

Mature Larvae of Euglossine Bees, a Comparative Study (Apoidea: Apidae: Euglossini)

JEROME G. ROZEN, JR.¹

ABSTRACT

Herein are described and illustrated the mature larvae of the following species assigned to the Euglossini: *Eufriesea surinamensis* (Linnaeus), *Eufriesea mussitans* (Fabricius), *Euglossa* (*Euglossa*) *cordata* (Linnaeus), *Eulaema* (*Apeulaema*) *polychroma* (Mocsáry). They are compared both with one another and with previous accounts of other taxa assigned to the tribe, and a taxonomic key is presented. The paper concludes with a preliminary larval characterization of the tribe.

INTRODUCTION

About 15 years ago in connection with their study of the cleptoparasite *Exaerete smaragdina* (Guérin-Méneville), Garófalo and Rozen (2001) presented a description of the mature larvae of the Euglossini based on previously described representatives. Since then a number of additional euglossine mature larvae have come to light. They are described below, enabling an expanded and improved interpretation of the larvae of the tribe.

¹ Division of Invertebrate Zoology, American Museum of Natural History.

METHODS

To study these larvae, specimens are first removed from storage vials and carefully examined with a stereomicroscope, after which they are illustrated with the use of a camera lucida and stereomicroscope. Each is then cleared as follows: the head is removed from the body and both parts are boiled in an aqueous solution of sodium hydroxide until all opaque tissue is removed. The two parts are transferred to 75% ethanol, stained with Chlorazol Black E, and in the end placed in glycerin on a well slide for study and eventual storage. Illustrations are augmented after examination of the cleared specimens, and necessary microphotographs are taken of spiracles and other important features with a Canon Power Shot A2300 camera hand held to the eyepiece of a Carl Zeiss compound microscope. Setae are represented only in diagrams of heads in lateral view. Arrows in diagrams identify positions of dorsolateral paired spines on thorax (and first abdominal segment when present). All scale bars = 1.0 mm and refer only to lateral views of larvae. ATP = anterior tentorial pit.

SPECIAL ANATOMICAL FEATURES

Presented here are interpretations and descriptions of important anatomical features that have come to light while studying the larvae described below. Mature larval representatives of all genera that have been collected possess an extremely robust shape accentuated by a small head borne on an elongate tapering prothorax. This would seem to enable the larva to retract its head into the thorax as demonstrated by figures 6 and 7 showing predefecating larvae actually doing so. However, the more likely adaptive function of the elongate prothorax is the following: observations of pupal structures developing within that last larval instar reveal that the elongation of the prothorax accommodates the extremely long labiomaxillary structures of the developing pupa (and future adult) that characterize this tribe. This was nicely illustrated by Camargo in Zucchi et al. (1969a: fig. 3) for *Euglossa* (*Glossuropoda*) *intersecta* (Latreille).

The presence of the darkly pigmented, apical spines on the paired sublateral dorsal mounds of the three thoracic segments (such as in figs. 1, 8, 20, 27, and Garófalo and Rozen, 2001: fig. 29) is an uncommon feature among bee larvae (but see below). However, it is characteristic of known mature larvae of all Euglossini (Michener, 1953; Roberts and Dodson, 1967; Zucchi et al., 1969a, 1969b; Garófalo and Rozen, 2001). Although we have yet to observe how they function, their position on the dorsal surface of the larva suggest that they may brace the body surface against the brood chamber wall as the larva moves around the cell perhaps during feeding, defecation, and/or cocoon spinning. It is unknown if these features are evident on earlier instars of *Eufriesea*, *Euglossa*, and *Eulaema*, but these paired pigmented spines are restricted to the last larval instar of *Exaerete smaragdina* in that instars 1–4 lack them (Garófalo and Rozen, 2001). This suggests that all euglossines may exhibit these structures only as last larval instars. Furthermore, it supports the hypothesis that the spines assist the larva in some activity associated with and restricted to this instar, such as defecation, cocoon production, or simple reorientation so that the pupa faces the front of the cell allowing for future adult egress.

A close examination of the spines reveals that they vary in shape, even on a single specimen, although those of a pair on any one segment match. In some cases they are simple tapering short points, but at the other extreme they may be narrow, sclerotized, cleatlike ridges (figs. 24, 25) extending transversely to the larva's long axis. Sometimes they are accompanied by a number of small, sclerotized spiculelike projections that may also be pigmented. While spines are generally well pigmented, pigmentation may be more pronounced on older last instars, and pigmentation may possibly be reduced when specimens are cleared for examination.

All taxa examined for this study exhibited scattered fine setae, numbering perhaps 8–10, close to each spine. It is unknown whether these are sensory in nature or assist with the mechanical function of the spine, but a fine channel leading from the alveolus inward through the integument suggests the former.

The integument of mounds bearing these spines seems similar to the paired mound of the caudal annulets of the abdomen, but it is more ridged, lacks regular spicules as found on other parts of body integument and stains darkly (fig. 15) when cleared and treated with Chlorazol Black E. As pointed out below, paired mounds each with a pigmented spine essentially like the ones on the thorax are also found on abdominal segment 1 of *Euglossa*.

Although these paired dorsal mounds, each with a darkly pigmented, small, sclerotized apical spine, are an uncommon feature among bee larvae, similar ones have been reported on the thoraces of *Bombus* and some other corbiculate apids (e.g., Michener, 1953). At least in the case of *Bombus (Fervidobombus) pensylvanicus* (DeGeer), the apical spines are simple tapering projections that are not transverse and the mounds are more defined. However, the mounds are positioned on the thorax exactly as in the Euglossini, their integument stains darkly with Chlorazol Black E, contrasting with the integument elsewhere, and each bears several small setae.

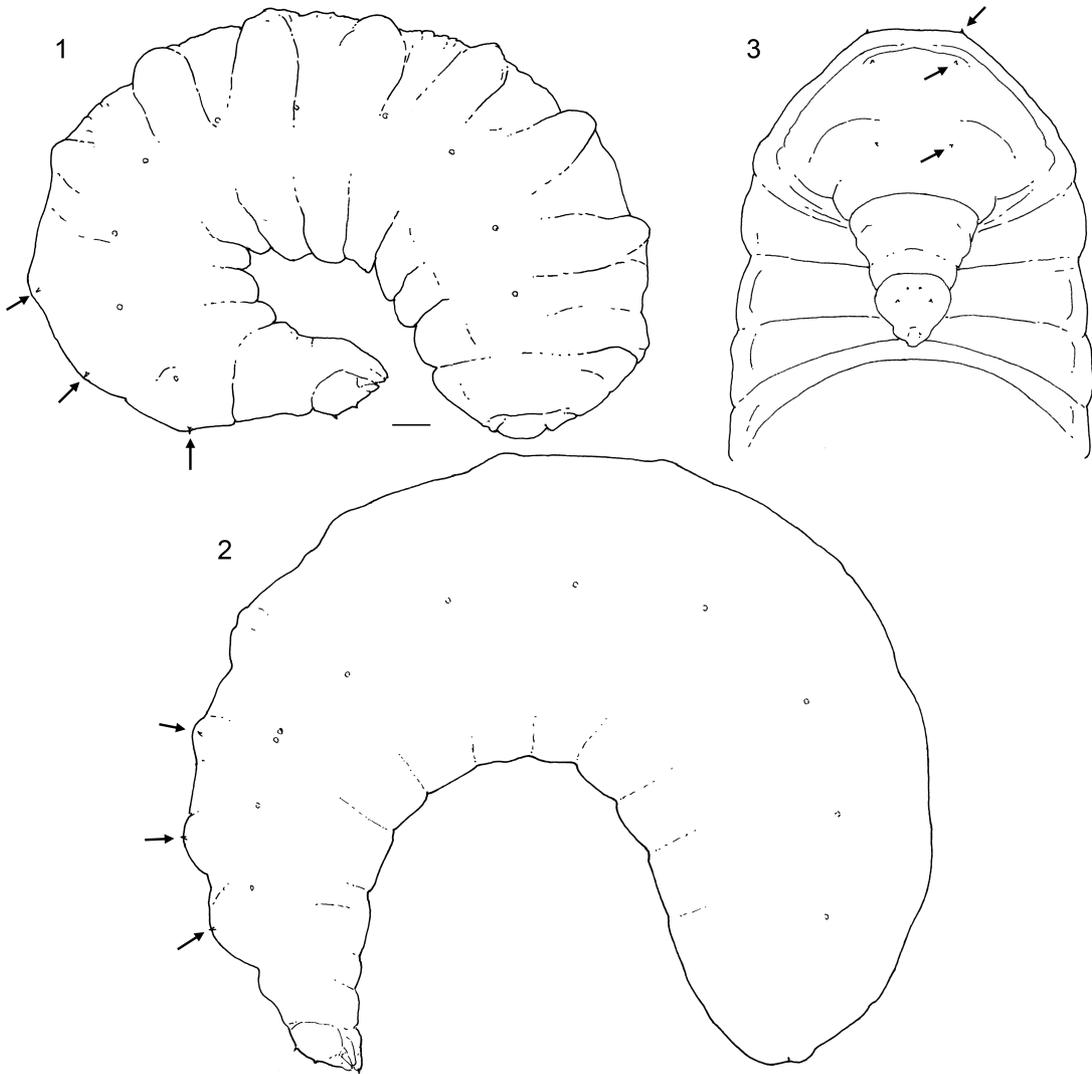
An unusual feature of the mature larva of *Euglossa* and *Eufriesea* are the paired sclerotized tubercles borne on the front of the cranium. Because the tubercles of cranium and thoracic mounds align on each side when viewed dorsally (fig. 3), it will be interesting to learn whether their function is interrelated.

Abdominal segments of all euglossines lacking spine-bearing mounds tend to have sublateral dorsal moundlike swellings arising from most caudal annulets. However, the integument of the swellings is no stiffer and does not stain more strongly than the surrounding integument and therefore cannot be confused with spine bearing mounds. Bodies of all mature larvae in this study are without intersegmental middorsal tubercles and thereby contrast with mature larvae of many Megachilidae (Rozen and Praz, in press).

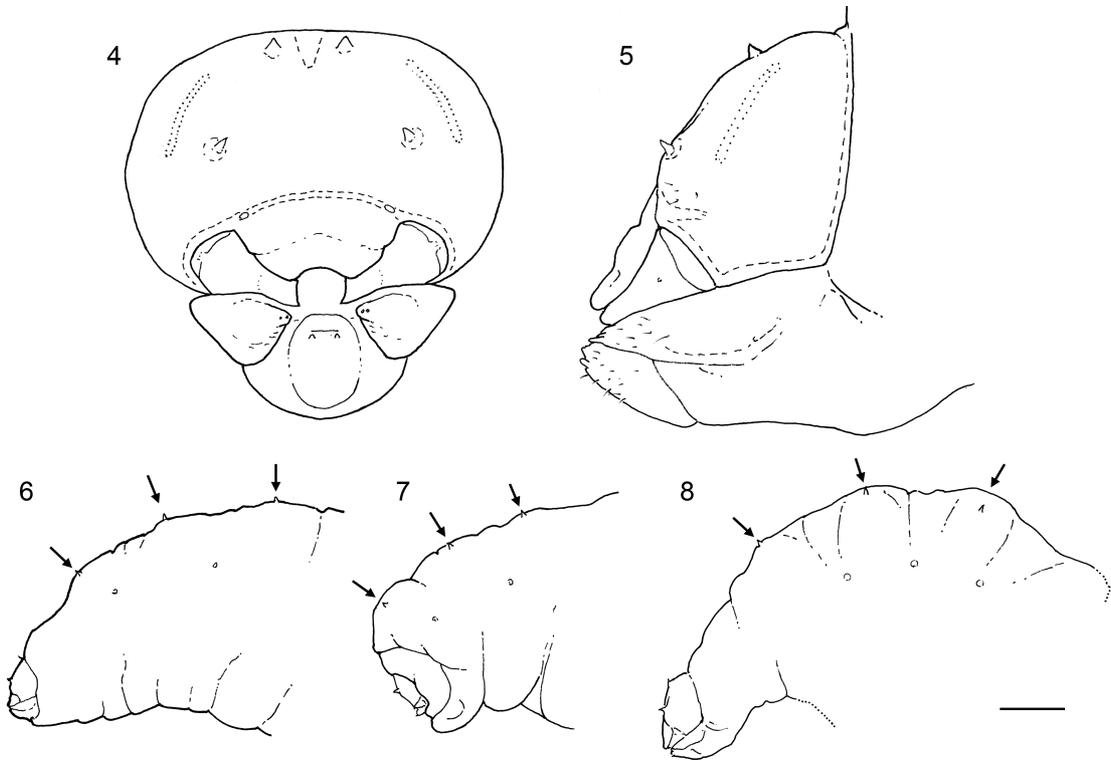
KEY TO KNOWN LARVAE OF EUGLOSSINE GENERA

Larval representatives of four of the five genera assigned to the Euglossini can now be compared: *Eufriesea*, *Euglossa*, *Eulaema*, and *Exaerete*. The larva of only *Aglae* remains unknown.

1. Vertex of head with paired pigmented paramedian pointed tubercles (figs. 4, 18)....2
– Vertex of head without tubercles (fig. 28; Garófalo and Rozen, 2001; fig. 34)....3



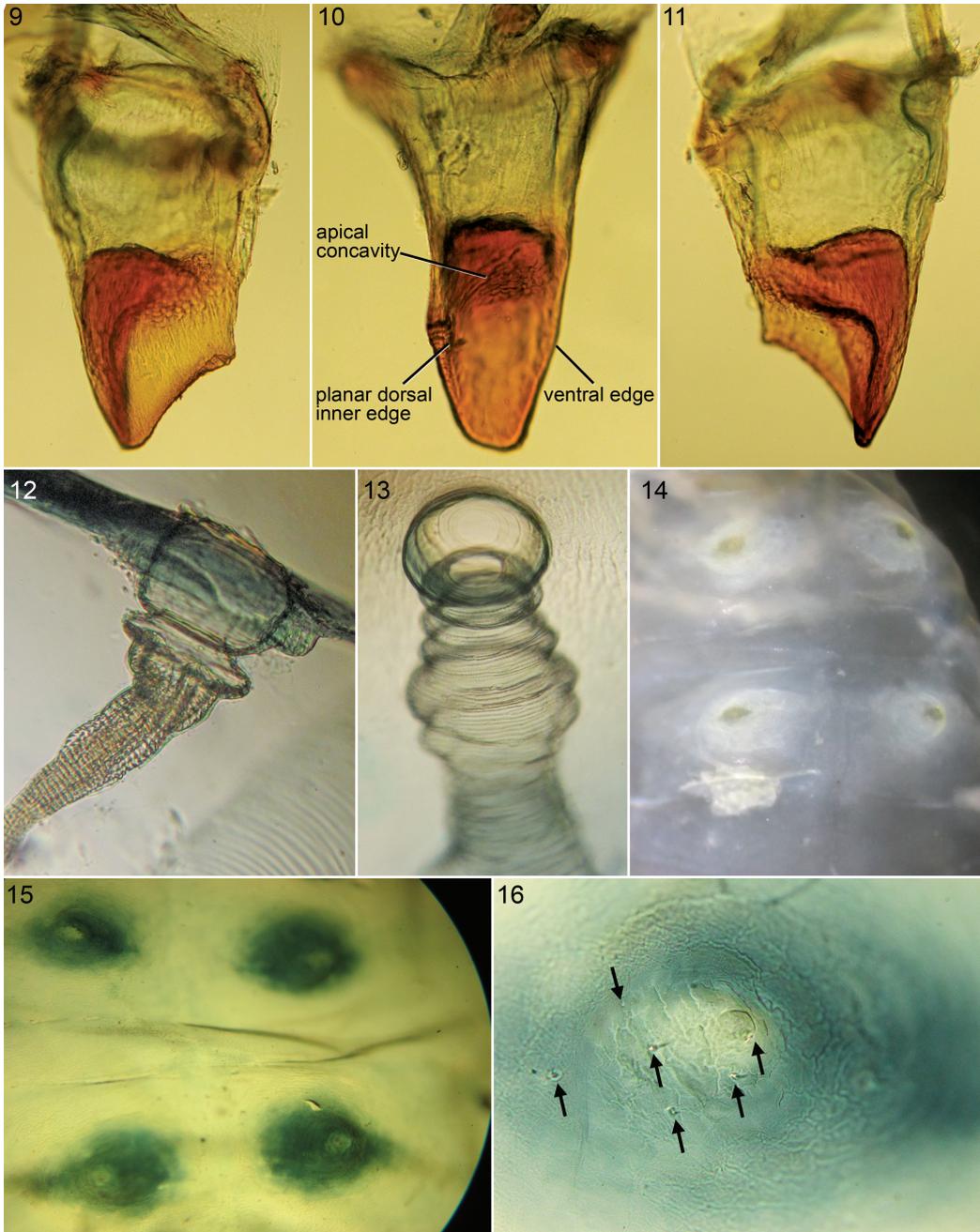
FIGURES 1–3. Diagrams of mature larvae of *Eufriesea surinamensis*. 1. Postdefecating larva, lateral view. 2. Predefecating larva, lateral view. 3. Front end of postdefecating larva, dorsal view. Scale bar applies to figures 1–3.



FIGURES 4–7. Additional diagrams of mature larvae of *Eufriesea surinamensis*. 4, 5. Head, frontal and lateral views, respectively. 6, 7. Front end of predefecating larvae, demonstrating contraction of head into thorax, lateral views. FIGURE 8. Diagram of front end of postdefecating larva of *Eufriesea mussitans*, lateral view. Scale bar refers only to figure 8.

frontal view (fig. 4); labrum lacking transverse sclerite, such as found in many Megachilidae (Rozen et al., submitted, fig. 3); labral apex faintly bilobed (fig. 4).

Mandible (figs. 9–11) robust in dorsal and ventral views, tapering somewhat apically with apex rounded (fig. 10); approximate apical half of mandible darkly pigmented. Apical concavity large and well formed, directed slightly ventrally; dorsal inner edge of concavity narrowly planar from cusp to apex, with planar surface finely toothed; ventral inner edge narrowly, thinly rounded; apical inner surface of concavity rather smooth but at base becoming coarsely pebbled or denticulate (fig. 10). Outer surface of mandible near base with small tubercle lacking seta. Labiomaxillary region elongate as seen in lateral view, so that apex extending forward but narrowing in profile (fig. 5); cardo and stipital rod sclerotized but not extensively pigmented; articulating arm of stipes darkly pigmented; maxilla narrowing apically, its surface well supplied with rather short setae; maxillary palpus and galea positioned at maxillary apex, with galea adoral to palpus; maxillary palpus slender, elongate, perhaps more than three times longer than basal diameter; galea elongate with long apical setae, about as diagrammed for *Exaerete*



FIGURES 9–16. Microphotographs of mature larvae of *Eufriesea surinamensis*. 9–11. Right mandible, dorsal, inner, and ventral view, respectively. 12. Spiracle of postdefecating larva, side view, showing subatrium nearly as wide at atrium, and short collar to primary tracheal opening. 13. Spiracle of predefecating larva, illustrating differences with that of postdefecating larva. 14. Dorsal surface of meso- and metathoracic segments on cleared but unstained specimen on which the pigmented apical tubercles can be seen. 15. Dorsal surface of meso- and metathoracic segments on cleared and stained specimen. 16. Close-up of one mound on cleared and stained thoracic segment showing slightly pigmented sclerotized, nipplelike spine surrounded by short setae (arrows).

smaragdina (Garófalo and Rozen, 2001: fig. 37).² Labium elongate, clearly divided into prementum and postmentum, with surface of both faintly sclerotized; labial palpus slender, elongate, length at least two times basal diameter. Salivary lips projecting, rather narrowly transverse. Hypopharynx consisting of two lobes with rough surface bearing spicules.

Body (figs. 1–3): Body vestiture and pigmentation described below. Body form of postdefecating larva extremely robust with rear part (abdominal segments 6–8) greatly enlarged in lateral view (fig. 1); thorax narrowing and attenuating from posterior to anterior in lateral and dorsal views (figs. 1, 3), resulting in extremely elongate prothorax (see Special Anatomical Features above); most body segments of postdefecating larval divided dorsally into cephalic and caudal annulets with each caudal annulet tending to be slightly more extended sublaterally than its cephalic annulet; thus caudal annulets tending to be slightly enlarged sublaterally when viewed from above, as in Garófalo and Rozen (2001: fig. 11); those of thorax scarcely projecting dorsally, so that each appearing as dorsal sublateral mound (too vague to be termed tubercle). Each sublateral mound of thorax bearing small, darkly pigmented, sometimes sharp sclerotized spine; this projection often appearing somewhat transverse and other times with one or two smaller projections occurring laterad to main spine; apical spine of each mound surrounded by large uneven nonpigmented area bearing fine scattered setae (fig. 16) numbering perhaps 8–10 per mound; when cleared and stained, entire dorsal surface of mound darkly staining (fig. 15), suggesting thicker, stronger sclerotization than body integument elsewhere; dorsal surface of sublateral swellings of caudal annulets of abdominal segments lacking thicker integument and not staining darkly, without pigmented apices and setae. Body form of predefecating larva (fig. 2) appearing greatly enlarged but similar, except paired dorsal sublateral mounds on three thoracic segments now more elevated; distinction between cephalic and caudal annulets of abdomen scarcely evident. On both pre- and postdefecating forms: body vestiture consisting in many areas of regular pattern of minute spicules (so small as to be seen only with compound microscope) in addition to setae on mounds of thorax. Abdominal segment 10 attached to approximate middle of segment 9; anus positioned dorsally on abdominal segment 10, short distance below dorsal ridge that identifies meeting of dorsal and posterior surfaces.

Spiracles (figs. 12, 13) moderately small, faintly pigmented, subequal in diameter; atrium somewhat wider than depth, projecting somewhat beyond body wall, with distinct rim; atrial wall faintly concentrically ringed; first chamber of subatrium, forming short collar into atrium, almost as broad as atrium; remainder of subatrium consisting of numerous, weakly sclerotized annulations that vary in width depending on preservation until they meet trachea. Sex-specific characters unknown.

MATERIAL STUDIED: Two postdefecating larvae: West Indies: Trinidad: Blandaria, I-02-1965 (F.D. Bennett) in sea cliff just above high-tide mark. Five predefecating larvae: West Indies: Trinidad: Queens Ranch Hotel, Plaisanes, VIII-1966 (no collector listed, but probably F.D. Bennett).

² On several specimens these structures as well as the antennal papilla were broken off, so that at first they appeared to be absent.

REMARKS: Bennett (1972) described the nesting biology of this species near Blandaria, on the eastern shore of Trinidad.

Postdefecating Larva of *Eufriesea mussitans* (Fabricius)

Figure 8

Because specimens described below were in poor condition, it was impossible to provide an accurate diagram of an entire larva. Because these larvae were indistinguishable from those of *Eufriesea surinamensis*, a second description here would be redundant.

MATERIAL STUDIED: Three postdefecating larvae: West Indies: Trinidad: Cumuto, III-21-1964 (F.D. Bennett).

Genus *Euglossa* Latreille

The three species of *Euglossa* in the key share the telltale pair of dorsal spines on the first abdominal segment. Although the head capsule of both *Euglossa cordata* (fig. 18) and *Eug. imperialis* (Roberts and Dodson, 1967: figs. 9, 10) are unusually broad in frontal view, this feature can not be evaluated for *Eug. intersecta* from Zucchi et al. (1969a: fig. 4B). Interestingly, although Zucchi et al. (1969a) clearly state that the paired dorsal spines of *Eug. intersecta* are present on the first abdominal segment, they are not depicted in their figure 3.

Predefecating Larva of *Euglossa (Euglossa) cordata* (Linnaeus)

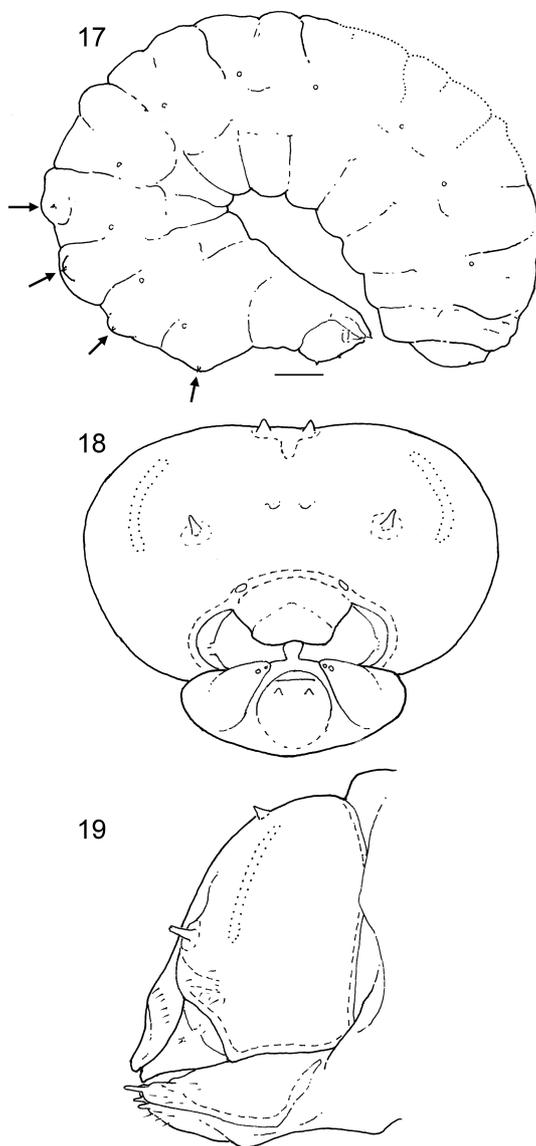
Figures 17–21

DIAGNOSIS: See: Key to Known Larvae of Euglossine Genera, above.

DESCRIPTION: **Head** (figs. 18, 19): Setae as described for *Eufriesea surinamensis*, but tending to be shorter. Pigmentation pattern as described for *Euf. surinamensis*, but staining necessary to accentuate sclerotized areas because of fainter pigmentation of predefecating form. Hypopharynx and internal head ridges as described for *Euf. surinamensis* except tentorium missing presumably because of impending ecdysis. Vertex bearing paired, pigmented, well-developed, apically pointed tubercles, as in *Euf. surinamensis*. Parietal bands, antennal prominence, curvature of cranium above prominence, and antennal papilla as described for *Euf. surinamensis*, except papilla distinctly longer than basal diameter. Clypeus, labrum, and labial apex as described for *Euf. surinamensis*.

Mandible (fig. 20) as described for *Euf. surinamensis* except angle of cusp in dorsal view somewhat more acute (arrow) and outer surface of mandible with several small seta-bearing tubercles. Other mouthparts as described for *Euf. surinamensis*.

Body (figs. 17, 21): Over all body form (fig. 17) almost identical to that described for larva of *Eufriesea surinamensis* although only predefecating larva of *Euglossa cordata* known. Thoracic segments with paired sublateral mounds each with small, darkly pigmented spines as described for *Euf. surinamensis*, but, unlike in that species, abdominal segment 1 also with caudal annulet bearing pair of sublateral mounds each with small sclerotized spine; these spines similar to those of thoracic mounds though sometimes less pigmented; surface of all paired mounds also uneven and distinctly darkly staining with treatment of Chlorazol Black E and



FIGURES 17–19. Diagrams of predefecating larva of *Euglossa (Euglossa) cordata*. **17**. Entire larva, lateral view. Scale bar refers only to figure 17. **18**, **19**. Head, frontal and lateral views, respectively.

bearing scattered small setae. Dorsal body integument with regular pattern of spicules that are larger and more obvious than spicules of *Euf. surinamensis*; these spicules becoming less numerous on sides of body and absent on venter. Rear of abdomen as described for *Euf. surinamensis*.

Spiracles (fig. 21) as described for *Eufriesea surinamensis* except atrium in side view deeper, tapering more toward primary tracheal opening; first two chambers of subatrium well sclerotized and distinctly narrower than atrium. Sex-specific characters unknown.

MATERIAL STUDIED: The three larvae available for study were rather badly distorted. The one selected for illustration and careful examination was least distorted. On dissection it was found to be a predefecating form. West Indies: Trinidad: II-04-1964 (F.D. Bennett), Nest 9.

REMARKS: Roberts and Dodson (1967: 1011) stated that larvae of the subgenus *Euglossa* and of the genus *Euplusia* (now *Eufriesea*) could be differentiated from those of the subgenus *Glossura* (of *Euglossa*) because only those of *Glossura* had "a pair of conical, sclerotized, dorsolateral tubercles on the first abdominal segment that the others lack." As *Eug. (Euglossa) cordata* here demonstrates that is not true. It is unknown what species of the subgenus *Euglossa* they had examined; the larvae of none had been described at that time (McGinley, 1989). Possibly they had overlooked the sharp projections (tubercles) because of lack of pigmentation, and almost certainly they were unaware of the thickened integument of the mounds since there is no mention of staining or even clearing of specimens for study, or this character is unreliable for subgeneric identification.

Genus *Eulaema* Lepeletier

Zucchi et al. (1969b) compared the mature larva of *Eulaema (Apeulaema) nigrita* Lepeletier with those of other euglossines. In that paper the larva was reported to have no body setae, but it seems likely they may have been overlooked since setae, though minute, were detected and associated with thoracic spines in *Eul. polychroma* (see below). Both species share the distinctive subapical tooth on the lower edge of the apical concavity.

Mature Larvae of *Eulaema (Apeulaema) polychroma* (Mocsáry)

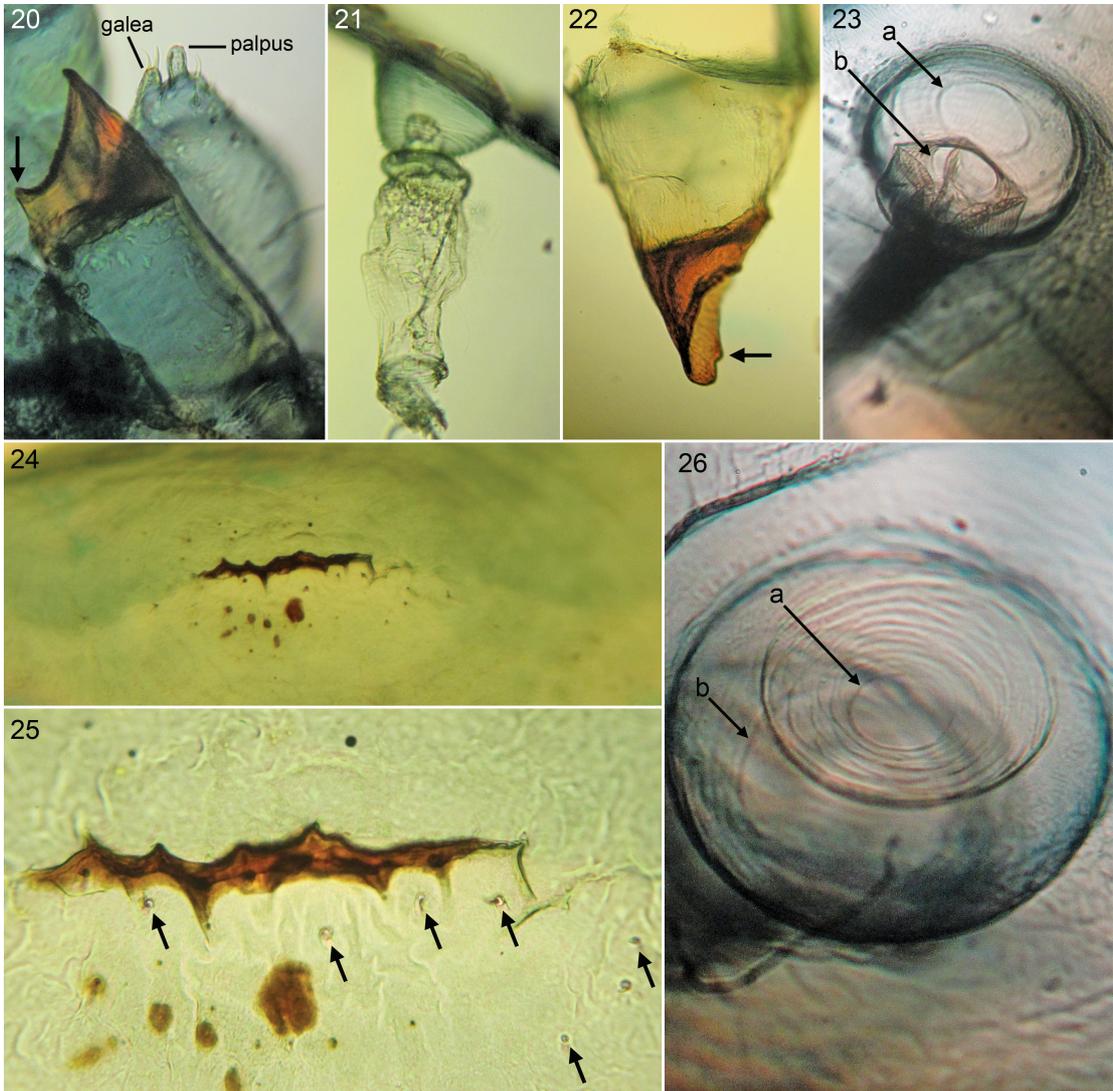
Figures 22–25, 27–29

DIAGNOSIS: See: Key to Known Larvae of Euglossine Genera, above.

DESCRIPTION: **Head** (figs. 28, 29): Integument vestiture and pigmentation about as in *Eufriesea surinamensis* except spiculation somewhat denser. Coronal ridge evident extending part way to level of antenna, farther than in *Euf. surinamensis*; other internal head ridges as in *Euf. surinamensis*. Vertex without paired, pigmented, apically pointed tubercles. Other head features as described for *Euf. surinamensis*.

Mandible (fig. 22) as described for *Euf. surinamensis* except the ventral edge of the apical concavity with a subapical tooth (arrow).

Labiomaxillary region as described for *Euf. surinamensis*, except salivary lips extremely broad, wider than distance between outside edges of bases of labial palpi.



FIGURES 20, 21. Microphotographs of mature larvae of *Euglossa* (*Euglossa*) *cordata*. **20**. Right side of mouthparts, seen from above, demonstrating acutely angled mandibular cusp (arrow) and elongate galea with elongate apical setae, and **21**. spiracle, side view, showing deep, tapering atrium. FIGURES 22–25. Microphotographs of mature larvae of *Eulaema* (*Apeulaema*) *polychroma*. **22**. Mandible, near dorsal view but turned to accentuate subapical tooth (arrow) on ventral edge. **23**. Spiracle, oblique external view, with arrow **a** pointing to the perimeter of the atrial opening and arrow **b** to that of the slightly smaller primary tracheal opening. **24**. One of the thoracic paired dorsal mounds with a transverse sclerotized apical spine with **25**. close-up showing setae (arrows). FIGURE 26. Photomicrograph of spiracle of mature larvae *Exaerete smaragdina*, oblique external view, with arrow **a** pointing to the perimeter of the atrial opening and arrow **b** to much larger tracheal opening.

Body (fig. 27): Entire body form (including terminal abdominal segments) of postdefecating larva as described for *Euf. surinamensis*, as in that species only thoracic segments bearing paired pigmented small spines on darkly staining mounds. Dorsal integument of body extremely finely spiculate although mounds of thorax not spiculate; setae of mounds minute, scattered but distinctly present.

Spiracles (fig. 23) moderate in size, somewhat larger than those of *Eufriesea surinamensis* and *Euglossa cordata*, moderately pigmented, subequal in diameter; atrium distinctly wider than depth, projecting somewhat beyond body wall, with distinct rim; atrial wall scarcely concentrically ringed; atrial opening slightly larger than primary tracheal opening. Sex-specific characters unknown.

MATERIAL STUDIED: Two postdefecating larva and 1 mature larvae:³ PERU: Lima Dept.: San Bartolome, V-10-1996 (J.G. Rozen, A. Ugarte, M. Laime).

Genus *Exaerete* Hoffmannsegg
Mature Larvae of *Exaerete smaragdina* (Guérin-Méneville)
Figure 26

DIAGNOSIS: See: Key to Larvae of Euglossine Genera, above.

Rozen (in Garófalo and Rozen, 2001) documented and fully illustrated the pre- and post-defecating larvae of this cleptoparasitic bee as well as its four earlier instars, pupa, and egg. The material came from the nest of one of its two documented hosts, *Eulaema (Apeulaema) nigrita* Lepeletier. The description is not repeated here, but a photomicrograph of its spiracle, showing a very small atrial opening contrasting with the large primary tracheal opening (fig. 26), is presented.

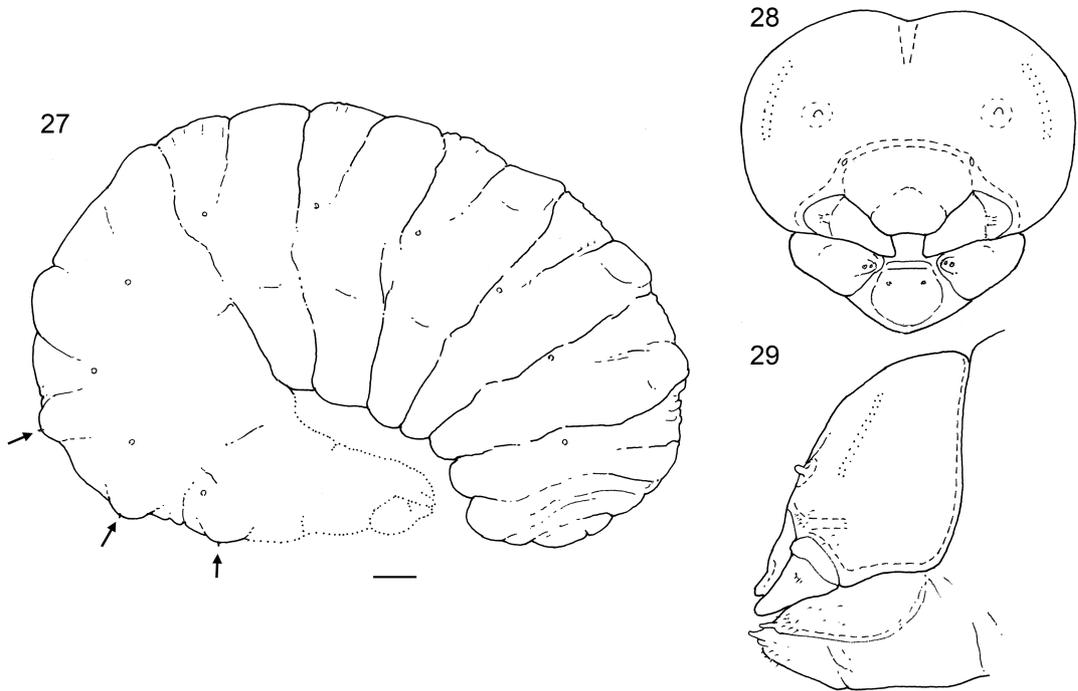
Mature Larva of *Exaerete dentata* (Linnaeus)

DIAGNOSIS: See: Key to Larvae of Euglossine Genera, above.

Known only from a caste exoskeleton, the specimen is inadequate to be described here. However, there is little question that the larva of this species is similar in most respects to that of *Exaerete smaragdina* described by Garófalo and Rozen (2001). Features of the head capsule are missing and the postcephalic integument is flattened. However, mouthparts (mandible, labium, maxilla) are completely intact as are the spiracles. These parts are clearly like those of *Ex. smaragdina* including the huge primary tracheal opening contrasting with the unusually small atrial orifice surrounded by a peritreme with a pattern of ridges concentric with that opening as seen in figure 26.

MATERIAL STUDIED: One caste exuviae of postdefecating larva with pupa undergoing ecdysis: West Indies: Trinidad: Caratal-Cumuto, II-1964 (F.D. Bennett), from cell of *Euplusia* (= *Eufriesea*) *surinamensis*.

³ With such robust larvae as those of the Euglossini, distinction between pre- and postdefecating forms often requires examination of gut content, which in turn often requires clearing and/or dissection.



FIGURES 27–29. Diagrams of postdefecating larva of *Eulaema* (*Apeulaema*) *polychroma*. 27. Entire larva, lateral view. Scale bar refers only to figure 27. 28, 29. Head, frontal and lateral views, respectively.

PRELIMINARY DESCRIPTION OF THE MATURE LARVA OF THE TRIBE EUGLOSSINI

DESCRIPTION: Head: Integument with scattered fine setae. Apex of mandibles and areas of mandibular articulation pigmented; sclerotized areas of head capsule and mouthparts including pre- and postmentum faintly pigmented on postdefecating larva. Hypopharynx and dorsal surface of maxillae finely spiculate. Coronal ridge varying in length depending on taxon but not extending to midsection of epistomal ridge; postoccipital ridge well developed; as seen from above, this ridge extending nearly directly across cranium, not curving forward at median line; hypostomal ridge well developed; dorsal ramus not developed; epistomal ridge present both laterad to (below) anterior tentorial pits and between pits; tentorium robust including dorsal arms except when larva approaching ecdysis. Vertex with or without paired, pigmented, well developed, apically pointed tubercles. Parietal bands evident. As seen in lateral view antennal prominence scarcely evident and cranium above prominence evenly curved; antennal papilla well defined, conical projecting about as far as basal diameter or farther depending on taxon. Clypeus, labrum, and labial apex moderately broad in frontal view; labrum lacking transverse sclerite, such as found in many Megachilidae; labral apex faintly bilobed.

Mandible robust in dorsal and ventral views; mandible tapering somewhat apically with apex rounded; apical part of mandible darkly pigmented. Apical concavity large and well formed, directed slightly ventrally; dorsal inner edge of concavity narrowly planar from cusp to apex, with planar surface finely toothed; ventral inner edge narrowly, thinly rounded, with or without ventral subapical tooth; apical inner surface of concavity rather smooth but at base becoming coarsely pebbled or denticulate. Outer surface of mandible near base with one or several small seta-bearing tubercles. Labiomaxillary region elongate as seen in lateral view, so that apex extending forward but narrowing in profile; cardo and stipital rod sclerotized but not extensively pigmented; articulating arm of stipes darkly pigmented; maxilla narrowing apically, its surface well supplied with rather short setae; maxillary palpus and galea positioned at maxillary apex, with galea adoral to palpus; maxillary palpus slender, elongate; galea elongate with long apical setae. Labium elongate, clearly divided into prementum and postmentum.

Body: Body form of postdefecating larva extremely robust with rear part (abdominal segments 6–8) greatly enlarged in lateral view; thorax narrowing and elongating from posterior to anterior in lateral and dorsal views; most body segments of postdefecating larva divided dorsally into cephalic and caudal annulet with each caudal annulet tending to be slightly more extended sublaterally than its cephalic annulet; those of thorax scarcely projecting dorsally, so that each appearing as dorsal sublateral mound (too vague to be termed tubercle). Each sublateral mound of thorax bearing small, darkly pigmented, sometimes sharp sclerotized spine; this projection often appearing somewhat transverse and other times with one or two smaller projections occurring laterad to main spine; apical spine of each mound surrounded by large uneven nonpigmented area bearing fine to very fine scattered setae numbering perhaps 8–10 per mound; when cleared and stained, entire dorsal surface of mound darkly staining suggesting thicker, stronger sclerotization than body integument elsewhere; dorsal surface of sublateral swelling of caudal annulets of abdominal segments lacking thicker integument and not staining darkly, without pigmented apices and setae. Body form of known predefecating larva appearing greatly enlarged but similar, except paired dorsal sublateral mounds on three thoracic segments now more elevated but distinction between cephalic and caudal annulets of abdomen scarcely evident. On both pre- and postdefecating forms: body vestiture consisting in many areas of regular pattern of small to minute spicules in addition to setae on mounds of thorax. Abdominal segment 10 attached to approximate middle of segment 9; anus positioned dorsally on abdominal segment 10, short distance below dorsal ridge identifying meeting of dorsal and posterior surfaces.

Spiracles moderate in size to small, faintly pigmented, subequal in diameter; atrium somewhat wider than depth, projecting somewhat beyond body wall, with distinct rim; atrial wall faintly to scarcely concentrically ringed; first chamber of subatrium, forming short collar into atrium, externally almost as broad as atrium to distinctly narrower than atrium; primary tracheal opening varying from distinctly narrower to distinctly wider than atrial opening; remainder of subatrium consisting of numerous, weakly sclerotized annulation that vary in width depending on preservation until they meet trachea. Sex-specific characters unknown.

ACKNOWLEDGMENTS

I acknowledge with appreciation the donation of many larval Euglossini by Fred D. Bennett acquired when he worked in Trinidad. This paper obviously could not have been written without his interest in the biology of these taxa and the specimens that he had collected and then passed on to me.

Steven Thurston, Senior Scientific Assistant, AMNH, expertly arranged the diagrams and microphotographs, and Corey Smith, Curatorial Assistant, AMNH, provided help in numerous ways including proofreading the manuscript. I acknowledge with thanks the comments and corrections from two anonymous reviewers.

REFERENCES

- Bennett, F.D. 1972. Observations on *Exaerete* spp. and their hosts *Eulaema terminata* and *Euplusia surinamensis* (Hymen., Apidae, Euglossinae) in Trinidad. *Journal of the New York Entomological Society* 80: 118–124.
- Garófalo, C.A., and J.G. Rozen, Jr. 2001. Parasitic behavior of *Exaerete smaragdina* with descriptions of its mature oocyte and larval instars (Hymenoptera: Apidae: Euglossini). *American Museum Novitates* 3349: 1–26.
- McGinley, R.J. 1989. A catalog and review of immature Apoidea (Hymenoptera). *Smithsonian Contributions to Zoology* 494: 1–24.
- Michener, C.D. 1953. Comparative morphology and systematics studies of bee larvae with a key to the families of hymenopterous larvae. *University of Kansas Science Bulletin* 35: 987–1102.
- Roberts, R.B., and C.H. Dodson. 1967. Nesting biology of two communal bees, *Euglossa imperialis* and *Euglossa ignita* (Hymenoptera: Apidae), including descriptions of larvae. *Annals of the Entomological Society of America* 60: 1007–1014.
- Rozen, J.G., Jr., and C.J. Praz. In press. The mature larvae and nesting biologies of bees currently assigned to the Osmiini (Hymenoptera: Megachilidae). *Bulletin of the American Museum of Natural History*.
- Rozen, J.G., Jr., J.S. Ascher, S.M. Kamel, and K.M. Mohamed. Submitted. Larval diversity in the bee genus *Megachile* (Hymenoptera: Apoidea: Megachilidae). *American Museum Novitates*.
- Zucchi, R., B. Lucas de Oliveira, J. M.F. de Camargo. 1969a. Notas bionômicas sobre *Euglossa* (*Glossura*) *intersecta* Latreille 1838 e descrição de suas larvas e pupa. *Boletim da Universidade Federal do Paraná, Zoological* 3: 203–224.
- Zucchi, R., S.F. Sakagami, J. M.F. de Camargo. 1969b. Biological observations of a Neotropical parasocial bee, *Eulaema nigrita*, with a review on the biology of Euglossinae (Hymenoptera, Apidae). A comparative study. *Journal of the Faculty of Science, Hokkaido University, series 6, Zoology* 17: 271–380.