

Description of a new species of cecidomyiid (Diptera: Cecidomyiidae) predator of mealybugs (Hemiptera: Pseudococcidae) on sugarcane

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Abstract. *Diadiplosis saccharum* sp. nov. (Diptera: Cecidomyiidae) is described based on male and female prey on nymphs of mealybug *Saccharicoccus sacchari* (Cockerell) (Hemiptera: Pseudococcidae) on *Saccharum* spp. (Poaceae) in São Paulo State, Brazil. Herein, the genus is composed by 33 species. The key of the eight species of the *Diadiplosis* distributed in Brazil is updated.

Key-Words. Biodiversity; Ecological association; Neotropical region; Predaceous insect; Taxonomy.

INTRODUCTION

Diadiplosis Felt (Diptera: Cecidomyiidae) is a cosmopolitan genus, better distributed in the tropical regions of the world, once thirteen of the 32 described species are distributed in Neotropical region (Gagné & Jaschhof, 2017). Larvae of these cecidomyiids are predators of several species of scale insects, especially mealybugs (Hemiptera: Pseudococcidae), and whiteflies (Hemiptera: Aleyrodidae) of which many are pests of crops of agricultural importance.

In Brazil seven species of *Diadiplosis* were reported, all predator of scale insects of the families Coccidae, Ericoccidae, Monophlebidae and Pseudococcidae. *Diadiplosis coccidivora* Felt, *D. multifila* (Felt) and *D. pseudococci* Felt have a wider distribution, chiefly in the Neotropical region. The other four species were registered only to the State of Espírito Santo, Brazil: *Diadiplosis abacaxii* Culik & Ventura associated with *Dysmicoccus brevipes* (Cockerell, 1893) (Pseudococcidae) on pineapple, *Ananas comosus* (L.) Merr. (Bromeliaceae) (Culik & Ventura, 2013a); *Diadiplosis bellingeri* Culik & Ventura with species of undetermined pseudococcid and the coccid *Saissetia* cf. *coffea* obtained from coffee, *Coffea arabica* L. (Rubiaceae); *Diadiplosis jamboi* Culik & Ventura, with *Planococcus halli* Ezzat and McConnell (Pseudococcidae) on jambo fruit, *Syzygium jam-*

bos (L.) Alston (Myrtaceae), and *Diadiplosis martinensis* Culik & Ventura, with *Pseudococcus* cf. *jackbeardsleyi* Gimpel and Miller (Pseudococcidae) on pineapple and coffee (Culik & Ventura, 2013b).

The genus *Diadiplosis* belongs to the supertribe Cecidomyiidi by possess 12 antennal flagellomeres, but this genus is unplaced to tribe. Other systematic studies need to be carried out to clarify the relationship among the genus of this supertribe. *Diadiplosis* is characterized by the eyes separated laterally or facets very sparse there; facets usually hexagonal above and below, circular and farther apart laterally; tarsal claws curved at the basal third; tarsal claws toothed or simple; presence of strap like adult abdominal sclerites; female tergite 10 with a pair of strong setae, with or without lesser ones; female cerci ovoid and without differentiated apical sensorial setae; gonocoxites may have ventro-apical lobes; gonostylus variously shaped, completely setulose, tooth pectinate; hypoproct entire to deeply bilobed (Gagné, 1994, 2010).

The systematic and biology of the cecidomyiid predators on the World Coccomorpha was made by Harris (1968, 1997), followed by taxonomic changes to Nearctic (Gagné, 1973) and Neotropical fauna (Gagné, 1994). Since then, little new information has become available, and four species have been described for the genus in the Neotropical region (Culik & Ventura, 2012, 2013a, 2013b).

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In this paper, a new species named *Diadiplosis saccharum* sp. nov. is described based on male and female specimens reared from nymphs of *Saccharicoccus sacchari* Cockerell) (Hemiptera: Pseudococcidae) in São Paulo State sampled on *Saccharum* spp. (Poales: Poaceae). An identification key to males of *Diadiplosis* distributed in Brazil is updated.

MATERIAL AND METHODS

Sampling of the natural enemies, among them the new species of *Diadiplosis*, collected from sugarcane stem (*Saccharum* spp.) prey on mealybugs (*Saccharicoccus sacchari*) between August 2016 and August 2017. Infested nodes were inspected visually mainly in looking for immature predators in Jaboticabal (21°18.00'34.70"S, 48°19.39'25.92"W, 605 m a.s.l.) and São Carlos (22°04'33.87"S, 47°48'37.59"W, 11.v.2017, 856 m a.s.l.), both in State of São Paulo, Brazil. From 10 to 20 individuals of *S. sacchari* per sample were transferred to plastic tubes for rearing its natural enemies in BOD for 28 days. The adults of cecidomyiids were obtained in this process. They were preserved in 80% ethanol and later were mounted on permanent slides using the methodology outlined by Gagné (1994) and deposited in Museu de Zoologia da Universidade de São Paulo. Topotypes of *cf., Diadiplosis abacaxii* (2 ♂ and 6 ♀), *cf., D. bellingeri* (1 ♂

and 1 ♀) and *cf., D. jamboi* (3 ♀) from Instituto Capixaba de Pesquisa, Assistência Técnica e Extensão Rural (INCAPER) were examined. The specimens of *D. martinsensis* and the male of *D. jamboi* were not available for examination, and in this way, their characteristics were compared with original description from literature. The larvae of cecidomyiids obtained among the sorted biological material was totally directed to obtain adults, by the small number of specimens. The areas where the larvae were found are more shaded and moist fields, which could be limiting for insects as small and with fragile bodies as the dipter in question. Furthermore, in sugarcane fields, even though scale insects are frequent, there is a constant application of insecticides to control various pest insects, which negatively end up interfering in beneficial insects as natural enemies.

RESULTS

Taxonomy

Genus *Diadiplosis* Felt, 1911

Type species: *Diadiplosis cocci* Felt (orig. des.).

For the diagnosis of *Diadiplosis* see Gagné (1994) and Gagné (2010).

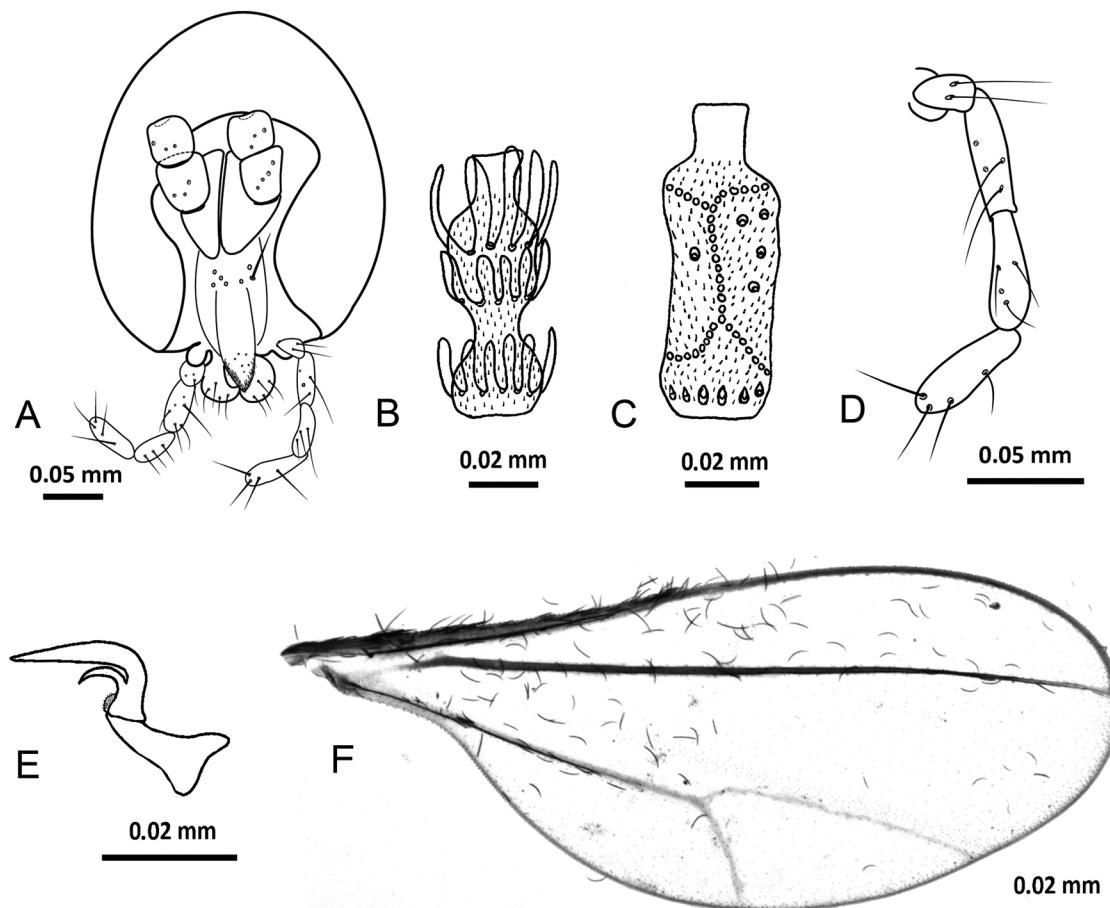


Figure 1. *Diadiplosis saccharum* sp. nov. (A) Male head, frontal view, (B) Male flagellomere 3; (C) Female flagellomere 3; (D) Maxillary palp four-segmented; (E) Tarsal claw, leg 3; (F) Wing.

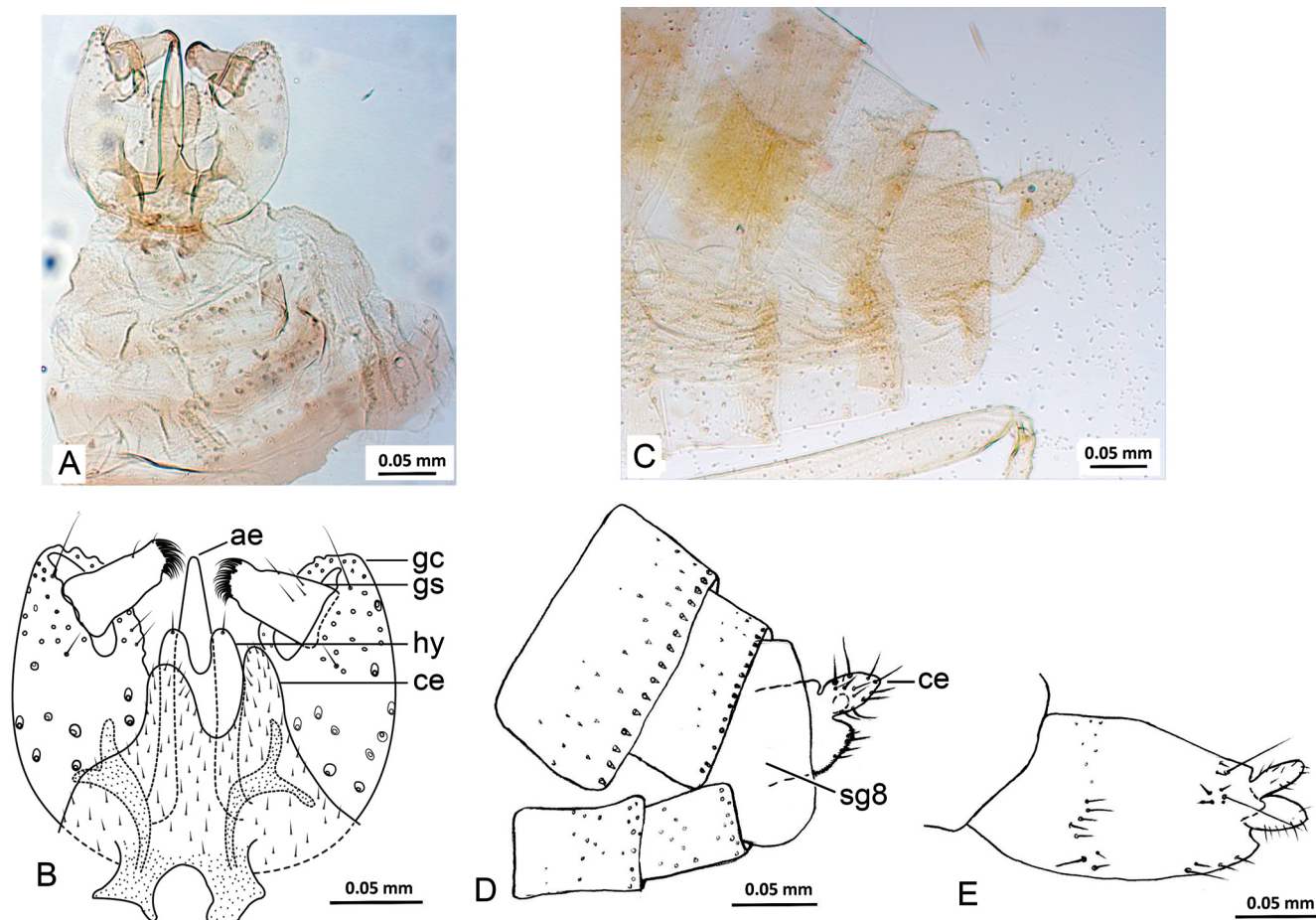


Figure 2. *Diadiplosis saccharum* sp. nov. (A) Male terminalia and posterior abdominal segments, vview; (B) Detailed male terminalia, dorsal view; (C) Female post-abdomen; (D) Female abdomen detailed. Abbreviations: ae = aedeagus, ce = cercus, gc = gonocoxites, gs = gonostylus, hy = hypoproct, sg8 = segment 8.

***Diadiplosis saccharum* sp. nov. Urso-Guimarães**
(Figs. 1-3)

Description: Adult (Figs. 1-2): Body length: male, 1.49-1.65 mm (N = 2); female, 1.04-1.89 mm (N = 2).

Head (Fig. 1A): Antennae with scape obconic, 5-6 setae, pedicel globose 3-4 setae. Antennal length: male 0.9-1.05 mm (N = 2), and female, 0.9-0.95 mm (N = 2). Male flagellomeres binodal, circumfila with three loops similar in length (Fig. 1B). Male flagellomere 3 length 0.08-0.09 mm; internode length 0.01 mm, width 0.012; neck length 0.016-0.017 mm, width 0.013 mm (N = 2). Female flagellomeres cylindrical, circumfila as in Fig. 1C, flagellomere 3 length 1.0 mm; neck length 0.018 mm, width 0.2 mm (N = 2). Flagellomeres 1 and 2 not connate. Male and female flagellomere 12 with a short apical process. Frontoclypeus with approximately 15 setae (N = 4). Labrum long and tapering, with two pairs of ventral setae. Hypopharynx shape similar to labrum, with long, anteriorly directed lateral setulae. Labella round, convex, each with three lateral setae and one mesal setae. Palpus four-segmented, the first globose and the other three cylindrical; second and third segments with equal length, the fourth 1.5 longer than second and third; all setose (Fig. 1D). **Thorax:** Scutum dark brown with a row of dorsocentral and lateral setae, scutellum light brown with scattered setae, anepimeron

setose, other pleural sclerites asetose. **Legs:** Tarsal claws with a small tooth in all legs, empodium rudimentary (Fig. 1E). **Wing:** Wing length: 0.15 mm in male; 0.17 mm in female (n = 2); R1 joining C at about wing midlength, CuA forked. (Fig. 1F).

Abdomen: Male (Fig. 2A): tergites 1-7 rectangular with a complete row of caudal setae, some lateral setae, two basal trichoid sensillae, and scattered scales. Tergite 8 unsclerotized with a row of caudal setae, trichoid sensillae and scales absent. Sternites 2-7 strap like sclerites with setae more abundant mesally, a complete row of caudal setae, some lateral setae and 2 basal trichoid sensilla, and scattered scales. Sternite 8 less sclerotized than preceding sclerites, setae, trichoid sensilla, and scales absent. Female (Fig. 2C): tergites and sternites as in male, except for tergites and sternites 1-7 wider than in male and tergite and sternite 8 unsclerotized with a row of setae each, trichoid sensillae and scales absent. Male terminalia (Fig. 2B): gonocoxites oblong, with dorso-lateral distal margin surpassing the insertion of gonostylus, setae concentrated at apex; gonostylus rectangular, stout, length 0.056-0.061 mm, width 0.024-0.027 mm (N = 2), with scattered setae, and setulae covering all gonostylus; aedeagus very long (1.2 times longer than hypoproct and 1.7 times longer than cercus); hypoproct bilobed, round, with a single long seta on each lobe and a row of setae

longitudinally in each lobe; cercus fused at base, deeply bilobed, round, covered by setae. Ovipositor: tergite 10 with a pair of long and strong setae, with lesser ones; cerci elongate-ovoid as shown in Fig. 2D-2E 0.15 mm long (N = 2).

Holotype: Male: BRAZIL, São Paulo: Jaboticabal (21°18.00'34.70"S, 48°19.39'25.92"W, 605 m), col. 10.iv.2017, Cruz, M.A. col., Urso-Guimarães, M.V. det. Slide mounted deposited in MZSP. **Paratypes:** Same data of holotype, except for: 8 ♂; 4 ♀, Cruz, M.A. col., Urso-Guimarães, M.V. det.; 1 specimen, BRAZIL, State of São Paulo: São Carlos (22°04'33.87"S, 47°48'37.59"W, 11.v.2017, 856 m a.s.l.), Cruz, M.A. col., Urso-Guimarães, M.V. det. Slide mounted deposited in MZSP.

Etymology: The name *saccharum* is based on the name of the sugarcane genus (*Saccharum*), cultivar in which the specimens of the new species was found prey on nymphs of *Saccharicoccus sacchari*.

Biology: Adults of *Diadiplosis saccharum* sp. nov. were reared from leaf sheaths on stem nodes of sugarcane (*Saccharum* spp.) with larvae of cecidomyiids preying on nymphs of *Saccharicoccus sacchari* (Fig. 3), which is a potential pest for Poaceae plant species, since sugarcane producers have reported frequent infestations in Brazil (Cruz et al., 2019).

Remarks: Despite the new species resemble the Neotropical *Diadiplosis*, *D. bellingeri*, *D. martinsensis* and

D. aleyrodici (Felt, 1922), with the eyes undivided, palp 4-segmented, tarsal claws toothed at base or not (except in *D. martinsensis*), cercus and hypoproct bilobed, *Diadiplosis saccharum* sp. nov. differ from all known species based mainly on the combination of the characters of male terminalia (Fig. 2B): gonocoxite oblong with the dorso-lateral distal margin surpassing the insertion of gonostyli, gonostylus rectangular and stout. The new species and *D. pseudococci* have prolongation of the dorso-lateral distal margin of gonocoxite after the insertion of gonostyle, but in this species, the prolongation is larger and shorter than in *D. pseudococci* (Fig. 4E). A long and triangular aedeagus is shared with *D. bellingeri* and *D. martinsensis*, but in the first, the hypoproct is deeper bilobed (Fig. 4G) than in the new species, and in the latter the aedeagus is smaller than hypoproct and cercus (Fig. 4F). The male terminalia of *D. saccharum* resembles the general shape of the *D. abacaxii* terminalia by the sclerotization, but they differ greatly in aedeagus, bulbous in *D. abacaxii* and regular in *D. saccharum*. In addition, they also differ in the number of segments of palpi, three in *D. abacaxii* and four in *D. saccharum*.

This is the first register of a cecidomyiid larvae preying on an insect pest on *Saccharum* spp. (Poaceae) – a major agricultural commodity in the tropics and used mainly for making sugar and ethanol for fuel. *Saccharicoccus sacchari* can be classified as an emergent pest in Brazil, since sugarcane producers have reported infestations frequently (Cruz et al., 2019). Further studies can indicate if the cecidomyiid can be used in biological control of *S. sacchari* in sugarcane plantation.



Figure 3. Stem nodes of sugarcane *Saccharum* spp. infested with nymphs of mealybugs *Saccharicoccus sacchari*.

Key to adult males of *Diadiplosis* distributed in Brazil (Modified of Culik & Ventura, 2013b)

- 1. Maxillary palp 3-segmented, aedeagus cylindrical 2
- 1': Maxillary palp 4-segmented, aedeagus triangular 4
- 2. Aedeagus longer than cercus and hypoproct, aedeagus bulbous (Fig. 4A) *Diadiplosis abacaxii* Culik & Ventura
- 2': Aedeagus approximately equal in length to hypoproct, aedeagus not bulbous (Fig. 4B) 3
- 3. Cercus, hypoproct and aedeagus equal in length, hypoproct shallowly bilobed (Fig. 4B) *Diadiplosis multifila* Felt
- 3': Hypoproct and aedeagus larger and longer than cerci, hypoproct deeply bilobed (Fig. 4C) *Diadiplosis jamboi* Culik & Ventura
- 4. Claws of legs 2 and 3 simple 5
- 4': Claws of legs 2 and 3 dentate 6
- 5. Hypoproct unilobed; aedeagus shorter than hypoproct and cerci, dorso-lateral distal margin of gonocoxite without prolongation (Fig. 4D)
..... *Diadiplosis coccidivora* (Felt)
- 5': Hypoproct deeply bilobed, aedeagus longer than hypoproct and cerci, dorso-lateral distal margin of gonocoxite with a long and narrow prolongation (Fig. 4E)
..... *Diadiplosis pseudococci* Felt
- 6. Aedeagus shorter than hypoproct (Fig. 4F) *Diadiplosis martinsensis* Culik & Ventura
- 6': Aedeagus much longer than hypoproct (Fig. 4G) 7
- 7. Gonostylus clavate and curved, dorso-lateral distal margin of gonocoxite without prolongation (Fig. 4G) *Diadiplosis bellingeri* Culik & Ventura
- 7': Gonostylus rectangular and stout, dorso-lateral distal margin of gonocoxite with prolongation after insertion of gonostyle (Fig. 2B)
..... *Diadiplosis saccharum* sp. nov.

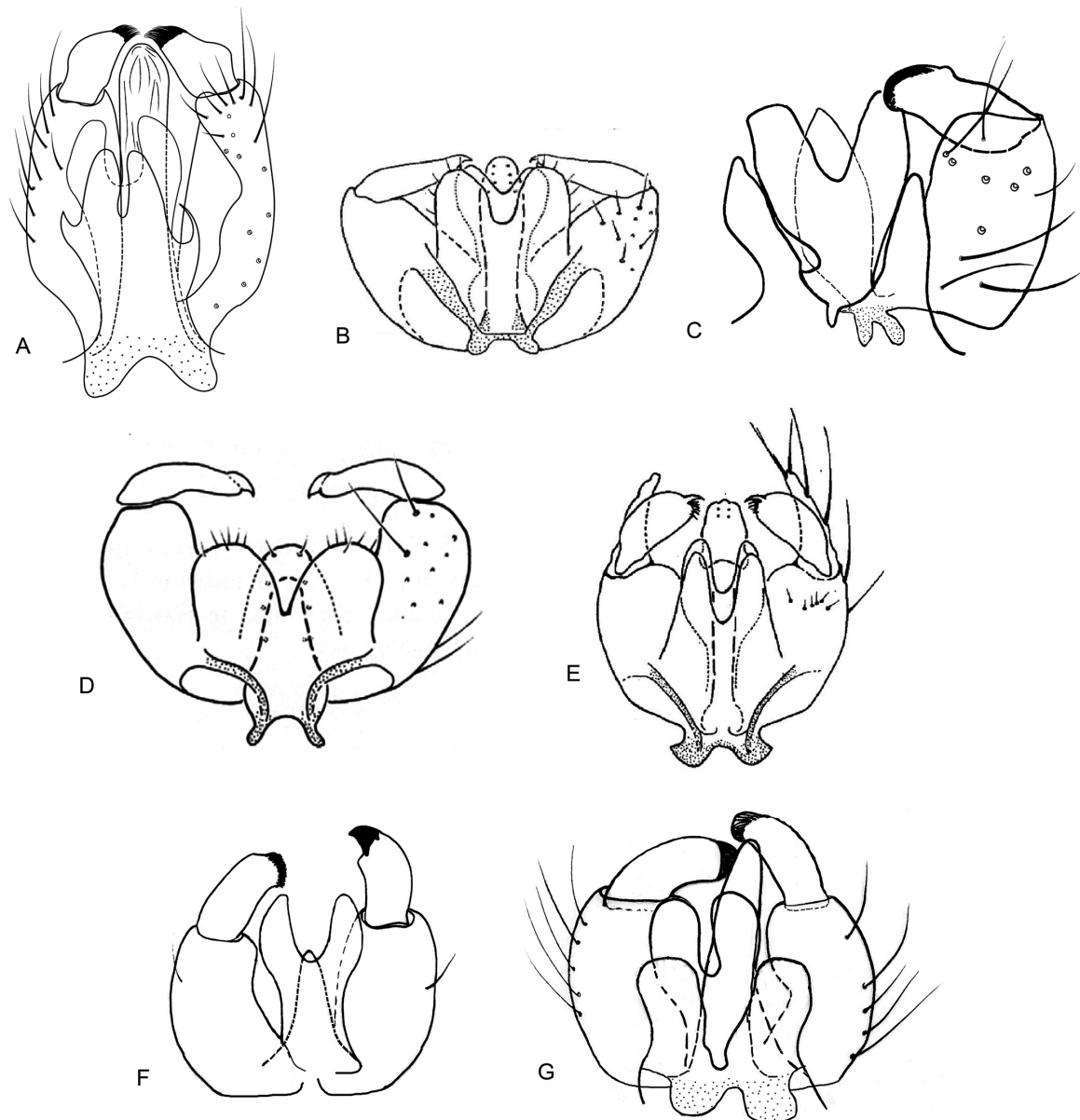


Figure 4. Male terminalia of *Diadiplosis* species. (A) *D. abacaxii*, (B) *D. multifila*, (C) *D. jamboi*, (D) *D. coccidivora*, (E) *D. pseudococci*, (F) *D. martinsensis*, (G) *D. bellingeri*. Illustrations B, D and E modified from Harris (1968); and C and F modified from Culik & Ventura (2013b).

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