RESEARCH ARTICLE



Two new species of nematode (Oxyurida, Hystrignathidae) parasites of *Passalus interstitialis* Escholtz, 1829 (Coleoptera, Passalidae) from Cuba and a new locality for Longior similis Morffe, García & Ventosa, 2009

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Abstract

Two new species of hystrignathids (Oxyurida: Hystrignathidae) are described as parasites of *Passalus interstitialis* Escholtz, 1829 from Cuba. *Hystrignathus splendidus* **sp. n.** differs from *H. inflatus* Travassos & Kloss, 1957 by having the eggs ridged, a stouter body and a shorter tail, and from *H. tarda* (Artigas, 1928) by its eggs being ridged and larger. *Lepidonema magnum* **sp. n.** can be differentiated from *L. brasiliensis* Travassos & Kloss, 1957 by the extension of the lateral alae, length of the first cephalic annule and the stouter body. It differs from *L. teresae* García, Ventosa & Morffe, 2009 by the esophagus and tail being comparatively shorter. *L. bifurcata* Cobb, 1898 differs from the new species by having the tail tip bifurcated. *L. caracae* Kloss, 1962 has more extended lateral alae and a shorter esophagus. Keys to the Cuban species of *Hystrignathus* and *Lepidonema* are given. *Longior similis* Morffe, García & Ventosa, 2009 is recorded from El Pan de Matanzas, Matanzas Province, Cuba.

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Keywords

Nematoda, Hystrignathidae, Hystrignathus, Lepidonema, Longior, Passalidae, Passalus, Cuba, parasites, new species

Introduction

The family Passalidae consists of a group of saproxylophagous and pan-tropical beetles with about 650 known species (Reyes-Castillo 2000). Due to their feeding habits passalids are frequently parasitized by monoxenous nematodes belonging to the family Hystrignathidae.

Two species of Passalidae have been recorded from Cuba: *Passalus pertyi* Kaup, 1869 (endemic) and *P. interstitialis* Escholtz, 1829. The latter is also distributed from Mexico to Argentina, including Jamaica (Peck 2005). However, only in Cuba has it been the object of parasitological studies. At present, six species, belonging to the genera *Artigasia*, *Glaber*, *Hystrignathus*, *Longior* and *Salesia*, are recorded as parasitizing *P. interstitialis* in Cuba (Coy 1990, Coy et al. 1993, García & Coy 1995a, b, García et al. 2009a, Morffe et al. 2009).

In this paper two new species of hystrignathid parasites of *P. interstitialis* are described and a new locality for *Longior similis* Morffe, García and Ventosa, 2009 is recorded from the same host.

Materials and methods

Nine specimens of *Passalus interstitialis* Escholtz, 1829 (eight from Escaleras de Jaruco, La Habana Province and one from El Pan de Matanzas, Matanzas Province) were collected by hand from rotting logs. The beetles were maintained alive in jars with moistened wood chips as food until dissection. They were killed in a killing jar with ethyl ether or acetone and immediately dissected according to Morffe et al. (2009). Nematodes extracted from their guts were killed with hot water (60–70°C) and fixed in 70% ethanol.

Specimens were clear-mounted in glycerine on glass slides and the edges of coverslips sealed with nail polish (Jex et al. 2004). Measurements were taken according to Travassos and Kloss (1958) and are given in millimeters. Variables are showed as range followed by median plus standard deviation in parentheses. De Man's ratios a, b, c and V% were calculated.

Parasites were photographed with an AxioCam digital camera attached to a Carl Zeiss compound microscope. Line drawings were made with CorelDRAW X3 and Adobe Photoshop CS2 using micrographs as templates. Scales of all plates are given in millimeters.

The type specimens are deposited in the Colección Helmintológica from the Colecciones Zoológicas del Instituto de Ecología y Sistemática, Havana, Cuba (CZACC).

Systematics

Genus Hystrignathus Leidy, 1850

Key to the species of Hystrignathus Leidy, 1850 from Cuba

Note: in the key we omit two species of Cuban hystrignathids formerly placed in *Hystrignathus*, which will be published in the future as new combinations.

1.	First cephalic annule markedly inflated; spines ending at level of procorpus
	<i>H. splendidus</i> Morffe & García, sp. n.
_	First cephalic annule not markedly inflated; spines surpassing the end of pro-
	corpus H. rosario García, Ventosa & Morffe, 2009

Hystrignathus splendidus sp. n.

urn:lsid:zoobank.org:act:981F3BC9-00E7-4B91-809A-CF741E6C366F Figs 1 A–I, 2 A–E

Type material. \bigcirc holotype, Cuba, La Habana Province, Jaruco, Escaleras de Jaruco; in *Passalus interstitialis*; 16.III.2008; E. Fonseca, J. Morffe & F. Alvarez coll.; CZACC 11.4530. 2 \bigcirc paratypes, same data as holotype, CZACC 11.4531–11.4532.

Measurements. Holotype (female) a = 15.28, b = 5.85, c = 7.24, V% = 54.55, total length = 2.750, maximum body width = 0.180, stoma length = 0.063, procorpus length = 0.360, isthmus length = 0.038, diameter of basal bulb = 0.078, total length of esophagus = 0.470, nerve ring to anterior end = 0.230, excretory pore to anterior end = 0.720, vulva to posterior end = 1.250, anus to posterior end = 0.380, eggs = $0.100-0.105 \times 0.045-0.050 (0.104 \pm 0.003 \times 0.048 \pm 0.002)$.

Paratypes (females) (n = 2): a = 14.71-15.89 (15.30 ± 0.84), b = 5.30-5.56 (5.43 ± 0.18), c = 5.71-6.41 (6.06 ± 0.50), V% = 53.93-54.00 (53.97 ± 0.05), total length = 2.225-2.500 (2.363 ± 0.194), maximum body width = 0.140-0.170 (0.155 ± 0.021), stoma length = 0.053 (0.053), procorpus length = 0.310-0.340 (0.325 ± 0.021), isthmus length = 0.035 (0.035), diameter of basal bulb = 0.068-0.078 (0.073 ± 0.007), total length of esophagus = 0.420-0.450 (0.435 ± 0.021), nerve ring to anterior end = 0.195-0.250 (0.223 ± 0.039), excretory pore to anterior end = 0.560-0.720 (0.640 ± 0.113), vulva to posterior end = 1.025-1.150 (1.088 ± 0.088), anus to posterior end = 0.390 (0.390), eggs = $0.098-0.108 \times 0.043-0.053$ ($0.104 \pm 0.003 \times 0.050 \pm 0.004$).

Description. Female body comparatively stout. Cuticle markedly annulated in spiny region and less in rest of body. Cervical cuticle with opposite rows of small spines, from end of first cephalic annule at or near end of procorpus. Spines arranged initially in 16 rows increasing to about 24 rows where spines cease. Longitudinal sub-cuticular striae present. Lateral alae extending from end of spiny region



Figure 1. *Hystrignathus splendidus* sp. n. female. A Esophageal region, lateral view. B Cephalic end, internal view C Cephalic end, external view D Spines at level of the end of procorpus E Tail, lateral view
F Vulva, lateral view G Egg. H Genital tract I Habitus, lateral view.

to level of vulva. Head bears eight papillae arranged in pairs. First cephalic annule long and inflated, about three head-lengths long and set-off from head by single groove. Stoma long, extending for about first two annule lengths and surrounded by an esophageal collar. Esophagus consisting of muscular procorpus with base slightly clavate and set-off from the isthmus. Basal bulb sub-pyriform with valve plate well developed. Intestine simple, sub-rectilinear and with its fore region inflated. Rectum short and anus not prominent. Nerve ring encircles procorpus at about its midpoint. Excretory pore situated at about one body-width posterior to basal bulb. Vulva a median transverse slit slightly displaced towards posterior half of body; lips not very prominent. Vagina muscular, forwardly directed. Genital tract didelphic-amphidelphic. Anterior ovary reflexed at about half of body-width posterior to excretory pore, with distal flexure about a body-width long. Posterior ovary



Figure 2. *Hystrignathus splendidus* sp. n. female. **A** Esophageal region **B** Cephalic end, internal view **C** Last cervical spines **D** Unreflexed tip of the posterior ovary **E** Tail, lateral view. Scale bars: **B–D** 0.05 mm **E** 0.1 mm **A** 0.2 mm.

shorter and not reflexed. Eggs ovoid with eight longitudinal but not very prominent ridges on shell. Tail conical, comparatively short, slightly subulate, ending in fine tip. Male unknown.

Differential diagnosis. H. splendidus sp. n. can be easily differentiated from most species of the genus by the long and inflated first cephalic annule. It shares this feature with H. tarda (Artigas, 1928) and H. inflatus Travassos & Kloss, 1957 from Brazil.

It is close to *H. inflatus* but differs by its ridged eggs which are shorter in length but just as wide $(0.098-0.108\times0.043-0.053: 0.110-0.129\times0.038-0.053)$. Also, *H. splendidus* sp. n. has a comparatively stout body (a = 14.71-15.89: 19.75-20.07) and comparatively short tail (c = 5.71-7.24: 4.74-5.04).

H. splendidus sp. n. differs from *H. tarda* by the extension of the cervical spines, which in the latter end at the middle of the basal bulb. In *H. tarda* the eggs are smooth and its measurements notably smaller $(0.085 \times 0.030 \text{ vs. } 0.098 - 0.108 \times 0.043 - 0.053)$.

Type host. Passalus interstitialis Escholtz, 1829 (Coleoptera: Passalidae).

Site. Gut caeca.

Type locality. Escaleras de Jaruco, Jaruco, La Habana Province, Cuba.

Etymology. Specific epithet is derived from the Latin *splendidus*, splendid, due to the beauty of the species.

Genus Lepidonema Cobb, 1898

Key to species of Lepidonema Cobb, 1898 from Cuba

Lepidonema magnum sp. n.

urn:lsid:zoobank.org:act:F6BFF727-6A4B-40F6-940E-2332CBD401CA Figs 3 A–I, 4 A–G

Type material. \bigcirc holotype, Cuba, La Habana Province, Jaruco, Escaleras de Jaruco; in *Passalus interstitialis*; 16.III.2008; E. Fonseca, J. Morffe & F. Alvarez coll.; CZACC 11.4533. 2 \bigcirc paratypes, same data as holotype, CZACC 11.4534, 11.4594.

Measurements. Holotype female a = 14.45, b = 4.93, c = 6.82, V% = 51.66, total length = 2.710, maximum body width = 0.188, first cephalic annule = 0.018×0.083, stoma length = 0.030, procorpus length = 0.435, isthmus length = 0.035, diameter of basal bulb = 0.095, total length of esophagus = 0.550, nerve ring to anterior end = 0.250, excretory pore to anterior end = 0.730, vulva to posterior end = 1.310, anus to posterior end = 0.398, eggs = 0.088–0.095×0.035–0.040 (0.092 \pm 0.004×0.037 \pm 0.003) (n = 3).

Paratypes (females) (n = 2) a = 13.15-15.09 (14.12 ± 1.37), b = 4.60-4.96 (4.78 ± 0.26), c = 6.90-6.92 (6.91 ± 0.02), V% = 49.81-53.42 (51.61 ± 2.55), total length = 2.415-2.630 (2.523 ± 0.152), maximum body width = 0.160-0.200 (0.180 ± 0.028), first cephalic annule = $0.018 \times 0.075-0.083$ ($0.018 \times 0.079 \pm 0.005$), stoma length = 0.030-0.035 (0.033 ± 0.004), procorpus length = 0.400-0.428 (0.414 ± 0.019), isthmus length = 0.030-0.040 (0.035 ± 0.007), diameter of basal bulb = 0.088-0.095 (0.091 ± 0.005), total length of esophagus = 0.525-0.530 (0.528 ± 0.004), nerve ring to anterior end = 0.233-0.245 (0.239 ± 0.009), excretory pore to anterior end = 0.670-0.710 (0.69 ± 0.028), vulva to posterior end = 1.125-1.320 (1.223 ± 0.138), anus to posterior end = 0.350-0.380 (0.365 ± 0.021) eggs = 0.093×0.038 (n = 1).

Description. Female body large and robust. Cuticle markedly annulated in spiny region (annule about 0.008 mm width) and less in rest of body. These annules almost disappear in last third of body. Cervical cuticle with opposite rows of spines from end of first cephalic annule to midpoint of basal bulb or very short distance beyond its end, arranged initially in 16 rows of robust, scale-like spines increasing to about 20 rows of thinner spines where they end. Longitudinal sub-cuticular striae present. Lateral alae well developed, from short distance posterior to end of spines (about 0.2 body-widths) to level of vulva. Head short, bearing eight small papillae arranged in pairs. First ce-



Figure 3. Lepidonema magnum sp. n. female. A Esophageal region, lateral view B Cephalic end, internal view C Cephalic end, external view D Spines at level of basal bulb E Tail, lateral view F Vulva, lateral view G Egg H Genital tract I Habitus, lateral view.

phalic annule long, with rounded margins and almost equivalent to head-width. Stoma stout, short, hardly extending posterior to first cephalic annule. Esophagus with powerful, muscular and sub-cylindrical procorpus which has base set off from short isthmus. Basal bulb sub-spherical; valve plate well developed. Intestine simple, sub-rectilinear, with fore region strongly dilated. Rectum short; anus not prominent. Nerve ring surrounding procorpus at about half of its length. Excretory pore situated at little less than body width posterior to basal bulb. Vulva a median transverse slit near mid-body; lips not prominent. Vagina muscular, forwardly directed. Genital tract didelphic-amphi-delphic. Ovaries similar in length and reflexed; distal flexures of about 1.5 body-widths in length. Anterior ovary reflexed just posterior to excretory pore. Posterior ovary reflexed at about 2.6 body-widths anterior to anus. Eggs comparatively small, ovoid; shell smooth and thin. Tail short, conical, subulate, ending in fine tip. Male unknown.

Differential diagnosis. L. magnum sp. n. is similar to *L. brasiliensis* Travassos & Kloss, 1957 in body length (2.415-2.710 vs. 2.640-2.850), the comparative length of the esophagus (b = 4.60-4.96: 4.71-4.83), spines which cease a short distance pos-



Figure 4. *Lepidonema magnum* sp. n. female. **A** Habitus, lateral view **B** Cephalic end **C** Spines from the cephalic end **D** Last spines and commence of lateral alae (arrows show the end of spines and the commence of lateral alae, respectively) **E** Excretory pore (arrow shows the nuclei of the excretory cell) **F** Vulva, lateral view **G** Egg. Scale bars: **B–G** 0.05 mm **A** 0.1 mm.

terior to the bulb in one specimen (in the other specimens they end at the midpoint of the basal bulb) and the termination of the lateral alae at the level of the vulva. *L. magnum* sp. n. can be distinguished from *L. brasiliensis* by the lateral alae arising at about 0.2 body-widths posterior to the end of the spines but without actually reaching them. In *L. brasiliensis* the lateral alae commence at the end of the spines. Also, *L. magnum* sp. n. has a shorter first cephalic annule (0.018 vs. 0.028–0.038), stouter body

(a = 13.15-14.45 *vs.* 17.6-17.81) and the tail is comparatively shorter (c = 6.82-6.92 *vs.* 6.29-6.33).

L. magnum differs from *L. teresae* García, Ventosa & Morffe, 2009 (the only other species of the genus known to occur in Cuba) by its larger body (2.630-2.710 vs. 1.610-1.790) and both the esophagus (b = 4.93-4.96: 3.65) and the tail (c = 6.82-6.92 vs. 4.10-4.42) are comparatively shorter. As in *L. brasiliensis* the lateral alae of *L. teresae* commence at the end of the spines (García et al. 2009b).

L. bifurcata Cobb, 1898, from Australia, has a bifid tail tip, a unique feature in the genus that differentiates it from the new species. From *L. caracae* Kloss, 1962 in Brazil, it differs by the extension of the lateral alae which, in the latter, end at the level of the anus. *L. caracae* has comparatively shorter esophagus (b = 6.43 vs. 4.93-4.96) and the tail (c = 11.59 vs. 6.82-6.92). Also, the vulva is more posterior in the Brazilian taxon (V% = 58.96 vs. 49.81-53.42).

Type host. Passalus interstitialis Escholtz, 1829 (Coleoptera: Passalidae) *Site.* Gut caeca

Type locality. Escaleras de Jaruco, Jaruco, La Habana Province, Cuba.

Etymology. Named after the Latin *magnus*, great or powerful, due to the size and robustness of the species.

Genus Longior Travassos & Kloss, 1958

Longior similis Morffe, García & Ventosa, 2009

Material examined 3 \bigcirc \bigcirc . Cuba, Matanzas Province, El Pan de Matanzas; in *Passalus interstitialis*; 13.VIII.2009; J. Morffe coll.; CZACC 11.4535–11.4537.

Measurements. Females (n = 3): a = 17.86–19.29 (18.75 ± 0.78), b = 4.24–4.43 (4.35 ± 0.10), c = 6.08–6.43 (6.25 ± 0.17), V% = 50.00–52.34 (51.17 ± 1.65), total length = 2.500–2.700 (2.625 ± 0.109), maximum body width = 0.140, stoma length = 0.060–0.073 (0.068 ± 0.007), procorpus length = 0.470–0.520 (0.497 ± 0.025), isthmus length = 0.028–0.038 (0.033 ± 0.005), diameter of basal bulb = 0.073–0.088 (0.078 ± 0.008), total length of esophagus = 0.590–0.610 (0.603 ± 0.012), nerve ring to anterior end = 0.218–0.225 (0.223 ± 0.004), excretory pore to anterior end = 0.690–0.810 (0.757 ± 0.061), vulva to posterior end = 1.250–1.275 (1.363 ± 0.018), anus to posterior end = 0.400–0.440 (0.420 ± 0.020), eggs = 0.128×0.053 n = 1.

Host. Passalus interstitialis Escholtz, 1829 (Coleoptera: Passalidae).

Site. Gut caeca.

Locality. El Pan de Matanzas, Matanzas Province, Cuba.

Remarks. L. similis was originally described in *P. interstitialis* from Escaleras de Jaruco, Jaruco, La Habana Province, Cuba (Morffe et al. 2009). The El Pan de Matanzas population was obtained from the same host. Both localities belong to the "Alturas de Habana-Matanzas", a chain of hill that extends along the northern part of La Habana and Matanzas Provinces. The specimens from El Pan de Matanzas exhibit a slightly shorter body and esophagus. The remaining measurements, including De Man's ratios, agree with the type population (Table 1).

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Table 1. Comparative measurements of females of *Longior similis* Morffe, García & Ventosa, 2009 parasites of *Passalus interstitialis* Escholtz, 1829 from the type locality Escaleras de Jaruco, Jaruco, La Habana province, Cuba and El Pan de Matanzas, Matanzas province, Cuba.

Measurements	Escaleras de Jaruco	El Pan de Matanzas	
	(type locality) n = 9	n = 3	
Total length	2.675-3.075	2.500-2.700	
Width	0.120-0.160	0.140	
Stoma length	0.058-0.065	0.060-0.073	
Procorpus length	0.500-0.570	0.470-0.520	
Isthmus length	0.030-0.045	0.028-0.038	
Basal bulb diameter	0.068-0.075	0.073-0.088	
Esophagus length	0.600-0.680	0.590-0.610	
Nerve ring-head	0.213-0.238	0.218-0.225	
Excretory pore-head	0.760-0.850	0.690-0.810	
Vulva-posterior end	1.250-1.500	1.250-1.275	
Anus-posterior end	0.410-0.470	0.400-0.440	
Eggs	0.120-0.135×0.043-0.063	0.128×0.053	
	n = 18	n = 1	
a	16.88-22.50	17.86-19.29	
b	4.18-4.73	4.24-4.43	
С	6.22-6.99	6.08-6.43	
V%	51.22-53.70	50.00-52.34	

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RESEARCH ARTICLE



First report and morphological, molecular characterization of *Xiphinema chambersi* Thorne, 1939 (Nematoda, Longidoridae) in Canada

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Abstract

A *Xiphinema* species, new to Canada was recovered from rhizosphere of oak trees in Ontario, Canada. The identity was confirmed with morphological and molecular methods as *X. chambersi* Thorne, 1939. Female bodies are 2.1-2.4 mm long; odontostyle lengths are 110-118 µm; tail 110-177 µm long, arcuate, elongate-conoid, with hyline region 22 - 43 µm long. Vagina directed about 30 degrees posteriorly. Reproductive system is monodelphic with ovary reflexed anteriorly, vulva opening at 23-26% of the body. Males were not found. The 18S and ITS1 sequences of this population had 3-4 bp differences (99% identity) and 30 bp differences (97% identity) from two Arkansas populations respectively. The nematode population had three juvenile stages. Some variations of the morphometrics were observed comparing with the other populations. This is the first report of *X. chambersi* in Canada.

Keywords

Xiphinema, dagger nematode, diagnostic, Canada, rDNA sequencing

Introduction

Xiphinema chambersi Thorne, 1939 was described from specimens from Virginia, USA. A more complete description of this species was added by Cohn and Sher (1972) based on the lectotypes. In USA, *X. chambersi* has been reported in 16 states and is widely

distributed (Cohn and Sher 1972, Robbins and Brown 1991, Ye 2002, Lamberti et al. 2002). It was also reported in Japan (Shishida 1983) and Korea (Cho et al. 1992). Males were only reported in Arkansas (Ye 2002). The Japan (Shishida 1983) and Florida (Lamberti et al. 2002) populations have been reported having 3 juvenile stages, the other reported populations have not been specified on the number of juvenile stages. Although Thorne (1939) described and illustrated a male, no males were seen on the syntype slides. Only 2 males were found in Arkansas (Ye 2002). This species has been reported to cause damage on sweet gum (*Liquidambar styraciflua*) in Georgia (Ruehle 1971) and strawberry (Perry 1958). During a survey of nematodes of grasslands in Ontario, a population of *Xiphinema* was discovered. It was identified as *X. chambersi*. The objective of this paper is to report and characterize *X. chambersi* in Ontario, Canada with morphological and molecular methods.

Materials and methods

Nematodes. Soil samples were collected with a soil probe from the rhizosphere of oak trees (*Quercus rubra* L.) at the Turkey Point Provincial Park of Ontario (42°42.460'N, 80°20.375'W), Canada in 2009. Nematodes were extracted with the modified pan method (Townshend 1963), fixed in TAF, processed to glycerine and mounted on slides (Hooper 1970) for compound microscopic studies. A portion of the nematodes were frozen at -20°C in water for molecular studies.

Microscopic observation. Specimens were examined using Leica DM5500 B compound microscope using differential interference contrast and pictures were taken with Leica DFC 420 digital camera. The observed characters of the adults were compared with those of the specimens described by Thorne (1939) and the description by Cohn and Sher (1972). Measurements were made using a Leica micro application system on the images, and dimensions are expressed in a formula suggested by de Man (1880). Drawings were aided using a drawing tube.

SEM. Nematodes were first fixed in TAF (7% formalin, 2% triethanolamine, 91% distilled water), and then transferred to Seinhorst solution 1 (1% glycerol; 4% formalin: 95% distilled water) in a foam capsule. The nematodes then were processed through a serial alcohol dehydration by placing in the foam capsule in succession into 40, 60, 70, 90, and 100% ethanol each for 24 h. the foam capsule with the nematodes was placed into a Polarum E3100 Jumbo II CPD, where critical point drying of the nematodes was accomplished utilizing carbon dioxide. The nematodes were then glued on pins using the wood glue as adhesive. The pins with nematodes were then placed in an Emitech K550X Sputter Coater and coated for 1 min with gold-palladium. Nematodes were observed using a Philips XL 30 Scanning Electron Microscope.

Molecular study. Two populations of *X. chambersi* from Arkansas were included for the molecular comparisons. Both ITS and 18S genes of the Ontario population and Arkansas populations were PCR amplified and sequenced. Primers were the same as described in Ye et al. (2004) and Neilson et al. (2004). The 25 µl PCR contained

12.5 µl 2X GoTaq DNA polymerase mix (Promega Corporation, Madison, WI 53711, USA), 1 µl each of 0.4-µM forward and reverse primers and 1 µl of DNA template. The thermal cycling program was as follows: denaturation at 95°C for 6 min, followed by 35 cycles of denaturation at 94°C for 30 s, annealing at 55°C for 30 s and extension at 72°C for 1 min. A final extension was performed at 72°C for 10 min. PCR products were cleaned by Montage[™] PCR Centrifugal Filter Devices (Billerica, MA, USA). PCR primers were used for direct sequencing by dideoxynucleotide chain termination using an ABI PRISM BigDye terminator cycle sequencing ready reaction kit (Applied Biosystems) in an Applied Biosystems 377 automated sequencer (Applied Biosystems) by Eurofins MWG Operon (Huntsville, AL35805, USA). The sequence was deposited in Genbank. The sequence was compared with other nematode species stored at the GenBank using the BLAST homology search program. The closest sequences were selected in the phylogenetic analysis. DNA sequences were aligned by Clustal W (http://workbench.sdsc.edu, Bioinformatics and Computational Biology group, Dept. Bioengineering, UC San Diego, CA). Maximal-parsmony (MP) analysis (Saitou and

Nei 1987) was conducted on both ITS and 18S. Sites with missing data or gaps were treated as missing characters for the analysis. The robustness of the MP tree was tested using the bootstrap method (Felsenstein 1985) based on 2,000 replicates.

Results and discussion

The specimens are deposited in the Canadian National Collection of Nematode. Morphometrics data of the females and 3 stages of juveniles are in Table 1.

Morphological characterization

The main characters of *X. chambersi* from Ontario, Canada match well with the lectotype described by Cohn and Sher (1972) and Arkansas populations (Ye 2002) regarding to the body shape, size, the tail shape, hyline tail length, the odontostyle length, and the female gonad. It has only 3 juvenile stages, and no male was found.

Female. Body is C- to L- shaped when relaxed, tapering off gradually at both ends, more so posterior. Lip region is slightly setoff from the rest of body by a faint depression. Amphid aperture is about four-fifth of the width of lip region. Reproductive system is monodelphic, opistodelphic with ovary reflexed. Vagina directed about 30 degrees angle posteriorly, lips thick. Intestine is transparent, pre-rectum is visible, and rectum is 45 μ m long. Tail is 132 μ m long, arcuate, elongate-conoid with 3 pairs of caudal pores, terminating in a cylindroid nonprotoplasmic tip with hyline region of 37.4 μ m long.

Most of the morphometirc measurements of the females agree with those described by Cohn and Sher (1972) and Ye (2002) in the USA and Japan, some morphometrics variations have been observed: The averaged body length of the female of the population in Ontario, Canada is 2.2 ± 0.1 (2.1–2.4) mm is smaller than that of the populations



Figure I. Drawings of female of *Xiphinema chambersi* from Ontario, Canada, **A** entire body **B** tail region **C** gonad **D** pharynx.



Figure 2. Juveniles and female of *Xiphinema chambersi* from Ontario, Canada, **A** first stage juvenile **B** second stage juvenile **C** third stage juvenile **D** female.

from Iowa, USA, the Florida population averaged 2.5±0.15 (2.4–2.7) µm (Lamberti et al. 2002) the Arkansas population averaged 2.5 (2.1–2.8) µm (Ye 2002) and the Iowa population 2.4 (2.2–2.5) µm (Cohn and Sher 1972); but is larger than that of the population in Japan averaged 1.9 (1.8–2.0) µm (Shishida 1983). The odontostyle lengths of females from these populations are similar. The hyline tail length of the Ontario population averaged 37.4 ± 6.1 (22.0–43.4) µm is much longer than that of the population



Figure 3. Comparison of tails of *Xiphinema chambersi* from Ontario, Canada, **A** first stage juvenile **B** second stage juvenile **C** third stage juvenile **D** female.



Figure 4. Comparison of pharyngeal regions of different stage of juveniles and female of *Xiphinema chambersi* from Ontario, Canada, **A** first stage juvenile **B** second stage juvenile **C** third stage juvenile **D** female.



Figure 5. Micrographs of *Xiphinema chambersi* from Ontario, Canada, **A** SEM image of lip region of female **B** anus region **C** head **D** vulva **E** tail.



Figure 6. Scatter diagram plotting body, odontostyle, and its replacement of individual juveniles and females of *X. chambersi* from Ontario, Canada.

Character	J1	J2	J3	Female
n	5	2	3	9
L (mm)	0.9±0.1	1.2±0.1	1.7±0.2	2.22±0.1
	(0.8 - 1.0)	(1.2–1.2)	(1.5–1.8)	(2.1–2.4)
Total stylet	103±2.7	122.1±0.6	152.3±3	180.5±3.3
	(98.5–105.8)	(121.5–122.6)	(148.3–155.8)	(173.0–185.1)
Odontostyle	64.1±1.2	72.9±0.1	94.9±1.5	114.7±1.9
	(62.4–66.1)	(72.8–73.0)	(92.8–96.0)	(110.5–118.1)
Odontophore	38.9±2.6	49.1±0.5	57.4±1.8	65.9±2.4
	(35.1–43.1)	(48.7–49.6)	(55.5–59.9)	(62.5–70.2)
Odontostyle	72.5±2.2	93.4±0.4	115.3±14.3	-
replacement	70.1–75.4	92.99–93.9	113.9–117.3	-
a	40.4±3.8	48.1±1.6	50.5±2	51.9±2.5
	(32.7–43.3)	(46.5–49.8)	(47.7–52.3)	(47.7–55.7)
b	3.7±0.3	3.8±0.2	4.4±0.2	5.8±0.3
	(3.2–4.1)	(3.7-4.0)	(4.2 - 4.7)	(5.4–6.2)
С	11.4±0.4	12±0.1	14.2±1.1	17±1.9
	(10.7 - 11.9)	(11.9–12.1)	(12.6–15.2)	(12.5–19.7)
c'	5.7±0.5	5.8±0.3	5.3±0.3	5.3±0.7
	(5.1–6.6)	(5.5–6.1)	(5.1–5.7)	(4.4–7.0)
V	-	-	-	24.4±0.9
	-	-	-	(23.1–26.4)
Lip region width	7.9±0.2	8.8±0.1	9.9±0.1	10.9±0.6
	(7.6–8.1)	(8.7-8.9)	(9.7 - 10.0)	(10.0-12.0)
Lip region height	2.8±0.2	4.3±0	4.2±0.1	5.3±0.8
	(2.6 - 3.0)	(4.3-4.3)	(4.1 - 4.4)	(4.5–7.2)
Guiding ring from	56.7±1.8	72.9±0.6	88.1±0.2	110±3.3
anterior end	(53.2–57.9)	(72.4–73.6)	(87.8–88.3)	(105.4–115.0)
Guiding sheath	19.9±6.1	10.3±0.3	6.3±1.9	10.2±3.7
	(8.6–25.2)	(10.1–10.6)	(4.4-8.9)	(4.4–15.7)
Flanges width	8.1±0.4	8.6±0.3	10.3±0.4	10.1±0.6
	(7.4-8.4)	(8.3-8.8)	(9.8–10.8)	(9.2–11.0)
Body width at	23.1±3.2	25.8±1.1	33±1.9	42.9±2.4
midbody	(20.1–28.9)	(24.7–26.8)	(31.1–35.7)	(39.9–47.8)
Pharyngeal bulb	63.8±1.8	74.1±0.9	89.3±0.9	95.9±5.4
length	(61.4–65.9)	(73.2–75.1)	(88.5–90.2)	(86.4–103.0)
Pharyngeal bulb	12.3±0.9	12.9±1	15.6±1.5	17.2±1.4
width	(11.0–13.2)	(12.0–14.0)	(14.2–17.7)	(15.7–20.0)
Pharynx	252.3±6.8	323.2±12.8	376.7±14.7	384.9±13.5
	(245.6–264.2)	(310.4–336.0)	(356.9–392.2)	(359.4–403.0)
G1	-	-	-	16.5±1.7
	-	-	-	(13.9–21.0)

Table 1. Morphometric data of X. chambersi from Canada

Character	J1	J2	J3	Female
n	5	2	3	9
G1%	-	-	-	0.7±0.1
	-	-	-	(0.6 - 0.9)
G2	-	-	-	195.7±37.2
	-	-	-	(154.6–289.2)
G2%	-	-	-	8.8±1.8
	-	-	-	(7.2–13.3)
Prerectum	111.1±19.9	163.4±27.5	184.3±20.2	278.7±67
	(72.3–128.4)	(135.9–190.8)	(155.8–199.0)	(215.0-413.7)
Rectum	14.7±0.9	25.5±0.9	35.4±2	45.2±5.8
	(13.4–15.8)	(24.5–26.5)	(33.4–37.4)	(37.5–56.9)
Tail length	81±2.8	102.9±1.6	117.6±2.3	132.1±17.6
	(76.3-84.6)	(101.2–104.5)	(115.1–120.7)	(110.2–177.3)
Body width at	14.4±1.3	17.8±1.3	22.1±1.2	24.9±1.6
anus	(12.4–16.1)	(16.6–19.1)	(20.5–23.1)	(23.4–28.9)
Hyaline tail tip	11.9±0.7	18.4±2.2	28.4±1.8	37.4±6.1
	(11.0–13.1)	(16.2–20.5)	(26.0-30.2)	(22.0-43.4)
H%	14.7±0.6	17.9±2.4	24.1±1.1	28.5±4.8
	(13.9–15.5)	(15.5–20.3)	(22.6–25.0)	(19.9–34.4)

Note: unless specified in the table, the unit for the measurements is µm.

from Florida averaged 20.4 \pm 2.1 (17.6–23) µm, and Arkansas's averaged 29.7 (15.0–35.0), is shorter than that of the population from Japan averaged 43.7 (38–47) µm.

Juvenile. The presence of three juvenile stages was determined. The body of the first stage juvenile ventrally curved slightly when heat relaxed, the anterior end of the replacement odontostyle almost adjacent to the posterior end of the functional odontostyle, the tail has one pair of caudal pores. The body of the second stage juvenile is curved slightly more than the first stage juvenile, the anterior end of the replacement odontostyle is behind the posterior end of the functional odontostyle. The tail has 2 pairs of caudal pores. The body of the third stage juvenile is ventrally curved slightly more than the second stage juvenile, especially in the tail region, the anterior end of the replacement odontostyle is more posterior to the end of the functional odontostyle. The tail has three pairs of caudal pores. Fig. 6 revealed *X. chambersi* from Canada only has 3 juvenile stages.

Male: not found

Molecular characterization

DNA Sequence: 2610 bp ribosome DNA segment consisting of the near-full-length 18S ribosomal RNA gene, the internal transcribed spacer 1 and partial 5.8S ribosomal

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RNA gene was PCR amplified and sequenced for Ontario population of *X. chambersi* (genBank accession number HM138503). The 18S sequence of this population had only 3–4 bp differences (99% identity) from two Arkansas populations sequenced (AY283174 for population Xiph-41 and HM191718 for population Xiph-61). ITS1 region between Ontario population and Arkansas population Xiph-61 had 30 bp differences (97% identity, 1029 total characters) and 4 gaps. Phylogenetic trees based on the 18S and ITS of rDNA agreed with the results from previous studies (Ye et al. 2004, Neilson et al., 2004) (trees not shown). Both trees revealed the closest relationships being in the same highly supported monophyletic clade for the Ontario population and the Arkansas populations of *X. chambersi*. Due to the short branch length difference in phylogenetic trees and lack of sufficient morphological differences among *X. chambersi* populations studied, the DNA sequence differences on 18S and ITS were considered as intraspecies variation when many *Xiphinema* species and populations were examined in the phylogenetic trees.

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RESEARCH ARTICLE



A new species of the genus Sphingius (Araneae, Liocranidae) from China, and first description of the female: Sphingius hainan Zhang, Fu & Zhu, 2009

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Abstract

A new species of the genus *Sphingius* to the family Liocranidae from Hainan Province is described and illustrated under the name of *Sphingius deelemanae* **sp. n.** In this paper the female of *Sphingius hainan* Zhang, Fu & Zhu, 2009 is described for the first time.

Keywords

Spider, taxanomy, new species, China

Introduction

The spider family Liocranidae currently contains 30 genera and 173 species worldwide, according to Platnick (2010). The spider genus *Sphingius* Thorell, 1890 was described based on the type species, *Sphingius thecatus* Thorell, 1890, from Malaysia, and the type is known from the male only. The genus *Sphingius*, so far, includes 21 described species distributed only in Southeast Asia (Platnick 2010). The species is mainly found

Copyright F. Zhang, J-Y. Fu. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. in Bangladesh, India, Thailand, Myanmar, Malaysia, Indonesia, Philippines, Vietnam, and Sri Lanka. Among these 21 species, 4 occur in China (Deeleman-Reinhold 2001,Tso et al. 2005, Zhang et al. 2009).

While examining the spider specimens collected in 2009 from Hainan Island, southern China, we found a few liocranid specimens. Among these we recognized one new species, *Sphingius deelemanae* sp. n., and we also first describe the female of *Sphingius hainan* Zhang, Fu & Zhu, 2009.

Materials and methods

All measurements given in the text are in millimeters. Carapace length was measured from the anterior face of the ocular area to the rear margin of the carapace medially, excluding the clypeus. Total length is the sum of carapace and abdomen length, regardless of the petiolus. The measurements of the legs are as follows: total length (femur + patella + tibia + metatarsus + tarsus). All specimens are preserved in 75% alcohol and were examined, drawn and measured under a Tech SMZ1500 stereomicroscope equipped with an Abbe drawing device. Epigyna were removed and cleared in 10% warm solution of potassium hydroxide (KOH), transferred to alcohol and temporarily mounted for drawing. Palpal organs were drawn in prolateral, ventral, and retrolateral view. Specimens examined in this paper are deposited in the Museum of Hebei University (MHBU), Baoding, China, unless indicated otherwise.

The following abbreviations are used in the text: AER, anterior eye row; ALE, anterior lateral eyes; ALS, anterior lateral spinneret; AME, anterior median eyes; AME–ALE, distance between AME and ALE; AME–AME, distance between AME; MOA, median ocular area; PER, posterior eye row; PLE, posterior lateral eyes; PLS, posterior lateral spinneret; PME, posterior median eyes; PME–PLE, distance between PME and PLE; PME–PME, distance between PME; PMS, posterior median spinneret.

Taxonomy

Sphingius Thorell, 1890

Sphingius Thorell 1890: 284; Gravely 1931: 269; Majumder and Tikader 1991: 147; Deeleman-Reinhold 2001: 488; Tso et al. 2005: 48; Zhang et al. 2009: 32.
Thamphilus Thorell 1895: 35.
Alaeho Barrion and Litsinger 1995: 170.
Scotophaeoides Schenkel 1963: 49.

Type species: *Sphingius thecatus* Thorell, 1890, by original designation. **Diagnosis and description**: see Zhang et al. 2009.

Sphingius deelemanae sp. n.

urn:lsid:zoobank.org:act:31749410-B22D-4A45-BC39-A977D3A01D87 Figs. 1–7

Type material. Holotype male, CHINA: Hainan Province, Mt. Jianfengling [N 18.62°, E 108.98°], May 28, 2009, G. X. Han leg. (MHBU), paratype 1³/₂, same data as holotype (MHBU).

Diagnosis. In the Chinese *Sphingius* species, such as *S. hainan* Zhang, Fu & Zhu, 2009, *S. pingtung* Tso et al., 2005, *S. sinensis* (Schenkel, 1963) and *S. zhangi* Zhang, Fu & Zhu, 2009, the new species can be easily distinguished from *S. hainan* by its broader embolus (Fig. 5), while in *S. hainan* the embolus is shorter and thinner (Zhang et al. 2009: fig. 6); by the chelicerae without a distal anterior tubercle (Fig. 4), while *S. hainan* (Zhang et al. 2009: fig. 3) has such a distal anterior tubercle on the chelicerae. Specifically compared to *S. pingtung*, the new species is also distinguished the embolus broader and shorter (Fig.5), while in *S. pingtung* the embolus thinner and longer (Zhang et al. 2009: fig. 10); by the tibial apophysis shorter (Fig. 5), while in *S. pingtung* the embolus thinner and longer (Zhang et al. 2009: fig. 10); by the tibial apophysis shorter (Fig. 5), while in *S. pingtung* the tibial apophysis very long (Zhang et al. 2009: fig. 12). The new species can be distinguished from *S. zhangi* by having a longer and broader embolus and with the embolus tip very near to the distal end of the cymbium (Fig. 6), while in *S. zhangi* the embolus thinner, shorter and far from the distal end of the cymbium (Zhang et al. 2009: figs. 29, 31).

Comparing the new species with the seven species with known males found in nearby south east Asian countries, we find the new species can be distinguished from *S. scrobiculatus* (Myanmar), *S. songi* (Thailand) and *S. gothicus* (Thailand) by having a longer and broader embolus and the embolus tip very near to the distal end of the cymbium (Fig. 6), while in *S. scrobiculatus*, *S. songi* and *S. gothicus* the embolus thinner, shorter and far from the distal end of the cymbium (Deeleman-Reinhold 2001: figs. 840, 854, 844). The new species can be distinguished from *S. penicillus* (Thailand), *S. gracilis* (Myanmar) and *S. octomaculatus* (Myanmar) by the tibial apophysis shorter (Fig. 5), while in *S. penicillus*, *S. gracilis* and *S. octomaculatus* the tibial apophysis very long (Deeleman-Reinhold 2001: figs. 849, 839, 858). The new species can be distinguished from *S. punctatus* (Thailand, Indonesia) by the lump-shaped median apophysis (Fig. 5), while in *S. punctatus* the median apophysis ribbon-shaped (Deeleman-Reinhold 2001: figs. 864).

Etymology. The specific name is a patronym in honor of Dr. Christa L. Deeleman-Reinhold, arachnologist.

Description. Male (holotype). Total length 2.25: carapace 1.12 long, 0.85 wide; abdomen 1.13 long, 0.77 wide. Carapace ovoid in dorsal view (Fig. 1), with wedge-shaped posterior margin; reddish brown, surface covered with many seta-bearing granules, each sunk in a large round pit, lateral and posterior margins with triangular thorns, with a long seta arising from the side. Eyes in two transverse rows; AER slightly recurved and PER straight in dorsal view (Fig. 1). Eye diameters: AME 0.13, ALE 0.12, PME 0.14, PLE 0.13. Eye interdistances: AME–AME 0.17, AME–ALE 0.12,



Figures 1–7. *Sphingius deelemanae* sp. n. **I** Male body, dorsal view **2** Male abdomen, ventral view **3** Endites, labium and sternum of male, ventral view **4** Male right chelicera, anterior view **5** Male left palp, ventral view **6** Same, prolateral view **7** Same, retrolateral view **c** conductor **e** embolus **es** epigastric scutum **is** intercoxal sclerites **ma** median apophysis **pt** precoxal triangles **sd** sperm duct **st** subtegulum **t** tegulum **ta** tibial apophysis **vs** ventral scutum. Scale bars: 1 mm (1–3); 0.4 mm (4–7).

PME–PME 0.16, PME–PLE 0.14; MOA 0.28 long, front width 0.26, back width 0.25. Thoracic groove obsolete. Chelicerae reddish brown (Fig. 4), with three promarginal and three retromarginal teeth, anterior surface somewhat swollen. Endites, labium and sternum dark brown (Fig. 3). Sternum shield-shaped, lateral margin with precoxal triangles and intercoxal sclerites. Space above the coxae and below the carapace with longitudinal, sclerotized pleural bars. Leg spination: femora I-IV with one small dorsal spine, tibia III v1-1-0, p0-0-1, metatarsus III v0-2-0; tibia IV v2-2-1, r0-0-1, metatarsus IV p0-1-0, v0-1-0, r0-1-0. Leg formula: 4123 (Table 1).

Abdomen (Fig. 1) dark brown dorsally, with nearly entire dorsal scutum, epigastric and postgenital scutum fused to some extent, postgenital scutum relatively large, about two thirds of abdomen length; venter smooth, without longitudinal lines.

Male palp as illustrated (Figs. 5–7). Tibia with short retrolateral apophysis. Bulb ovoid in ventral view (Fig. 5), tegulum straight at base; sperm duct distinctive Ushaped, originating from upper part of tegulum; subtegulum relatively large (Fig. 6); embolus bent, long and thick, originating from prolateral-apical tegulum, extending beyond tegulum (Fig. 5); conductor apical, corn-flake shaped; median apophysis nearly rectangular from retrolateral view, on distal-retrolateral sector of tegulum.

Distribution. Presently known only from the type locality, Mt. Jianfengling, Hainan, China.

Sphingius hainan Zhang, Fu & Zhu, 2009

Figs. 8–13

Sphingius hainan Zhang, Fu & Zhu, 2009: 34, f.1-8.

Material examined. 3♂2♀, CHINA: Hainan Province, Mt. Jianfengling [N 18.62°, E 108.98°], May 28, 2009, S. T. Guo and X. X. Zhang leg. (MHBU); 1♂ (holotype), CHINA: Hainan Province, Changjiang County, Mt. Bawangling, November 5, 2008, M. S. Zhu leg. (MHBU).

Diagnosis. In comparing Chinese *Sphingius* species, such as *S. sinensis* (Schenkel, 1963) and *S. zhangi* Zhang, Fu & Zhu, 2009, with the female of *S. hainan*, we find the epigyne *of S. hainan* has a large anterior hood (Fig. 9) while *S. sinensis* with two small anterior hoods (Zhang et al. 2009: fig. 18); and additionally, the epigynal hood of *S. hainan* is half-oval shaped (Fig. 9), while *S. zhangi* has a hood nearly <u>rectangle</u>-shaped (Zhang et al. 2009: fig. 27).

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
Ι	1.13	0.54	0.86	0.59	0.54	3.66
II	0.86	0.45	0.72	0.54	0.50	3.07
III	0.59	0.40	0.54	0.70	0.67	2.90
IV			mis	sing		

Table 1. Leg measurements of Sphingius deelemanae sp. n., male.



Figures 8–13. Sphingius hainan Zhang, Fu & Zhu, 2009. 8 Female body, dorsal view 9 Epigyne, ventral view 10 Vulva, dorsal view 11 Left male palp, prolateral view 12 Same, ventral view 13 Same, retrolateral.
b bursa c conductor co copulatory opening e embolus h hood ma median apophysis s spermatheca sd sperm duct st subtegulum t tegulum ta tibial apophysis. Scale bars: 1 mm (8); 0.5 mm (9–13).

Comparing *S. hainan* with the seven *Sphingius* species with known females found in nearby south east Asian countries, *S. hainan* can be distinguished from *S. penicillus* (Thailand), by having a large anterior hood (Fig. 9) while *S. penicillus* with a small anterior hoods (Deeleman-Reinhold 2001: fig. 850). *S. hainan* is also very similar to *S. vivax* (Thorell, 1897) (Myanmar, Vietnam, Malaysia, Philippines) in the conformation of the male palpal organ, but can be distinguished from *S. vivax* by having a longer and thicker male palpal retrolateral tibial apophysis (Fig. 13), by the bulb with apical membranous conductor (Fig. 12), and by the shape of the median apophysis (Fig. 12). *S. hainan* can also be distinguished from *S. songi* (Thailand), *S. gothicus* (Thailand) and *S. punctatus* (Thailand, Indonesia), by having a half-oval shaped epigynal hood (Fig. 9) while epigynal hood M-shaped in *S. songi*, triangle-shaped in *S. gothicus*, and nearly rectangle-shaped in *S. punctatus* (Deeleman-Reinhold 2001: figs. 855, 845, 866). *S. hainan* can be distinguished from *S. octomaculatus* (Myanmar) and *S. gracilis* (Myanmar), by having a large anterior hood (Fig. 4) while the latter two without anterior hood (Deeleman-Reinhold 2001: figs. 861, 837).

Comparing *S. hainan* with the seven *Sphingius* species with known females found in nearby south east Asian countries, *S. hainan* can be distinguished from *S. penicillus* (Thailand), by having a large anterior hood (Fig. 9) while *S. penicillus* with a small anterior hood (Deeleman-Reinhold 2001: fig. 850). *S. hainan* can also be distinguished from *S. songi* (Thailand), *S. gothicus* (Thailand), *S. vivax* (Myanmar, Vietnam, Malaysia, Philippines) and *S. punctatus* (Thailand, Indonesia), by having a half-oval shaped epigynal hood (Fig. 9) while the epigynal hood rather 'M-shaped' in *S. songi* (Deeleman-Reinhold 2001: fig. 855), triangle-shaped in *S. gothicus* (Deeleman-Reinhold 2001: fig. 842) and nearly rectangle-shaped in *S. punctatus* (Deeleman-Reinhold 2001: fig. 866). *S. hainan* can be distinguished from *S. octomaculatus* (Myanmar) and *S. gracilis* (Myanmar), by having a large anterior hood (Fig. 4) while the latter two without anterior hood (Deeleman-Reinhold 2001: figs. 861, 837).

Description. Female. Body length 5.00–5.53. One specimen was measured, total length 5.53: carapace 2.52 long, 2.07 wide; abdomen 3.01 long, 1.80 wide. Carapace ovoid in dorsal view (Fig. 8), deep reddish brown, with numerous small granulations, lateral and posterior margins with angular granulations. Eyes in two transverse rows; AER slightly recurved, PER straight or slightly recurved in dorsal view and longer than AER. Eye diameters: AME 0.13, ALE 0.12, PME 0.14, PLE 0.13. Eye interdistances: AME-AME 0.13, AME-ALE 0.19, PME-PME 0.50, PME-PLE 0.17; MOA 0.33 long, front width 0.29, back width 0.28. Chelicerae with three promarginal and two retromarginal teeth, anterior side with a tubercle. Endites brown, longer than wide, constricted at middle on lateral margin, anterior edge with clear serrula and scopula. Labium slightly rectangular, anterior margin with a slight concavity centrally. Sternum light brown, shield-shaped, covered with sparse granulations, posterior margin slightly extending between coxae IV, lateral margin with precoxal triangles and intercoxal sclerites. Space above the coxae and below the carapace with longitudinal, sclerotized pleural bars. Legs brown, anterior tibiae and metatarsi spineless, tarsi I–III almost as long as metatarsi. Leg spination: femora I-II with one small dorsal spines, tibia III v2-2-2, p 0-1-1, r 0-0-1; metatarsus III v 2-0-0; tibia IV v 1-1-1, p0-0-1, r 0-0-1, metatarsus IV p0-1-0, v 2-1-0, r 0-1-0. Leg formula: 4123 (Table 2).

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
Ι	1.75	0.98	1.47	1.09	1.08	6.37
II	1.73	0.92	1.42	1.06	1.01	3.14
III	1.32	0.52	1.06	0.92	0.87	4.69
IV	1.90	1.01	1.45	1.83	1.33	7.52

Table 2. Leg measurements of Sphingius hainan Zhang, Fu & Zhu, 2009, female.

Abdomen ovoid (Fig. 8), dark brown, light brown centrally; dorsal scutum covering nearly all, and dorsum with one pair of muscular impression on middle part. Venter of abdomen yellow brown, epigastric scutum tripartite (to some degree, at least in the color) divided into a central plate and two lateral plates, postgenital scutum relatively small, about two thirds of abdomen length, venter with two rows of longitudinal lines of spots.

Epigyne as illustrated (Figs. 9–10). Epigynal plate oval-rectangular, anterior half concave and posterior half convex. Anterior atrial hood arch-shaped (Fig. 9). Copulatory openings situated in the corners of the depression, leading through funnel-shaped ducts to the spermathecae and bursae. Spermathecae posteriorly (Fig. 10), large, globose; bursae anteriorly, smaller globose, thin-walled; a short connecting tube between the anterior bursa and posterior spermatheca.

Male (holotype) . The male has been described by Zhang et al. (2009). Male palp as illustrated (Figs. 11–13).

Distribution. Hainan.

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RESEARCH ARTICLE



Revision and phylogeny of the Caribbean weevil genus Apotomoderes Dejean, 1834 (Coleoptera, Curculionidae, Entiminae)

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Abstract

The weevil genus Apotomoderes Dejean, 1834 (Curculionidae: Entiminae: Geonemini) is revised, including a redescription of the only previously known species, A. lateralis (Gyllenhal, 1834), and descriptions of five new species: A. anodontos sp. n., A. menocrater sp. n., A. sotomayorae sp. n., A. chariedris sp. n., and A. hadroprion sp. n. The monophyly of Apotomoderes is supported by multiple synapomorphic character states including the two-segmented labial palps, a postocular constriction on the head, a sexually dimorphic, globular pronotum in males, and the presence of setae in the dorsal subapical region of the aedeagus. In addition, all species of Apotomoderes except A. anodontos have a large, knife-like cuticular tooth on the profemur and a toothed ridge along the anteromesal margin of the protibia. Illustrations of external and internal morphological traits are provided, along with a key to the six constituent species. A cladistic analysis of 12 taxa (6 outgroup, 6 ingroup) and 22 characters yielded a single most parsimonious cladogram (L=33, CI=75, RI=90) with the topology (A. anodontos, (A. menocrater, (A. sotomayorae, (A. lateralis, (A. chariedris, A. hadroprion))))). A species of Artipus Sahlberg (Naupactini) was placed as the most immediate relative of Apotomoderes; however, the state of phylogenetic knowledge of Caribbean entimine weevil is still too incomplete to warrant any higher level rearrangements. All species of Apotomoderes occur on Hispaniola with the exception of A. sotomayorae which is endemic to Mona Island, Puerto Rico. A historical biogeographic reconstruction yielded the taxon-area cladogram (southwestern Dominican Republic, (eastern Dominican Republic, Mona Island)), suggesting two successive eastbound colonization events in the Miocene/Pliocene, originating from the southern Hispaniola peninsula. Reliable host plant records are unavailable although adults of A. menocrater have been found on allspice (Pimenta Lindley; Myrtaceae) and lignum vitae (Guaiacum Linnaeus; Zygophyllaceae).

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Keywords

Dominican Republic, Mona Island, Puerto Rico, cladistics, colonization, endemism, historical biogeography, new species, taxonomy, weevils

Introduction

The entimine weevil genus Apotomoderes Dejean (1834: 253) was originally proposed to accommodate a single species, A. lateralis (Gyllenhal 1834: 45), from Hispaniola. Dejean had transferred this species out of Schoenherr's Apotomus (1834: 44), a name which was published just weeks earlier (Alonso-Zarazaga and Lyal 1999) yet which constitutes a junior homonym of Apotomus Illiger (1807: 348), a genus of Carabidae. Consequently, Eurilia Laporte (1840: 308) is an unnecessary replacement name for Apotomus Schoenherr, and also a synonym of Apotomoderes. Both Dejean (1834) and Schoenherr (1840) incorrectly attributed the valid genus and species name to Carl Gustav Mannerheim who had described the species in a letter to Schoenherr and then donated the type specimen to Schoenherr's museum. For a relatively short period of time, a second species, A. albicans (Lacordaire 1863a: 21) was placed in this genus, until it was transferred to Megalostylus Schoenherr (1840: 114) by Chevrolat in 1878 (p. LXVI; as *M. farinosus* [junior synonym]) and then by Pascoe 1881 (p. 42; as *M.* expansus [junior synonym]), as reviewed in Champion (1911: 241-246). Thus in effect, no other species of Apotomoderes have been described since 1834 (O'Brien and Wibmer 1982: Pérez-Gelabert 2008).

Schoenherr (1834) provided the most detailed description of Apotomoderes to date, emphasizing the postocular constriction of the head, prominent eyes, expanded pronotum, subovate elytra, and conspicuously toothed profemora as diagnostic features. He placed the genus in his division Brachyderides, and particularly in the vicinity of the Old World genus Cratopus Schoenherr which is presently assigned to the tribe Cratopodini Hustache (Lyal and Alonso-Zarazaga 2006). Lacordaire (1863b: 25-27, 64-66) classified Apomotoderes in the Naupactides (= Naupactini Gistel), but distinguished the genus from all other members of this tribe in light of the posteriorly constricted head. Lacordaire (1863b: 81-82) also mentioned a possible affinity of Apotomoderes with Megalostylus. Interestingly, his description of "A. lateralis" from Haiti ('uniform opal grey, epipleura of elytra chalk white') applies to another species, described below. Subsequently, the genus was placed in the tribe Barynotini Lacordaire (e.g. Blackwelder 1947: 796, O'Brien and Wibmer 1982: 41) whose current valid name is Geonemini Gistel (Alonso-Zarazaga and Lyal 1999). However, none of the past or present tribal placements of Apotomoderes are well corroborated given that the mid-level classification of entimine weevils remains poorly understood (Thompson 1992; Marvaldi 1997; Oberprieler et al. 2007).

Field work in the Dominican Republic and on Mona Island, Puerto Rico, has brought to light several new species of *Apotomoderes*. These species are herein described and illustrated, and the genus is revised, including a generic redefinition, redescription of the type species, key to all species, phylogenetic analysis, and historical biogeographic reconstruction.

Methods

Morphological studies. The descriptive sequence used in this study is in accordance with Franz and Girón (2009). Morphological terms usually follow Torre-Bueno (Nichols 1989); with additional specialized terms used for the mouthparts (Ting 1936; Morimoto and Kojima 2003), apex of rostrum (Vaurie 1963), metendosternite (Velázquez de Castro 1998), wings (Zherikhin and Gratshev 1995), tibial apices and abdominal segments (Thompson 1992), and male and female terminalia (Howden 1995; Velázquez de Castro 1997; Wanat 2007). Specimens were observed with a Leica MZ16 stereomicroscope (magnification: 7-115×) and an Olympus BX41 compound microscope (magnification: 20-400×), each equipped with an ocular graticule for length measurements. The overall body length was measured (in dorsal view) from the anterior margin of the eye to the posterior margin of the elytra; whereas the length of the rostrum was measured from its apex to the anterior margin of the eye. The number of individuals measured is written once in parentheses for all measurements of external structures; another separate number reflects the number of measurements for the length/width relations of the wings and the median lobe. The numbering of the abdominal ventrites reflects their homology within Curculionoidea (Thompson 1992). The original species accounts were trimmed to emphasize diagnostic features and characters with potential phylogenetic relevance. Features that are shared between the male and female are usually mentioned only once (in the male), as are similar traits on serially homologous structures such as the legs.

The habitus photographs were taken with a Microptics XLT imaging system. All drawings of internal structures were prepared with a drawing tube attached to the compound microscope. The initial, simplified line sketches were scanned and redrawn using an illustration software program, thus highlighting features with diagnostic significance.

Type material. The labels for new type specimens include the genus name and species epithet, a gender symbol, and the author and year. They are colored red for the holotypes and yellow for all paratypes. The insect collection codens are based on Arnett et al. (1993), as follows.

CMNC	Canadian Museum of Nature Collection, Ottawa, Canada
CWOB	Charles W. O'Brien Collection, Green Valley, Arizona, USA
FSCA	Florida State Collection of Arthropods, Gainesville, Florida, USA
MEBT	Museum of Entomology and Tropical Biodiversity, Río Piedras, Puerto
	Rico, USA
MHND	Museo Nacional de Historia Natural, Santo Domingo, Dominican Republic
NMNH	National Museum of Natural History, Washington, D.C., USA

- **UPRM** Invertebrate Collection, University of Puerto Rico at Mayagüez, Puerto Rico, USA
- WIBF West Indian Beetle Fauna Project Collection, Bozeman, Montana, USA

Phylogenetic analysis. All species of *Apotomoderes* were identified as such through application of the phylogenetic species concept (Wheeler and Platnick 2000), and were included as ingroup taxa in the phylogenetic analysis. Suitable outgroup taxa include representative species from the tribes Eustylini: *Exophthalmus quadrivittatus* (Olivier, 1807) and *Scelianoma elydimorpha* Franz & Girón 2009; Geonemini: *Lachnopus kofresi* Wolcott 1941 and *Lachnopus valgus* (Fabricius, 1775); and Naupactini: *Artipus flori-danus* Horn 1876 and *Pantomorus elegans* (Horn, 1876; named *Phacepholis elegans* in Lanteri 1990; though see Scataglini et al. 2005 for a later perspective). The selection was informed in part by preliminary results from phylogenetic studies of Caribbean entimine weevils (NMF, unpublished), and the cladogram was rooted accordingly with *E. quadrivittatus*. Autapomorphies for species of *Apotomoderes* are presented in the species accounts yet were excluded from the cladistic analysis. Reductive coding (Strong and Lipscomb 1999) was use in select instances to represent homology assessments pertaining to particular species groups.

The character matrix was compiled, edited and refined using the matrix and tree interfaces in WinClada (Nixon 2002). The characters were numbered based on their sequence of appearance in the taxonomic descriptions. The most parsimonious cladogram and character state optimizations were identified using NONA (Goloboff 1999). An exhaustive search of the tree space for the 12-taxon matrix was performed using the commands "whennig" and "mswap+". Finally, branch support values (Bremer 1994) were calculated in NONA with "hold 10000", "suboptimal 20" and "bsupport 20".

Historical biogeography. A historical vicariance analysis of *Apotomoderes* was performed through integration of the species phylogeny with the inferred areas of endemism (Morrone 2009). In light of an obvious alignment of the phylogeny and geographic areas, only assumption 0 *sensu* Nelson and Platnick (1981; component analysis) was employed to generate a taxon-area cladogram (see also Page 1990). The resulting scenario was reconciled with available geological information (Iturralde-Vinent 2006).

Apotomoderes Dejean (1834: 253)

- = *Apotomus* Schoenherr (1834: 44) [non Illiger 1807; junior synonym]
- = Apotomoderes Schoenherr (1840: 402) [non Dejean 1834; unnecessary replacement name]
- = *Eurilia* Laporte (1840: 308) [unnecessary replacement name]
- **Type species:** *Apotomoderes lateralis* (Gyllenhal, 1834: 45), by monotypy (originally as *Apotomus lateralis*).
Diagnosis. Apotomoderes keys to Artipus Sahlberg in Anderson (2002), by virtue of the absence of a postocular lobe and vibrissae, the laterally positioned scrobe, the long median sulcus on the rostrum, laterally positioned eyes, and the conspicuous epistoma. However, Apotomoderes can be distinguished from this and other genera of Caribbean entimine weevils (cf. O'Brien and Wibmer 1982) by a unique combination of synapomorphic and/or diagnostic features; viz. scale coverage complete; labial palps 2-segmented (Fig. 3B); rostrum dorsally with a transverse depression (e.g. Fig. 13B); antennal scape only moderately stout; head with a postocular constriction (e.g. Fig. 9B); eyes protruded, globular; pronotum sexually dimorphic, larger and more globular in males (e.g. Fig. 11A); metatibial apex simple, without a bevel or flange ("corbel open"), margins lined with spiniform setae, surface surrounding condyle partially covered with scales; presence of setae in the dorsal subapical region of the aedeagus (e.g. Fig. 5D); aedeagus with a pair of weakly sclerotized rami along ostium; and spermatheca with collum and ramus subcontiguous (e.g. Fig. 17C). In addition, nearly all species of Apotomoderes have a large, knife-like cuticular tooth only on the profemur and a conspicuously toothed ridge along the anteromesal margin of the protibia (in idealized orientation of legs) in both males and females (e.g. Fig. 13C). The genera and species most closely related to Apotomoderes are likely still undescribed (NMF, personal observation), but differ from this taxon minimally by the shape of the head and pronotum.

Redescription – male. Length 4.32–10.70 mm, width 1.65–4.95 mm; shape elongate to oval, length/width ratio 2.16–2.80; widest at humeri (to anterior third). Integument dark reddish brown. Linear, piliform scales ("setae") sparse throughout, short, recurved, transparent white to yellow. Scales densely and homogeneously arranged throughout, partially overlapping and covering most of integument, mostly subcircular to subquadrate to irregular (pronotum), colors variously interspersed creamy white to beige/tan to (light rusty to dark) brown, or locally "transparent", scales arranged in complex regional to irregular patters, often locally (rostrum, pronotum, legs, elytral punctures) also with yellowish, greenish, pinkish, turquoise or (pale) blue iridescent metallic scales creating secondary underlying patterns.

Mouthparts. Mandibles with 4–6 longer setae, and several shorter setae and piliform scales adjacent to projected, apicolaterally positioned scar. Maxillae (Fig. 3A) with cardo elongate, basically widely bifurcate, with sparse setae; stipes elongate, not mesally projected, with lateral setae; galeo-lacinial complex not extending to apex of maxillary palpomere I, apically rounded, covered with setae throughout, with 6–8 apicomesal "lacinial teeth" (Ting 1936), thereafter (along mesal margin) with a tuft of very long setae; palpiger with transverse row of setae; maxillary palps 3-segmented; I longer than II, with 2 apical setae; II slightly shorter than III, with 2 apical setae; III elongate, with parallel sulci, apically papillate. Labium (Fig. 3B) with prementum entirely covering maxillary palps; escudate or pentagonal, ventrally evenly concave; apical margin medially projected (ligula), angulate; each lateral region with 3–5 long setae; labial palps 2-segmented, II reaching apical margin of prementum; I shorter than II, with 1 apical seta; II elongate, apically papillate.



Figure I. Habitus of A. lateralis: **A** male, dorsal view **B** male, lateral view **C** male, ventral view **D** female, venter, ventral view.

Rostrum. Length 0.45–1.28 mm, rostrum/pronotum length ratio 0.28–0.42, rostrum length/width ratio 0.60–0.82; shape in cross-section subrectangular. Dorsal outline of rostrum subrectangular; dorsolateral margins anteriorly slightly diverging; apical margin emarginate-triangular, profoundly incised. Nasal plate (Vaurie 1963) well defined, inversely V-shaped, concave, posteriorly carinate; epistoma forming a narrow line basad of carina, without scales yet with a row of long, mesally directed setae; region basad of epistoma distinctly depressed, covered with variously colored, iridescent metallic scales. Dorsal surface of rostrum with a subcircular to transverse concavity near midpoint, and with 1 median sulcus extending from posterior margin of epistoma to imaginary midpoint between (or slightly beyond) dorsal margins of eyes, ending in a narrow fovea; each dorsolateral margin with (or without) a poorly defined, short and irregular sulcus anteriad of eye; ventrolateral margins subparallel. Rostrum in lateral view nearly straight, apically slightly expanded; ventrolateral sulci well defined, extending parallel



Figure 2. Habitus of female type specimen of *A. lateralis*, located in the Naturhistoriska Riksmuseet, Stockholm, Sweden: **A** lateral view **B** head, thorax and prolegs, dorsal view **C** specimen label. Photographs taken by Johannes Bergsten.

to and ventrad of scrobe; margins of mandibular incision with evenly spaced, linear scales. Rostrum ventrally with 2 paramedian sulci. Antennal insertion near anterior 2/5 of rostrum. Scrobe lateral, strongly curved and posteriorly widened (subtriangular), initiating at apicodorsal apex, region, terminating in ventrolateral region, anteriad of eye, dorsal margin angulate, ventral margin (typically) curved, covered with scales.

Antennae 11-segmented. Scape moderately stout, nearly straight, clavate; extending to region between posterior margin of eye and anterolateral margin of pronotum, directed ventrad of eye in idealized position; covered with linear scales. Funicle 7-segmented, slightly longer than scape; funicular antennomeres progressing from elongate to equilateral, clavate, covered with appressed and suberect, linear scales; I and II (usually) similar in length. Club 3-segmented, similar in length to funicular antennomeres III–VI, nearly 3× longer than wide, dark brown, pubescent; I and II similar in length; III slightly longer, conical, transversely sutured.

Head. Eyes laterally positioned, variously globular, strongly protruded, in some species posteriorly abruptly curved and "tilted" posteriad, anterodorsal margin of each



Figure 3. Mouthparts of A. lateralis: A right maxilla, ventral view B labial prementum, ventral view.

eye impressed, posterior margin nearly straight, elevated (set off) in relation to head; eyes (usually) separated (in dorsal view) by distance nearly 2× as long as anterior-toposterior length of each eye. Head with apparent postocular constriction extending along entire circumference, rostrum and head in lateral view angulate.

Thorax. Pronotum variously equilateral, length/width relation 0.80–1.20, pronotum/elytra ratio 0.42–0.55, slightly to strongly globular (convex); widest near midpoint, anteriorly constricted; surface punctate, with equilateral to irregularly shaped, variously colored scales; median sulcus absent. Anterior margin of pronotum slightly curved, lateral margins strongly curved, posterior margin bisinuate, posterior side with plumose scales. Pronotum in lateral view globular, anteriorly constricted; anterior margin nearly straight, postocular lobe and vibrissae absent.

Scutellum exposed, semi-circular, slightly wider than long, anterior margin straight, posterior margin rounded, covered with creamy white scales.

Epipleura with mesepisternum triangular; mesepimeron dorsally obliquely narrowed; metepisternum linear, anteriorly abruptly widened; metepimeron entirely covered by elytron.

Prosternum (Figs. 1C, 14B) longer than mesosternum, with a transverse sulcus on each side anteriorly and posteriorly of procoxal cavities; procoxal cavities positioned at midpoint, contiguous, prosternal process short, elevated. Mesosternum slightly shorter than metasternum, strongly angulate, mesocoxal process slightly elevated; anterior half coved with plumose scales, posterior half with longer, suberect, linear scales; mesocoxal cavities separated by distance nearly half as long as width of each mesocoxal cavity. Metasternum with median sulcus present as a large, transverse fovea positioned anteriad of posterior margin, surface slightly undulate, posterolateral regions set off (with small posterior "face"), and with linear scales (see above); metacoxal cavities separated by distance slightly shorter than width of each mesocoxal cavity.



Figure 4. Metendosternite and hind wing of *A. lateralis*: **A** metendosternite, posterior view **B** right hind wing.

Metendosternite (Fig. 4A) with stalk slightly shorter than furcal arms, ventral margin 2–3× wider than dorsal width of stalk; hemiducts wide, truncate; dorsal margin of sheath undulate; anterior tendons positioned near midpoint between median keel and base of furcal arms; furcal arms diverging at 30–45° in relation to medial keel.

Legs. Prothoracic legs longer than mesothoracic legs; scale colors variously interspersed, though forming a more uniform light/dark/light pattern on femora, metallic scales often present on anterior sides of profemora and near tibial apices; ventral sides of tibiae with rows of longer, whitish or yellowish, suberect setae. Profemur/pronotum length ratio 0.80-1.08; profemur moderately stout, in cross-section subcircular; (usually) with 1 very large, knife-like cuticular tooth inserted at apical 2/5 on anteromesal margin, tooth ventrally directed (absent in one examined species). Protibia/profemur length ratio 0.84-1.02; protibia moderately stout, nearly straight, in cross-section elliptical, apically slightly expanded; anteromesal margin with a distinct, laminate, rounded or triangular projection near basal 2/5 (absent in one examined species), from thereon to apex with row of 10-15 smaller, apically rounded or (oblique) truncate cuticular teeth (teeth larger along laminate projection), each tooth distally with an aurate, spiniform seta; protibial apex with anterior margin truncate, setal comb absent; mucro similar in length to tarsal claw, surpassed by tufts of aurate setae. Protarsus with tarsomere I nearly 2× as long as II, elongate, clavate; II and III similar in length, equilateral to transverse; and jointly similar in length to V; claw paired, separate, simple. Meso- and metathoracic legs slighter shorter and longer than prothoracic legs, respectively; meso- and metafemora unarmed; meso- and metatibiae lacking laminate projec-



Figure 5. Terminalia of *A. lateralis,* male: **A** sternum VIII **B** spiculum gastrale **C** tegmen **D** aeadeagus, ventral and lateral view.

tions, teeth along anteromesal margin less pronounced; metatibial apex simple, with anterior margin curved (on side opposed to mucro), projected, margins with a comb of spiniform setae of increasing length, yet without a bevel or flange ("corbel open"), surface surrounding metatarsal condyle glabrous to partially covered with (metallic) scales "invading" surface from dorsal side.

Elytra. Length/width ratio 1.52–1.90; widest at humeri (to anterior third); anterior margins jointly wider than posterior margin of pronotum, sinuate; humeri obliquely rounded; lateral margins posteriorly slightly converging in anterior half, thereafter more strongly converging, rounded, posteriorly attenuate; posterior margins narrowly truncate. Elytra in lateral view slightly convex; posterior declivity apparent though not strongly angulate, nearly straight. Elytra with 9 complete striae and 1 incomplete stria; striae similar in width to intervals; stria X indistinct ("merging with stria IX") in second third of entire length; punctures separated by distance similar to, or slightly longer than, width of each puncture; intervals slightly elevated; scales covering entire integument, arranged in mostly irregular micro-patterns of creamy white to dark brown hues, though often locally also with iridescent metallic scales, including (in most species) a single colored or metallic scale in each strial puncture.



Figure 6. Terminalia of A. lateralis, female: A sternum VIII B coxites and styli C spermatheca.

Wings. Wings (Fig. 4B) fully developed (absent in one examined species), elongate (linear), wing/body length ratio 1.15–1.35, wing length/width ratio 3.30–3.78; anterior margin slightly angulate near midpoint; posterior margin nearly straight, undulate in anal area; anal lobe absent. Alar veins well defined: C, Sc, R, Rr and rs distinct, radial cell present; M_r and Cu₁ short, r-m reduced; 2A distinct, 3A and 4A weaker; R₃ distinct, M₁ reduced, only apparent distally.

Abdomen. Venter (Figs. 1C, 1D, 14B) with segments III and IV narrowly connected (jointed), slightly elevated, V-VII separate; appressed, subcircular scales less abundant in mesal region of venter, "replaced" with longer, suberect linear scales, particularly on III and posterior half of VII; III longer than IV, mesally plane, posterior margin slightly emarginate; IV longer than V and VI together; V and VI similar in the length, anterior and posterior margins nearly straight; VII similar in length to IV, (widely) subtrapezoidal, with 2 subcircular, slightly impressed anterolateral regions with abundant scales, lateral margins gradually rounded, posterior margin very slightly emarginate. Tergum VII on each side with a subcircular, transversely strigulate region. Pygidium (tergum VIII) entirely covered by elytra, convex, lateral margins posteriorly roundly converging, posterior margin plicate, medially roundly emarginate.

Terminalia. Sternum VIII (Fig. 5A) consisting of 2 transversely oriented, subtriangular sclerites (connected via membrane); each sclerite laterally acuminate, posterior margin strongly angulate, with 4-6 setae; spiculum relictum minute. Spiculum gastrale (Fig. 5B) slightly longer than median lobe; anteriorly expanded into an alate, irregular lamina; stylus slightly sinuate; posteriorly bifurcate, furcal arms weakly sclerotized, wide and explanate, arms apically slightly diverging, gradually narrowed, apices more sclerotized, slightly curved outwards, lacking setae. Tegmen (Fig. 5C) slightly shorter to slightly longer than median lobe; tegminal apodeme slender, sinuate; basal piece apically with 2 narrowly triangular projections (parameres), each arm apically increasingly finely denticulate. Aedeagus (e.g. Fig. 5D) with median lobe (aedeagal pedon) length/width ratio 6.12-9.50; basiventral margin strongly emarginate, with 2 lobe-like (to triangular), sclerotized projections; lateral margins mostly subparallel throughout, outline minimally expanded in region of ostium, thereafter gradually converging, rounded or straight, apex variously rounded to narrowly projected. Median lobe in lateral view homogeneously curved; width similar throughout basal three fourths of entire length, in apical fourth dorsal margins converging towards apex in a straight line; dorsal subapical region with a small region of short, recurved setae; apex narrowed or with a terminal, knob- or lobe-like projection. Internal sac with variously plicate membranes though lacking sclerites or denticles, in most species with 2 weakly sclerotized, angulate-uncinate rami (apices directed laterally or mesally); ostium large, elliptical, basal and apical edge of ostium each with a recurved invagination. Aedeagal apodemes nearly half as long as median lobe, proximally embedded in a membranous evagination of median lobe, not sclerotized; distally sclerotized, slender.

Female. Overall very similar to male. Length 4.76–11.88, width 1.95–4.60 mm, length/width ratio 2.40–2.92, widest at humeri to midpoint. Rostrum length 0.46–1.32 mm, rostrum/pronotum length ratio 0.30–0.46, rostrum length/width ratio 0.60–0.82. Eyes slightly less protruded and/or posteriorly "tilted". Pronotum length/ width ratio 0.92–1.04, pronotum/elytra length ratio 0.36–0.48, typically slightly smaller, less globular, and anteriorly less constricted than in male. Metasternum mesally subplane. Profemur/pronotum length ratio 0.80–1.10, profemur slightly less stout, tooth slightly smaller, protibia/profemur length ratio 0.95–1.03. Elytra length/width ratio 1.66–2.08, widest at humeri to midpoint, lateral margins subparallel in anterior half, posteriorly less attenuate, declivity in lateral view more distinct, very slightly concave. Venter with segment VII slightly shorter than IV, subtriangular, lateral margins posteriorly more strongly converging, posterior margin narrowly rounded. Pygidium larger and more triangular than in male, lateral margins posteriorly more strongly converging, posterior margin narrowly rounded.

Terminalia. Sternum VIII (e.g. Fig. 6A) with anterior two thirds (spiculum ventrale) narrowly stylate, anterior end knob-like; posterior third (lamina) variously triangular, entire (arms jointed); anterior edges rounded or (slightly) projected, lateral margins nearly straight, continuously converging, posterior margin rounded to truncate; lamina separated in to anterior region (2/5 of entire length) without setae, thereafter laterally with 2 semi-circular, transparent (less sclerotized) regions, and posterior region (3/5 of entire length) with pores, increasingly dense short setae, and several longer setae along posterior margin. Coxites (Fig. 6B) similar in length to sternum VIII, elongate, slender, posteriorly slightly narrowed, with 2–3 longer setae; styli relatively small, digitate, apically obliquely truncate, with 2–3 long setae. Genital chamber slightly shorter than sternum VIII. Spermatheca (e.g. Fig. 6C) variously C-, U-, V-, or ?-shaped; collum short to reduced, apex of spermathecal duct truncate; collum subcontiguous with, and variously angled (45–150°) in relation to, (very) short to moderately long ramus; corpus very short, though widest overall ("swollen"); cornu much longer, variously curved to angled, apically gradually narrowed, apex with or without additional deflection.

Variation. Variation in size, shape (relative expansion) of the pronotum, "armature" of the profemur and protibia, and particularly in scale patterns is considerable within and among species of *Apotomoderes*. In spite of the remarkable palette of scale colors – ranging from creamy white to dark brown and including several hues of iridescent scales that can occur on many parts of the rostrum, pronotum, elytra and legs – these patterns are often too variable to clearly separate species. In older, worn specimens, large portions or nearly all of the scales are lost, or have turned transparent, exposing the underlying, dark reddish brown integument. Some minor intraspecific variation is apparent in the shape of the male aedeagus and female spermatheca.

Natural history. *Apotomoderes* is restricted to Hispaniola – with two apparently disjunct regions of occurrence in the southwestern and eastern parts of the island – and to Mona Island, Puerto Rico (Fig. 18). The sampled species tend to inhabit lower elevation coastal dry forests. No specific host plant associations are known. It is likely that the species have fairly broad host ranges within their particular habitats, as observed generally in many entimine lineages (e.g. Woodruff 1985; Oberprieler et al. 2007; Franz and Girón 2009).

Etymology. The name *Apotomoderes* is derived from the name *Apotomus* (see above), based on the Greek term *apo-tomós* = abruptly, curtly; and the Greek term *deire* = neck, throat. Thus the name likely refers to the postocular head constriction. The gender is masculine.

Apotomoderes anodontos Franz, sp. n.

urn:lsid:zoobank.org:act:A4DF9315-045D-4684-9A7D-0C04BA623BD7 Figs. 7, 8

Diagnosis. *Apotomoderes anodontos* is the smallest of the herein treated species and is readily differentiated from other species by the absence of a large, knife-like tooth of the profemur and the lack of a ridge-like, toothed projection along the anteromesal margin of the protibia (Fig. 7C).

Description - male. Length 4.32–6.28 mm, width 1.65–2.58 mm, length/width ratio 2.40–2.62 (N=5), widest at humeri to anterior third of elytra or near midpoint of pronotum. Linear piliform scales moderately long and abundant, particularly on



Figure 7. Habitus of *A. anodontos*, male: **A** dorsal view **B** lateral view **C** frontal view, showing unarmed profemora.

legs, elytra, and thoracic and ventral sterna, either transparent white or light (rusty) brown, recumbent to suberect, more appressed on pronotum. With characteristic though locally variable patterns of creamy white and (light) (rusty) brown or tan scales, lighter scales typically more abundant on lateral sides and on legs, creating a two-colored impression, some specimens with semi-regular micro-patterns on elytra, (very) pale blue, moderately iridescent, metallic scales primarily on rostrum and tibiae. Rostrum (Figs. 7B, 7C) short and wide, length 0.45-0.68 mm, rostrum/pronotum length ratio 0.28–0.30, rostrum length/width ratio 0.60–0.66, depressed region basad of epistoma covered with creamy white (slightly iridescent) to (very) pale blue or light greenish metallic scales, thereafter increasingly with tan scales, lateral sulcus anteriad of eye reduced. Rostrum in lateral view nearly 2× wider (dorsoventrally) than long. Ventral margin of scrobe strongly angulate. Scape extending to anterolateral margin of pronotum, laterally compressed, covered with linear and subcircular scales. Funicular segment I longer than II. Head with eyes relatively large, moderately and almost evenly globular (posteriorly not abruptly curved), anterior, ventral, and posterior margins nearly straight, eyes separated (in dorsal view) by distance (much) less than 2× anterior-to-posterior length of each eye, scales on head predominantly creamy white and tan. Pronotum length/width ratio 0.88-0.98, pronotum/elytra length ratio 0.53–0.55, laterally strongly expanded (wide) though not strongly globular (more plane than in other species), scales dorsally predominantly darker, rusty or tan, irregularly shaped, though often with a subquadrate patch of lighter scales mesally near posterior margin, laterally with creamy white scales, creating a two-colored



Figure 8. Terminalia of *A. anodontos*: **A** aedeagus, ventral and lateral view **B** sternum VIII, female **C** spermatheca.

impression. Metendosternite similar to *A. lateralis* though furcal arms shorter. Legs predominantly covered with creamy white, rusty, and tan scales (more rarely with pale blue metallic scales, profemur/pronotum length ratio 0.80–0.83, profemur unarmed (lacking anteromesal tooth), protibia/profemur length ratio 0.84–1.02, lacking laminate, rounded anteromesal projection, though with 6–10 alternating smaller and larger, triangular (apically subacute) teeth, less much less prominent on meso- and metatibiae. Elytra (Fig. 7A) length/width ratio 1.60–1.68, scales dorsally (~ striae I–VI) predominantly darker, rusty brown or tan, sometimes with irregular patches of lighter scales, laterally (~ striae VII-X) with creamy white scales more abundant, creating the impression of a lighter stripe, punctures also with a small, creamy white scale. Wings absent.

Terminalia with tegmen slightly longer than median lobe. Aedeagus (Fig. 8A) narrowly elongate, with median lobe length/width relation 8.62–9.50 (N=3), basiventral margin strongly emarginate, lobe-like projections subtriangular, lateral margins subparallel along basal 5/6 of entire length, thereafter nearly straight and triangularly converging towards narrowly rounded, though not point-like, apex. Median lobe in lateral view with width similar throughout basal 5/6 of entire length, apex narrowly projected, slightly reclined, minimally expanded. Internal sac with ostium relatively small, with 2 weakly sclerotized, strongly arcuate-uncinate rami, positioned in ostium and curved outward, apices directed basally. **Female.** Length 4.76–5.88 mm, width 1.95–2.38 mm, length/width ratio 2.45–2.50 (N=3), widest near midpoint of elytra. Linear piliform scales on pronotum and elytra more conspicuous and suberect. Rostrum length 0.46–0.60 mm, rostrum/ pronotum length ratio 0.30–0.36, rostrum length/width ratio 0.75–0.80, rostrum slightly more narrow than in males. after increasingly with creamy white and variously brownish scales. Pronotum length/width ratio 0.95–0.97, pronotum/elytra length ratio 0.40–0.48, pronotum laterally smaller than in males, laterally not particularly expanded. Legs similar to males, profemur/pronotum length ratio 0.80–0.94, protibia/ profemur length ratio 0.96–1.00. Elytra length/width ratio 1.66–1.74, widest near midpoint, very slightly diverging in anterior half, thereafter gradually and roundly converging, declivity apparent in dorsal view as a slight, angulate constriction, mesal interval and stria I at point just posteriad of anterior end of declivity with a small, subcircular, convex elevation with suberect, linear scales, transparent white scales (similar to *A. menocrater;* see Fig. 9D). Venter with segment VII only 3/5 as long as IV.

Terminalia with sternum VIII (Fig. 8B) with posterior 2/5 (lamina) narrowly triangular, in anterior half with a mesal, narrowly elongate, weakly sclerotized area, anterior edges rounded, not projected, posterior margin (narrowly) truncate, with a clear rectangular mesal incision. Coxites with styli basally strongly oblique. Spermatheca (Fig. 8C) V-shaped, ramus and collum angled at nearly 45°, subcontiguous, collum very short, ramus moderately long, apically slightly and roundly expanded, corpus reduced, not strongly expanded, cornu long, strongly angled/curved at basal 2/5, thereafter nearly straight and slightly narrowed towards end which more declined and oriented at nearly 150° in relation to proximal end of spermatheca.

Variation. Larger males have a more strongly expanded pronotum. Some specimens are primarily covered with red or rusty brown scales, other specimens have larger region with an underlying pale blue or greenish metallic hue.

Material examined. Male holotype "D. R. Pedernales, Sierra de Bahoruco, along Rd. Cabo Rojo to Aceitillar, 12.0 km uphill from Rd. 44, transition forest, 395 m, N 18°4'32.0" W 71°39'14.6"/ Jun 09/2008 (RD 9–2), Leg. N. Franz, J. Girón, A. Mazo, S. Navarro" (UPRM). Paratypes, same label information as male holotype (UPRM: 2 males, 3 females); "DOMINICAN REPUBLIC, Pedernales, 4km W Oviedo, 10m, arid[]thorn for[est], 91–344, 28.XI.-4.XII.1991, FIT, L. Masner & S. Peck" (CMNC: 2 males, 1 female); "DOMINICAN REPUBLIC, Pedernales, 26km N Cabo Rojo, 565m, 91–347, 29.XI.-3.XII.1991, FIT, evergreen dry forest, L. Masner & S. Peck" (CMNC: 1 male); "D. R. Pedernales, Sierra de Bahoruco, km 10.5 Rd. Cabo Rojo to Aceitillar, night collecting (incl. Hg & UV lights), 100 m, N 18°0'36.1" W 71°38'48.1"/ Jun 09/2008 (RD 9–5), Leg. N. Franz, J. Girón, A. Mazo, S. Navarro" (CWOB: 1 male, 1 female; MHND: 1 male); "REPUBLICA DOMINICANA, Pedernales, Oviedo, dry forest, 5–8-VI-2001, H. Takizawa" (MNHD: 1 male); "DO-MINICAN REPUBLIC, 15 km N Cabo Rojo, 10.VII.2004, N18.06.76 W71.37.24. 670 m, leg. A. Konstantinov" (NMNH: 1 male).

Etymology. Named for the unarmed profemora, with *an-* signifying "not" and *odontos* signifying "tooth" (Brown 1956). The epithet is treated as a noun in apposition.

Natural history. *Apotomoderes anodontos* is known to occur in the low to mid elevation dry forests (100–670 m) of the southwestern Pedernales province of the Dominican Republic: Sierra de Bahoruco, Cabo Rojo, and Oviedo (Fig. 18). The host plant associations remain unknown.

Apotomoderes menocrater Franz, sp. n.

urn:lsid:zoobank.org:act:D196352B-4B83-4A30-9633-6A2BF03A25D6 Figs. 9, 10

Diagnosis. Apotomoderes menocrater is most readily separated from other congeneric species by the larger, subfoveate punctures in the posterior half of the pronotum (Fig. 9A, 9C). Other diagnostic features include a more elongate shape and more tubular pronotum (particularly in males), the presence of grey metallic scales (though see comments on variation), only moderately protruded and more evenly convex eyes (Fig. 9B), the presence of a patch of suberect scales near the mesal anterior end of the declivity in females (Fig. 9D; shared with *A. anodontos*), the apparently V-shaped uncinate rami along the ostium of the aedeagus (Fig. 10A), and the strongly curved cornu of the spermatheca (Fig. 10C).

Description - male. Length 5.40–9.05 mm, width 2.00–3.50 mm, length/width ratio 2.58-2.70 (N=10), more elongate than oval, widest at humeri. Linear piliform scales relatively sparse, transparent white or yellow to light brown. With variable patterns of creamy white, gray metallic (several hues), light rusty brown (less abundant), and variously grayish or light to dark brown scales, particularly the creamy white and gray metallic scales have an underlying, greenish-turquoise-pinkish-yellowish iridescence ("opal gray"; cf. Lacordaire 1963b: 82). Rostrum length 0.70-1.12 mm, rostrum/pronotum length ratio 0.38-0.42, rostrum length/width ratio 0.78-0.80, depressed region basad of epistoma covered with pale pink metallic scales, thereafter increasingly with creamy white and variously brownish scales. Head (Fig. 9C) with eyes (only moderately) protruded, almost evenly globular, posteriorly not abruptly curved, rostrum and head in lateral view only moderately angulate. Pronotum (Fig. 9C) length/width ratio 1.00-1.22, pronotum/elytra length ratio 0.42-0.48, pronotum equilateral to elongate, relatively narrow and only slightly globular (subtubular in small males), anteriorly slightly constricted, punctures in posterior half of pronotum larger, subfoveate, scales dorsally predominantly darker (gravish and brown), laterally with wider, irregularly shaped and variously interspersed stripe of creamy white scales. Metendosternite more elongate than in A. lateralis (less laterally expanded), ventral margin nearly 2× wider than dorsal width of stalk, furcal arms diverging at nearly 30° in relation to medial keel. Profemur/pronotum length ratio 1.06–1.10, profemur with anteromesal tooth only moderately large (in comparison with males of congeneric species), triangular, protibia/profemur length ratio 0.96-1.00, anteromesal projection and associated teeth of protibia only weakly projected, basally rounded, scales predominantly creamy white and variously brown, interspersed with pale turquoise



Figure 9. Habitus of *A. menocrater*: **A** female, dorsal view **B** female, lateral view **C** male, head and pronotum, dorsal view, showing subfoveate punctures **D** female, declivity with patch of suberect setae, lateral view.

and pinkish metallic. Elytra length/width ratio 1.78–1.92, more narrowly triangular in general appearance, widest at humeri, thereafter slightly yet continuously narrowed (attenuate), elytra predominantly with creamy white, gray metallic, and brown scales, each color varying in abundance and micro-patterns, in some specimens interspersed with light rusty brown and pale blue metallic scales, punctures with or without a creamy to transparent white scale. Wing/body length ratio 1.23–1.35, wing length/ width ratio 3.30–3.62 (N=2).

Terminalia with sclerites of sternum VIII diamond-shaped, posterior margin strongly angulate. Spiculum gastrale with furcal arms apically strongly curved out-



Figure 10. Terminalia of *A. menocrater*: **A** aedeagus, ventral and lateral view **B** sternum VIII, female **C** spermatheca.

wards. Aedeagus (Fig. 10A) with median lobe length/width relation 7.08–8.00 (N=5), lateral margins subparallel in basal 5/6 (greatest width near mid region), thereafter nearly straight and converging to very small, lobe-like, apically narrowly rounded projection. Median lobe in lateral view only slightly (though homogeneously) curved, mid region (second and third fourth of entire length) nearly straight, greatest width near base of ostium, apically with a small, very narrow lobe-like projection that is minimally expanded and reclined. Internal sac with 2 moderately sclerotized, uncinate, apically obliquely truncate rami, positioned in ostium and reclined mesally, creating the impression of a V-shaped transparent area in apical half of ostium.

Female. Largest specimens longer and wider than males, length 6.26–11.88 mm, width 2.15–4.60 mm, length/width ratio 2.58–2.92 (N=10), otherwise very similar to males. Rostrum length 0.75–1.33 mm, rostrum/pronotum length ratio 0.42–0.46, rostrum length/width ratio 0.78–0.80. Eyes slightly smaller than in males. Pronotum (Fig. 9A) length/width ratio 1.00–1.02, pronotum/elytra length ratio 0.37–0.39, pronotum less globular than in males, subtubular. Profemur/pronotum length ratio 1.06–1.10, profemoral tooth slightly smaller than in males, protibia/profemur length ratio 0.95–1.02, anteromesal projection and associated teeth only weakly developed. Elytra (Figs. 9A, 9D) length/width ratio 1.86–2.08, lateral margins subparallel in anterior half, thereafter gradually and roundly converging, mesal interval and stria I at point

just posteriad of anterior end of declivity with a small, subcircular, slightly elevated (convex) tuft with longer, suberect, linear, transparent white scales.

Terminalia with sternum VIII (Fig. 10B) with posterior 2/5 (lamina) triangular, anterior margins rounded, not projected, lateral margins sinuate, expanded ("alate") in anterior half, posterior setae relatively sparse. Spermatheca (Fig. 10C) U-shaped, ramus and collum angled at nearly 45°, subcontiguous, collum very short, ramus moderately long, corpus reduced, overall ("swollen"), cornu very long, very strongly angled/ curved at basal 2/5, thereafter more gradually curved and continuously narrowed towards end which is positioned on the same plane yet oriented at nearly 180° in relation to proximal end of spermatheca.

Variation. This species is perhaps the most externally variable within the genus. Specimens differ in size by a factor of nearly two, and this variation is partly mirrored in larger specimens having a slightly more globular (as opposed to subtubular) pronotum and more conspicuously "armed" prolegs. The size, abundance and extension of subfoveate punctures on the pronotum are variable. However, the most dramatic intraspecific differences are manifested in the scale patterns and colors, ranging in general appearance from almost entirely "silver" (light opal gray scales) to tan and darker brown, yet also (less commonly) reddish or rusty brown, with many combinations of larger or more localized micro-patterns (resulting in a checkered appearance).

Material examined. Male holotype "D. R. Pedernales, Las Cuevas, Bahía de las Águilas Station, afternoon & night collecting (incl. Hg & UV lights), 40 m, N 17°51'43.8" W 71°38'18.3"/ Jun 08/2008 (RD 8-3), Leg. N. Franz, J. Girón, A. Mazo, S. Navarro" (UPRM). Paratypes, same label information as male holotype (CMNC: 1 male, 1 female; CWOB: 3 males, 3 females; FSCA: 1 male, 1 female; MNHD: 1 male, 1 female; NMNH: 1 male, 1 female; UPRM: 12 males, 3 females; WIBF: 1 male, 1 female); "DOMINICAN REPUBLIC, Pedernales Prov., Cabo Rojo, 18 May 1992, R. Turnbow" (CMNC: 1 female); "DOMINICAN REPUBLIC, Pedernales Prov., Cabo Rojo, 20 May 1992, R. Turnbow" (CMNC: 1 male, 1 female); "DO-MINICAN REPUBLIC, Pedernales Prov., Cabo Rojo, 21 May 1992, R. Turnbow" (CMNC: 1 male); "DOMINICAN REPUBLIC, Pedernales, 23-24 km. N Cabo Rojo, 535 m, 11 July 1996, R. Turnbow" (CMNC: 1 male); "REPUBLICA DO-MINICANA, Pedernales, Oviedo, dry forest, 5-8-VI-2001, H. Takizawa" (MNHD: 1 male); "DOMINICAN REPUBLIC: Prov. Pedernales, Cabo Rojo, Alcoa, 1-3-VII-1998, R. E. Woodruff, Lignum vitae leaves" (FSCA: 2 males, 1 female); "DOMINI-CAN REPUBLIC: Pedernales Prov., PN Jaragua, 3 km S. of Los Tres Charcos, 99 m.; 17°48.063' N, 71°26.809' W, 16-VI-2005; Gino Nearns" (FSCA: 1 male); "REPUB-LICA DOMINICANA, Pedernales, midway Oviedo-Cabo Rojo, dried busch [sic], 10-VI-2001, H. Takizawa" (MNHD: 1 male); "DOM. REP.: Prov. Pedernales, Cabo Rojo, 24–28 AUG 1988, in pool & at light, 0–10 m, M. A. Ivie, T. K. Philips & K. A. Johnson colrs." (WBIF: 3 males); "DOMIN. REP: Pr. Pedernales, 0.5 km N. Cabo Rojo, 18°00' N, 71°39' W, 140 ft., 10 JULY 1993, D. S. Sikes & R. P. Rosenfeld, uv light" (WBIF: 1 male); "DOMIN. REP: Prov. Pedernales, P. N. Jaragua, Savana del Plato, 17°55.480' N, 71°30.983' W, 12.2 km N. Oviedo, 28 JULY 1999, G. Dominici, beating pimenta" (WBIF: 1 male); "DOMIN. REP: Pr. Pedernales, P. N. Jaragua, "El Papayo", 17°54.252' N, 71°30.688' W, 29 JULY 1999, 195 m, G. Dominici, on Pimenta" (WBIF: 2 males, 1 female).

Etymology. Named for the characteristic, subfoveate punctures on the pronotum that resemble a moon crater landscape, with *mene* signifying "moon" and *krater* signifying "vessel, crater" (Brown 1956).

Natural history. *Apotomoderes menocrater* is known to occur in the lower elevation coastal dry forest habitats of the southwestern Pedernales province of the Dominican Republic: Jaragua National Park, Cabo Roho, Los Tres Charcos, and Oviedo (Fig. 18). The species likely also occurs in southern Haiti (cf. Lacordaire 1963b: 82). Label information (G. Dominici) suggests an association of adults with "lignum vitae" ("guayacán"; *Guaiacum officinale* Linnaeus – Zygophyllaceae) and "pimenta" ("allspice"; *Pimenta* Lindley – Myrtaceae); although the specific host plant associations remain unknown.

Apotomoderes sotomayorae Franz, sp. n.

urn:lsid:zoobank.org:act:B4C96D33-0D16-4E62-B44F-57B7826E7EC6 Figs. 11, 12

Diagnosis. *Apotomoderes sotomayorae*, the only species occurring on Mona Island, is most readily separated from other congeners by the presence of regularly appearing, creamy white scales along the elytral striae (Fig. 11A; less distinctive in females). Other diagnostic features include the presence of transparent scales, particular on the pronotum of males (Fig. 11B), the lack of a pronounced elytral declivity in males and females (Fig. 11C), the apically triangular, point-like aedeagus (Fig. 12A), and the relatively narrow triangular lamina of the sternum VIII in females (Fig. 12B). Large males of similarly shaped species (*A. lateralis, A. chariedris,* and *A. hadroprion*) have a basally triangularly projected (as opposed to rounded) protibial ridge.

Description - male. Length 7.40–10.70 mm, width 3.15–4.95 mm, length/ width ratio 2.15–2.45 (N=5). Integument with legs dark reddish brown (slightly lighter). Linear piliform scales sparse, transparent white. With distinct, heterogeneous pattern of uniformly arranged, or locally interspersed, transparent, creamy white, light brown, and pale blue metallic scales, the latter of various lighter to darker hues. Rostrum length 0.78–1.28 mm, rostrum/pronotum length ratio 0.30–0.36, rostrum length/width ratio 0.74–0.82, depressed region basad of epistoma covered primarily with pale blue metallic scales, thereafter increasingly with creamy white scales, lateral region anteriad of eye with patch of light brown scales, sulcus reduced, region adjacent to mandibular incision with pale blue metallic scales. Head with eyes small, slightly "tilted" posteriad, separated (in dorsal view) by distance slightly more than $2\times$ anterior-to-posterior length of each eye, scales on head predominantly creamy white and light brown. Pronotum (Fig. 11A) length/width ratio 0.80–0.98, pronotum/elytra length ratio 0.45–0.50, pronotum strongly globular, mesally with large,



Figure 11. Habitus of A. sotomayorae, male: A dorsal view B frontal view C lateral view.

suboval region covered with pale blue metallic scales, or seemingly "glabrous" (only with transparent, slightly iridescent scales), and laterally with a wide, slightly undulating stripe of creamy white scales, thereafter (ventrad) predominantly "glabrous" (see above). Thoracic and ventral sterna predominantly covered with creamy white scales, interspersed with pale blue metallic scales. Metendosternite more elongate than in A. lateralis (less laterally expanded), ventral margin nearly 2× wider than dorsal width of stalk, furcal arms diverging at nearly 30° in relation to medial keel. Profemur/pronotum length ratio 0.80–0.94, profemur (Fig. 11 B) with anteromesal tooth very large, almost planate, slightly curved, protibia/profemur length ratio 1.00-1.02, anteromesal projection of protibia (Fig. 11B) distinct yet basally rounded, scales typically less dense on legs, creamy white and pale blue metallic. Elytra (Figs. 11A, 11C) length/ width ratio 1.52-1.68, posterior declivity not pronounced, nearly indistinct, elytra with characteristic scale pattern: intervals seemingly glabrous, with slightly iridescent, transparent scale "remnants" (not protruding from cuticle), striae predominantly with creamy white scales, interspersed with pale blue metallic and pale yellow scales (near punctures), punctures with a greenish to yellowish metallic scale. Wing/body length ratio 1.25, wing length/width ratio 3.45 (N=1).

Terminalia with tegmen similar in length to median lobe. Aedeagus (Fig. 12A) with median lobe length/width relation 6.12–6.85 (N=3), basiventral margin strongly emarginate, lobe-like projections subtriangular, lateral margins very slightly diverging in basal 5/6 of entire length, thereafter nearly straight and triangularly converging



Figure 12. Terminalia of *A. sotomayorae*: **A** aedeagus, ventral and lateral view **B** sternum VIII, female **C** spermatheca.

towards point-like, through very narrowly rounded apex. Median lobe in lateral view apically with small, knob-like projection that is neither expanded nor reclined. Internal sac with 2 weakly sclerotized, angulate-uncinate rami, positioned in ostium and reclined mesobasally.

Female. Length 7.66–9.04 mm, width 2.82–3.40 mm, length/width ratio 2.58–2.72 (N=3). Pattern of scale colors varying considerably from that of males: rostrum, pronotum, sterna, legs, and elytra more homogeneously and densely covered with scales of multiple colors including creamy white, pale yellow (rare), light rusty brown, dark brown (as opposed to transparent), pale blue metallic, and yellow-light-green-pink metallic. Scale colors arranged in semi-consistent patterns though particularly variable among specimens on rostrum and pronotum, and transparent scales (present in males) absent on pronotum and elytra, therefore not appearing "glabrous" and with less conspicuous pronotal or strial scale stripes. Brown scales more prominent on rostrum (not just anteriad of eyes). Legs more consistently covered with creamy white, light rusty brown, and variously metallic scales. Region of elytra just posteriad of scutellum with patch of metallic scales. Rostrum length 0.85–0.98 mm, rostrum/pronotum length ratio 0.39–0.43, rostrum length/width ratio 0.76–0.80. Pronotum length/width ratio

tio 0.98–1.04, pronotum/elytra length ratio 0.36–0.38, pronotum considerably less globular than in males. Legs more slender than in males, profemur/pronotum length ratio 0.98–1.08, profemoral tooth (much) smaller and more triangular than in males, protibia/profemur length ratio 0.97–1.03, anteromesal projection and associated teeth of protibia less pronounced. Elytra length/width ratio 1.80–1.93, posterior declivity similarly unpronounced as in males.

Terminalia with lamina of sternum VIII (Fig. 12B) triangular, longer than wide, anterior margins projected, mesally with elongate, transparent (not sclerotized) region, posterior margin narrowly truncate. Coxites small, suboval. Spermatheca (Fig. 12C) nearly V-shaped, ramus and collum angled at nearly 150°, ramus short and wide, truncate, cornu strongly curved at basal 2/5, thereafter nearly straight until apical 1/8 which is more curved.

Variation. Males vary considerably in size, and several presumably allometric characteristics – viz. expansion of the pronotum, profemoral and protibial teeth, posterior attenuation of elytra – are less pronounced in smaller males. In some males yellow scales are more abundant in the lateral pronotal area. The relative abundance of creamy white, light rusty brown, and dark brown scales varies in females, particularly on the elytra, thus making the appearance of alternating stripes of darker scales (intervals) and lighter scales (stria) more or less obvious.

Material examined. Male holotype "Mona Island (PR, USA), Bajura Los Cerezos, 45 m, general collecting, N 18°05'18", W 67°54'04", leg. N. Franz, V-22–2008" (UPRM). Paratypes, same label information as male holotype (UPRM: 1 male, 2 females; CMNC: 1 male; CWOB: 1 male;); "PUERTO RICO, La Mona, III-8–1984, N. Virkki" (MEBT: 1 male); "PUERTO RICO, La Mona, 5-VI-1984, N. Virkki/ on citrus" (MEBT: 1 male). "PUERTO RICO, La Mona, 5-VI-1984, N. Virkki/ on citrus" (MEBT: 1 male). "PUERTO RICO, La Mona, 5-VI-1984, N. Virkki/ on female).

Etymology. Named in honor of Sonia Maria Sotomayor, Associate Justice of the Supreme Court of the United States, whose personal story and academic and professional achievements are an inspiration for people in Puerto Rico and elsewhere.

Natural history. *Apotomoderes sotomayorae* is endemic to Mona Island, Puerto Rico (Fig. 18), where it is likely widespread, though not particularly abundant, in the plateau and depression forests (Cintrón and Rogers 1991). Most specimens were taken at night, on a variety of shrubs and trees.

Apotomoderes lateralis (Gyllenhal, 1834)

Figs. 1, 2, 3, 4, 5, 6

= Apotomus lateralis Gyllenhal 1834: 45 (first valid combination in Dejean 1834: 253)

Diagnosis. Apotomoderes lateralis, the type species, most closely resembles A. chariedris and A. hadroprion though it is slightly smaller than the latter two species, and has a

slightly less expanded male pronotum Fig. 1A). The scale patterns on the elytra are usually more homogeneous (initially appearing a one primary color) and less "spotty" (Figs. 2A, 2B). In addition, the aedeagus is apically more widely rounded, and the internal sac lacks well sclerotized rami along the ostium (Fig. 5D). The spermatheca is C-shaped (as opposed to more strongly curved), and has a short, tubular (as opposed to almost completely reduced) ramus (Fig. 6C). See also the species accounts of *A. chariedris* and *A. hadroprion*.

Description - male. Largely coinciding with the generic description above. Length 6.68-7.26 mm, width 2.26-2.86 mm, length/width ratio 2.54-2.68 (N=3). Scales variously interspersed creamy white to beige or tan to brown, often rather evenly interspersed or creating variable localized patterns, in some specimens with a more homogenous (and conspicuous) creamy white stripe laterally on pronotum and elytra. Rostrum length 0.75-0.85 mm, rostrum/pronotum length ratio 0.32-0.36, rostrum length/width ratio 0.72-0.78, depressed region basad of epistoma covered primarily with pinkish metallic scales. Head with eyes slightly "tilted" posteriad. Pronotum length/width ratio 0.96-1.02, pronotum/elytra length ratio 0.47-0.49, pronotum (strongly) globular, predominantly with beige to tan (mesal) and creamy white (mostly lateral) scales. Metendosternite wide (laterally expanded), ventral margin nearly 3× wider than dorsal width of stalk, furcal arms widely diverging at nearly 45° in relation to medial keel. Legs with scales less densely arranged, forming a more uniform light/dark/light pattern on femora, with pinkish metallic on anterior sides near tibial apices, profemur/pronotum length ratio 0.80-1.00, protibia/profemur length ratio 0.95-1.02, anteromesal projection of protibia basally triangular. Elytra length/width ratio 1.72–1.76, scales covering entire integument, arranged in mostly irregular micro-patterns of creamy white, beige, and brown colors, punctures with a green metallic scale. Wing/body length ratio 1.15-1.20, wing length/width ratio 3.63-3.78 (N=2).

Terminalia with tegmen (Fig. 5C) slightly shorter to slightly longer than median lobe. Aedeagus (Fig. 5D) with median lobe length/width relation 7.62–8.08 (N=3), basiventral margin with rounded projections, lateral margins subparallel to ostium, thereafter gradually and roundly converging, apex (widely) rounded. Median lobe in lateral view apically with small, knob-like, minimally deflexed projection. Internal sac without apparent rami.

Female. Largely coinciding with the generic description above. Length 6.34–8.20 mm, width 2.62–3.20 mm, length/width ratio 2.42–2.56 (N=3). Rostrum length 0.76–0.92 mm, rostrum/pronotum length ratio 0.38–0.42, rostrum length/width ratio 0.74–0.76. Pronotum length/width ratio 0.94–0.98, pronotum/elytra length ratio 0.40–0.43. Profemur/pronotum length ratio 1.02–1.04, protibia/profemur length ratio 0.96–1.00. Elytra length/width ratio 1.74–1.76.

Terminalia with lamina of sternum VIII (Fig. 6A) triangular, slightly longer than wide, anterior margins slightly projected, posterior margin narrowly rounded. Spermatheca (Fig. 6C) C-shaped, collum very short (reduced), collum subcontiguous with, and angled at nearly 90° in relation to, moderately long ramus, corpus very short and expanded (widest), cornu continuously curved to end (at nearly 150° in relation to proximal orientation), gradually narrowed, apically very narrowly rounded.

Variation. The examined specimens vary primarily in the abundance of scales on the integument.

Material examined. Holotype specimen– female (only images seen: Fig. 2) "90. *Apotomoderes* Mannerh., *Apotomus* Schönherr 195. [box label 1]/ 1. *lateralis* Mannerh., Ghl. [Gyllenhal] 1. [box label 2]/ Typus [red, specimen label 1/ *Apotomoderes lateralis* S. [specimen label 2]" (located in the Naturhistoriska Riksmuseet, Stockholm, Sweden, NHRS). Additional specimens: "DOMINICAN REPUBLIC: Prov. La Altagracia, Cueva de Bernay, Boca de Yuma, 6-VI-1986, R. Miller & L. Strange" (CWOB: 1 male); "DOMINICAN REPUBLIC, San Pedro Prov., 13 km E. Boca Chica, 27-V-1992, coll. M.C. Thomas" (CWOB: 1 male); "D. R. San Pedro de Macoris, Rd. San Pedro de Macoris to Bocachica, along road-coast, 0 m, N 18°24'39.2" W 69°29'27.0"/ Jun 04/2008 (RD 4–3), Leg. N. Franz, J. Girón, A. Mazo, S. Navarro" (UPRM: 1 male); "DOM. REP., SPM, 21 km. W. S. Pedro de Macoris, May 30, 1978, CW & LB O'Brien & Marshall" (CWOB: 1 female); "DOMINICAN REPUBLIC, San Pedro Prov., 13 km E. Boca Chica, 27-V-1992, coll. M.C. Thomas" (CWOB: 2 females).

Etymology. The Latin term *lateralis* means "of the side" (Brown 1956), and may refer to the relatively well defined lateral stripe of creamy white scales on the pronotum and elytra of the female type specimen.

Natural history. *Apotomoderes lateralis* is known to occur in low elevation habitats in the southeastern provinces of the Dominican Republic (Fig. 18): La Altagracia (Boca de Yuma) and San Pedro de Macoris/Santo Domingo (east of Boca Chica). The host plant associations remain unknown.

Apotomoderes chariedris Franz, sp. n.

urn:lsid:zoobank.org:act:474D949C-484C-486C-8384-720979328F9B Figs. 13, 14, 15

Diagnosis. *Apotomoderes chariedris* closely resembles *A. hadroprion* though it has a more metallic appearance, particularly in males (e.g. Fig. 13A). The pronotum is strongly globular (Figs. 13A, 14A) and the protibial ridge is distinctly triangular near the basal 2/5, particularly in large males (Fig. 13C). In addition, the apex of the aedeagus is narrowly rounded though not pointed, and in lateral view forms a small, knob-like (as opposed to lobe-like), slightly deflexed projection (Fig. 15A). Two mesally reclined, uncinate rami are present along the aedeagal ostium. The cornu of the spermatheca is abruptly angled at the basal one third (Fig. 15C), thereafter only slightly curved, and ending in a straight, slightly deflected tip (as opposed to gradually curved throughout). See also the species accounts of *A. chariedris* and *A. hadroprion*.

Description - male. Length 8.90–9.70 mm, width 3.58–3.78 mm, length/width ratio 2.38–2.60 (N=3). Linear piliform scales more dense on pronotum, very short, appressed, transparent white; setae (much) longer and suberect on thoracic and ventral



Figure 13. Habitus of *A. chariedris*, male: **A** dorsal view, showing strongly expanded pronotum **B** head, dorsal view **C** frontal view, showing large profemoral tooth and toothed, triangularly projected protibial ridge.

sterna and coxae. Scales predominantly creamy white, with a subtle iridescence, creating an almost silver effect, variously interspersed with rusty brown (localized, rare), tan, dark brown (more frequent, patchy/spotty) and turquoise (green to light blue) metallic scales (particularly as a secondary color on pronotum, anterior side of profemora), depressed region basad of epistoma covered primarily with creamy white to turquoise metallic scales, thereafter increasingly with creamy white scales, lateral region anteriad of eye with patch of light brown scales, sulcus reduced, region adjacent to mandibular incision with pale blue metallic scales. Rostrum length 0.98-1.00 mm, rostrum/pronotum length ratio 0.31-0.33, rostrum length/width ratio 0.75-0.80. Head with eyes "tilted" posteriad, particularly in large males. Pronotum length/width ratio 0.91–0.97, pronotum/elytra length ratio 0.48-0.52, globular and strongly convex, dorsally with irregularly shape scales of various colors including dark brown and pale blue metallic patches, in some specimens laterally (posterior half) with a wide, more uniformly creamy white "stripe", flanked by darker regions. Profemur/pronotum length ratio 0.90–0.98, profemur (Fig. 13C) with (minimally) anterior side often covered in part with turquoise scales, with anteromesal tooth very large, also completely covered with



Figure 14. Habitus of A. chariedris, male: A lateral view B ventral view.

scales, protibia/profemur length ratio 0.98–1.02, anteromesal projection of protibia (Fig. 13C) strongly and triangularly elevated (not rounded), associated teeth large, apically rounded to truncate. Elytra (Fig. 13A) length/width ratio 1.66–1.68, scales predominantly creamy white, often with turquoise metallic undertones, mesal striae more beige or tan, and with distinct though irregularly positioned and shaped dark brown spots, punctures also with a small, turquoise metallic scale.

Terminalia with tegmen similar in length to median lobe. Aedeagus (Fig. 15A) length/width relation 6.38–6.74 (N=2)., basiventral margin strongly emarginate, lobe-like projections elongate and subtriangular, lateral margins very slightly diverging in basal 5/6 of entire length, thereafter slightly rounded and continuously converging towards relatively narrowly rounded, though not pointed, apex. Median lobe in lateral view only slightly curved along extended mid region (second and third fourth of entire length), thereafter (apical fourth) dorsal margins converging towards apex in a straight slightly concave line, apically with very small, knob-like, minimally deflexed and expanded projection. Internal sac with 2 weakly sclerotized, angulate-uncinate rami, positioned in ostium and reclined mesally.



Figure 15. Terminalia of *A. chariedris*: **A** aedeagus, ventral and lateral view **B** sternum VIII, female **C** spermatheca.

Female. Length 7.58–10.70 mm, width 2.96–4.42 mm, length/width ratio 2.42–2.56 (N=3). Pattern of scale colors varying considerably from that of males: overall scales with beige and (light reddish) tan tomes more abundant, not appearing silver, scale distribution more finely heterogeneous, lighter and darker colors (including pale blue metallic) continuously interspersed, resulting in a "salt-and-pepper" appearance. Rostrum length 0.83–1.11 mm, rostrum/pronotum length ratio 0.35–0.40, rostrum length/width ratio 0.74–0.80. Eyes slightly smaller and more separated than in males. Pronotum length/width ratio 0.93–0.97, pronotum/elytra length ratio 0.40–0.42, pronotum only moderately globular. Profemur/pronotum length ratio 1.00–1.05, profemoral tooth (slightly) smaller than in males, protibia/profemur length ratio 0.96–0.98, anteromesal projection of protibia conspicuous and triangular, though slightly smaller than in males. Elytra length/width ratio 1.70–1.82.

Terminalia with lamina of sternum VIII (Fig. 15B) widely triangular, length and width similar, anterior margins projected, lateral margins slightly sinuate, posteriorly widely rounded, densely setose. Spermatheca (Fig. 15C) widely ?-shaped, ramus and collum angled at nearly 90°, subcontiguous, collum very short, rounded, ramus also very short, rounded, corpus reduced though expanded (widest region of spermatheca), cornu long, abruptly angled at basal one third, thereafter slightly curved and gradually narrowed, ending (apical 1/8) in a narrow, straight, slightly deflected tip.

Variation. The examined males vary primarily in the abundance of darker brown scales on the pronotum (spotty to predominant) and elytra (near absent to very con-

spicuous); one specimen has multiple patches of rusty brown scales on the legs. The females differ more strongly in size and in the overall scale color appearance, with some females have a more bluish white or rusty orange brown pattern.

Material examined. Male holotype "DOMINICAN REPUBLIC, RD-55 ~ 2 km N Bayahibe, La Altagracia Prov., 31.vii.2002, 18°23.423' N, 68°50.453' W, D. Perez, R. Bastardo, B. Hierro" (MHND). Paratypes, same label information as male holotype (MHND: 2 males, 3 females).

Etymology. Named for the visually appealing scale colors and patterns, with *charieis* signifying "graceful" (Brown 1956), and the inserted letters *dr* (*charie-DR-is*) representing the initials of the Dominican Republic where the species occurs. The epithet is treated as an adjective.

Natural history. *Apotomoderes chariedris* is known to occur in coastal, humid forest habitats of the southeastern La Altagracia Province (Bayahibe, Parque del Este) of the Dominican Republic (Fig. 18). The host plant associations remain unknown.

Apotomoderes hadroprion Franz, sp. n.

urn:lsid:zoobank.org:act:D44A955A-4F65-442C-B738-0C83D5FFBFCF Figs. 16, 17

Diagnosis. Apotomoderes hadroprion closely resembles A. chariedris though it has a more patchy beige/dark brown scale pattern on the elytra (Fig. 16A). The pronotum is strongly globular (Fig. 16B) and the protibial ridge is distinctly triangular near the basal 2/5, particularly in large males. In addition, the apex of the aedeagus is point-like and not just narrowly rounded, and in lateral view forms a small, lobe-like (as opposed to knob-like) projection that is neither expanded nor reclined (Fig. 17A). Two mesally reclined, uncinate rami are present along the aedeagal ostium. The cornu of the spermatheca is strongly curved at the basal 2/5 (Fig. 17C), and thereafter gradually curved towards the tip (as opposed to apically slightly deflected). See also the species accounts of A. chariedris and A. hadroprion.

Description - male. Length 8.85–9.58 mm, width 3.15–3.40 mm, length/width ratio 2.60–2.80 (N=2). Scale colors and patterns, to the extent that they are apparent in the available specimens (see remarks on variation), very similar to those of *A. lateralis*, with pale pink metallic scales restricted to depressed region basad of epistoma, with light green (or similar, yellowish, pinkish to pale blue) metallic scales more abundant on anterior sides of profemora. The pronotum (Fig. 16B) has a larger abundance of transparent scales, thus appearing "glabrous". The scale pattern on the elytra is slightly more patchy (segregated), with white and beige scales predominating over semi-regular, subcircular to irregular sections of brown scales. Rostrum length 0.92–1.02 mm, rostrum/pronotum length ratio 0.32–0.36, rostrum length/width ratio 0.78. Head with eyes "tilted" posteriad. Pronotum length/width ratio 0.88–0.98, pronotum/elytra length ratio 0.48–0.52, strongly globular and seemingly transverse (short and wide), anteriorly strongly constricted. Profemur/pronotum length ratio



Figure 16. Habitus of *A. hadroprion*, male: **A** lateral view **B** frontal view, showing posteriorly "tilted" eyes.

0.90–1.00, profemur stout, with anteromesal tooth very large, protibia/profemur length ratio 0.98–1.02, anteromesal projection of protibia strongly elevated, triangular, associated teeth large, apically rounded to truncate. Elytra length/width ratio 1.68–1.72, punctures with a small, greenish to turquoise metallic scale (no longer visible in very old specimens).

Terminalia with furcal arms of spiculum gastrale apically strongly curved outwards. Tegmen similar in length to median lobe. Aedeagus (Fig. 17A) with median lobe length/width relation 6.-44–6.88 (N=1), basiventral margin strongly emarginate, lobe-like projections elongate and subtriangular, lateral margins slightly diverging in basal 5/6 of entire length, thereafter slightly rounded and gradually (triangularly) converging towards point-like, through very narrowly rounded apex. Median lobe in lateral view only slightly curved along extended mid region (second and third fourth of entire length), thereafter (apical fourth) dorsal margins converging towards apex in a slightly concave line, apically with very small, lobe-like, narrowly rounded projection that is neither expanded nor reclined. Internal sac with 2 weakly sclerotized, angulateuncinate rami, positioned in ostium and reclined mesobasally.



Figure 17. Terminalia of *A. hadroprion*: **A** aedeagus, ventral and lateral view **B** sternum VIII, female **C** spermatheca.

Female. Length 9.24–9.38 mm, width 3.73–3.78 mm; length/width ratio 2.48 (N=2). Rostrum length 1.04–1.10 mm, rostrum/pronotum length ratio 0.39–0.41, rostrum length/width ratio 0.80–0.82. Pronotum length/width ratio 0.92; pronotum/ elytra length ratio 0.40–0.42, pronotum smaller, less wide and less globular than in males. Profemur/pronotum length ratio 0.98–1.00, profemoral tooth slightly shorter and more equilaterally triangular, protibia/profemur length ratio 1.00–1.02, anteromesal projection and associated teeth of protibia slightly less pronounced than in males. Elytra length/width ratio 1.75–1.78.

Terminalia with lamina of sternum VIII (Fig. 17B) widely triangular, all sides almost exactly equilateral, anterior margins projected, anterior half with 2 lateral, poorly defined transparent regions. Spermatheca (Fig. 17V) nearly V-shaped, ramus and collum angled at nearly 60°, each very short (reduced) and wide, resulting in a subcontiguous, uniformly swollen structure (corpus reduced), cornu strongly curved at basal 2/5, thereafter more gradually curved and continuously narrowed towards end.

Variation. Except for the male holotype, all available specimens are nearly 30 years old and appear highly worn, with many regions appearing "glabrous" in light of abrasion and other structural changes of the scales, thereby exposing the color of the un-

derlying integument (particularly the pronotum and elytra) through a transparent, wax-like cover. Consequently, the original variation in scale color pattern cannot be assessed.

Material examined. Male holotype "DOMINICAN REPUBLIC: La Altagracia Prov, El Veron, rd. to Hoyo Azul, 26.VI.2005, 18°34.805' N, 68°26.543' W, 40 m, leg. A. Konstatinov, L. Chamorro" (NMNH). Paratypes, same label information as male holotype (MHND: 1 male); "Juan Dolio, S. P. Macoris, PROV. S. P. Macoris, R. D., 29-VI-1980, Col. Dguez/ 19813" (MHND: 1 female); "Juan Dolio, S. P. Macoris, PROV. S. P. Macoris, R. D., 29-VI-1980, Col. Dguez/ 19815" (MHND: 1 female).

Etymology. Named for the particularly prominent row of teeth on the protibia, with *hadros* signifying "well developed", and *prion* signifying "saw" (Brown 1956). The epithet is treated as a noun in apposition.

Natural history. *Apotomoderes hadroprion* is known to occur in low elevation habitats in two southeastern provinces of the Dominican Republic (Fig. 18): La Altagracia (Hoyo Azul) and San Pedro de Macoris (Juan Dolio). The host plant associations remain unknown.

Key to the species of Apotomoderes

1.	Length 4.32–6.28 mm; profemur unarmed (Fig. 7C); protibia lacking a ridge-like projection; aedeagus with rami along ostium curved outward
	(Fig. 8A): sternum VIII (female) slightly incised at posterior end of lamina
	(Fig. 8B)
1'	Length 5.40–11.88 mm; profemur armed with a large, knife-like tooth (e.g.
	Fig. 2B); protibia with a ridge-like, toothed projection along anteromesal
	margin (e.g. Fig. 2B); aedeagus with rami along ostium curved inward (e.g.
	Fig. 12A); sternum VIII (female) with lamina posteriorly not incised 2
2(1')	Pronotum only slightly globular in males (Fig. 9C); pronotum with larger,
	subfoveate punctures in posterior half (Fig. 9C); elytral punctures without
	an iridescent metallic scale; elytra with a patch of suberect scales near mesal
	anterior end of declivity in females (Fig. 9D)A. menocrater Franz, sp. n.
2'	Pronotum strongly globular in males (e.g. Fig. 13A); pronotum without larger
	punctures; elytral punctures with an iridescent metallic scale (e.g. Fig. 13A);
	elytral punctures typically with an iridescent metallic scale; elytra without
	suberect scales near mesal anterior end of declivity in females
3(2')	Protibial projection rounded near basal 2/5 (Fig. 11B); elytra with regularly
	appearing, creamy white scale stripes along striae (Fig. 11A)
3'	Protibial projection triangular near basal 2/5, particularly so in large males
	(e.g. Fig. 13C); elytra variously covered with scales though without pro-
	nounced creamy white stripes

4(3')	Length 6.68-8.20 mm; aedeagus apically (widely) rounded, internal sac
	without apparent rami (Fig. 5D); lamina of sternum VIII (female) longer
	than wide (Fig. 6A) and spermatheca with ramus moderately long, tubular
	(Fig. 6C)
4'	Length 7.58–10.70 mm; aedeagus apically (very) narrowly rounded, internal
	sac with apparent rami (Figs. 15A, 17A); lamina of sternum VIII (female)
	nearly as wide as long (Figs. 15B, 17B) and spermatheca with ramus very
	short (Figs. 15C, 17C)
5(4')	Aedeagus with apex narrowly rounded though not pointed, in lateral view
	apex with a small, knob-like, minimally deflexed projection (Fig. 15A); sper-
	matheca with cornu abruptly angled at basal one third, thereafter slightly
	curved and a straight, slightly deflected tip (Fig. 15C)
5'	Aedeagus with apex very narrowly rounded, point-like, in lateral view with a
	small, lobe-like projection is neither expanded nor reclined (Fig. 17A); sper-
	matheca with cornu strongly curved at basal 2/5, thereafter more gradually
	curved towards end (Fig. 17C)

Phylogenetic analysis

The 12-taxon matrix (Table 1) yielded a single most parsimonious cladogram (Fig. 19) with a length of 33 steps, a consistency index (CI) of 75 and a retention index (RI) of 90 (Farris 1989). The character states and inferred optimizations are presented simultaneously in this section. Due to limited outgroup representation, the discussion of synapomorphies is restricted to the ingroup taxa. Individual consistency and retention indices (ci, ri) are provided for all characters that are not shown as unreversed synapomorphies.

- 1. Scales, extent of coverage: (0) integument only partly or sparsely covered with scales; (1) integument densely and homogeneously covered with scales.
- 2. Labium, number of labial palpomeres: (0) with 3 labial palpomeres; (1) with 2 labial palpomeres. Synapomorphy for the species of *Apotomoderes*.
- 3. Rostrum, presence of median sulcus (dorsal view): (0) median sulcus absent or obscure (*L. kofresi*); (1) median sulcus well developed, deep and narrow.
- 4. Rostrum, shape of dorsal surface: (0) plane to slightly convex; (1) at least slightly concave.
- 5. Head, presence of postocular constriction: (0) absent; (1) present. Synapomorphy for the species of *Apotomoderes*.
- Eyes, extent of protrusion: (0) eyes only slightly protruded; (1) eyes strongly protruded, globular. Convergently present in *L. kofresi* and in the *Artipus floridanus-Apotomoderes* clade (ci=50; ri=66).

		1	1	2	
Taxon / character	5	0	5	0	
Exophthalmus quadrivittatus	00000	0-000	00000	00000	0-
Scelianoma elydimorpha	10100	0-000	00101	-0000	0-
Lachnopus kofresi	00000	10000	01000	10000	10
Lachnopus valgus	00000	0-000	00000	10000	10
Artipus floridanus	10110	10000	00110	10000	0-
Pantomorus elegans	10110	0-000	00100	00000	0-
Apotomoderes anodontos	11111	10100	01101	11100	10
Apotomoderes chariedris	11111	11212	11110	01211	11
Apotomoderes hadroprion	11111	11212	11110	01211	11
Apotomoderes lateralis	11111	11212	11110	01-01	10
Apotomoderes menocrater	11111	10111	11101	11200	10
Apotomoderes sotomayorae	11111	11211	11110	11201	10

Table 1. Character matrix for the cladistic analysis of the species of *Apotomoderes*, with selected outgroup taxa. All multistate characters are coded as additive; "–" represents inapplicable character states (see also text).

- 7. Eyes, orientation of globular eyes: (0) eyes evenly spherical; (1) eyes "tilted" posteriad, posterior side nearly plane (not evenly spherical), particularly in large males. Coded as inapplicable for taxa that lack globular eyes (see character 6). Synapomorphy for the *A. sotomayorae-A. hadroprion* clade.
- 8. Pronotum, shape and sexual dimorphism: (0) shape of pronotum similar between males and females; (1) pronotum more expanded in males, slightly globular; (2) pronotum strongly globular in males. Coded as additive. Synapomorphy for the species of *Apotomoderes* (state 1) and for the *A. sotomayorae-A. hadroprion* clade (state 2), respectively.
- 9. Profemur, presence of 1 very large, knife-like cuticular tooth: (0) absent; (1) present. Synapomorphy for the *A. menocrater-A. hadroprion* clade.
- 10. Protibia, presence and shape of anteromesal projection: (0) anteromesal projection absent; (1) anteromesal projection present, rounded near basal 2/5 of protibia; (2) anteromesal projection present, triangular near basal 2/5 of protibia, especially so in large males. Coded as additive. Synapomorphy for the *A. menocrater-A. hadroprion* clade (state 1) and for the *A. lateralis-A. hadroprion* clade (state 2), respectively.
- 11. Protibia, shape of ventral teeth: (0) ventral teeth triangular, evenly spaced and similar throughout; (1) ventral teeth apically rounded to truncate, particularly near basal 2/5 of protibia. Synapomorphy for the *A. menocrater-A. hadroprion* clade.
- 12. Metatibial apex, presence of spines: (0) both inner flange and outer bevel with a row of spines ("corbel enclosed"); (1) without an inner flange or outer bevel with a row of spines ("corbel open"). Convergently present in *L. kofresi* and in the species of *Apotomoderes* (ci=50; ri=75).
- 13. Metatarsal condyle, presence of scales: (0) surface surrounding metatarsal condyle glabrous; (1) surface surrounding metatarsal condyle partially covered with scales.

- 14. Elytra, presence of a metallic scale in punctures: (0) absent; (1) present. Convergently present in *A. floridanus* and in the *A. sotomayorae-A. hadroprion* clade (ci=50; ri=75).
- 15. Elytra, presence of a patch of suberect, linear scales near mesal anterior end of declivity, in females only: (0) absent; (1) present. ACCTRAN optimization preferred (see Agnarsson and Miller 2008), therefore convergently present in *S. elydimorpha* and in the species of *Apotomoderes*, with a reversal in the *A. sotomayorae-A. hadroprion* clade (ci=33; ri=0).
- 16. Male terminalia, outline of lateral margins of median lobe in apical 1/4 (dorsal view): (0) lateral margins gradually rounded towards apex; (1) margins nearly straight, subparallel or triangularly converging. DELTRAN optimization preferred (see Agnarsson and Miller 2008), therefore convergently present in the two examined species of *Lachnopus* Schoenherr and in the in the *A. floridanus-Apotomoderes* clade, with a reversal in the *A. lateralis-A. hadroprion* clade (ci=33; ri=50).
- 17. Male terminalia, presence of setae in dorsal subapical region of median lobe: (0) absent; (1) present. Synapomorphy for the species of *Apotomoderes*.
- 18. Male terminalia, orientation of rami along ostium of median lobe: (0) rami subparallel, apically not strongly expanded; (1) rami apically uncinate, curved outward; (2) rami apically uncinate, curved inward. Coded as additive, inapplicable in *A. lateralis* (rami not apparent). Synapomorphy for the species of *Apotomoderes* (state 1) and for *A. menocrater-A. hadroprion* clade (state 2), respectively.
- 19. Female terminalia, shape of lamina of sternum VIII: (0) linear to narrowly triangular; (1) widely triangular, all sides nearly straight and equilateral. Synapomorphy for the *A. chariedris-A. hadroprion* clade.
- Female terminalia, anterior edges of lamina of sternum VIII: (0) rounded, not projected; (1) anterior edges slightly projected. Synapomorphy for the *A. sotomayorae*-*A. hadroprion* clade.
- 21. Female terminalia, relative proximity of collum and ramus on spermatheca: (0) collum and ramus at least slightly separated, corpus not completely reduced; (1) collum and ramus subcontiguous, corpus reduced. Convergently present in the two examined species of *Lachnopus* Schoenherr and in the species of *Apotomoderes* (ci=50; ri=66).
- 22. Female terminalia, length of ramus of spermatheca: (0) ramus at least slightly projected, tubular; (1) ramus strongly reduced, nearly equate with surrounding surface of spermatheca. Coded as inapplicable in taxa where the collum and ramus are clearly separated (see character 21). Synapomorphy for the *A. chariedris-A. hadroprion* clade.

Historical biogeography

The known *Apotomoderes* species records (Fig. 18) suggest the presence of two areas of endemism with multiple species occurrences, i.e. the southwestern Dominican Re-



Figure 18. Reported occurrences and posited areas of endemism for the species of Apotomoderes.

public (Pedernales) and the eastern Dominican Republic (La Altagracia and San Pedro de Macoris), assuming that the habitat conditions of the latter area are sufficiently similar to sustain a wider distribution of (minimally) *A. lateralis* than herein reported. A third area of endemism, Mona Island (Puerto Rico), is inhabited by a single species, *A. sotomayorae* (Fig. 18). Consequently, component analysis (Component 1.5; see Page 1990) yields a single, unambiguous taxon-area cladogram with the southwestern Dominican Republic as sister area to the most closely associated eastern Dominican Republic and Mona Island areas (Fig. 20). *Artipus floridanus* from Florida and the Bahamas (O'Brien and Wibmer 1982) represents the outgroup.

Discussion

According to the preferred cladogram (Fig. 19), the monophyly of *Apotomoderes* is well supported by a series of putative synapomorphies; viz. two-segmented labial palps (char. 2), a postocular constriction on the head (char. 5), a more expanded pronotum in males (char. 8), the presence of setae in the dorsal subapical region of the aedeagus (char. 17), and the presence of (ancestrally) outwardly directed, uncinate rami along the ostium of the aedeagus (char. 18). Additional homoplasious traits that characterize the genus include the "open" metatibial corbel (char. 12), the presence of a patch of suberect scales on the female elytral declivity (char. 15; reversed in the *A. sotomayorae-A. hadroprion* clade), and the subcontiguous collum and ramus of the spermatheca (char. 21). This redefinition of *Apotomoderes* is more comprehensive and also slightly more inclusive than Schoenherr's (1834) and Lacordaire's (1863b) generic concepts

(cf. Franz and Peet 2009), given that it includes one species – *A. anodontos* – which lacks the large profemoral tooth (char. 9) and elevated and toothed protibial ridge (chars. 10, 11) of the remaining species including *A. lateralis.* The unique combination of modifications of the rostrum, eyes, head (chars. 3–8; e.g. Fig. 13) are sufficient to separate the genus taxonomically from all other Caribbean entimine genera. The species of the *S. sotomayorae-S. hadroprion* are furthermore differentiated by posteriorly "tilted" eyes (char. 7), a strongly globular pronotum in males (char. 8), and projected anterior edges of the lamina of the sternum VIII in females (char. 20). The presumably youngest species in the Hennigian comb-shaped topology, *A. chariedris* and *A. hadroprion*, are externally very similar and only distinguished by features of the terminalia.

Although *Apotomoderes*, as presently redefined, is a readily recognizable and monophyletic group, its immediate relatives and tribal placements remain uncertain. The inferred phylogeny (Fig. 19) places the genus closer to other naupactine genera, i.e. *Artipus* and *Pantomorus* Schoenherr, than to examined members of the Geonemini (= current tribal placement *sensu* Alonso-Zarazaga and Lyal 1999) and Eustylini. Such a placement is also indicated when using Anderson's (2002) key to the North American genera of Entiminae. Nevertheless, our knowledge of the phylogenetic limits of these tribes is judged too incomplete and the available character support too weak to warrant a tribal reallocation of *Apotomoderes* at this time (see also Marvaldi 1997; Franz 2010; Franz and Girón 2009). Likewise, the



Figure 19. Phylogeny of the species of *Apotomoderes* and select outgroup taxa, according to the single most parsimonious cladogram (L=33, CI= 75, CI=90). Character 15 is mapped under ACCTRAN optimization, whereas character 16 is mapped under DELTRAN optimization. All other characters have unambiguous optimizations. Black rectangles represent single, non-homoplasious character state transformations, and white rectangles represent multiple, homoplasious character state transformations. The numbers above and below each rectangle correspond to character numbers and states, respectively; the numbers displayed at the left end of each branch represent Bremer support values.

herein presented phylogeny should not be interpreted as a strong hypothesis about the relationships among the outgroup taxa. In his recent review, Pérez-Gelabert (2008) lists more than 70 entimine species for Hispaniola; nevertheless the actual number of species may be twice as high based on the difficulty to identify dozens of species found on the island during a single field trip in 2008 (Charles W. O'Brien, personal communication). It is therefore likely that the closest relative to *Apotomoderes* remains undescribed. On the other hand, the outgroup selection is considered adequate for polarizing character states within *Apotomoderes* (Nixon and Carpenter 1993).

The distributions of A. anodontos and A. menocrater in the southwestern Dominican Republic on one side, and the A. lateralis-A. hadroprion clade in the eastern Dominican Republic on the other side (Fig. 18), are congruent with the geological separation of a (1) southern ("Tiburón") and (2) central (central + northern) peninsula constituting the paleoislands that make up Hispaniola (Iturralde-Vinent and MacPhee 1999). The two regions are separated by the Cul-de-sac Lake Enriquillo Valley (corresponding to the Muertos Trough), a very dry desert habitat that divides many components of the fauna of Hispaniola (e.g. Rosen 1985; Liebherr 1992; Liebherr and Godwin 2004). However, the age of origin of Apotomoderes is likely (much) younger than the Miocene collision of the southern and central/northern peninsulas (cf. Heubeck and Mann 1991). In particular, the A. sotomayorae / A. lateralis-A. hadroprion split (Fig. 20) suggests that all components of this clade are of late Miocene or early Pliocene origin (i.e. 5-7 mya), or possibly even younger, given that Mona Island rose above sea level at this stage (González et al. 1997). This would suggest that Apotomoderes originated and speciated some time in the Oligocene-Miocene on the southern Hispaniola peninsula, followed by two individual and unidirectional colonization events of the central/northern peninsula and of Mona Island, respectively. On the other hand, the presence of multiple, apparently sympatric species of Apotomoderes within each of the Hispaniolan areas of endemism cannot be explained with the scarce available information on habitat preferences and host plant associations.



Figure 20. Inferred taxon-area cladogram for *Apomotoderes*, with *Artipus floridanus* representing the outgroup area.

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Two new species of Aleocharinae (Coleoptera, Staphylinidae) found in fungus gardens of Odontotermes termites (Isoptera, Termitidae, Macrotermitinae) in Khao Yai National Park, Thailand

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Abstract

Discoxenus katayamai **sp. n.** and *Odontoxenus thailandicus* **sp. n.** are described from Khao Yai National Park, East Thailand. Both species were collected from nests of termite of the genus *Odontotermes* Holmgren, 1912. These are the first records of both genera from Thailand. *Discoxenus katayamai* is similar to *D. indicus* Wasmann, 1904, and *O. thailandicus* is similar to *O. butteri* (Wasmann, 1916). Each species is easily distinguished from their congeners by the body size, the number of the setae on the pronotum, elytra and abdomen and other characters discussed below.

Keywords

New species, *Odontotermes*, Compactopediina, Aleocharini, Pygostenini, *Discoxenus katayamai* sp. n., *Odontoxenus thailandicus* sp. n., termitophily

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Introduction

Many species of insects are known to be associated with termites, and especially with fungus-growing termites of the genus *Odontotermes* Holmgren, 1912, which is a host for various groups of termitophiles in their fungus gardens, e.g., beetles, flies and silverfish (Wasmann 1904, 1912, 1916; Kistner 1969). David H. Kistner investigated the termitophile fauna in Khao Yai National Park, Thailand, and reported some new species of staphylinid beetles (Kistner and Newton 1999; Jacobson and Kistner, 1999) and a few scuttle flies (Disney and Kistner 1997). However, no staphylinid beetles associated with *Odontotermes* termites have been reported from Thailand.

In 2007, the junior author and his colleagues investigated termitophilous insects in Khao Yai National Park, and they found several new species of termitophiles. Two of them are described new species of staphylinid beetles, one in the genus *Discoxenus* (Wasmann, 1904) belonging to the tribe Aleocharini and one in *Odontoxenus* Kistner, 1958 belonging to the tribe Pygostenini. All the specimens were found in fungus gardens of *Odontotermes* termites; both genera have not been previously known from Thailand.

The genus *Discoxenus* was described by Wasmann (1904) to accommodate two species from India. Later Wasmann (1916) described two species from Sri Lanka. Kistner (1975) revised the genus and added three species from India, Malaysia and Myanmar. Thus, seven *Discoxenus* species have been known in the Oriental Region.

The genus *Odontoxenus* was established by Kistner (1958) for 12 species originally described as the members of *Doryloxenus* Wasmann, 1898 by Wasmann (1904, 1916), Cameron (1926, 1932), Kemner (1929), and as *Mimocete* Fauvel, 1899 by Fauvel (1899). Later, Jacobson and Kistner (1975a) added one species and Jacobson and Kistner (1975b) reviewed the genus. Later, Kistner (2005) described one new species from Malaysia. Up to now, 14 species have been described from India, Sri Lanka, Indonesia and Malaysia.

Material and methods

The field research was conducted in 2007, by M. Maruyama, Yûji Katayama and Takashi Komatsu in Khao Yai National Park, 30 km northeast of Bangkok. The fungus garden was carefully removed from the nest and crushed little by little on a white plastic tray to find symbiotic insects. The insects were observed and photographed on fragments of the fungus garden. They were finally put in 2 ml vials with 80% ethanol.

The technical procedures used here are generally as described in Maruyama (2006). Measurements are all in millimeters with averages and standard variations in parentheses.

Number of macrosetae is confined to both sides of the body, except for that of tergite IX on one side of the body.

Habitus photographs were taken with Microptics system and merged with the automontage software CombineZM.

The symbiotic termite was identified by Yoko Takematsu. However, the current taxonomic status of the genus *Odontotermes* is still not settled, and the identification of the termite species in this paper is tentative (Takematsu, personal communication).

Holotypes and most of the paratypes of new species are deposited in the Kyushu University Museum (KUM), and some of paratypes are deposited in the National Park, Wildlife and Plant Conservation Department, Thailand (DNP).

Taxonomy

Genus Discoxenus Wasmann

Wasmann 1904: 655 (original description); Kistner 1982: 165 (revision).

Comments. This genus is similar to *Compactopedia* Kistner, 1970, associated with termites of the genus *Longipeditermes* Haviland, 1898 in Malaysia, from which *Discoxenus* is distinguished by the body being smaller, the antennae being thicker and the tarsal formula 4-4-5 (Kistner 1982). It is new record from Thailand.

Discoxenus katayamai Kanao & Maruyama, sp. n.

urn:lsid:zoobank.org:act:CE782948-FE3C-4809-B2F2-CA09C7196C2A Figs 1, 2, 5C

Type series: Holotype: ♂, "Thai: Nakhon Nayok, Khao Yai National Park, Mo Sing To (700 m alt.), 26 IX 2007, Maruyama M. and Katayama Y. leg. // Holotype *Discox*enus katayamai des. Kanao & Maruyama, 2010", abdomen dissected and mounted in Euparal (KUM). Palatypes: 2♀, 23 sex?, same data as holotype; 8 sex?, ditto, but 28 IX 2007 (KUM, DNP).

Symbiotic host: Odontotermes proformosanus Ahmad, 1965.

Etymology: Dedicated to Y. Katayama, a collector of the type series.

Diagnosis. This species is similar to *D. indicus* through the shape of the median lobe of the aedeagus, but may be distinguished from it by the shorter body and by the number of setae on tergites III and IV, six setae on each. The smallest species of the genus.

Description. Body (Figs 1A–1B) almost uniformly orange brown, but antennae and elytra slightly darker, apical segments of antennae lighter than middle segments. Dorsal surfaces of pronotum, elytra and abdomen (Fig. 1A) smooth, glossy; elytra and abdomen (Figs 1A–1B, 2B) sparsely covered with long yellow setae. Pronotum (Figs 1A, 2A) moderately covered with macrosetae. Antennae (Figs 1A–1B) with segment I much longer than wide; segment II reduced; segment III–VII transverse; segment VIII–X subquadrate; segment XI conical, twice as long



Figure 1. Habitus of *Discoxenus katayamai*. A dorsal view and B ventral view.

as wide, blunt at apex. Elytron (Fig. 2B) 2/3 as long as pronotum, with a row of 4 macrosetae, about 10 setae on lateral margin, and with 10–11 macrosetae and about 30 setae on dorsal surface. Abdominal tergite VIII (Fig. 2C) with 4 pairs of macrosetae along lateral margins and 14–15 pairs of setae on dorsal surface; macrochaetotaxy of abdominal tergites II–VIII: 0, 6, 6 (7), 6, 6, 6, 8; each sternite (Fig. 1B) with macrosetae on posterior marginal row. Median lobe of aedeagus elongate (Fig. 2D); apical lobe slightly curved paramerally; distal crest well produce. Spermatheca (Fig. 2E) with apical part swollen, its inner wall densely wrinkled from apex to around apical 3/5 of its length; basal part twice as long as apical part and slightly curved near apex.

Measurements. Body length: ca. 1.8–2.2; pronotal length: 0.41–0.56 (0.46±0.053); pronotal width: 0.70–0.82 (0.75±0.046); antennal length: 0.54–0.65 (0.62±0.045). N=10.



Figure 2. *Discoxenus katayamai*. **A** pronotum **B** elytron **C** abdominal tergite VIII **D** median lobe of aedeagus, in lateral view, and **E** spermatheca.

Genus Odontoxenus Kistner

Kistner 1958: 104 (original description); Jacobson and Kistner 1975: 293 (key, diagnosis).

Comments. This genus in general appearance and body size is similar to *Doryloxenus* among the Asian genera of Pygostenini, but distinguished from it by the shape and position of eyes having part of their surface on the anterior margin of the head, the relatively long mesosternum, and the reduced 4-segmented tarsi (Jacobson and Kistner 1975).

Odontoxenus thailandicus Kanao & Maruyama, sp. n. urn:lsid:zoobank.org:act:EF7AED85-A974-4EE3-9144-D5B6B6BDE487 Figs 3, 4, 5D

Type series. Holotype: ♂, "Thai: Nakhon Nayok, Khao Yai National Park, Mo Sing To (700 m alt.), 28 IX 2007, Maruyama M. and Katayama Y. leg. // Holotype *Odon*-



Figure 3. Habitus of *Odontoxenus thailandicus*. A dorsal view and B lateral view.

toxenus thailandicus des. Kanao & Maruyama, 2010". Palatypes: $2\stackrel{\bigcirc}{\rightarrow}$, same data as holotype; $2\stackrel{\bigcirc}{\rightarrow}$, $2\stackrel{\bigcirc}{\rightarrow}$, ditto, but 26 IX 2007.

Symbiotic host: Odontotermes proformosanus Ahmad, 1965

Etymology. Named after the type locality.

Diagnosis. Most similar to *O. butteri* (Wasmann, 1916) and *O. malaysianus* Kistner, 2005 through the pronotum with a row of macrosetae at the lateral margin, but distinguished from them by the macrochaetotaxy of the tergites II–VIII: 0, 2, 2, 2, 4, 6, 8.

Description. Body (Figs 3A–3B) almost uniformly reddish brown; head and elytra slightly darker. Dorsal surfaces of head, pronotum and elytra (Fig. 3A) smooth, glossy and glabrous. Head to elytra (Fig. 3B) well convex, laterally curved in shape of half cir-



Figure 4. *Odontoxenus thailandicus.* **A** elytron **B** pronotum **C** male abdominal tergite VIII **D** male abdominal sternite VIII **E** male abdominal tergite IV & V **F** female abdominal tergite VIII **G** median lobe of aedeagus, and **H** spermatheca.

cle. Pronotum (Figs 3A–3B, 4B) much narrower than elytra, with a row of 5 macrosetae on lateral margin. Elytra (Figs 3A–3B, 4A) with inflexed lateral margins, and about 10 macrosetae on lateral margins. Macrochaetotaxy of abdominal tergites II–VIII: 0, 2, 2, 2, 4, 6, 8; male abdominal tergite VIII (Fig. 4C) slightly truncate at apex and slightly wrinkled on dorsal surface, with 3 pairs of macrosetae near apex (1 laterally, 2 dorsally), and with 1 pair of flattened setae at apex; sternite VIII (Fig. 4D) with 2 pairs of macrosetae on dorsal surface and 3 pairs at apex; female tergite VIII (Fig. 4F) with basal projections and macrosetae shorter than in male. Tergite IX (Fig. 4E) with 7 pairs of macrosetae laterally; tergite X (Fig. 4E) with 3 macrosetae around middle and 2 pairs of macrosetae at apex. Median lobe of aedeagus (Fig. 4G) with apical lobe almost straight, much narrower than basal capsule; copulatory piece membranous; basal capsule swollen, half as long as apical lobe. Spermatheca (Fig. 4H) curved twice, S-shaped; apical part swollen, its inner wall hollowed at apex, densely wrinkled from apex to around apical 1/3; basal part 2.5 times as long as apical part, roundly curved around basal 1/3 and gently curved around apex.



Figure 5. A Odontotermes proformosana, queen, workers and soldiers B the fungus garden of O. proformosana C Discoxenus katayamai, on fungus garden D Odontoxenus thailandicus, on fungus garden. Photos © Y. Katayama (5A–5B), T. Komatsu (5C–5D), 2007.

Measurements. Body length: ca. 1.7–2.0; pronotal length: 0.44–0.51 (0.47±0.031); pronotal width: 0.64–0.73 (0.68±0.037); antennal length: 0.29–0.30 (0.30±0.012). N=5.

Biological notes

These new species were found in the fungus gardens of *Odontotermes proformosanus* (Figs 5A–5B). The scuttle flies *Clitelloxenus perdosetae* Disney, 1997, *C. thailandae* Disney, 1997, *Franssenia* sp., *Crasilla* sp. and *Dicranopteron* sp. were also caught at the same time. The individual number of each species was very low, compared to *D. malaysianus* collected in a high number from a few *Odonototermes* Holmgren, 1912 nests in Malaysia (Kistner 1982). Only a few specimens of *D. katayamai* (Fig. 5C) were found in one nest, which generally contained one to ten, fist-sized fungus gardens, and none or one specimen of *O. thailandicus* was found in one nest, though density of the host termites was very high at Mo Sing To, the type locality of the present new species. The behavior of *D. katayamai* was almost the same as it was reported for *D. malaysiensis* by Kistner (1982). The behavior of *O. thailandicus*

(Fig. 5D) was similar to that of *D. katayamai*, but it moved much slower than *D. katayamai* and it often stopped.

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RESEARCH ARTICLE



A new genus and species of Acaenitini (Hymenoptera, Ichneumonidae, Acaenitinae) from China

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turn:lsid:zoobank.org:author:3C0EBDB7-26F7-469B-8DB1-5C7B1C6D9B89 turn:lsid:zoobank.org:author:974C0354-6118-4EA9-890F-EF5ECE8F257A

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Abstract

Dentifemura Sheng & Sun, **gen. n.** and *Dentifemura maculata* Sheng & Sun, **sp. n.** belonging to tribe Acaenitini of subfamily Acaenitinae (Hymenoptera: Ichneumonidae), collected from Jiangxi Province, China, are described.

Keywords

Dentifemura, new genus, new species, taxonomy, China

Introduction

In the genera of Ichneumonidae (Townes 1971), the subfamily Acaenitinae, family Ichneumonidae (Hymenoptera), comprises two tribes, Acaenitini and Coleocentrini. Wahl and Gauld (1998) suggested "that use of the two tribes be discontinued", but the catalogue of Yu et al. (2005) follows Townes's treatment, again with two tribes. The tribe Acaenitini comprises nineteen genera (Townes 1971, Yu et al. 2005). Rather little is known about the biology of Acaenitini. Shaw and Wahl (1989) reported that *Acaeni*-

tus dubitator (Panzer) is a koinobiont endoparasitoid of the larva of an endophytic beetle, *Cleonis piger* (Scopoli) (Curculionidae).

Eleven genera of Acaenitini have been reported in China (Sheng and Sun 2009, 2010). The hosts of Acaenitini known in China (Sheng and Sun 2009, 2010) are: *Eriotremex formosanus* (Matsumura) (Hymenoptera: Siricidae), the woodborer of *Castanopsis fabri* Hance (Fagaceae) in Jiangxi Province; *Dendroctonus valens* LeConte (Coleoptera: Scolytidae), the woodborer of *Pinus tabulaeformis* Carr. (Pinaceae) in Henan Province; *Rhyncolus* sp. (Coleoptera: Curculionidae), with larvae in dead wood of *Quercus liaotungensis* Koidz. (Fagaceae) in Liaoning Province, is a new host record for *Jezarotes levis* Sheng, 1999.

In this article, one new genus and its type species, collected in Quannan County, Jiangxi Province, China, are described. Type specimens are deposited in the Insect Museum, General Station of Forest Pest Management, State Forestry Administration, People's Republic of China.

The morphological terminology is mostly that of Gauld (1991). Wing vein nomenclature is based on Ross (1936) and the terminology on Mason (1986, 1990).

Dentifemura Sheng & Sun, gen. n.

urn:lsid:zoobank.org:act:C7C1382E-22D0-4793-AF67-6AC56E3150F4

Type species: Dentifemura maculata Sheng & Sun, sp. n.

Etymology. The name of the new genus is based on the large tooth on the ventral side of the hind femur. The gender is feminine.

Description. Fore wing length 9.6 to 10.5 mm. Clypeal suture very weak. Clypeus flat, apical median portion concave, apical margin thin. Lower tooth of mandible as long as or slightly longer than upper tooth. Labrum crescentic, 0.4 to 0.5 as long as wide. Maxillary palps with evenly distributed hairs. Third segment of maxillary palp gradually expanded apically, its apical truncation strongly oblique (Figure 3). Malar space distinctly longer than basal width of mandible. Pedicel relatively long, shortest side approximately as long as widest diameter. Occipital carina complete. Without epomia. Areolet absent. Fore wing vein 2*rs-m* basad of 2*m-cu*. Ventral profile of hind femur with a strong blunt tooth on hind 0.25. Inner sides of front and middle claws with acute accessory tooth. Hind claws simple. Propodeum evenly sloping from anterior transverse carina to apex, without posterior transverse carina. First tergum evenly and slightly narrowed toward base. First sternite evenly convex sub-basally, with a few erect hairs. Ovipositor sheath about 0.33 times as long as fore wing.

Remarks. This new genus is similar to *Jezarotes* Uchida and *Ishigakia* Uchida and can be distinguished from *Jezarotes* in lacking a subapical, strong transverse ridge on the clypeus; the upper tooth of the mandible as long as or slightly shorter than the lower tooth; the median lobe of the mesoscutum is vertical in front; and fore wing vein 2*rs-m* is basad of 2*m-cu*. In *Jezarotes*, the clypeus has a strong, transverse subapical ridge; the upper tooth of the mandible is very small; the median lobe of the mesoscutum strongly projects forward;

and fore wing vein 2*rs-m* is distad of 2*m-cu*. The new genus can be distinguished from *Ishi-gakia* by the position of fore wing vein 2*rs-m* (basad of vein 2*m-cu* in *Dentifemura* gen. n., far distad in *Ishigakia*) and the presence of a conspicuous ventral tooth on the hind femur in *Dentifemura* gen. n.

In Townes's (1971) key to genera, the new genus can be inserted as follows:

5.	Clypeus without a transverse ridge or carina next to apex, its apical half rather
	flat and apical margin thin. Fore wing vein 2rs-m [intercubitus] far distad of
	2m-cu [second recurrent vein] (distad by about its length). Oriental Region
	Ishigakia
_	Clypeus with a strong transverse preapical ridge that gives its apex a chopped-off
	appearance; if without such a transverse ridge, fore wing vein 2rs-m basad of 2m-
	<i>cu</i> ; 2 <i>rs-m</i> opposite 2 <i>m-cu</i> or a little basad or distad 5'
5'.	Clypeus without a transverse ridge or carina next to apex. Fore wing vein 2rs-m
	basad of 2 <i>m-cu</i> . Oriental Region (China)Dentifemura
_	Clypeus with a strong transverse preapical ridge. Fore wing vein 2rs-m opposite
	<i>2m-cu</i> or distad 6

Dentifemura maculata Sheng & Sun, sp. n.

urn:lsid:zoobank.org:act:E6A590FE-B8F5-4DE3-AFE7-C96528EC196A Figures 1–7

Etymology. The name of the new species is based on the body colour, which is yellowish brown with black flecks.

Type material. *Holotype*, female, CHINA: Quannan County, 530m, Jiangxi Province, 10 June 2008, leg. SHI-CHANG LI. *Paratype*: female, CHINA: Quannan County, 470m, Jiangxi Province, 12 May 2008, leg. SHI-CHANG LI.

Description. Female. Body length 10.2 to 11.5 mm. Fore wing length 9.6 to 10.5 mm. Ovipositor length 3.3 to 3.5 mm.

Head. Face 1.5 to 1.7 times as wide as long, with dense punctures (Figure 2), median portion convex, upper portion with a median longitudinal carina, reaching to middle ocellus. Clypeal foveae circular. Clypeal suture vestigial between clypeal foveae. Clypeus nearly flat, basal portion with punctures sparser than on face, apical portion smooth and impunctate, apical median portion narrowly concave, apical margin thin. Labrum crescentic, 0.42 to 0.45 as long as wide. Mandible with fine and dense longitudinal lines and unclear fine punctures, lower tooth slightly longer than upper tooth. Cheek with punctures sparser than on face. Malar space 1.18 to 1.23 times as long as basal width of mandible. Subocular sulcus distinct. Gena glossy, with distinct punctures, but gradually finer and more sparsely punctate towards upper portion, in lateral view approximately 0.7 times as long as width of eye, evenly convergent backward. Vertex (Figure 4) with punctures. Lateral margin of lateral ocellus concave. Interocellar area with fine and indistinct punctures. Postero-ocellar line approximately as long as



Figures 1–7. *Dentifemura maculata* Sheng & Sun, gen. and sp. n., \bigcirc , holotype. **I** Body, lateral view **2** Face **3** Second to fifth segments of maxillary palpus (arrow indicates the third segment) **4** Vertex **5** Mesoscutum **6** Propodeum **7** Apical portion of ovipositor.

ocular-ocellar line. Frons deeply concave, but laterally more convex, with dense punctures except medially smooth. Antenna length 6.5 to 6.8 mm. Scape slightly wider apically, apical truncation about 40 degrees from transverse. Shortest length of pedicel approximately as long as widest diameter. Antenna with 22 to 23 flagellomeres, ratio of length of flagellomere 1:2:3:4:5 is 5.0:4.5:4.3:4.0:3.7. Occipital carina complete, medially evenly arched upward.

Mesosoma. Pronotum glossy, anterior portion with sparse punctures, apical margin slightly protruding and longitudinally ridge-shaped, laterally concave with distinct transverse wrinkles, upper posterior portion with distinct punctures, distance between punctures 0.2 to 0.5 times diameter of puncture. Without epomia. Mesoscutum with dense punctures (Figure 5), front portion of median lobe vertical, posterior portion with a short median longitudinal carina. Notaulus very strong, almost reaching to posterior margin of mesoscutum. Scutoscutellar groove with longitudinal wrinkles. Scutellum weakly convex, with sparse and fine punctures, distance between punctures 0.5 to 2.0 times diameter of puncture. Postscutellum smooth, evenly oblique posteriorly, anterior-lateral portion deeply concave. Upper portion of mesopleuron including speculum smooth; lower portion, anterior portion and subtegular ridge with dense and distinct punctures. Without mesopleural fovea. Prepectal carina strong, upper end reaching to mid-height of front margin of mesopleuron. Mesosternum with dense punctures, but comparatively finer than on mesopleuron. Metapleuron smooth, with sparse and fine punctures, distance between punctures 1.0 to 2.0 times diameter of puncture. Juxtacoxal carina absent. Submetapleural carina complete. Wing brownish hyaline. Fore wing vein 1cu-a basad of 1-M, distance between them about 0.3 to 0.4 times length of 1cu-a. Areolet absent. Vein 2rs-m basad of 2m-cu, distance between them approximately as long as or slightly longer than width of vein. Vein 2-Cu approximately as long as 2cu-a. Hind wing vein 1-cu slightly shorter than cu-a. Legs stout. Ventral profile of hind femur with a strong blunt tooth on hind 0.25. Fourth segment of tarsus very short, in lateral view of hind tarsi, ratio of length of tarsomere 1:2:3:4:5 is 12.0:4.3:4.0:3.0:9.0. Inner sides of front and middle claws with an acute accessory tooth. Hind claws simple. Propodeum (Figure 6) with distinct punctures except apico-median portion polished, with distinct anterior transverse carina, lateral carina of area basalis and lateral longitudinal carina. Area basalis wider than long. Propodeal spiracle obliquely elliptical, approximately 1.6 times as long as maximum width.

Metasoma. First tergum 1.9 to 2.0 times as long as apical width, evenly and slightly narrowed toward base, with sparse and fine punctures. Median dorsal carina slightly longer than sternite. Dorsolateral carinae indistinct. Ventrolateral carinae complete. Spiracle transversely elliptical, located slightly anterior of middle. Second and following terga with very sparse and fine punctures, gradually weaker and indistinct. Second tergum approximately 0.5 times as long as apical width. Fourth to sixth terga expanded. Posterior median portions of sixth and seventh terga weakly sclerotized. Apex of hypopygium reaching to or slightly projecting beyond tip of metasoma. Cercus almost reaching to tip of eighth tergum. Ovipositor sheath 1.1 to 1.2 times as long as hind tibia. Ovipositor slightly compressed, apical portion with 4 weak and unclear teeth.

Colour (Figure 1). Yellowish brown. Antenna dark brown, scape and dorsal profile of pedicel blackish brown. Dorsal and ventral profiles of front and middle femora and tibiae and tarsi more or less dark brown. Apical portions of front and middle femora, longitudinal line on dorsal profile of hind coxa and small fleck on ventral profile, basal portions of

trochanters, basal portion of hind femur and two longitudinal lines on dorsal and ventral profiles brownish black. Hind tibia reddish brown, tarsus dark brown. Median portion of occipital carina, longitudinal flecks on median and lateral lobes of mesoscutum, scutoscutellar groove, basal margin of propodeum, oblique longitudinal fleck of first tergum and basal transverse bands of second and third terga black. Apical margin of third tergum, basal and apical median portion of fourth to sixth terga, and median transverse band of seventh tergum dark brown. Fore wing with stigma brown, veins brownish black.

Remarks. *Dentifemura* can be recognised by the following combination of characters. The clypeus lacks a transverse ridge or carina next to the apex. The lower tooth of the mandible is slightly longer than the upper tooth. The malar space is about 1.2 times as long as the basal width of the mandible. The third segment of the maxillary palp is gradually expanded apically, its apical truncation strongly oblique. Fore wing vein 2rs-m is basad of 2m-cu. In ventral profile, the hind femur has a strong, blunt tooth on the hind 0.25. The fourth tarsomere is very short. On the propodeum, only the anterior transverse carina, the lateral carina of the area basalis and the lateral longitudinal carina are distinct.

Biology. Unknown.

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