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## Description of the larva and pupa of *Phileurus truncatus* (Palisot de Beauvois, 1806) (Coleoptera: Scarabaeidae: Dynastinae: Phileurini) with a key to described third instars of New World Phileurini

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### Abstract

The third instar and pupa of *Phileurus truncatus* (Palisot de Beauvois, 1806) (Coleoptera: Scarabaeidae: Dynastinae: Phileurini) is described for the first time based on specimens from Florida, United States of America. An identification key to the third instars of New World Phileurini is also provided.

**Key words:** scarab beetle, morphology, immature insects

### Introduction

*Phileurus* Latreille, 1807 (Coleoptera: Scarabaeidae: Dynastinae: Phileurini) comprises 31 species and subspecies distributed from the southern United States of America to southern South America and the West Indies (Endrödi 1978, 1981, 1985; Ratcliffe 1988; Ratcliffe & Cave 2015). The natural history of these mostly large, conspicuous beetles is poorly known. Adults and larvae can be found in association with decaying wood. The broadly distributed species *P. valgus* (Olivier, 1789) has been collected from “basswood” (*Tilia* sp., Malvaceae) (Ritcher 1966), *Inga ingoides* (Rich.) Willd. (Fabaceae) (Chalumeau 1983), *Mangifera indica* L. (Anacardiaceae) (Chalumeau 1983), *Swietenia macrophylla* King (Meliaceae) (Touroult 2005), and *Pinus caribaea* Morelet (Pinaceae) (Ratcliffe & Cave 2015). *Phileurus didymus* (Linnaeus, 1758) has been collected from *Spondias mombin* L. (Anacardiaceae) (Ritcher 1966) and *Quercus* sp. (Fagaceae) (Ratcliffe *et al.* 2013). *Phileurus affinis* Burmeister, 1847 was collected from *Salix* sp. in Uruguay (Morelli 1990). *Phileurus truncatus* (Palisot de Beauvois, 1806) adults, pupae, and larvae can be found in the root crown area of dead *Quercus* (both standing and fallen trees) in Florida (personal communication, Paul E. Skelley, 2016). *Phileurus truncatus* adults have also been reported to fall into chimneys (Saylor 1948).

A growing body of literature suggests that phileurine species, including some *Phileurus*, are at least facultatively associated with ant and termite nests or their midden piles. Examples include: *P. valgus* adults reported from *Atta mexicana* (Smith, 1858) (Hymenoptera: Formicidae) detritus mounds in Mexico (Deloya 1988) and a damaged termite nest in Guadeloupe (Ponchel 2009), *P. carinatus declivis* Prell, 1914 adults from within the nests of *Azteca* (Hymenoptera: Formicidae) ants in Brazil (Alves-Oliveira *et al.* 2016), and *P. didymus* adults and larvae observed in association with a termite nest in French Guiana (Ponchel 2009). More detailed observations are needed to determine whether *Phileurus* species can complete their entire development within these microhabitats, as has been suggested for *Homophileurus tricuspis* Prell, 1914 (Neita Moreno & Ratcliffe 2011).

Larvae are described for three *Phileurus* species: *P. affinis*, *P. didymus*, and *P. valgus* (Ritcher 1966; Morelli 1990; Ibarra-Polesel *et al.* 2017). Among *Phileurus* species, the pupal stage is described for the South American *P. affinis* and the widely distributed *P. valgus* (Morelli 1990; Ibarra-Polesel *et al.* 2017). Synapomorphic larval characters have not been hypothesized for *Phileurus* nor is there a proposed set of unambiguous characters that would serve to diagnose the genus. However, the known larvae of *Phileurus* share the presence of anterior frontal setae and similar sized tarsal claws on all legs (Ibarra-Polesel *et al.* 2017). Ratcliffe & Skelley (2011) provided a

synthetic key to species for the third instars of New World phileurines that serves as the standard identification tool for the group, which has been built upon by subsequent authors (Ibarra-Polesel *et al.* 2017). Herein, we describe the third instar and pupa of *P. truncatus* (Palisot de Beauvis, 1806) based on specimens from Florida, United States of America. This widespread species occurs from the southeastern United States of America south to Panama (Endrödi 1985; Ratcliffe 2003; Ratcliffe & Cave 2006; Ratcliffe *et al.* 2013).

## Material and methods

Terms and characters used in the larval description are those of Ritcher (1966) and Ratcliffe & Skelley (2011). The two larvae and one pupa were preserved in 70% ethanol. A second pupa was preserved by air drying. Dissected structures in the illustrations were air dried and placed on a white, flat backdrop for imaging and study. The larvae and pupae were deposited in the Florida State Collection of Arthropods (Gainesville, Florida, United States of America). Larvae were associated with adults at the time of collection or reared from larvae to pupae or adults.

Among other large Florida dynastines, third instars of *P. truncatus* could be confused with *Dynastes tityus* (Linnaeus, 1763) (Dynastinae: Dynastini) or *Strategus* spp. (Dynastinae: Oryctini). *Phileurus truncatus* is distinguishable from these species by characters of the tarsal claws (two setae in *P. truncatus* and four in *Strategus* spp.) and the antennae (five dorsal sensory spots in *P. truncatus* and seven to eight in *D. tityus*) (Ritcher 1966). *Phileurus valgus* also occurs in Florida, although this species is generally much smaller (18–29 mm adult length) than *P. truncatus* (29–38 mm adult length) (Ratcliffe *et al.* 2013). Characters of the antennae serve to diagnose third instars of these species in Florida, with *P. valgus* having 2–4 dorsal sensory spots on the terminal antennomere (Ritcher 1966; Ibarra-Polesel *et al.* 2017), and *P. truncatus* having five.

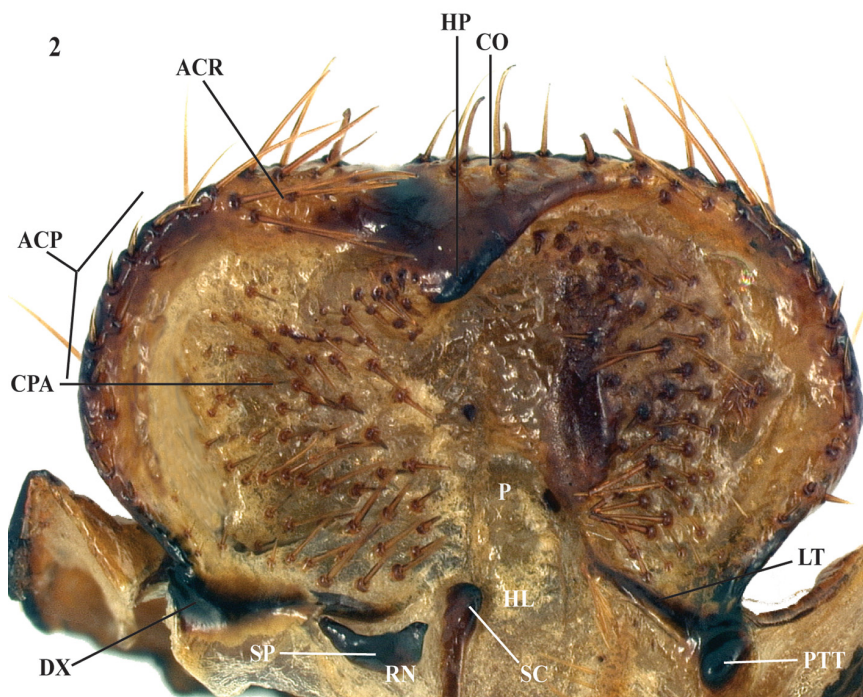
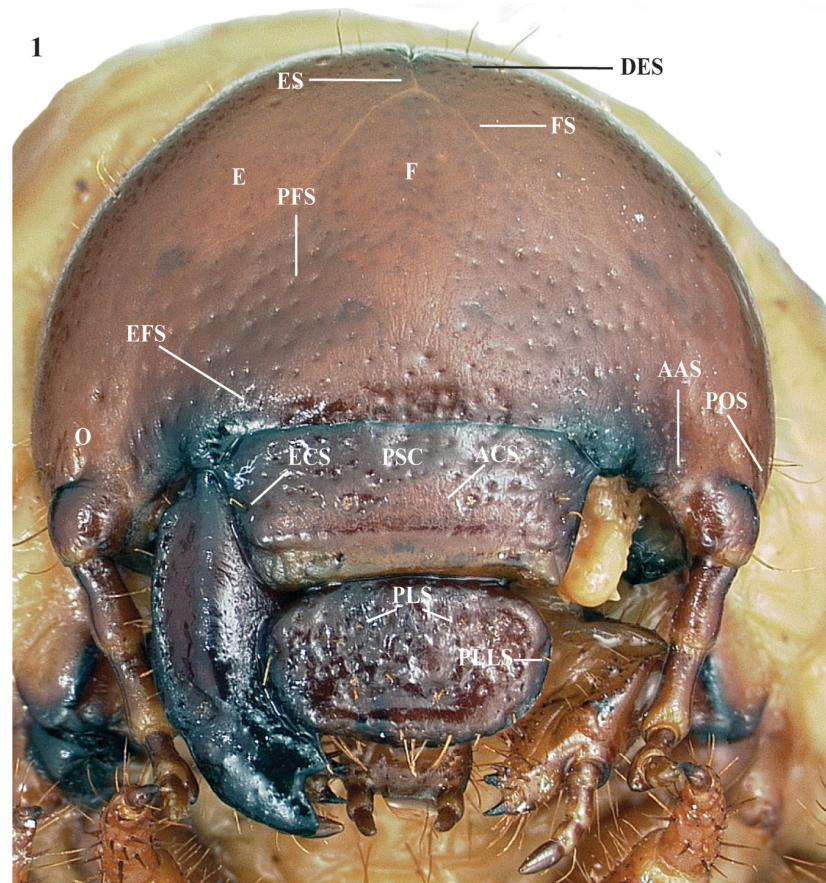
## *Phileurus truncatus* (Palisot de Beauvois, 1806)

### Third instar

(Figs 1–10)

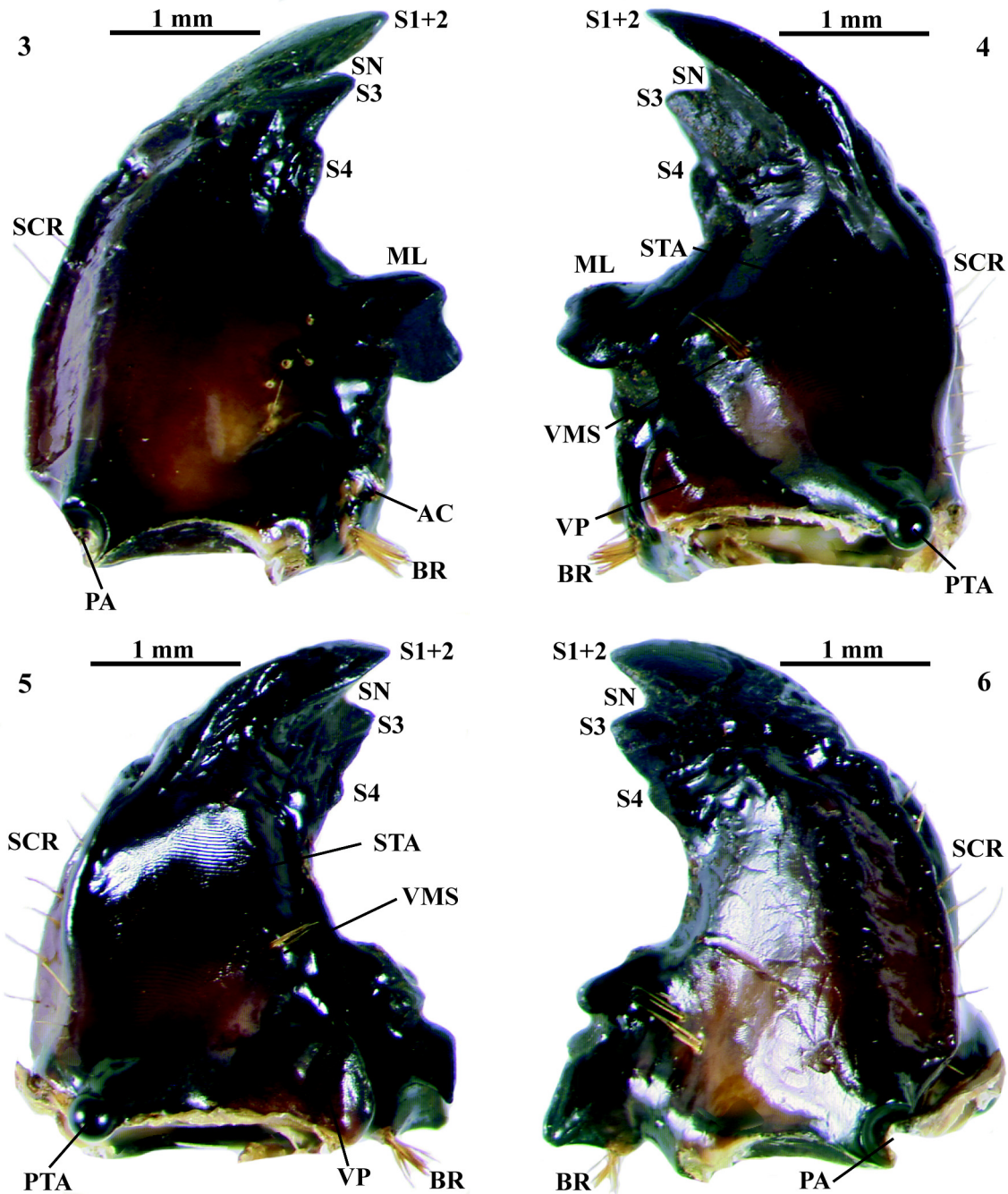
**Material examined.** One third instar with the following data: “FLORIDA: Alachua Co/Archer; 10-XII-1976/rotten log of turkey oak/Scarabaeidae/*Phileurus truncatus*/P.M. Choate collr.”. One third instar with the following data: “FLORIDA: Alachua Co. Archer; 20-II-2017/in rotting pine wood in association with adult/coll. Oliver Keller”.

**Description.** Dorsal body length approximately 48 mm. **Cranium:** Width of head capsule 8 mm. Color yellowish brown (Fig. 1). Surface moderately punctate on frons (F) (punctures separated by slightly more than a punctures diameter), epicranium (E) less densely punctate (most of the large punctures are near the frontal suture and less dense on posterior portions of the epicranium), postclypeus (PSC) with large punctures as dense as on the anterior portion of the frons, and labrum densely punctate. Epicranial suture (ES) and frontal suture (FS) distinct. **Frons:** Surface with 1 exterior frontal seta (EFS) (Fig. 1). Anterior frontal setae absent. Two posterior frontal setae (PFS) on each side of frons. Each anterior angle (AAS) with 2 setae. Epicranium on surface with 3 dorsoepicranial setae (DES). About 10 total epicranial setae distributed irregularly. Eight paraocellar setae (POS) on each side, setae arranged in two distinct rows of four setae each. Ocellus (O) present. **Clypeus:** Form trapezoidal. Surface of postclypeus with no anterior clypeal setae (ACS) and 2 external clypeal setae (ECS) on both right and left side (Fig. 1). **Labrum:** Surface slightly asymmetrical with lateral margins of labrum (and epipharynx) angulate on each side (Fig. 1). One long posterior labral setae (PLS) on each side and about 10 posterolateral labral setae (PLLS). **Epipharynx:** Asymmetrical, left lateral margin slightly angulate (Fig. 2). Haptomer process (HP) ridge-like, not notched. Right and left chaetoparia (CPA) well developed, without sensillae; each with about 50 setae. Acroparia (ACR) with about 10 long, stout, slightly curved setae. Corypha (CO) with 8 short, stout, slightly curved setae. Left acanthoparia (ACP) with 10 short, curved, spine-like setae; right acanthoparia with 11 short, curved, spine-like setae. Pedium (P) longer than wide and without setae. Dexiotorma (DX) sclerotized, broad, and elongate. Laetorma (LT) shorter than dexiotorma (by approximately 1 mm). Pternotorma (PTT) rounded. Haptolachus (HL) lacking setae. Sclerotized plate (SP) of right nesium (RN) well developed, nearly half as broad at middle as the sense cone, sclerotized plate projected medially, half its length to sense cone. Sense cone (SC) a well-sclerotized, rounded



**FIGURES 1–2.** *Phileurus truncatus*, third instar. **1**, Structural features of the cranium and labrum. AAS—anterior angle setae; ACS—anterior clypeal setae; DES—dorsoepicranial setae; E—epicranium; ECS—exterior clypeal setae; EFS—exterior frontal setae; ES—epicranial suture; F—frons; FS—frontal suture; O—ocellus; PFS—posterior frontal setae; PLLS—posterolateral labral setae; PLS—posterior labral setae; POS—paraocellar setae; PSC—post clypeus; **2**, epipharynx. ACP—acanthoparia; ACR—acroparia; CO—corypha; CPA—chaetoparia; DX—dextotorma; HP—haptomer process; HL—haptolochus; LT—laetorma; PTT—pternotorma; SC—sense cone; SP—sclerotized plate; RN—right nesium.





**FIGURES 3–6.** *Phileurus truncatus*, third instar. **3**, Left mandible, dorsal view; **4**, left mandible, ventral view; **5**, right mandible, ventral view; **6**, right mandible, dorsal view. AC—acia; BR—brustia; ML—molar lobe; PA—preartis; PTA—postartis; S<sub>1–4</sub>—scissorial teeth; SCR—scrobis; SN—scissorial notch; STA—stridulatory area; VMS—ventral molar setae; VP—ventral process.

plate. **Left mandible:** Form falcate (Figs 3–4). Scissorial area with blade-like apical tooth (S1+S2 fused), separated from S3 by scissorial notch (SN), S4 below notch. S3 large and triangular. Scrobis (SCR) with 10 slender, long setae. Acia (AC) well developed and acute. Ventral surface with elongate, oval stridulatory area (STA) that are similar in width with about 52–54 narrowly separated, subparallel ridges. Preartis (PA) distinct, concave. Ventral process (VP) large, anterior portion subangulate. Brustia (BR) with about 15 long setae. Molar area with about 6 ventral molar setae. Molar lobe (ML) with a large, prominent anterior tooth, with apex weakly emarginate. Flattened posterior portion of subdivided molar with dorsal margin weakly depressed. Postartis (PTA) large, rounded. **Right mandible:** Form falcate (Figs 5–6). Scissorial area with apical, blade-like tooth (S1+S2

fused), separated from S3 by scissorial notch, S4 below notch. S3 slightly smaller than on left mandible. Scrobis (SCR) with 8 long setae. Acia (AC) absent. Dorsal surface with 1 long seta posterior to base of S3. Preartis (PA) distinct, concave. Ventral surface with elongate-oval, stridulatory area (SA) with about 50 narrowly separated, subparallel ridges. Ventral process (VP) large, subangulate. Brustia with about 10–12 long setae. Molar area with about 6 ventral molar setae (VMS). Postartis (PTA) large, rounded. **Maxilla and labium:** Stridulatory area of left maxilla with row of 9–10 stridulatory teeth (SD), teeth becoming increasingly smaller basally; apical most tooth much larger than other teeth (Fig. 7). Stridulatory area of right maxilla with row of 7 teeth. Glossa in dorsal view with about 40 setae; disc of glossa in dorsal view developed into a round mound. Hypopharyngeal sclerome (HSC) (Fig. 8) symmetrical; apical portion of hypopharyngeal sclerome developed into a large, roughly symmetrical lobe, apex of this lobe is broadly emarginated and fits snugly onto the glossal mound. Truncate process (TP) prominent, elevated slightly and produced. Lateral lobes with about 13 long setae on left side. **Antenna:** Antenna with 4 antennomeres; antennomeres I–II subequal in length, each slightly longer than antennomere III; length of terminal antennomere slightly less than length of antennomere III. Terminal antennomere on dorsal surface with 5 dorsal sensory spots (DSS) (Figs. 9–10). **Thorax:** Prothoracic spiracle about 0.8–1.0 mm long, 0.6–0.7 mm wide; respiratory plate light brown. C-shaped, spiracular bulla rounded, barely elevated; respiratory plate with about 40 regularly edged holes across diameter at middle. Dorsum of pronotum and prescutum segments II and III each with transverse row of long slender setae. **Legs:** Coxa, trochanter, femur, and tibiotarsus of all legs with numerous long, stout, setae. Tarsal claws falcate, with 1 basal external seta and 1 internal, preapical seta. Protarsal, mesotarsal, and metatarsal claws equal in length. **Abdomen:** Abdominal spiracles slightly larger (1.1 mm long, 0.8 mm wide) than prothoracic spiracle, all abdominal spiracles subequal in size. Abdominal segments I–VIII each with multiple transverse rows of long, spine-like setae. **Raster:** Teger with short, spine-like setae projecting towards anal slit. Lower anal lobe entire, covered with short, stout setae like those of the raster; fringed posteriorly with longer, slender setae. Anal slit transverse.

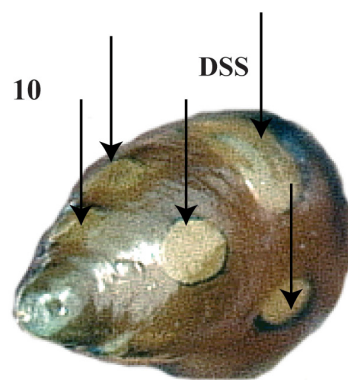
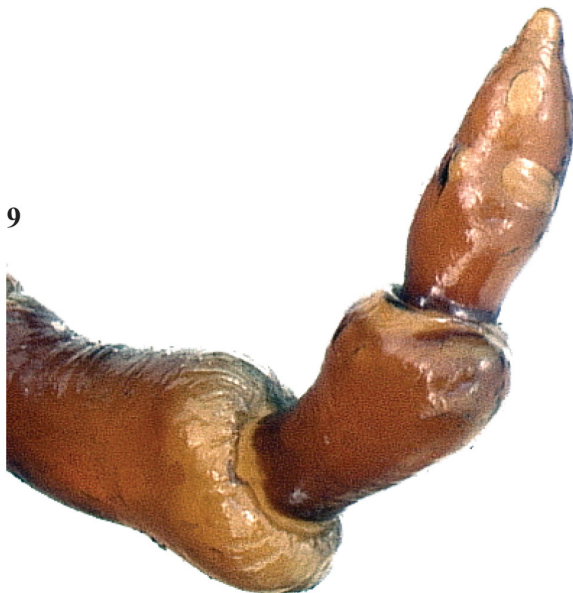
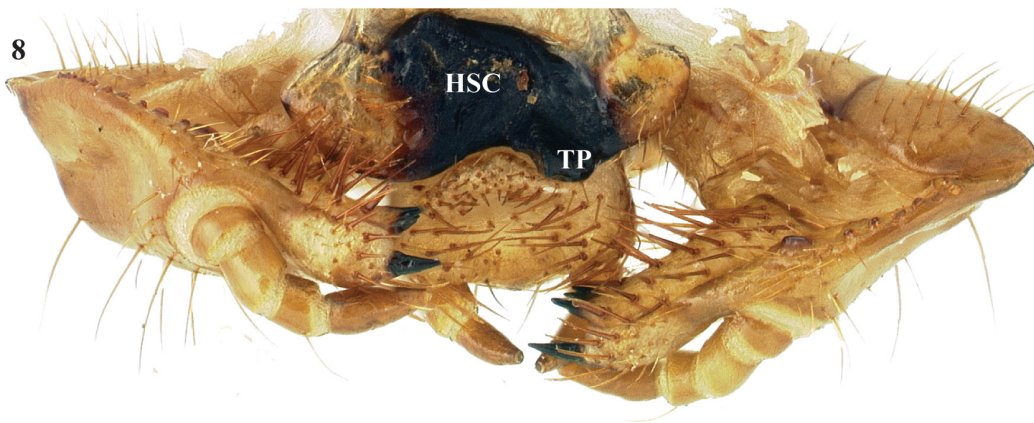
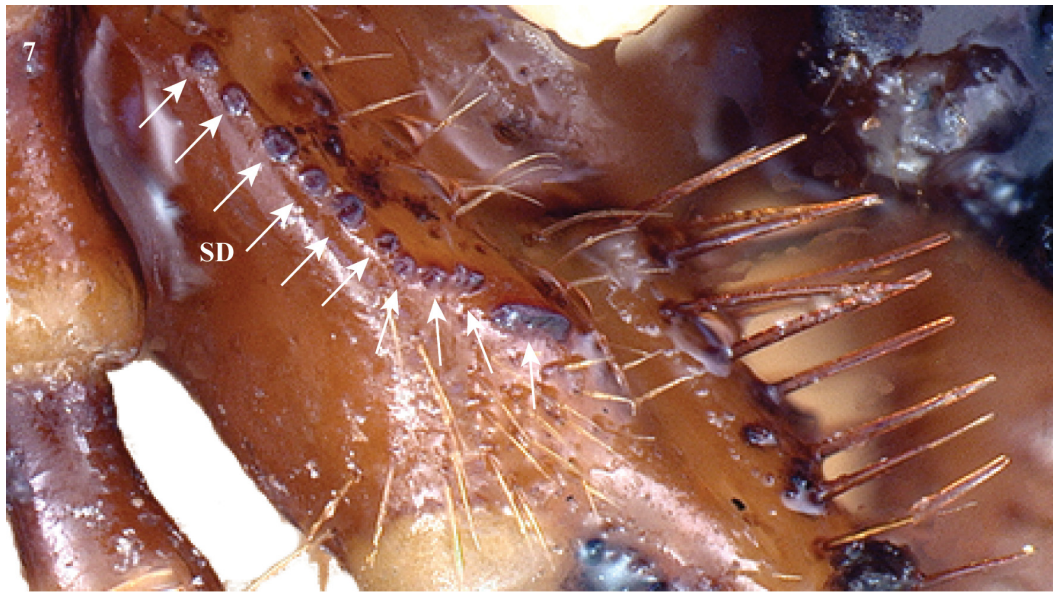
### ***Phileurus truncatus* (Palisot de Beauvois, 1806)**

#### **Pupa**

(Figs 11–13)

**Material examined.** Two pupae with the following data: “FLORIDA: Alachua Co/Gainesville; turkey oak;/larva 7-II-1976/pupa 15-IV-1976/Scarabaeidae *Phileurus/truncatus*/P.M. Choate collr.”; “FLORIDA: Alachua Co./Gainesville; NATL, I-2016./coll. Gabe Somarriba”.

**Description.** Length 42–44 mm; greatest width 18–20 mm (Figs 11–13). Body elongate, oval, stout, exarate. Color dark reddish brown. Entire body with very fine, small, golden setae. **Head:** Surface glabrous, bent sharply beneath thorax, mouthparts directed ventrally; antennae, labrum, mandibles, maxillary, and labial palps discernible; antennal thecae expanded, stout, with apices rounded. Compound eyes sunken, visible, with 2 tubercles between eyes. **Thorax:** Pronotal surface glabrous. Form transverse, with wide, anteromedial, rounded apex. Mesonotum and metanotum well differentiated. Elytral and posterior wing thecae closely appressed, curved ventrally around body; elytral thecae extending to end of abdominal segment I; posterior wing thecae extending to middle of abdominal segment III. Protibia with 3 distinct teeth on external edge. Mesotibia and metatibia with 3 swellings at apices; characters indicative to spines and spurs seen in adults, with the external swelling most likely the spine and the 2 inner swellings most likely the 2 apical spurs (1 spine on each tibia in adults). **Abdomen:** Segments III–X (ventral view) well defined. Segment VII slightly long than preceding segment and segment VIII 0.25 times longer than segment VII; segments VIII and IX fused. Segments I–X (dorsal view) with well-defined, dioneiform (gin trap) organs between segments I–II, II–III, III–IV, IV–V, V–VI, and VI–VII. Pleural lobes rounded. Spiracle I ovate, covered by wing thecae, more broadly opened than spiracles II–IV; spiracles II–IV ovate, prominent, each with strongly sclerotized peritreme; spiracles V–VI less sclerotized compared to I–IV; spiracles V–VIII closed. Abdominal apex rounded, with fine, short setae.



**FIGURES 7–10.** *Phileurus truncatus*, third instar. 7, Maxillary stridulatory area. SD—stridulatory teeth; 8, labium and maxillae, dorsal view. HSC—hypopharyngeal sclerome; TP—truncate process; (9) antennomeres II–IV; 10, terminal antennomere. DSS—dorsal sensory spots.





FIGURES 11–13. *Phileurus truncatus*, pupa. 11, Dorsal habitus; 12, ventral habitus; 13, lateral habitus.

**Diagnosis.** Third-instar *P. truncatus* will key out to the terminal 4<sup>th</sup> couplet in the phileurine larval key to species of Ibarra-Polesel *et al.* (2017). This is based on the lack of anterior frontal setae and the presence of an angulate margin on the left side of the labrum in *P. truncatus*. In the modified key below, the 4<sup>th</sup> couplet now separates *Phileurus* and *Hemiphileurus* species based on the number of dorsal sensory spots on the terminal antennomere. *Phileurus truncatus* keys to the 5<sup>th</sup> couplet where it is separated from *H. elbitae* Neita & Ratcliffe, 2010 by the size of the abdominal spiracles and the number of maxillary stridulatory teeth.

The third-instar *Phileurus truncatus* examined for this study lack long, thin anterior frontal setae. The presence of anterior frontal setae, along with similar sized tarsal claws on all the legs, are characters shared between the other known third instars of *Phileurus* species (Ibarra-Polesel *et al.* 2017). The lack of long, thin anterior frontal setae in *P. truncatus* thus broadens the diagnosis for the genus. Examined specimens of third-instar *P. truncatus* do have setose punctures across the anterior margin of frons. However, these punctures are sporadically arranged and the short, stout setae in them does not reach past the margin of the punctures. We do not think that these punctures are associated with the anterior frontal setae found in other phileurine larvae.

## Key to the third instars of New World Phileurini

Modified from Neita & Ratcliffe (2011), Ratcliffe & Skelley (2011), Ibarra-Polesel *et al.* 2017.

1. Anterior frontal setae absent ..... 2
- Anterior frontal setae present ..... 7
2. Lateral margins of labrum broadly rounded, not angulate (Argentina, southern Brazil, Paraguay, Uruguay) .....  
..... *Trioplus cylindricus* (Mannerheim, 1829) ..... 3
- At least one lateral margin of labrum angulate ..... 3
3. Left and right lateral margins of labrum angulate. Maxilla with a row of six conical, stridulatory teeth (Uruguay, Brazil) ....  
..... *Archophileurus fimbriatus* (Burmeister, 1847) ..... 4
- Left lateral margin of labrum angulate. Maxilla with 6–10 stridulatory teeth ..... 4
4. Terminal antennomere with 5 dorsal sensory spots ..... 5
- Terminal antennomere with less than 5 dorsal sensory spots ..... 6
5. Abdominal spiracle I smaller than spiracles II–VII. Maxilla with row of 6–7 truncate, stridulatory teeth (Colombia).....  
..... *Hemiphileurus elbitae* Neita & Ratcliffe, 2010 ..... 5
- Abdominal spiracles similar in size. Maxilla with row of 7–10 truncate, stridulatory teeth (United States of America to Pan-  
ama)..... *Phileurus truncatus* (Palisot de Beauvois, 1806) ..... 6
6. Terminal segment of antenna with 2 dorsal sensory spots. Inner margin of left mandible, distad of molar area, with short,  
rounded tooth (Hispaniola) ..... *Hemiphileurus dispar* Kolbe, 1910 ..... 7
- Terminal segment of antenna with 3–4 dorsal sensory spots. Inner margin of left mandible, distad of molar area, with promi-  
nent, triangular tooth (United States of America, Mexico) ..... *Hemiphileurus illatus* (LeConte, 1854) ..... 8
7. Protarsal claw longer than mesotarsal and metatarsal claws ..... 8
- Protarsal claw similar in size to mesotarsal and metatarsal claws ..... 11
8. Surface of head coarsely pitted, with dense covering of setae. Stridulatory area of mandible formed by approximately 30 sepa-  
rated ridges (Brazil)..... *Actinobolus trilobus* Lüderwaldt, 1910 ..... 8
- Surface of head moderately punctate and sparsely setae. Stridulatory area of mandible formed by 40 or more separated ridges  
..... 9
9. Left lateral margin of labrum angulate ..... 10
- Lateral margins of labrum broadly rounded, not angulate (northeastern South America) .....  
..... *Homophileurus luederwaldti* (Ohaus, 1910) ..... 10
10. Anterior clypeal setae absent (Brazil, Paraguay) ..... *Homophileurus integer* (Burmeister, 1847) ..... 11
- Anterior clypeal setae present (Mexico to Brazil) ..... *Homophileurus tricuspis* Prell, 1914 ..... 11
11. Ocelli absent ..... 12
- Ocelli present ..... 13
12. Right lateral margin of labrum rounded, raster and lower anal lobe with short setae alternates with numerous long setae (South  
America) ..... *Archophileurus vervex* Burmeister, 1847 ..... 12
- Right lateral margin of labrum angulate, raster and lower anal lobe with short and thin setae (United States of America to  
Argentina) ..... *Phileurus valgus* (Olivier, 1789) ..... 13
13. Lateral margins of labrum broadly rounded, not angulate. Laephoba with 11 slender, short setae Maxilla with a row of 7 strid-  
ulatory teeth (Mexico to Paraguay)..... *Phileurus didymus* (Linnaeus, 1758) ..... 13
- Left and right lateral margins of labrum angulate. Laephoba with 17 slender, short setae. Maxilla with a row of 9 stridulatory  
teeth (French Guiana, Brazil, Uruguay) ..... *Phileurus affinis* Burmeister, 1847 ..... 13

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