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## Redescription of the immatures stages of *Forcipomyia (Phytohelea) bromelicola* (Lutz, 1914) (Diptera: Ceratopogonidae)

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The fourth instar larva and pupa of *Forcipomyia (Phytohelea) bromelicola* (Lutz) are redescribed and illustrated, and compared with immatures of *F. (P.) musae* Clastrier and Delécolle and *F. (P.) dominicana* de Meillon and Wirth. Both life stages were photographed using scanning electron microscopy and phase-contrast light microscopy. The immatures were collected from bromeliads in Florida, USA.

**Keywords:** Bromeliaceae; immatures; *Forcipomyia bromelicola*; *Forcipomyia musae*; phytotelmata

### Introduction

Bromeliads (Bromeliaceae) are a family of at least 2500 species of monocotyledonous plants mostly restricted to the Neotropical region including Mexico and southernmost USA. The complex architecture of some species traps water in leaf axils (forming phytotelmata) and harbours many species of invertebrate animals (Frank 1983).

Spinelli, Ronderos, Marino, Silveira Carrasco and Menezes Ferreira (2007) stated that the immatures of Ceratopogonidae are one of the most conspicuous inhabitants of phytotelmata environments. They fully described the preimaginal stages of *Forcipomyia (Phytohelea) musae* Clastrier and Delécolle, 1994 from leaf axils of banana stems in Brazilian Amazonia, comparing the adult with a very similar species, *Forcipomyia (Phytohelea) bromelicola* (Lutz, 1914). Unfortunately, the immatures of the latter species were poorly described by Saunders (1925) (as *Apelma bromelicola*) and consequently, a precise comparison between the species was not possible. De Meillon and Wirth (1979) defined the *F. bromelicola* species group.

Through the courtesy of Dr Lawrence Hribar, who kindly sent to us immatures of *F. (P.) bromelicola* collected from bromeliads in Florida, USA, we were able to study in detail its larval and pupal stages. The purpose of this paper is to redescribe and illustrate the fourth instar larva and pupa of this species, and to compare with the previously described immatures of *F. (P.) musae*.

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## Materials and methods

For microscopic observation, larvae were slide-mounted in Canada balsam with their ventral side upward to facilitate examination of the pharyngeal apparatus. Pupae were also slide-mounted in Canada balsam following the technique described by Borkent and Spinelli (2007). They were examined, measured, and drawn using a binocular microscope equipped with millimetre ocular and camera lucida. Photographs were taken with a Pentax Optio S 60, digital camera through a Leitz Wetzlar SM-LUX binocular light microscope, and the images processed in Photoshop 7.0. For scanning electron microscopy (SEM) the specimens were prepared following the technique of Ronderos et al. (2000). The ultrastructure of the fourth instar larvae and pupae was examined and photomicrographed by using SEM (JSM 6360LV). Terminology for immatures follows Spinelli et al. (2007) for *Forcipomyia*, with modifications in the following larval terms: ASL, anal segment length (instead of CSL); ASW, anal segment width (instead of CSW); and ASR, anal segment ratio (instead of CSR).

Studied specimens are deposited in the collection of the Museo de La Plata, Argentina (MLP).

## Results

### *Forcipomyia (Phytohelea) bromelicola* (Lutz, 1914) (Figures 1–36)

*Ceratopogon bromelicola* Lutz, 1914, p. 84 (male, female; Brazil); Floch and Abonnenc 1942, p. 2 (figures).

*Apelma bromelicola*: Saunders 1925, p. 263 (larva, pupa).

*Lasiohelea bromelicola*: Lane 1945, p. 360 (redescription, lectotype designation); Cavalieri 1962, p. 360 (comparison with other Neotropical species).

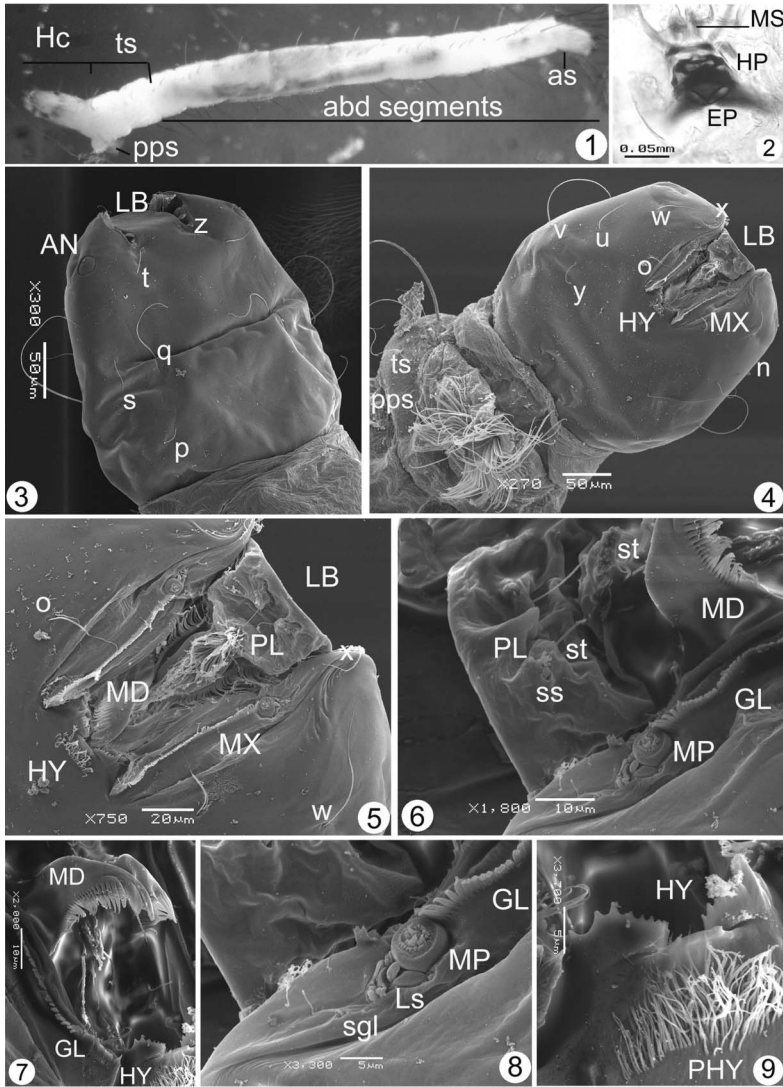
*Forcipomyia (Phytohelea) bromelicola*: Remm, 1971, p. 189 (combination, selection of the type-species of the subgenus); Wirth 1974, p. 9 (New World catalogue south of the USA); de Meillon and Wirth, 1979, p. 201 (in key); Borkent and Wirth 1997, p. 45 (World catalogue); Borkent and Spinelli, 2000, p. 20 (New World catalogue south of the USA); Grogan and Hribar 2006, p. 319 (USA record); Borkent and Spinelli, 2007, p. 56 (Neotropical catalogue).

*Specimens examined*. USA, Florida, Monroe Co., Shelter Key, Key Colony beach, 5-II-2007, C. Samul, ex bromeliad, 6 larvae, 1 ♂ pupa, 1 ♀ pupa, 1 ♂ pupal exuvia. *Specimens examined with SEM*. USA, Florida, Monroe Co., Shelter Key, Key Colony beach, 5-II-2007, C. Samul, ex bromeliad, 4 larvae, 2 ♂ pupae.

### *Redescription of fourth instar larva* (Figure 1)

*Exuviae*. Pale brown.

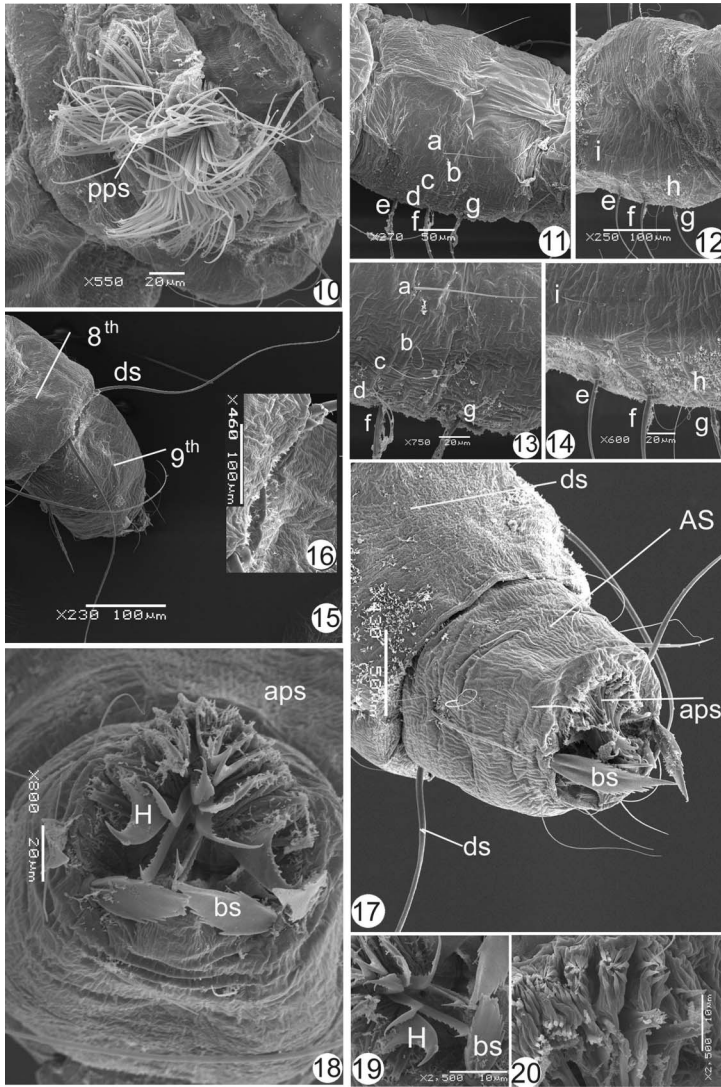
*Head capsule*. Brown, well developed, prognathous; HL 0.33 (0.31–0.34,  $n = 6$ ) mm; HW 0.27 (0.25–0.29,  $n = 6$ ) mm; HR 1.20 (1.14–1.29,  $n = 6$ ); SGW 0.22 (0.21–0.23,  $n = 6$ ) mm; SGR 1.22 (1.15–1.29,  $n = 6$ ). Head chaetotaxy (Figures 3 and 4) as follows: 10 sensory, thin setae, two pits; seta “p” short; seta “q” long; seta “s” medium-sized; seta “t” slightly shorter than “s”; seta “v” longer than q; two setae “o”, one long, other medium-sized; “n” pit simple; seta “u” medium-sized; setae “x” short; seta “y” short; seta “w” medium-sized; “z” pit simple. Antennae (Figure 3)



Figures 1–9. *Forcipomyia (Phytohelea) bromelicola*, larva. (1) Habitus (lateral view); (2) messors, epipharynx, hypopharynx; (3) head capsule (dorsal view); (4) head capsule (ventral view); (5) detail of head capsule (ventrofrontal view); (6) palatum (ventrolateral view); (7) mandible; (8) maxilla; (9) hypostoma. Chaetotaxy of head capsule: p: posterior perifrontal setae; q: postfrontal setae; s: anterior perifrontal setae; t: prefrontal setae; n: anterolateral pits; o: parahypostomal setae; u: mesolateral setae; v: posterolateral setae; w: anterolateral setae; x: parantennal setae; y: ventral setae. z: frontal pits; head capsule (Hc), thoracic segments (ts); abdominal segments (abd segments); anal segment (as); prothoracic pseudopod (pps); antennae (AN); labrum (LB); epipharynx (EP); hypopharynx (HP); hypostoma (HY); post-hypostomal area (PHY); mandible (MD); maxillary palpus (MP); galeolacinia (GL); lateral sclerite (Ls); messors (MS); maxilla (MX); palatum (PL); sensilla styloconica (ss); sensilla trichoidea (st); galeolacinia setae (sgl).

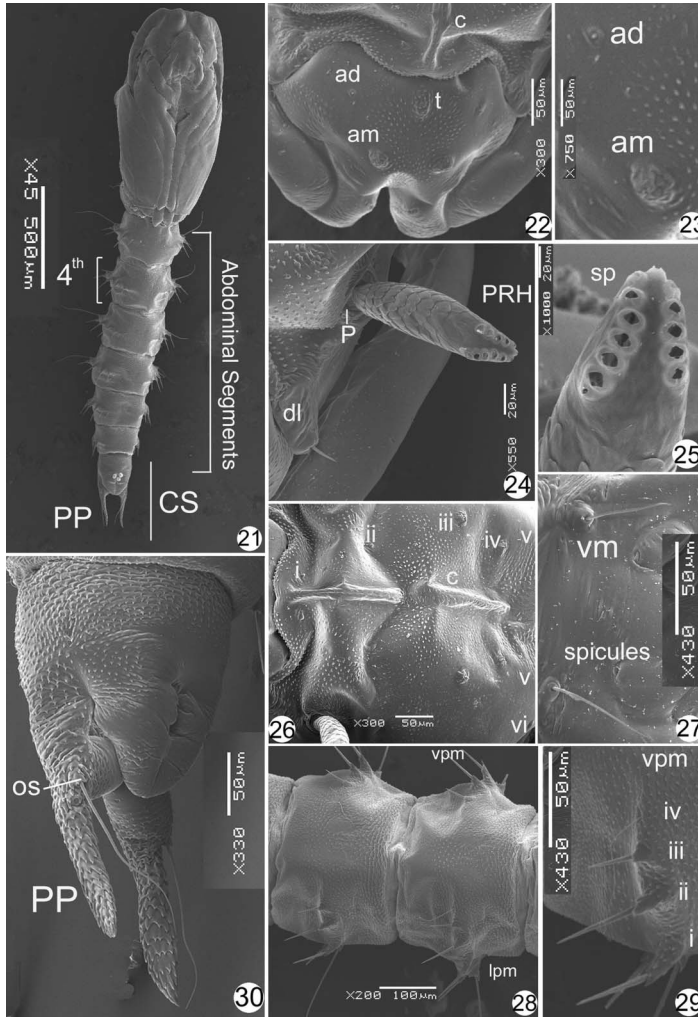
rounded, reduced. Labrum (Figures 3–5) short, not extending beyond hypostoma; palatum (Figures 5 and 6) with group of three sensillae styloconica on outer edge, one posteromedial sensilla trichoidea, behind these with tuft of sensillae trichodea of





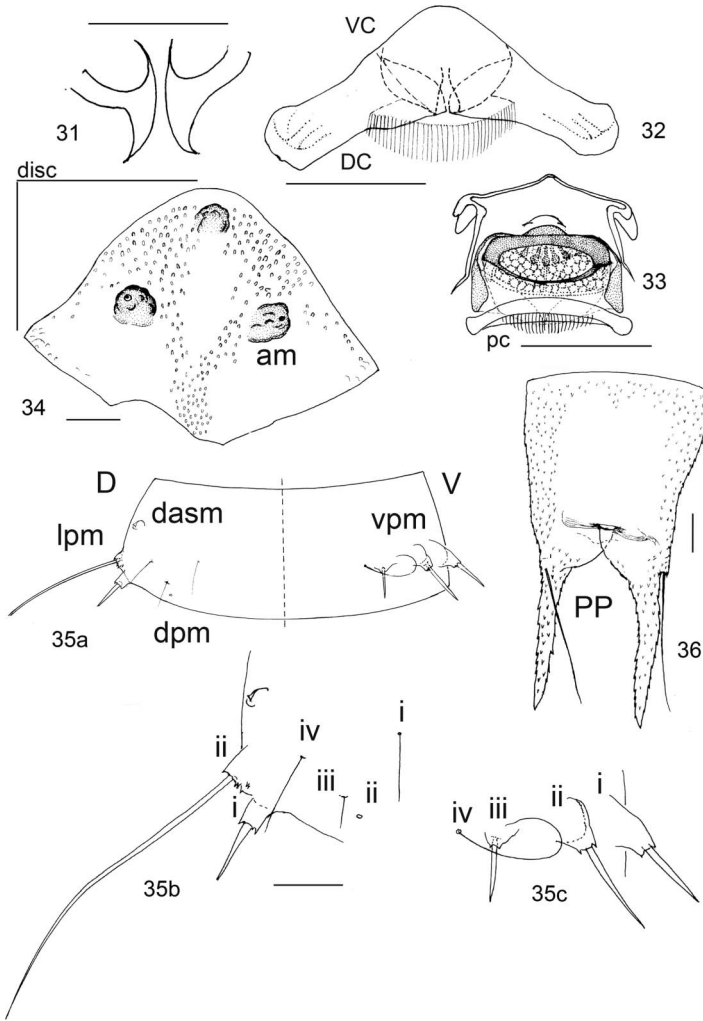
Figures 10–20. *Forcipomyia (Phytohelea) bromelicola*, larva. (10) First thoracic segment with prothoracic pseudopod (pps); (11) second abdominal segment (dorsal view) with setae a–g; (12) second abdominal segment (ventral view) with setae e–i; (13) detail of second abdominal segment (dorsal view) with setae a–g; (14) detail of second abdominal (ventral view) with setae e–i; (15) eighth abdominal segment and anal segment (dorsal view), dorsal setae (ds); (16) detail of insertion of the dorsal setae; (17) anal segment (ventral view); (18) pseudopod of anal segment (aps), hooks (H), blade setae (bs); (19) detail of hooks and blade setae; (20) detail of anal pseudopod.

different length; messors (Figures 2 and 31) stout, axe-shaped. Maxilla bilobed (Figures 4 and 5) with conspicuous basal fringe; galeolacinia (Figures 6–8) with stout, long seta; maxillary palp (Figures 6 and 8) rounded, flattened, with four small papillae, and lateral sclerite. Mandible (Figures 5–7) stout, not articulated with head capsule, with 21–23 teeth, apical one blunt, subapical one strong with apical hair, remaining ones elongated, slender; ML 0.11 (0.10–0.13,  $n = 6$ ) mm; MW 0.025



Figures 21–30. *Forcipomyia (Phytohelea) bromelicola*, pupa. (21) Habitus (ventral view), caudal segment (CS), posterolateral processes (PP); (22) operculum, anteromarginal tubercle (am), tubercle (t), anterodorsal tubercle (ad), crest (c); (23) detail of anteromarginal tubercle (am), anterodorsal tubercle (ad); (24) dorsolateral tubercle (dl), respiratory horn (PRH), pedicel (P); (25) respiratory horn (apical view), spiracles (sp); (26) dorsal tubercles, crest (c); (27) ventromedian (vm) setae, spicules; (28) fourth abdominal segment (ventral view), ventral posteromarginal tubercle (vpm), lateral posteromarginal tubercle (lpm); (29) detail of the fourth abdominal segment (ventral view), ventral posteromarginal tubercle (vpm); (30) male caudal segment (ventral view), posterolateral processes (PP), outer setae (os).

(0.024–0.026,  $n = 6$ ) mm. Hypostoma (Figures 4, 5, 7, 9) membranous; mesal portion broad, smooth, flanked by two strong teeth, each one bearing approximately 10 teeth, one of them conspicuous; post-hypostomal area with tuft of numerous setae. Epipharynx (Figures 2 and 32) massive, strongly sclerotised; ventral comb without fringe, dorsal comb with approximately 40–50 fine teeth; DCW 0.06 (0.05–0.07,  $n = 6$ ) mm; lateral arms short, stout. LAW 0.13 (0.12–0.15,  $n = 6$ ) mm.



Figures 31–36. *Forcipomyia (Phytohelea) bromelicola*, (31–33) larva; (34–36) pupa. (31) Messors; (32) epipharynx, dorsal comb (DC), ventral comb (VC); (33) hypopharynx, posterior comb (PC); (34) operculum, anteromarginal tubercle (am), disc; (35) fourth abdominal segment, (a) overview; details of (b) dorsal anterosubmarginal tubercle (dasm), dorsal posteromarginal tubercle (dpm), lateral posteromarginal tubercle (lpm), (c) ventral posteromarginal tubercle (vpm); (36) female caudal segment (ventral view) with posterolateral processes (PP). Scale bar = 0.05 mm.

Hypopharynx (Figures 2 and 33) quadrangular, stout, heavily sclerotised; lateral arms hyaline, thin; posterior comb curved, rounded laterally, with fringe.

*Thorax.* Prothoracic pseudopod (Figures 1, 4, 10) divided at midportion, each ramus with two rows of eight golden thorn-like hooks, 12–13 pairs of anterior hairs.

*Abdomen.* Chaetotaxy of second abdominal segment (Figures 11–14): dorsally with four setae, as follows: “a” long, stout; “b” short, thin; “c” as long as “a”, thin; “d”, medium-sized, thin, all with base poorly developed; ventrally, with five setae: three very stout (“e”, “f”, “g”) all longer than dorsal seta “a”, with base well developed; other two (“h”, “i”) very thin, “h” shorter than “a”, “i” short, both with

base poorly developed. Eighth abdominal segment (Figures 15–17) bearing very long dorsal setae measuring 0.33 (0.30–0.37,  $n = 6$ ) mm, arising from crossbar, surpassing anal segment; cuticle devoid of spicules. Anal segment (Figures 15, 17–20) with two dorsolateral, strong, blade-like setae, lateral margins serrate. Anal pseudopod (Figures 17–20) with four pairs of sclerotised hooks directed laterally, five pairs of medial hooklets; all hooks short, stout, with recurved tips; hooklets elongated, slender, slightly paler, with lateral margins serrate. ASL 0.185 (0.17–0.20,  $n = 6$ ) mm; ASW 0.17 (0.16–0.19,  $n = 4$ ) mm; ASR 1.08 (1.04–1.12,  $n = 4$ ).

### **Redescription of pupa**

*Male* (Figure 21). Length 2.82 mm; exuviae pale yellowish except cephalothorax brown.

*Cephalothorax*. Length 1.14 mm; width 0.75 mm. Operculum (Figures 22–23, 34) 0.5 as long as greatest width, apex broadly rounded; disc surface covered posteromesally by rounded spicules; anteromarginal tubercle (am) (Figures 22–23, 34) well developed, with minute seta, without basal sensillum; one anterior, strong tubercle (t) with rounded base, without seta; OL 0.12 mm; OW 0.23 mm; OW/OL 1.55. Cephalothoracic tubercles as follows: anterodorsal tubercle (ad) (Figures 22 and 23) small, rounded with minute seta; dorsolateral tubercle (dl) (Figure 24) stout, with one medium-sized, stout seta; dorsal tubercles (d) (Figure 26) poorly developed: i–ii rounded without seta, iii–iv with minute setae, v pore, vi flattened tubercle without seta. Respiratory horn (Figures 24 and 25) length 0.17 (0.17–0.18,  $n = 2$ ) mm; amber brown, with scale-like spicules on basal 3/4, with 12 apical spiracles; pedicel short, length 0.040 (0.030–0.050,  $n = 2$ ) mm; P/H 0.23 (0.18–0.28,  $n = 2$ ). Ventral setae (Figure 27): one ventromedian (vm) long, thin seta, one pore; stout spicule immediately underneath.

*Abdomen*. Segments (Figure 21) with scarce anterior spinules. Fourth abdominal segment (Figures 21, 28, 29, 35) with tubercles as follows: dorsal anterosubmarginal tubercle (dasm) with short, anteriorly-directed seta, triangular minute base; four dorsal posterosubmarginal tubercle (dpm): i,iv with long, thin seta, base poorly developed, ii pore, iii with medium-sized, thin seta, base poorly developed; lateral posteromarginal tubercle (lpm) stout setae, i medium-sized seta, base broad, tuberculate, ii very long seta, base broad, tuberculate, shorter than i; four ventral posteromarginal tubercles (vpm): i,ii with strong setae, triangular base, ii seta longer than i, iii with medium-sized strong seta, triangular small base, iv with very long, thin seta, base poorly developed. Caudal segment (Figures 21 and 30) length 0.38 mm, width 0.21 mm, approximately two times longer than width; ventrolateral surface with posteriorly directed spicules; posterolateral processes as long as base, tip pointed, base with outer long setae, genital processes ventral, stout, with distal wrinkles. Female: length 2.16 mm; cephalothorax length 0.99 mm; width 0.66 mm; caudal segment (Figure 36) length 0.36 mm, width 0.20 mm, as male except the sexual differences.

*Distribution*. USA (Florida), Trinidad, French Guiana, Brazil (Rio de Janeiro).

### **Discussion**

This species belongs to the *F. bromelicola* species group, as defined by de Meillon and Wirth (1979).



Adults of *F. (P.) bromelicola* resemble *F. (P.) musae* and *Forcipomyia (P.) dominicana* de Meillon and Wirth. Immatures of *F. (P.) musae* are also very similar to *F. (P.) bromelicola*, but can be distinguished from the latter by the larger larval head ratio (HR 1.394); palatum bearing two groups of sensilla trichoidea on medial surface; mandible armed with only seven teeth; membranous, entirely serrate hypostoma; lateral arms of epipharynx with basal teeth; massive hypopharynx; and second abdominal segment with only one dorsal seta. In the pupa of *F. (P.) musae*, the operculum lacks the tubercle anterior to the anteromarginal tubercle, and the fourth abdominal segment shows only two dorsal posterosubmarginal tubercles.

Since the description of the immatures of *F. dominicana* by de Meillon and Wirth (1979) is incomplete, it has been very difficult to properly compare its larva and pupa to those of *F. (P.) bromelicola*. Nevertheless, it was possible to establish that the larval head ratio of *F. (P.) dominicana* is larger, and that the posterolateral processes of the pupal caudal segment are slightly longer than its base.

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