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Generic changes in the stag beetle tribe Aesalini (Coleoptera: Lucanidae: Aesalinae) with the description of two new species

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Generic changes in the stag beetle tribe Aesalini (Coleoptera: Lucanidae: Aesalinae) with the description of two new species

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Abstract. The status of genera and species in the stag beetle tribe Aesalini (Coleoptera: Lucanidae: Aesalinae) is revised. The Asian subgenus *Zelenkaesalus* Krikken, formerly included within *Echinoaesalus* Zelenka, is elevated to generic level based on the presence of complete ventral sulci and the form of the ocular canthus. This results in the following **new combinations**: *Z. cechovskyi* (Huang et al.), *Z. gedeensis* (Huang and Wu), *Z. javanus* (Krikken), *Z. sabahensis* (Zelenka), and *Z. timidus* (Krikken). *Zelenkaesalus pazuzus* Paulsen, **new species**, is described from the Philippines and is the first record of the subfamily for the country. A **new genus** *Strabaesalus* is created for species of *Echinoaesalus* that have a narrow dorsal lobe of the eye, acuminate clypeus, and lack abdominal sulci. This results in the following **new combinations**: *S. borneoensis* (Huang and Imura), *S. hidakai* (Araya et al.), and *S. schuhi* (Zelenka). In the Americas, *Trogellus trajectus* Paulsen, **new species**, is described from southern Panama. The male habitus and male genitalia of *Trogellus maesi* Paulsen are illustrated for the first time.

Key words. Taxonomy, aesaline, Philippines, Nicaragua, *Aesalus*.

Introduction

The tribe Aesalini (Coleoptera: Lucanidae: Aesalinae**)** includes five genera and forty species of small, convex and atypical stag beetles that are frequently overlooked and rarely collected. The tribe is distributed in Europe, Asia, and the Americas (Paulsen 2013; Huang and Chen 2017). Until 1974, only five valid species were known, but since that time new species have been routinely discovered. The best methods of finding these beetles are with flight intercept traps, beating dead branches, or careful inspection of suitable logs in montane habitats.

Historically most of the earliest described species in the tribe were placed in the genus *Aesalus* Fabricius. Advances in the taxonomy of the group led to the subsequent recognition of the genera *Lucanobium* Howden and Lawrence, 1974, *Echinoaesalus* Zelenka, 1993, *Trogellus* Paulsen, 2013, and *Himaloaesalus* Huang and Chen, 2013. Paulsen (2013) and Huang and Chen (2017) discussed the extreme variation present within the generic concept for *Echinoaesalus*, with species groups differing in several morphological characters that are typically of generic importance within the subfamily. In this paper these groups are raised to constitute three distinct genera with strong morphological support.

New aesaline species are described from the Philippines, the first member of the subfamily known from the country, and Panama. Finally, the male of the Nicaraguan species *Trogellus maesi* Paulsen is illustrated for the first time.

Materials and Methods

Specimens and taxonomic material. The following institutions and private collections provided specimens or are designated as the repository for specimens examined in this study.

FSCA Florida State Collection of Arthropods, Gainesville, FL, USA (P. Skelley)
KSEM University of Kansas, Snow Entomological Museum, Lawrence, KS, USA (Z. Falin)
MJPC M.J. Paulsen Collection, Lincoln, NE, USA

Taxonomic Treatment

Aesalini MacLeay, 1819

Echinoaesalus Zelenka, 1993

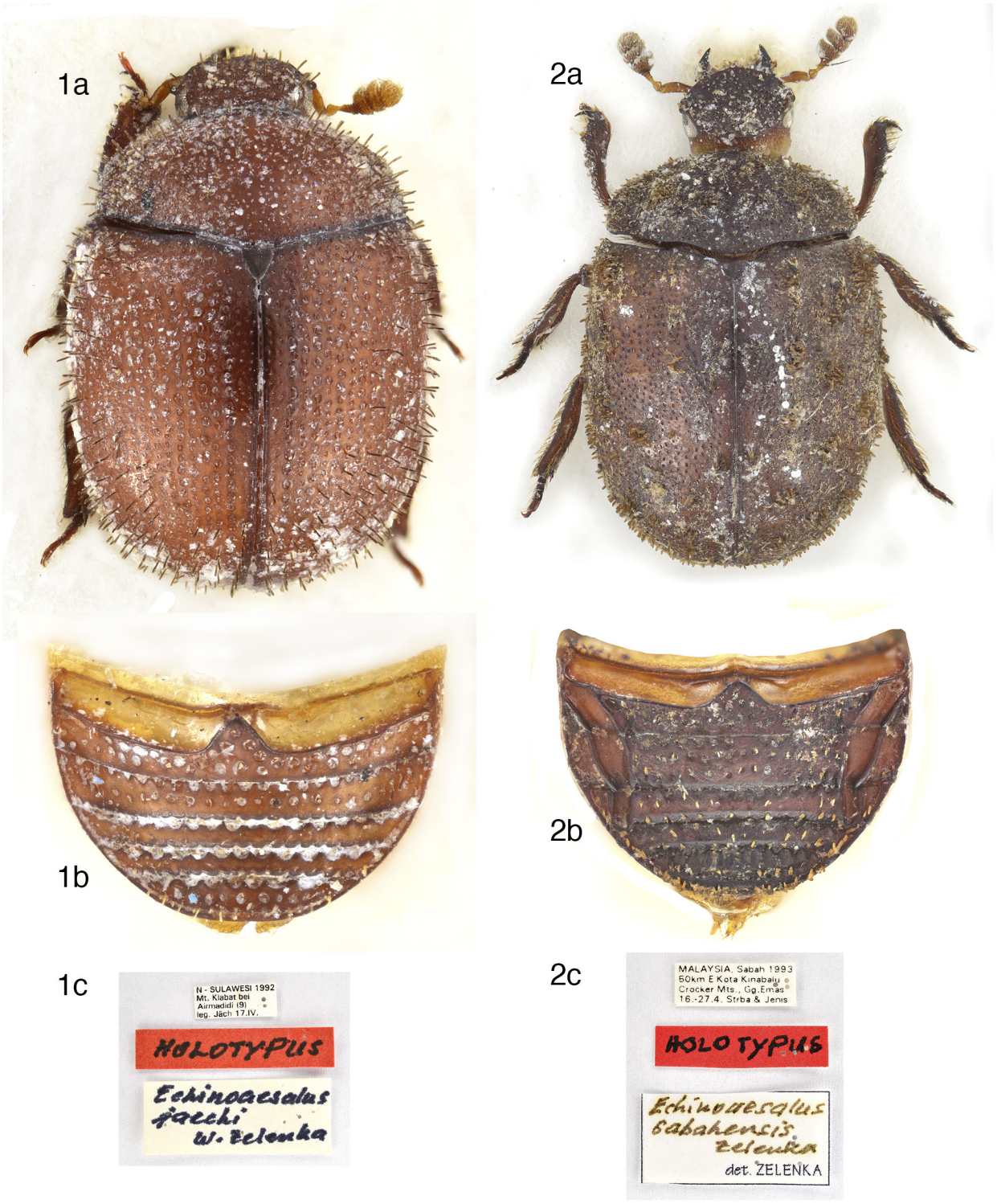
Type species. *Aesalus jaechi* Zelenka.

The first aesaline from Southeast Asia was described by Krikken (1975). The years 1993 and 1994 were extremely active for species for the region, as Araya (1993), Araya et al. (1993), and Araya et al. (1994) named new species. At the same time, Zelenka (1993) created the subgenus *Echinoaesalus* to accommodate three species of *Aesalus* from Southeast Asia, including two new species and *A. timidus* Krikken. The new genus was differentiated from *Aesalus* based on the species' convex form, protibiae with three teeth and lacking other minute serrations, middle and hind legs lacking strong external teeth, and lack of sexual dimorphism in the mandibles. Zelenka (1993) also discussed the presence of weak depressions or complete sulci on the abdomen to receive the hind legs. However, two of the three species he included in *Echinoaesalus*, including the type species *A. jaechi* Zelenka (Fig. 1), have the venter more or less unmodified and do not possess complete sulci (Fig. 2). Zelenka (1994) added two more new species and transferred *A. hidakai* Araya et al. to the genus while removing the presence of ventral depressions or sulci on the abdomen from the generic description (indicating that they could be absent or distinct). Later, Krikken (2008) created the subgenus *Zelenkaesalus* for *A. timidus* (type species), *E. sabahensis* Zelenka (Fig. 3), and one new species, uniting them for their distinctive, complete ventral sulci (Fig. 4). Huang et al. (2011) described three new species from Borneo and Java, and included a key to the twelve species of *Echinoaesalus* then known. Huang and Chen (2015) described a new species from Taiwan. Huang et al. (2015) described one new Malaysian species and elevated *E. borneoensis* Huang and Imura to specific status.

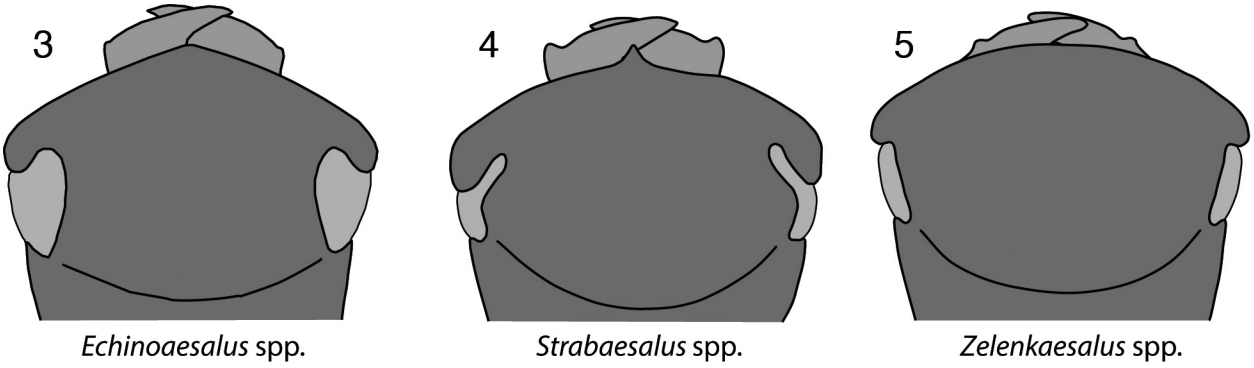
Huang and Chen (2017) noted that *Echinoaesalus* was a composite of three disparate groups based on characters of the vestiture and female genitalia, but they refrained from formalizing these groups due to their inability to study the type species, *E. jaechi*. Instead they characterized the three groups as the matsuii group, hidakai group, and subgenus *Zelenkaesalus*. The characters separating these groups are robust and typically used to separate genera within Aesalini (Table 1). For this reason, after examination of detailed images of the Zelenka types in Vienna the three groups can be formally recognized as genera.

Table 1. Generic characters of groups previously comprising *Echinoaesalus* Zelenka.

Genus	Vestiture	Ocular canthus	Thoracic sulci	Abdominal sulci
Echinoaesalus (matsuii group of Huang and Chen 2017)	All stick-like, scattered	Strongly intruding; dorsal lobe of eye large (Fig. 3)	Short, longitudinal	Absent (Fig. 1b)
Strabaesalus (hidakai group of Huang and Chen 2017)	Some scale-like, clumped	Strongly intruding; dorsal lobe of eye narrow (Fig. 4)	Short, transverse	Absent
Zelenkaesalus	Some scale-like, clumped	Almost obsolete; eye without distinct dorsal lobe (Fig. 5)	Complete (leg-shaped)	Complete (leg-shaped; Fig. 2b)



Figures 1–2. Zelenka holotypes. **1)** Holotype of *Echinoaesalus jaechi* Zelenka. **a)** Dorsal habitus. **b)** Abdomen, ventral view. **c)** Labels. **2)** Holotype female of *Echinoaesalus sabahensis* Zelenka. **a)** Dorsal habitus. **b)** Abdomen, ventral view, showing complete leg-shaped sulci. **c)** Labels. Photos courtesy H. Schillhammer (Naturhistorisches Museum, Vienna).



Figures 3–5. Generic differences of ocular canthus/eye and clypeal apex. **3)** *Echinoaesalus* spp. **4)** *Strabaesalus* spp. **5)** *Zelenkaesalus* spp.

Echinoaesalus Zelenka (matsuii group of Huang and Chen 2017) is restricted to the following seven species:

E. arayai Huang and Imura	MALAYSIA: Sabah (Borneo)
E. barriesi Zelenka	INDONESIA: Sumatra
E. chungi Huang and Chen	TAIWAN
E. dharma (Araya et al.)	THAILAND
E. jaechi Zelenka	INDONESIA: Sulawesi
E. matsuii (Araya)	MALAYSIA: Pahang
E. yongi (Araya)	MALAYSIA: Selangor

Among Southeast Asian taxa the genus *Echinoaesalus* can be distinguished easily by the scattered, stick-like bristles on the elytra (Fig. 1a; clumps of broad scales are absent). The ventral surface is relatively unmodified and lacks the complete sulci to receive the middle or hindlegs found in *Zelenkaesalus*. Instead the metasternum has only a short, longitudinal pit laterally (that may receive the tarsi only), and the abdomen is unmodified (Fig. 1b). The ocular canthus is long and the eye has a large, ovoid, dorsal portion that cannot be obscured by the pronotum (Fig. 3). The clypeus is more or less triangular but not distinctly acuminate medially (Fig. 3).

Strabaesalus Paulsen, new genus

Type species. *Echinoaesalus borneoensis* Huang and Imura, here designated.

Strabaesalus Paulsen, new genus, (hidakai group of Huang and Chen 2017) contains the following 3 species:

S. borneoensis (Huang and Imura), n. comb.	MALAYSIA: Sabah (Borneo), Kelantan
S. hidakai (Araya et al.), n. comb.	MALAYSIA: Pahang, Kelantan
S. schuhi (Zelenka), n. comb.	MALAYSIA: Pahang

The genus (see description below) can be distinguished by the ventral surface without complete sulci to receive the middle or hindlegs, metasternum with short, transverse pit laterally (that may receive the tarsi only), canthus long and the eye with a narrow dorsal lobe that cannot be obscured by the pronotum (Fig. 4), and clumped scales on elytra. The clypeus is triangular and the apex distinctly acuminate (Fig. 4).

Description. Coleoptera: Scarabaeoidea: Lucanidae: Aesalinae: Aesalini. **Length:** 4.0–4.5 mm. **Width:** 2.4–3.2 mm. **Color:** Body reddish brown to dark brown. **Vestiture:** Pronotum and elytra with 3 types: scattered, erect, slender bristles; stout, erect, scale-like bristles in clumps; and irregularly branched, tomentous scales covering surface. **Head:** Anterior margin of clypeus acutely triangular, occasionally

with apex tumid. Mentum narrowly rectangular in males, subquadrate in females, emarginate anteromedially in both sexes, deeply punctate. Eye canthus well developed (anterior margin of eye located on dorsal surface of head), form short and broad, creating a narrow dorsal lobe of the eye (Fig. 4). Antennal club composed of 3 antennomeres in both sexes; club strongly asymmetrical, entirely tomentose. Mandibles small in both sexes, not distinctly sexually dimorphic, approximately 1/3 length of head; form simply falcate, right mandible with 1 strong internal tooth, left mandible with 1 usually weakly indicated internal tooth; external margin with tooth-like projection at basal angle. Labrum concealed by mandibles when closed. **Pronotum:** Form convex. Surface punctate, punctures lacking anterior tubercles; numerous scattered erect bristles and 2 clumps of scales at either side of midline on disc. **Elytra:** Form strongly convex. Vestiture as above. **Mesosternum:** Mesosternal punctures oval, never lunate. **Abdomen:** Abdominal segments 1–2 appearing connate; punctures more elongate laterally. Abdominal segments 3–5 with broadly scalloped anterior margin. Abdominal punctures containing setae (not scales). **Legs:** Protibia broad, apex with spur minute; apical tooth large, curved, as long as the typical width of protibia; 2 small, external teeth extending ventrally from margin. Mesotibia with 2 minute, external teeth that are almost obsolete in both sexes. Metatibia lacking external teeth, apex sexually dimorphic (tumid in females vs. acutely dentate in males). **Male genitalia:** Parameres 1/2 to 1/3 as long as median lobe; median lobe cylindrical, elongate.

Remarks. Among the Southeast Asian fauna, species of this genus can be distinguished from *Zelenkaesalus* species by the lack of complete leg-shaped sulci ventrally. They can be distinguished from *Echinoaesalus* species by the narrow dorsal lobe of the eye and the pit behind the mesocoxae being transverse, not longitudinal.

Etymology. The name, gender masculine, is formed from the Latin 'strabus' = "squinting" and joined to the conventional generic name *Aesalus*, to denote the pinched quality of the dorsal lobe of the eye.

Zelenkaesalus Krikken, 2008

Type species. *Aesalus timidus* Krikken.

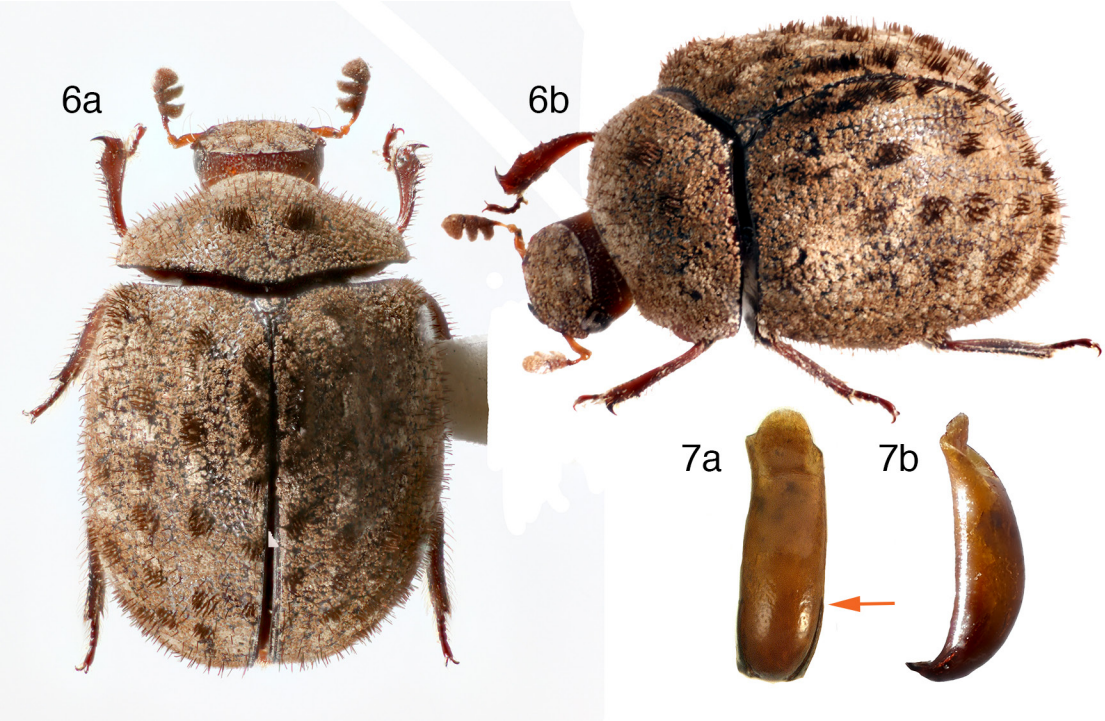
Zelenkaesalus Krikken is elevated to generic status and contains the following six species, five of which represent new combinations, and one of which is described herein:

Z. cechovskyi (Huang et al.), n. comb.	MALAYSIA: Johor; SINGAPORE
Z. gedeensis (Huang and Wu), n. comb.	INDONESIA: Java
Z. javanus (Krikken), n. comb.	INDONESIA: Java
Z. pazuzus Paulsen, n. sp.	PHILIPPINES: Luzon
Z. sabahensis (Zelenka), n. comb.	MALAYSIA: Sabah (Borneo)
Z. timidus (Krikken), n. comb.	INDONESIA: Borneo, Sumatra; MALAYSIA: Pahang, Perak; THAILAND

The genus is defined by the presence of well-developed sulci on the abdomen (Fig. 2b) and metasternum for receiving the entire tibia and tarsus. The canthus is short (Fig. 5) and the eye in dorsal view is almost entirely covered by the pronotum when the head is retracted. The dorsal vestiture includes clumped scales, scattered bristles, and a low covering of minutely branched scales as in *Trogellus* species (Paulsen 2013). The branched scales generally anchor a waxy exudate, unless abraded.

Zelenkaesalus pazuzus Paulsen, new species

Type material. Holotype male, ex MJPC, deposited at FSCA, labeled: a) "PHILIPPINES: Luzon: / Cagayan Valley: / Quirino (Sierra Madre) / XI.2012; local collector"; b) on red paper, "*Zelenkaesalus* / *pazuzus* / ♂ Paulsen / HOLOTYPE". Allotype female, ex MJPC, deposited at FSCA, labeled: a) "PHILIPPINES: Luzon: / Cagayan Valley: / Quirino (Sierra Madre) / IX.2015; local collector"; b) on red paper, "*Zelenkaesalus* / *pazuzus* / ♀ Paulsen / ALLOTYPE". Paratype female, MJPC, labeled: a) "PHILIPPINES:



Figures 6–7. *Zelenkaesalus pazuzus* Paulsen, new species. **6)** Habitus of paratype female. **a)** Dorsal. **b)** Oblique lateral. **7)** Genitalia of holotype male. **a)** Ventral view. **b)** Lateral view.

Luzon: / Cagayan Valley: / Quirino, Nagtipunan / VIII.2014; local coll."; b) on yellow paper, "*Zelenkaesalus* / *pazuzus* / ♀ Paulsen / PARATYPE" (Fig. 6).

Description. Holotype male. Coleoptera: Scarabaeoidea: Lucanidae: Aesalinae: Aesalini. **Length:** 4.3 mm. **Width:** 3.0 mm. **Color:** Surface dark reddish brown, where not abraded covered with whitish yellow branched scales and light brown, waxy exudate. **Head:** Canthus short, not dividing eye into dorsal lobe. Mentum transverse, setose, with deeply impressed, inverted U-shaped sulcus. Antennomere 3 elongate, 2 times as long as wide. **Pronotum:** Surface densely punctate; punctures moderate in size, bearing setae of two distinct types: stick-like bristles and broad scales; bristles as long as scutellum, scattered irregularly; scales forming two clumps on disc either side of median line. **Elytra:** Form strongly convex. Surface with irregularly scattered (not in rows) acute bristles as on pronotum, with pattern of several scale clumps on disc. **Legs:** Protibia with large, curved apical tooth and 2 minute teeth on external margin. Mesotibia lacking distinct external teeth, subserrate; apex strongly toothed. Metatibia lacking distinct external teeth; apex with small, acute apical tooth. **Venter/Abdomen:** Metasternum and abdominal sternites with complete tibial and tarsal sulci. **Male genitalia:** Parameres less than 1/3 as long as median lobe. Median lobe bulbous, cylindrical for most of length but flattened dorsoventrally before spatulate, less sclerotized apex (Fig. 7).

Description. Allotype female, paratype female (Fig. 6) differ from the holotype as follows. **Length:** 4.5–4.7 mm. **Width:** 3.1–3.2 mm. **Head:** Mentum subquadrate, less transverse. **Legs:** Mesotibia with 3–4 minute external teeth. Metatibia of with apex blunt, lacking acute tooth.

Remarks. The species appears to differ from other known *Zelenkaesalus* species in having only two clumps of dark scales on the pronotum, whereas all other species examined have a row of four clumps. The male genitalia are not as widened apically as in other members of the genus and are more apparently cylindrical, however this may be an artefact of the method of dissection resulting in the membranous structures not being fully everted.

Etymology. The name, used as a noun in apposition, is an attempt at Latinizing the name of the Assyro-Babylonian demon Pazuzu, king of the wind demons, that is prominently featured in the classic (and personally favorite) horror film, *The Exorcist*.

Distribution. PHILIPPINES: Luzon (Cagayan Valley): Quirino.

Trogellus Paulsen, 2013

Type species. *Trogellus herrmanni* Paulsen.

Paulsen (2013) created the genus *Trogellus* to accommodate ten species from Central America, eight of which were new, placing them into three subgenera. At that time the genus was known from northeastern Mexico to the Costa Rica/Panama border area. The discovery of three specimens from the Darién Gap region of Panama, representing a new species described below, advances the distribution of the genus to extreme eastern Panama only a few kilometers from Colombia. In addition, males of the species *T. maesi* Paulsen have been recently collected for the first time. This allows for the first illustration of the dorsal habitus of males as well as of the male genitalia.

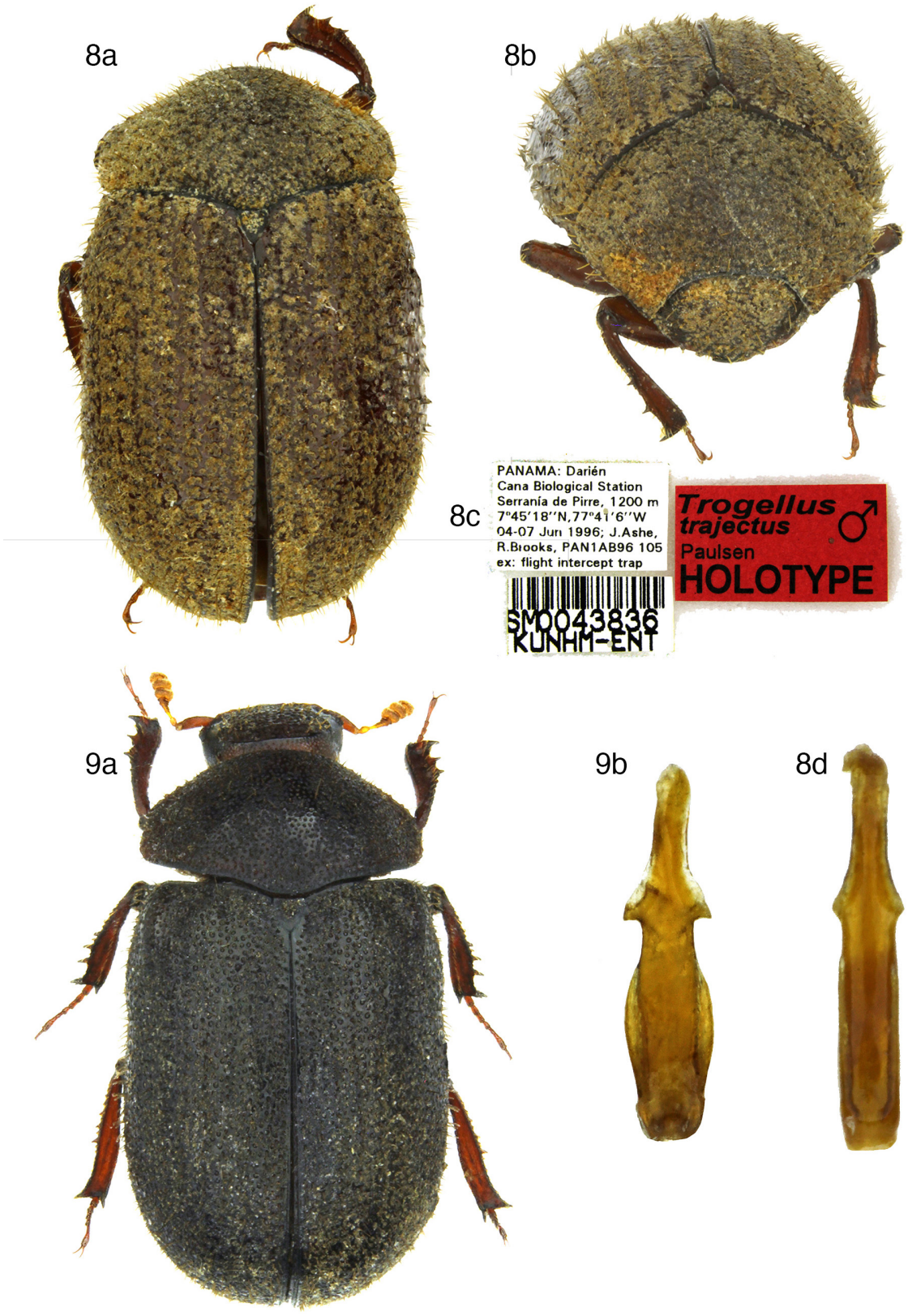
Trogellus (*Trogoides*) *trajectus* Paulsen, *new species*

Type material. Holotype male, KSEM, labeled: a) "PANAMA: Darién / Cana Biological Station / Serranía de Pirre, 1200 m / 7°45′18″N, 77°41′6″W / 04–07 Jun 1996; J. Ashe, / R. Brooks, PAN1AB96 105 / ex: flight intercept trap"; b) database label "SM0043836 / KUNHM–ENT"; c) on red paper, "*Trogellus* / *trajectus* Paulsen ♂ / HOLOTYPE". Allotype female, KSEM, labeled: a) "PANAMA: Darién / Cana Biological Station / Serranía de Pirre, 1200–1400 m / 7°45′18″N, 77°41′6″W / 05 Jun 1996; J. Ashe, / R. Brooks, PAN1AB96 043 / ex: fungusy log"; b) database label "SM0039755 / KUNHM–ENT"; c) on red paper, "*Trogellus* / *trajectus* Paulsen ♀ / ALLOTYPE". Paratype female, MJPC, labeled: a) as holotype; b) database label "SM0043845 / KUNHM–ENT"; c) on yellow paper, "*Trogellus* / *trajectus* Paulsen ♀ / PARATYPE".

Description. Holotype male (Fig. 8). **Length:** 4.5 mm. **Width:** 2.4 mm. **Color:** Everywhere dark reddish brown. **Vestiture:** Dorsally scales consisting of two types: erect bristles and brownish gray tomentosity (obscuring color of integument). **Head:** Canthus long (reaching pronotum when head retracted) and broad. Eye dorsally narrowed. Clypeus triangular, apex not distinctly produced. Mentum bifoveate. Mandibles weakly dentate externally at basal angulation. **Pronotum:** Surface densely punctate, some punctures with erect bristles (lacking distinct tubercle), remaining punctures obscured by tomentous scales. **Metasternum:** Punctures anterolaterally large in size. **Elytra:** Surface everywhere with moderate punctures obscured by tomentous scales, and with rows of moderate punctures with blunt bristles and a shiny tubercle anteriorly; bristles moderately long (2X longer than 4th metatarsomere). **Legs:** Protibiae tridentate, teeth subtriangular; margin between teeth more concave than in other species. Mesotibia with 2 larger external teeth, 1-2 smaller teeth, and acute apex. Metatibia straight, with 1–2 small median teeth and 1–2 smaller teeth proximally; apex acute. **Male genitalia:** Parameres narrow and elongate, 1/2 as long as median lobe, appressed to median lobe; median lobe symmetrical, with moderate, rounded lateral processes at distal third (Fig. 8d).

Description. Allotype female, paratype female, differing from the holotype in the following. **Length:** 4.5–4.6 mm. **Width:** 2.5–2.6 mm. **Legs:** Metatibia with external teeth almost obsolete, apex tumid. **Female genitalia:** Not examined.

Remarks. This species is a member of the subgenus *Trogoides* Paulsen based on the lateral projections on the median lobe of the male genitalia. Uniquely in this species the lobes are rounded, not triangular (Fig. 8d). The external protibial teeth are more triangular in this species making the external margin more concave between them, while a flat margin had been a uniting character for the rest of the species in the subgenus. This is a matter of degree, and species in other subgenera possess a distinctly concave margin. Interestingly, the dorsal bristles of *T. trajectus* are occasionally blunt, but for the most part



Figures 8–9. *Trogellus* Paulsen species. **8)** *Trogellus trajectus* Paulsen, new species, holotype male. **a)** Dorsal habitus. **b)** Oblique lateral habitus. **c)** Labels of holotype. **d)** Male genitalia. ventral view. **9)** *Trogellus maesi* Paulsen, male. **a)** Dorsal habitus. **b)** Male genitalia, ventral view.

distinctly acute, which removes blunt bristles as a useful character for delineating the subgenus.

Etymology. The name is a Latin adjective in the nominative singular referring to "crossing over, a passage", a reference to the species' location in the Darién Gap and its potential to also occur in South America.

Distribution. PANAMA: Darién: Cana Biological Station. The type locality is less than 7 km from Colombia, so this species is likely to occur in that country. When discovered it is expected to qualify the genus as a member of the South American fauna.

***Trogellus* (*Trogoides*) *maesi* Paulsen, 2013**

Trogellus maesi was described from two females from Selva Negra in Nicaragua, based on molecular data indicating that the species was distinct (Paulsen 2013). Additionally, morphological characters such as the more sinuate metatibiae and narrower prosternum were present to diagnose the species. The collection of the first males of this species at the type locality by collector Ryo Ishikawa was reported to me recently (J.-M. Maes, pers. comm.), and a specimen generously sent to me by Mr. Ishikawa for study (Fig. 9a). The male genitalia do possess the triangular lateral processes on the median lobe as expected by the species' placement in the subgenus *Trogoides* Paulsen (Fig. 9b). The parameres are similar to those of *T. chapinitus* Paulsen and *T. hawksi* Paulsen in being broad and placed laterally. The lateral processes are similar in shape to those of *T. chapinitus*, but begin closer to the base. Proximal to the lateral processes, the median lobe is distinctly wider than in *T. chapinitus*.

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