 ♂); Yumurí del Sur 450 m, 20°11'21"N, 74°29 31"W, 20/I/2009, R. Núñez & E. Oliva (2 ♂, 2 ♀). CZACC, MFP.

Distribution. The species is present across the Cuban archipelago from coastal areas to mountains up 1100 m (Figs 56–59).

Immature stages. Egg & oviposition – Eggs are laid loose, near spherical in shape and ivory white in color becoming beige with irregular orange brown spots a day after laid. Torre (1968) also mentioned that eggs are laid loose. Surface is covered by a fine raised reticulation forming minute polygonal areas (Dethier 1940, Torre 1968). Time to hatch 7 to 9 days (n=16), according Dethier (1940) 6 to 11 and Torre (1968) gave 5 to 8 days.

First instar larva (Fig. 90) – Head capsule dark brown, almost black, with a bronze gloss and with two short horns on top. Body beige, greenish white after fed on host leaves, with a dorsal line and four pairs of longitudinal pale brownish green thin lines all of same width and more or less equally spaced: subdorsal, suprastigmatal, stigmatal and infrastigmatal. Dimensions (n=16): head capsule width 0.52–0.57 mm, head capsule height 0.56–0.59 mm, initial total length 2.2–2.5 mm, final total length 3.4–3.7 mm. Duration (n=16): 7–10 days. This description agrees with that by Dethier (1940), who reported an instar duration of 7 days.

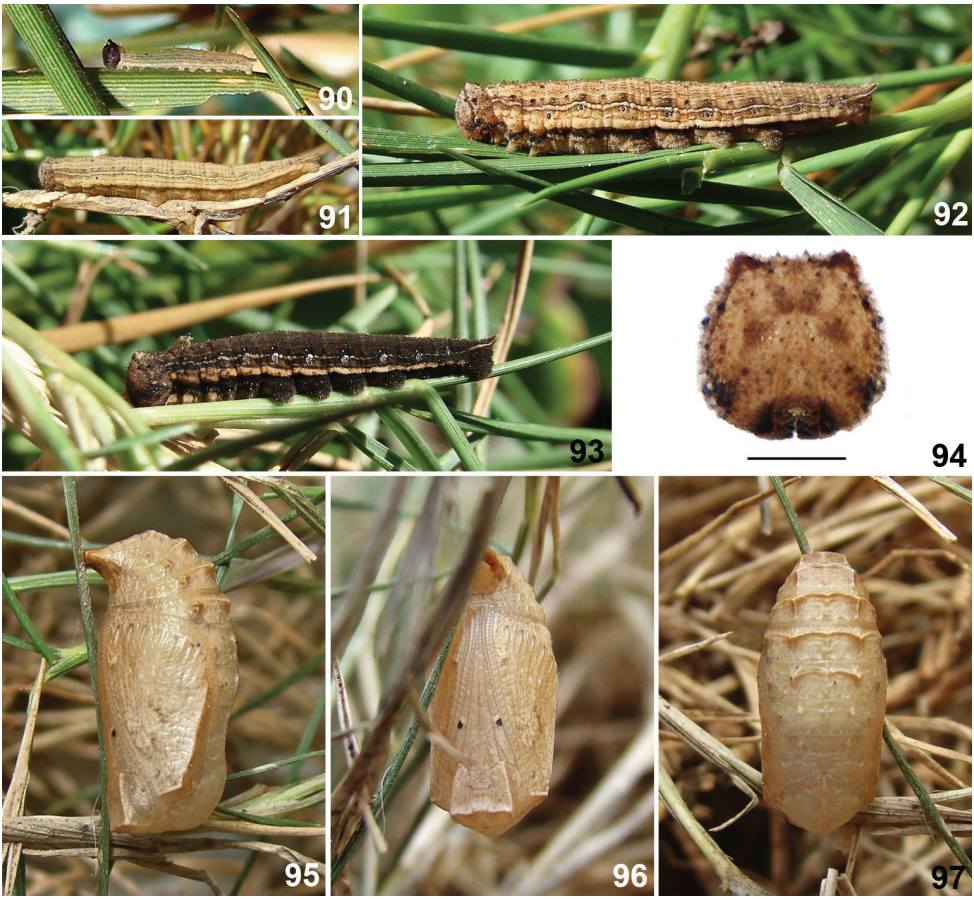
Second to fourth instars (Fig. 91) with the same pattern of fifth, described below, but paler and less contrasting.

Fifth instar larva (Figs 92, 94) – Pale morph. Head capsule pale brownish gray with numerous slightly darker dots, base of setae dark brown, a vertical brown line from each side reaching horns and almost joining at epicranial suture, horns reduced; stemmatal area, clypeus and area around mandibles brown or dark brown; mandibles amber brown, black at edge; X–mark of epicranium slightly darker than background with lower arms longer and rounded at tip, broken as four spots in some specimens. Body pale brownish yellow minutely striated in brownish gray thin lines on dorsum between subdorsal lines, with a dorsal line and five pairs of longitudinal pale brownish gray lines: subdorsal, suprastigmatal, stigmatal and infrastigmatal; dorsal line brownish gray edged at beginning of each segment by two black dots; subdorsal lines somewhat diffuse toward segments margins, with a black dot on its lower edge at posterior margin of each segment, dots on thorax enlarged, lines ending at caudal tails; suprastigmatal lines dark brown, thin, above it on each segment a central white dot encircled in black and another, black near posterior margin; stigmatal lines dark brown, thin, space between it and suprastigmatal pale beige, contrasting, edged on its lower edge by spiracles which are dark and encircled in grayish white; infrastigmatal lines thin, somewhat diffuse; subventral lines thick, wavy, and darkest; ventral side, including prolegs pale brownish yellow. Dimensions (n=4): head capsule width 1.41–1.57 mm, head capsule height 1.55–1.62 mm, initial total length 12–15 mm, final total length 20–23 mm. Duration (n=9): 11–18 days. Larvae reared by the senior author match Dethier (1940) descriptions of instars two to fourth, in general, color pattern is about the same, including the fifth instar, with minor variations.

Dark morph (Fig. 93). Head with all tones darkened. Body background pale brown with lines dark brown, somewhat diffuse; dots at edges of mid dorsal and subdorsal and encirclement of spiracles ashy white, contrasting; a thin pale yellowish beige line between subdorsal and suprastigmatal line, contrasting; dots above suprastigmatal line and encirclement of white dots above it indistinct; space between infrastigmatal and

subventral offline pale yellowish beige, contrasting; subventral line thicker than in pale morph, dark brown extending over dorsum of prolegs. Torre (1968) apparently also reared larvae of this morph but only mentioned the general darkening of coloration.

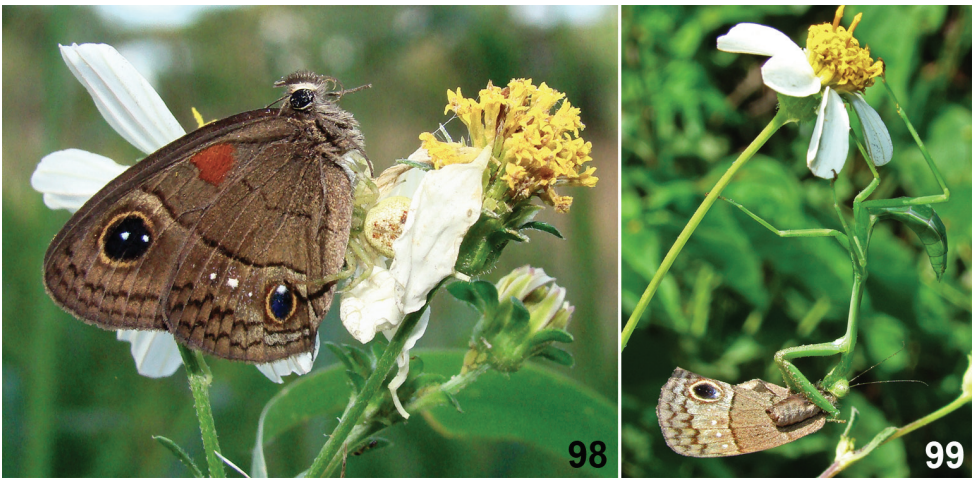
Pupa (Figs 95–97) – Entirely more or less uniform stramineous; one pair of black dots at first third of legs sheaths; abdomen with a transverse ridge with a pair of more prominent crests on dorsum of segments 1 to 6; last abdominal segment short and stout, cremaster area enlarged, broad. Three days before emergence color turns brown on dorsum extending gradually to occupying entire surface. Dimensions (n=9): total length 10–11 mm, maximum width 3.5–4.5 mm. Duration (n=9): 8–10 days.



Figures 90–97. Immature stages of *Calisto h. herophile*. **90** First instar **91** Fourth instar **92** Fifth instar, pale morph **93** Fifth instar, dark morph **94** Fifth instar head capsule, scale bar 1 mm. **95** Pupa, lateral view **96** Pupa, ventral view **97** Pupa, dorsal view.

Habitat and biology. *Calisto herophile* inhabits many habitats, from suburban areas at major cities to the edges of evergreen and rainforests up to 1100 m of altitude, always disturbed in some degree. Individuals can be found any month of the year

throughout the island. The species is one of the commonest butterflies in Cuba, especially in altered land with predominantly herbaceous vegetation but shaded to some degree (Fontenla 1987a; Núñez and Barro 2003; Fernández 2007). Fernández (2007) recorded it in Camagüey province from groves, hedges and open scrub land and recorded 26 plant species as nectar sources. We recorded two predation events on this species, one in November 2008 at La Chata, La Habana province, by a crab spider, Thomisidae (Fig. 98); the other in July 2009 at Pan de Matanzas, Matanzas province, by a nymph of the mantid *Stagmomantis domingensis* Palisot de Beauvois (Fig. 99).



Figures 98–99. Predation on *Calisto h. herophile* **98** Predation by a crab spider, Thomisidae, November 2008 at La Chata, La Habana province **99** Predation by a mantis nymph, *Stagmomantis domingensis*, July 2009 at Pan de Matanzas, Matanzas province.

Larvae eat the entire corion after hatching and feed at night, remaining in the lower parts of grasses during the day. They accepted well the substitute grasses supplied. Duration of first three instars was about one to one and half weeks each whereas the last two were around two weeks each. The prepupal stage duration was one day long and the pupal stage extended for eight to ten days. Immature development takes 60 to 70 days and goes through five larval instars. Adult emergence occurred after mid day. Dethier (1940) apparently did not complete the life cycle, describing it only to the fourth instar without mentioning the pupa or adult emergence. Dethier used several grass species as food and said that the larvae preferred lawn grass; however, he did not give scientific names of any grass species. Torre (1968), although successful in rearing the species, only described the cycle superficially and mentioning the duration, 70 to 73 days, and number of larval instars, four. He used as substitute food *Saccharum officinarum*, *Zea mays*, and *Stenotaphrum secundatum*, and noted that larvae grew slower with the first.

Remarks. *Calisto herophile* is one of the easiest to recognize among all Cuban *Calisto* species. Its smaller size on average, as well as its pale wing pattern allow their unequivocal identification, although some specimens from altitudes above 800 m can

be distinctly larger. The genitalia and immature stages can be also diagnostic. The species has a wide ecological range and tolerance to anthropogenic habitat alteration.

The status of *C. herophile* subspecies, *Calisto herophile parsonsi* Clench, 1943 and *C. herophile apollinis*, is yet pending further investigation. In the present study, only old material of *parsonsi* was available. The unique morphological difference with the nominal subspecies is the more homogeneous pattern at UN of wings, as pointed out by Clench (1943). Genitalic comparisons revealed an identical morphology. We were able to sequence a small fragment (337 bp) of COI for two specimens of the Bahamian subspecies *C. herophile apollinis* Bates. These specimens were clearly quite different to Cuban *C. herophile* (Fig. 66) and might warrant species status. Future studies involving fresh specimens, immature stages and DNA data could clarify the status of both of these taxa.

Key to the adults of Cuban *Calisto* based on wing pattern and geographic distribution

1 UNFW cell without red spot; UNHW with a large white triangle shaped spot..... ***C. israeli***

– UNFW cell red spotted, UNHW without a large white triangle shaped spot **2**

2 Four white dots on post discal area at UNHW, dot at M_3–Cu_1 the smallest and sometimes absent in rubbed specimens **3**

– Less than four white dots on post discal area at UNHW, dot at Rs– M_1 always absent **5**

3 UN of wings background pale brown heavily mixed with pale yellow; male with outer third of UPFW distinctly paler than basal two thirds; androconial patch indistinct..... ***C. herophile***

– UN of wings background brown mixed with pale yellow, ochre and reddish scales; male with UPFW uniform; androconial patch distinct..... **4**

4 Anal lobe, and occasionally part of inner margin, at UPHW with a ferruginous suffusion; UN of wings brown heavily mixed with reddish scales, surface with a distinct reddish wine color; restricted to Sierra Maestra Mountains.... ..... ***C. smintheus***

– Anal lobe without ferruginous suffusion at UPHW; UN of wings brown heavily mixed with pale yellow and ochre scales, surface without distinct reddish wine color; restricted to NSB Mountains..... ***C. brochei***

5 UNHW with white dot at M_2–M_3 no distinctly larger than remainder dots; UNHW ocellus pear shaped; UN of wings background mixed with grayish and, in less extent, pale yellow scales..... ***C. bruneri***

– UNHW with white dot at M_2–M_3 distinctly larger than remainder dots; UNHW ocellus ovoid shaped; UN of wings background mixed with ochre and/or pale yellow scales **6**

6 Androconial patch not entering into cell, with a rounded lobe at apex; UNHW anal lobe with a small bar of iridescent blue scales; restricted to Guaniguanico Mountains ..... ***C. bradleyi***

– Androconial patch entering into cell, apex without rounded lobe; UNHW anal lobe without small bar of iridescent blue scales; not in Guaniguanico Mountains **7**

7 Male UPHW uniform dark brown, almost black; female UP of wings dark brown; area below cell at UNFW with slight red scaling; restricted to NSB Mountains ..... ***C. occulta***

– Male UPHW dark brown at basal two thirds, outer third distinctly paler; female UP of wings brown; area below cell at UNFW without slight red scaling; restricted to Guamuhaya Mountains ..... ***C. muripetens***

Discussion

The number of *Calisto* species recognized for Cuba, several more than the two accepted for most recent works (Smith et al. 1994; Lamas 2004; Sourakov & Zakharov 2011), was expected. Previous researchers, from Bates in early 1930's to Torre in the late 1960's, were aware of such diversity and described the majority of species, while Brown and Heineman (1972) proposed several taxonomical changes and the species number fell to only two species with a large number of subspecies.

The synonymy of all Cuban mountain species under *C. sibylla* was unjustified as noted before by Munroe (1972) and Núñez (2009). The absence of *C. sibylla* specimens for dissections and DNA sequencing left as the only means for comparisons the examination of pictures of several specimens, including the holotype, and the descriptions made by Bates (1934; 1935), which provides just wing pattern descriptions.

Despite the scarcity of evidence on hand, there are several elements pointing towards the valid species status of *C. sibylla*, distinct from Cuban species. The clearest difference is the lack of the reddish color in cell at UNFW, similar to only *C. israeli* within Cuban taxa. The presence of a black dot at both sides of HW anal lobe is also notable, being absent in all former Cuban synonyms of *C. sibylla,* except for *C. bradleyi* where the spot is edged in the UN by a small iridescent blue band. *Calisto sibylla* presents a white dot at Rs–M_1 which is absent in *C. bradleyi*, *C. muripetens* and *C. occulta*. In the latter three species, the white dot at M_2–M_3 is distinctly larger than remainder dots whereas in all other Cuban and Bahamian species it may just be slightly larger.

The number, disposition and size of white dots at UNHW post discal area may constitute visual signals for sexual selection within *Calisto*. Robertson and Monteiro (2005) and Costanzo and Monteiro (2007) demonstrated that females of the nymphalid butterfly *Bicyclus anynana* Butler, 1879 select males based on critical features such as the size and brightness of the dorsal eyespot's ultraviolet reflecting pupils. Several combinations of those wing pattern elements are present in Cuban *Calisto*, with sympatric species at all major mountain ranges, except perhaps Sierra Maestra, having dots located in

different parts of the UNHW, varying in size and number. At NSB Mountains, *Calisto israeli* exhibits additional white reflecting elements at UNHW that probably evolved as visual signals in response to selective pressure caused by a larger number of sympatric congeners. Indeed, the existence of such a mechanism in *Calisto* needs to be tested in experiments including other reproductive isolation mechanisms like sex pheromones, probably secreted by glands associated to androconia present in males of most species.

The androconial patch at male UPFW seems to also be important in species differentiation, with the shape and conspicuousness varying between species. In all Cuban species, except *C. bruneri* and *C. herophile*, the patch is at least partially distinct from surrounding areas. In *C. sibylla*, as in *C. herophile*, the patch is hidden by the dark brown basal two thirds of FW. Such differences in the secondary sexual structure seem to constitute a key diagnostic element in *Calisto*, as noted also by Bates (1935), Michener (1943), and Johnson and Hedges (1998).

Island isolation, habitat differences and morphology suggest specific differentiation between Cuban and Bahamian *Calisto*. Whereas *C. sibylla* inhabits coastal thickets (Clench 1977; Harvey and Peacock 1989), all Cuban species previously regarded as synonyms to the former are found only in montane habitats.

Within the Cuban *Calisto*, genitalic characters proved to be useful in taxonomy as has been found for Hispaniolan congeners (Jonhson et al. 1987; Sourakov 1999). The most important features are the shape of digitiform projection of genitalia valve, the shape and relative size of tegumen and uncus, the relative size of female genitalia, the height of sterigmal ring dorsal crown of the latter, and the relative size of corpus bursae and ductus bursae. Previously, Bates (1934) and Torre (1968) partially illustrated and described the masculine genitalia of *C. smintheus* and *C. herophile*, as well as the uncus, gnathos and the apex of valvae of *C. herophile*, *C. bruneri*, and *C. smintheus*, respectively. For females, Torre (1973) poorly illustrated the genitalia of *C. brochei* and *C. israeli* without describing them; whereas Jonhson and Hedges (1998) illustrated and discussed the sterigmal ring and dorsal crown of the "*C. herophile* complex" and "*C. sibylla* complex".

The immature stages of Cuban *Calisto* have more divergent characters than those present on adults. The case of *C. smintheus* and *C. brochei* illustrates this well. Similar to the species pair *C. batesi* Michener – *C. hysius* (Sourakov 1996) from Hispaniola, characters such as larva head capsule color pattern at all instar as well as pupae color pattern and the shape of head, last abdominal segment, and cremaster, clearly differ between species.

Preliminary DNA analyses, part of a larger work aiming to study the phylogenetic relationships of the whole genus *Calisto* and to examine their relationships with continental relatives (Matos et al. in prep.), showed that the Cuban species form a compact group. Excepting *C. sibylla*, which was not sequenced due to lack of fresh specimens, all species were grouped together supporting the idea of a species group: the *herophile* complex, as defined by Bates (1935) based on morphology. The average COI genetic distance supports the specific validity of all Cuban *Calisto*. Although *muripetens-occulta* and *bradleyi-herophile* species pairs exhibit relatively low values, 2.5% and 1.9% respectively, they are distinct lineages. The relationship of the *herophile* clade to Hispaniolan species remains to be tested, although Sourakov and Zakharov (2011) suggested that

the Cuban species are derived from Hispaniolan species. Such a relationship with some taxa occurring on Hispaniola could be logical due to the common geological history of both islands (Pindell 1994; Iturralde–Vinent and MacPhee 1999). Furthermore, Johnson and Hedges (1998) described three species from Haiti's Tiburon peninsula similar to Cuban species but deeper genitalic comparisons or DNA sequencing are required to confirm any possible relationship between them.

The presence of more undescribed *Calisto* species in Cuba may be expected. Ecosystems with special features like the semi desert area at extreme southeast coast or the white sand savannahs at Isla de La Juventud and Pinar del Río may still possess yet undiscovered species. Other regions are far from adequately sampled. Torre (1968) mentioned an unidentified *Calisto* specimen collected in the hills of Isla de La Juventud, the status of this entity remains unresolved. The NSB Mountains themselves are still poorly surveyed with the scarce collections in the past being focused on three or four localities mostly at foothills.

Although the phylogenetic relationships between the Cuban *Calisto* species are quite robust and well-supported, conflict between mitochondrial and nuclear datasets has been detected in *C. brochei*, *C. muripetens* and to a lesser degree in *C. bradleyi*. Either incomplete lineage sorting or hybridization might be invoked in those cases, as reported previously in other nymphalid genera (e.g. Bull et al. 2006; Kronforst et al. 2006; Wahlberg et al. 2009). The group *israeli-brochei-smintheus* may be a case of incomplete lineage sorting as the monophyly of *israeli* and *smintheus* are confirmed, but while the nuclear genes agree in placing *C. israeli* as sister to *C. smintheus* and *C. brochei*, the mitochondrial gene reconstructs the phylogeny with *C. israeli* as sister to all Cuban *Calisto* taxa. Similar observation has been made for the *occulta-muripetens-herophile-bradleyi* group, where the mitochondrial dataset infers *occulta-muripetens* as sister to *herophile-bradleyi* whereas the nuclear genes place *herophile* as sister to the *occulta-muripetens-bradleyi* clade. On the other hand, hybridization may be a common phenomenon in *Calisto* as suggested by our DNA sequence data which found several independent lineages (vouchers PM07-11, PM07-06, PM07-03 and PM15-03) that do not appear to be consistently placed within a certain clade in the tree. Based on morphology, the individual PM07-03 has been identified as *C. brochei* but the nuclear dataset robustly places it within *C. occulta*, leaving the possibility of hybridization between these two sympatric species occurring in the NSB Massif. Similarly, PM07-11 and PM07-06 may be hybrid forms of *C. herophile* and *C. bradleyi* as their phylogenetic position is not resolved and there is conflict even within the nuclear genes in placing these within either *herophile* or *bradleyi*. Clearly, a larger number of specimens needs to be analyzed genetically to discover which patterns are more common and whether this actually represents hybridization.

The origin and diversification of Cuban *Calisto* taxa remain to be studied under a rigorous biogeographic approach. However, in the present study, the phylogenetic relationships elucidated from molecular markers generate some insights about such processes. Indeed the mountains in the easternmost part of the island, including Sierra Maestra and the NSB Massif, seem to have played an important role in the diversification of the genus in Cuba, as suggested by the earlier divergence events in the phy-

logeny in most of the taxa occurring in those localities, whereas more derived species occupy current mountain systems in west central (*C. muripetens*) or western Cuba (*C. bradleyi*) and broad distribution ranges across the entire island (*C. herophile*). Although some phylogenetic relationships require further clarification, such as the *israeli-brocheismintheus* and the *herophile-bradleyi-occulta-muripetens* groups, the general pattern of diversification and spreading from Sierra Maestra and NSB westwards Cuba would not be altered. Interestingly, eastern Cuba and north central Hispaniola were physically connected until the Windward Passage began to separate those landmasses by late Oligocene whereas the connection between eastern Cuba and central/western Cuba happened geologically more recently, after the disappearance of the Havana-Matanzas Channel by middle/late Miocene (Iturralde-Vinent and MacPhee 1996; Iturralde-Vinent and Macphee 1999) making it more plausible that ancestral Cuban *Calisto* taxa colonized western territories from the primitive eastern Cuba-northern Hispaniola landmass. Whether extant species are able to overcome the 80 km wide Windward Passage or not remains to be verified. Sourakov and Zakharov (2011) supported the idea of dispersal events by *Calisto* ancestors from Hispaniola to other Greater Antillean islands; however, they only included *C. herophile* from Cuba in their study. Future studies on the entire genus *Calisto* will allow us to assess whether the Cuban species form a monophyletic group within the Hispaniolan clade, as a sister to the Hispaniolan clade, or whether the Cuban species are in fact not a monophyletic group. What ever the case may be, a more comprehensive study will help us understand the evolutionary history of this special group of butterflies.

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