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Short Article

Description of the immature stages of *Germarostes* (*Germarostes*) *plicatus* (Germar, 1843) (Coleoptera: Scarabaeoidea: Hybosoridae: Ceratocanthinae)

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ABSTRACT. The third-instar larva and pupa of *Germarostes* (*Germarostes*) *plicatus* Germar are described, based on specimens collected under the bark of a live Mango tree and inside a wooden plank, collected in the locality of Los Caobos, Chilibre, Panama, during the year 2020. An updated key for the identification of the described larvae is provided. In addition, a key for recognizing the pupae of the described new world genera of Ceratocanthinae is presented. Illustrations are provided with the diagnostic characters of the larvae, and the measurements of the second and third larval instars and pupa are provided.

KEYWORDS: Larvae, Morphology, Neotropic, Pupae, Epypharynx

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INTRODUCTION

Very little is known about the immature stages of Ceratocanthinae (Morón & Arce 2003). Larvae and pupae have been found in the bark of fallen or standing trees, termite nests, tree holes with moss, and under old compost in botanical gardens (Ritcher 1966; Choate 1987; Costa et al. 1988; Morón & Arce 2003). The Ceratocanthinae larvae have been characterized by the presence of the following characters: anterior margin of labrum strongly serrate; epipharynx with a dextral beak-like process. Galea and lacinia separate. Maxillary stridulatory area with a row of conical teeth. Antenna 4-segmented; last segment not reduced in diameter and with a dorsal sensory spot extending to the ventral region of the last antenna segment. Thoracic spiracle with concavity of respiratory plate facing posteriorly; abdominal spiracles with concavities of respiratory plates facing anteriorly. Second to fifth dorsal segments plicate. Palidia present, transverse, with spatulate setae. Legs 4-segmented, with well-developed claws. Stridulatory organs on mesothoracic and metathoracic legs (Ritcher 1966; Morón & Arce 2003). Within the genus *Germarostes* Paulian, 1982, the larva of *Germarostes* (*Germarostes*) *aphodioides* (Illiger, 1800) (described under the name of *Cloetus aphodiodes*) (Ritcher 1966), and the larva and pupa of *Germarostes* (*Germarostes*) *macleayi* (Perty, 1830) (Costa et al. 1988) have been described. Grebennikov et al. (2004) realized a phylogeny of ceratocanthinae larvae including the mentioned above larvae and that of *Germarostes* (*Germarostes*) *globosus* (Say, 1835), however they do not provide a description as yet. This paper presents the description of the third-instar larva and pupa of *Germarostes* (*Germarostes*) *plicatus* (Germar, 1843).

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MATERIALS AND METHODS

Three adults, one third-instar larva, one third-instar larval exuvia, and one pupa of *Germarostes* (*Germarostes*) *plicatus* were examined and are deposited in the author's collection (MDBC-LEBA). One adult was collected at a mercury-vapor light trap in Panamá Province, Chilibre, Los Caobos (9°09'06.5"N, 79°36'59.6"W), on 2–3.iv.2020 by M.D. Barria. A second adult was collected under the bark of a living *Mangifera indica* L. tree (Anacardiaceae) at the same locality (9°09'07.7"N, 79°36'59.3"W) on 19.xii.2020. A third adult was reared from a larva collected beneath the bark of the same living *M. indica* tree, which was covered by a thick layer of moss, and emerged on 20.xii.2020. The third-instar larva, its exuvia, and the pupa were obtained from the same rearing event. All specimens were collected by M.D. Barria. The taxonomic characters were examined using a ZEISS® Stemi 305 stereo microscope and subsequently photographed with the built-in AxioCam 208 camera. The structures were illustrated using Adobe Illustrator software and edited using Affinity software.

RESULTS

Order Coleoptera Linnaeus, 1758

Family Hybosoridae Erichson, 1847

Subfamily Ceratocanthinae Martinez, 1968

Tribe Ceratocanthini Martinez, 1968

Genus *Germarostes* Paulian, 1982

Germarostes (*Germarostes*) *plicatus* (Germar, 1843)

[Figs 1–15]

***Description*. — Third instar larva** (Fig. 12). based on one third-instar larva and one third-instar larval skin.

Cranium (Fig. 1). Total body length: 11 mm. Cephalic capsule width: 1.8 mm. Epicranial suture (ES) well defined, short, not extending beyond the middle of the cranium. Frontal suture present (FS), poorly visible. Stemmata absent. Each side of epicranium with 2 long dorsoepicranial setae (DES), 4 short lateroepicranial setae (LES), 2–3 short posteroepicranial setae (PES), 2 anteroepicranial setae (AES), 3 externoepicranial setae (EES). Front with 2 anterofrontal setae (AFS), 2 posterofrontal setae. In ventral view, hypostomal rod (HyS) short. Clypeus: Asymmetrical, separated from the frons with a suture (FCS). With 2 anteroclypeal setae (ACS), each side with 2 setae in the anterior angle of the clypeus (AACS). Labrum: Dorsal surface with some gibbosities, anterior margin strongly serrate. Each side with 2 long anterolabral setae (ALS), each side with 1 posterolateral labral seta (PLLS), 4 internal labral setae (ILbS), 12 setae emerging from the ventral region of each lobe of the anterior margin (AMLS).

Epipharynx (Fig. 2). Haptomerum well developed, forming an irregular transversal carina with a dextral beak-like process (HP); paria without chaetae; acroparia (ACP) with 12 long setae; 4 central setae below the acroparia; laeophoba (LP) with 10-11 phobae; dexiotorma (DX) and laetorma (LT) well developed and united; epitorma (ETA) united to haptomerum; nesium (NE) present, with 1 large seta and some spiniform setae in the laterals.

Antenna (Figs 5–6). 4-segmented, last segment with a large sensory spot (DSS) covering almost the entire segment and extending to the ventral region, with some setae scattered in the posterior region. Apical region with some short setae.

Mandibles (Figs 3–4, 7–8). Asymmetrical, each mandible with two incisive teeth, S_1 and S_2 divided by a scissorial notch (SN). Each mandible with a dorsal perpendicular keel (DPK), a ventral mandibular process (VMP), and a ventral articulation condyle (PTA); scrobis with 1 long seta. Stipe (ST) short, stridulatory area with 10 conical stridulatory teeth (SST); each mandible with 1 basolateral seta (BLS); 1 long seta on the caudolateral scissorial notch area (CSnS), 1 long seta in the anterior area of the dorsal carina (DC); brustia (BR) present. Left Mandible (Figs 3, 8): Molar area (MoA) concave with a dentiform

distal projection. Right mandible (Figs 4, 7): Molar area with some tubercles; calx (CA) well developed, acuminate. *Maxilla* (Fig. 9). Galea (GA) and lacinia (LA) separate; galea with an apical uncus (UNGA), lacinia with uncus (UNLA); galea and lacinia with many setae. Maxillary palpus (MP) 3-segmented, second segment with 2 long (CL) well-developed, acute, with 2 pre-apical setae. Coxa of the prothoracic leg with a granular area (stridulatory area) (visible only with a compound microscope).

Legs (Fig. 10). 4-segmented, claws well developed. Profemur of the prothoracic leg with a stridulatory area in the external lateral side. Internal lateral side of the femora and tibia of the mesothoracic legs with stridulatory organs, consisting of truncate tubercles. Metathoracic legs without stridulatory organs.

Abdomen. Dorsal segments of thorax and abdomen with many short and long setae. Dorsum of the first abdominal segment divided into two folds. First dorsal fold with 2 long setae; second dorsal fold with 32 setae. Abdominal segment II: prescutum with 30 setae; scutum with 25 setae; scutellum with 38 setae. Abdominal segment III: prescutum with 25 setae; scutum with 30 setae; scutellum with 38 setae. Abdominal segment IV: prescutum with 30 setae; scutum with 25 setae; scutellum with 28 setae. Abdominal segment V: prescutum with 25 setae; scutum with 20 setae; scutellum with 28 setae. Rest of dorsal folds of abdominal segments with similar chaetotaxy. Last segment (raster) (Fig. 11) with the anal slit transverse; venter of the last segment with an asymmetrical transverse-recurved palidia with 13 spatulate palli (originally 14).

Spiracles. Cribriforms; thoracic spiracles with concavities of the respiratory plate facing posteriorly; abdominal spiracles smaller than thoracic, concavities of the respiratory plates facing anteriorly.

Pupae (Figs 13–15)**.** Description based on only one pupa. Body length: 6 mm. Pupae exarate type. Body elongated. White-yellowish. *Head*: Eyes, ocular canthus, mouthparts, and antennae well differentiated. Frons with 2 longitudinal carinae. In dorsal view, each pterotechae with a dorsal-lateral dentiform projection. *Thorax*: lateral margins of pronotum without projections. Pterotechae compressed around the body; pterotechae slightly longer than elytral techae. *Abdomen*: Dorsal dioeniform organs (gin-traps) absent. Last abdominal segment with 2 dentiform urogomphi.

Key to genera of Ceratocanthinae from the Americas – pupae

1 Lateral margins of pronotum, lateral area of clypeus and dorsal-lateral elytra area with spatulate projections; Last abdominal segment with a rounded projection. ..... ***Ceratocanthus* White, 1842**

– Lateral margins of the pronotum without projections; frons with 2 longitudinal carinae. In dorsal view, each pterotechae with a dorsal-lateral dentiform projection; Last abdominal segment with a dentiform projection. ..... ***Germarostes* (*Germarostes*) Paulian, 1982**

Key to Ceratocanthinae from the Americas – the third instar larvae (Modified from Morón & Arce 2003).

1 Dorsal surface of labrum irregularly punctated. Abdominal spiracles with concavity of respiratory plate facing ventrally. ..... ***Ceratocanthus relucens* (Bates, 1887)**

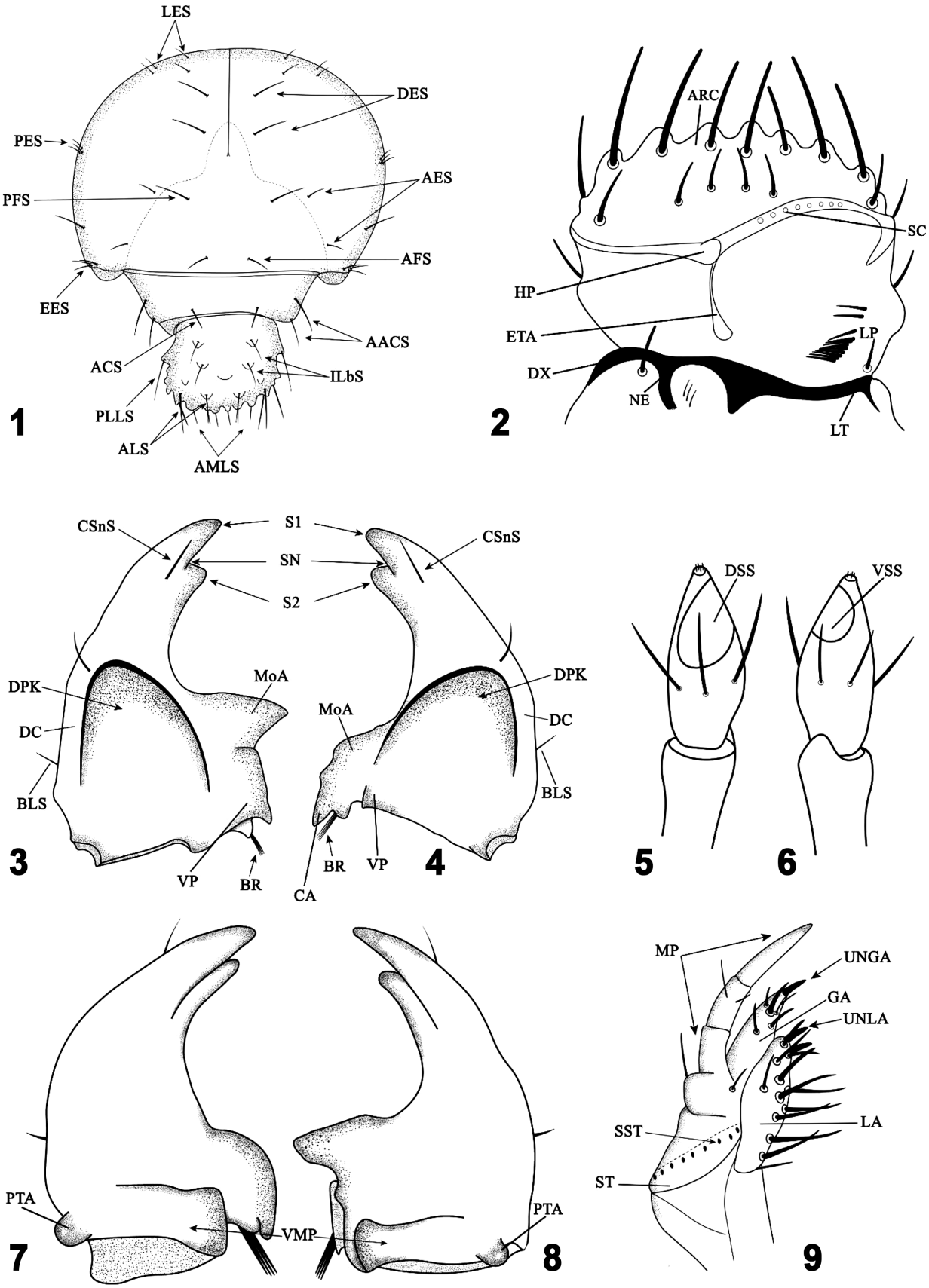
– Dorsal surface of labrum with coarse tubercles. Abdominal spiracles with concavity of respiratory plate facing anteriorly [*Germarostes* (*Germarostes*)] **2**

2 Anterior margin of the clypeus slightly sinuated, with lateral angles scarcely projected. Meso- and metanotum with sclerotized areas at sides. Profemur with microscopic stridulatory area. Palidia formed by 20 spatulate pali. ..... ***G.* (*G.*) *macleayi* (Perty, 1830)**

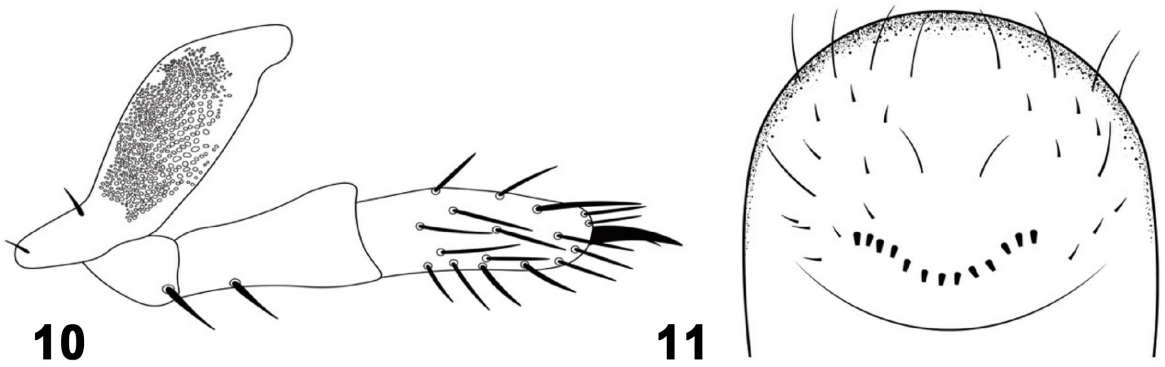
– Anterior margin of clypeus deeply sinuated, with lateral angles clearly projected, Meso- and metanotum without sclerotized areas at sides. **3**

3 Palidia formed by 9–10 spatulate pali. Profemur without microscopic stridulatory area..... ..... ***G.* (*G.*) *aphodioides* (Illiger, 1800)**

– Palidia formed by 13 or 14 spatulate pali. Profemur with microscopic stridulatory area..... ..... ***G. (G.) plicatus* (Germar, 1843)**



Figures 1–9. *Germarostes plicatus*, third instar larvae. **1.** Cranium, frontal view; **2**. Ephypharynx; **3.** Left mandible, dorsal view; **4**. Right mandible, dorsal view; **5**. Antenna last segment, dorsal view; **6.** Antenna last segment, ventral view; **7.** Right mandible, ventral view; **8.** Left mandible, ventral view; **9.** Left maxilla, dorsal view.







Figures 10–15. *Germarostes plicatus*, third instar larvae. **10.** Prothoracic leg; **11.** Raster, ventral view; **12.** Third instar larvae, lateral view. *Germarostes plicatus*, pupae; **13.** Habitus, lateral view; **14.** Habitus, ventral view; **15**. Habitus, dorsal view.

DISCUSSION

Among the three described *Germarostes* larvae species, the larva of *Germarostes plicatus* differs from *Germarostes macleay* by having the anterior margin of the clypeus deeply sinuate, with the lateral angles distinctly projected, and the mesonotum and metanotum lacking lateral sclerotized areas, characters absent in *G. macleay* (*sensu* Costa et al. 1988). Compared to the *Germarostes aphodioides* larvae, *G. plicatus* shares the clypeal sinuation and non-sclerotized thoracic pleural regions, but differs in raster chaetotaxia and in the presence or absence of stridulatory organs on the profemur, which are present in *G. plicatus* and absent in *G. aphodioides*. The raster of *G. plicatus* consists of 13 spatulate pali, whereas *G. aphodioides* has 9–10 pali (*sensu* Ritcher 1966), and *G. macleayi* has 20 pali (*sensu* Costa et al. 1988).

The morphological comparisons between the larvae and pupae allow for distinction between the genera *Ceratocanthus* and *Germarostes*. The larvae of *Ceratocanthus relucens* (Bates, 1887) differ from all known *Germarostes* species in that they possess a labium with an irregularly punctate dorsal surface (tuberculate–gibbous in *Germarostes*) and abdominal respiratory plates with ventrally oriented concavities (anteriorly oriented in *Germarostes*) (Morón & Arce 2003). In the pupae, the absence of lateral pronotal projections, together with the presence of dorsolateral dentiform projections on the pterothecae and a dentiform urogomphus, clearly distinguishes *Germarostes* pupae from those of *Ceratocanthus*, whose pupae have spatulate lateral projections and rounded terminal abdominal processes (Morón & Arce 2003).

Future descriptions of immature stages in other Hybosoridae genera from the Americas will test the phylogenetic stability of these diagnostic characters.

FUNDING

This research received no specific grant from any funding agencies.

AVAILABILITY OF DATA AND MATERIAL

The specimens listed in this study are deposited in LEBA, Universidad de Panamá (Laboratorio de Estudios Biológicos de Atrópodos) and are available from the curator upon request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study only included arthropod material, and all required ethical guidelines for the treatment and use of animals were strictly adhered to in accordance with international, national, and institutional regulations. No human participants were involved in any studies conducted by the authors for this article.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this paper.

GENERATIVE AI STATEMENT

The author declares that no AI tools were used in the writing or analysis of this manuscript.

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توصیف مراحل نابالغ *Germarostes* (*Germarostes*) *plicatus* (Germar, 1843) (Coleoptera: Scarabaeoidea: Hybosoridae: Ceratocanthinae)

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چکیـده: لارو سن سوم و شفیرهٔ *Germarostes* (*Germarostes*) *plicatus* Germar بر اساس نمونه‌هایی که در سال ۲۰۲۰ از زیر پوستِ یک درخت زندهٔ انبه و از داخل یک تختهٔ چوبی در محلهٔ لوس کائوبوس، چیلیبره، پاناما جمع‌آوری شده بودند توصیف شد. کلید شناساییِ به‌روزشده‌ای برای لاروهای توصیف‌شده ارایه شد. افزون بر این، کلیدی برای تشخیص شفیره‌های سرده‌های توصیف‌شدهٔ منطقه دنیای جدید از زیرخانوادهٔ Ceratocanthinae ارایه شد. تصاویرِ صفات افتراقی لاروها ارایه و اندازه‌های سنین دوم و سوم لاروی و شفیره نیز گزارش شد.

واژگـان کلیدی: لاروها، ریخت‌شناسی، نئوتروپیک، شفیره‌ها، اپی‌فارینکس