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DESCRIPTION OF THE LARVA OF *LOPHODIPLOSIS TRIFIDA*, AN AUSTRALIAN GALL MIDGE (DIPTERA: CECIDOMYIIDAE) AND BIOCONTROL AGENT OF PAPERBARK IN FLORIDA, USA

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ABSTRACT

Lophodiplosis trifida Gagné, an Australian gall midge on paperbark, *Melaleuca quinquenervia* (Myrtaceae), is a recent release in southern Florida for the biological control of that host. The larval stage is described for the first time and compared to that of other *Lophodiplosis* species. Photos of galls and illustrations of larvae are provided. Second and third instars of *L. trifida* are unusual among Cecidomyiidae for the lack of setae on most papillae.

Key Words: *Melaleuca*, biological control, bud gall, cecidomyiid

RESUMEN

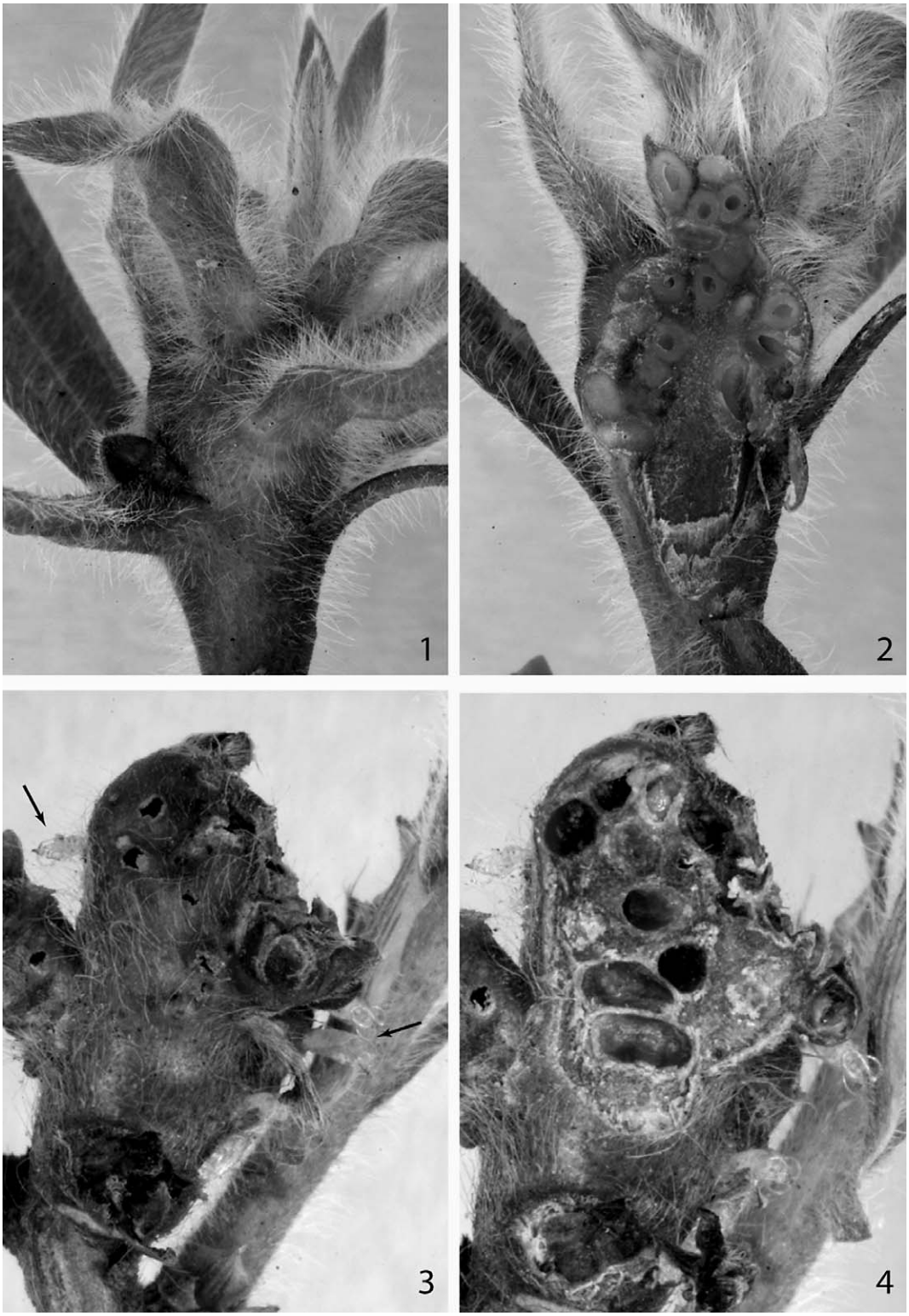
Lophodiplosis trifida Gagné, una mosquita de agalla sobre *Melaleuca quinquenervia* (Myrtaceae) de origen Australiano, fue recién liberada en el sur del estado de Florida para el control biológico de este hospedero. Se describe el estadio larval por primera vez y se compara contra larvas de otras especies de *Lophodiplosis*. Se provee fotos de las agallas e ilustraciones de las larvas. El segundo y tercer estadio de *L. trifida* no son comunes entre los Cecidomyiidae por la falta de setas sobre la mayoría de las papilae.

Lophodiplosis trifida Gagné has been successfully introduced into southern Florida to aid in the control of paperbark, *Melaleuca quinquenervia* (Myrtaceae) (P. D. Pratt, unpublished). This insect was initially described as one of 5 *Lophodiplosis* species reared from *Melaleuca* spp. in the vicinity of Townsville, Qld., Australia (Gagné et al. 1997). No further species has been added to *Lophodiplosis* and, except for *L. trifida* in Florida, the genus is still known only from eastern Australia. The other 4 species, *Lophodiplosis bidentata* Gagné, *Lophodiplosis cornuata* Gagné, *Lophodiplosis indentata* Gagné, and *Lophodiplosis denticulata* Gagné, were taken from separate and distinctive galls of paperbark. *Lophodiplosis trifida* was initially thought to be an inquiline in galls of 3 of the other species because it was reared in association with them but not associated with any particular distinctive gall of its own (Gagné et al. 1997). Subsequent observations in the vicinity of Brisbane, Qld., showed that *L. trifida* forms separate, often very prominent galls (Figs. 1-4) in young shoots (Purcell et al. 2007). In the earlier situation in Townsville, stem galls of *L. trifida* galls were evidently inconspicuous, perhaps containing only 1 or 2 larvae, and had presumably been masked by galls of the other *Lophodiplosis* species and associated plant tissue in rearing cages. The larval stage of *L. trifida* was not described initially, unlike those of 3 of the other species of *Lophodiplosis* (that of *L. denticulata* remains undescribed). Now that *L. trifida* has taken on biological control importance, we take this opportunity to describe the instars for future identification.

MATERIALS AND METHODS

Larvae of known *L. trifida*, as determined from adults and pupae reared in quarantine in Ft. Lauderdale, FL, were removed from paperbark shoot galls in various stages of growth. Specimens were the progeny, many generations removed, of material originally sent from Indooroopilly, Qld., Australia.

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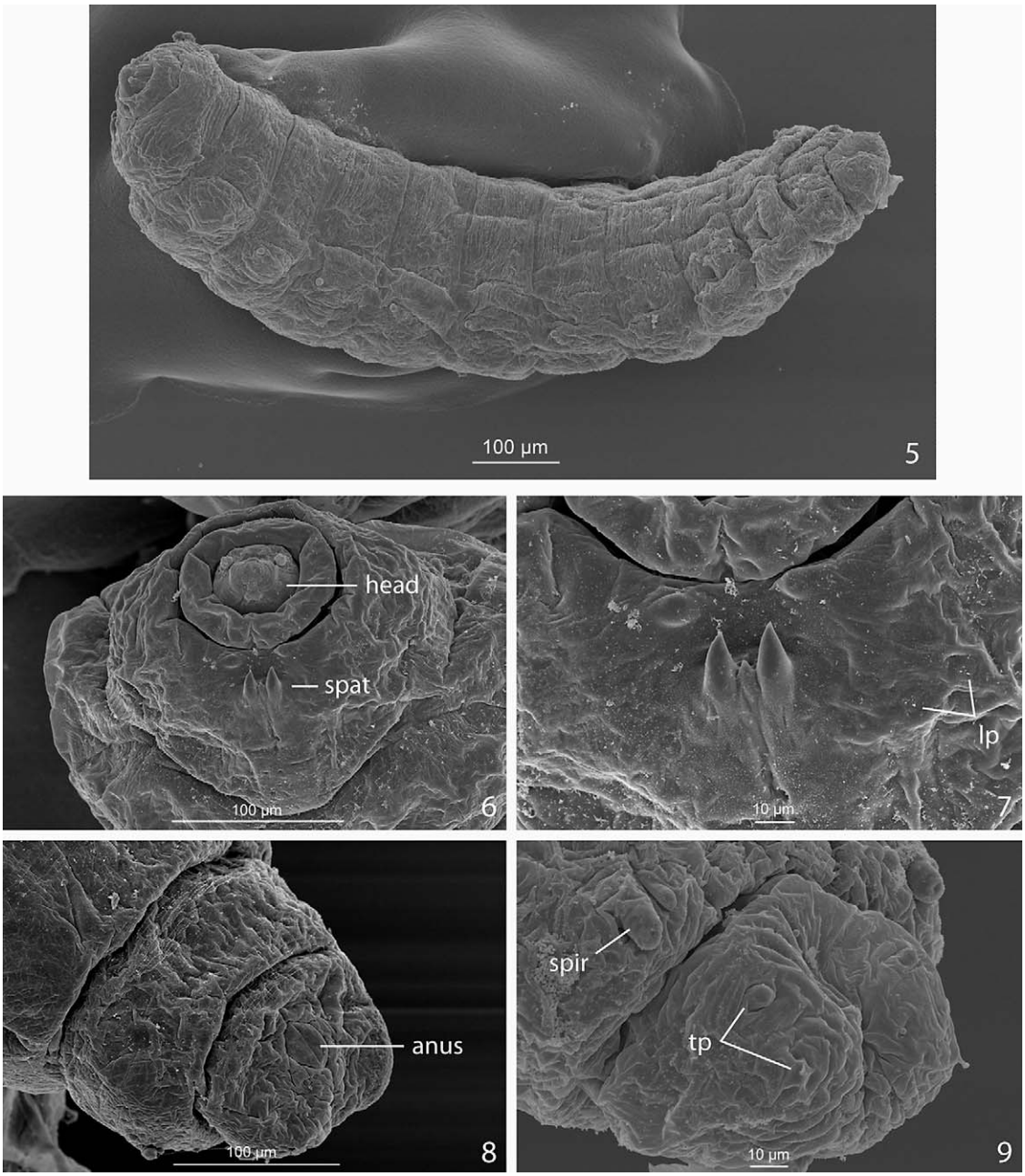
Figs. 1-4. Shoots of paperbark galled by *Lophodiplosis trifida*. 1, Galled young, soft shoot. 2, Longitudinal section of same largely filled with spherical larval cells containing first instars. 3, Older, woody gall with exit holes, the arrows indicating pupal exuviae still attached. 4, Same, longitudinal section, the topmost cell with pupa still inside.

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Specimens were placed on slides for viewing in accordance with the method outlined in Gagné (1989). Other specimens were critical-point dried and placed on SEM stubs. Terminology for larval morphology follows that in Gagné (1989).

Description of larva of *L. trifida*
Third Instar (Figs. 5-12)

Length, 1.3-2.0 mm (n = 10). Body cylindrical, spindleform. Head capsule hemispherical, with



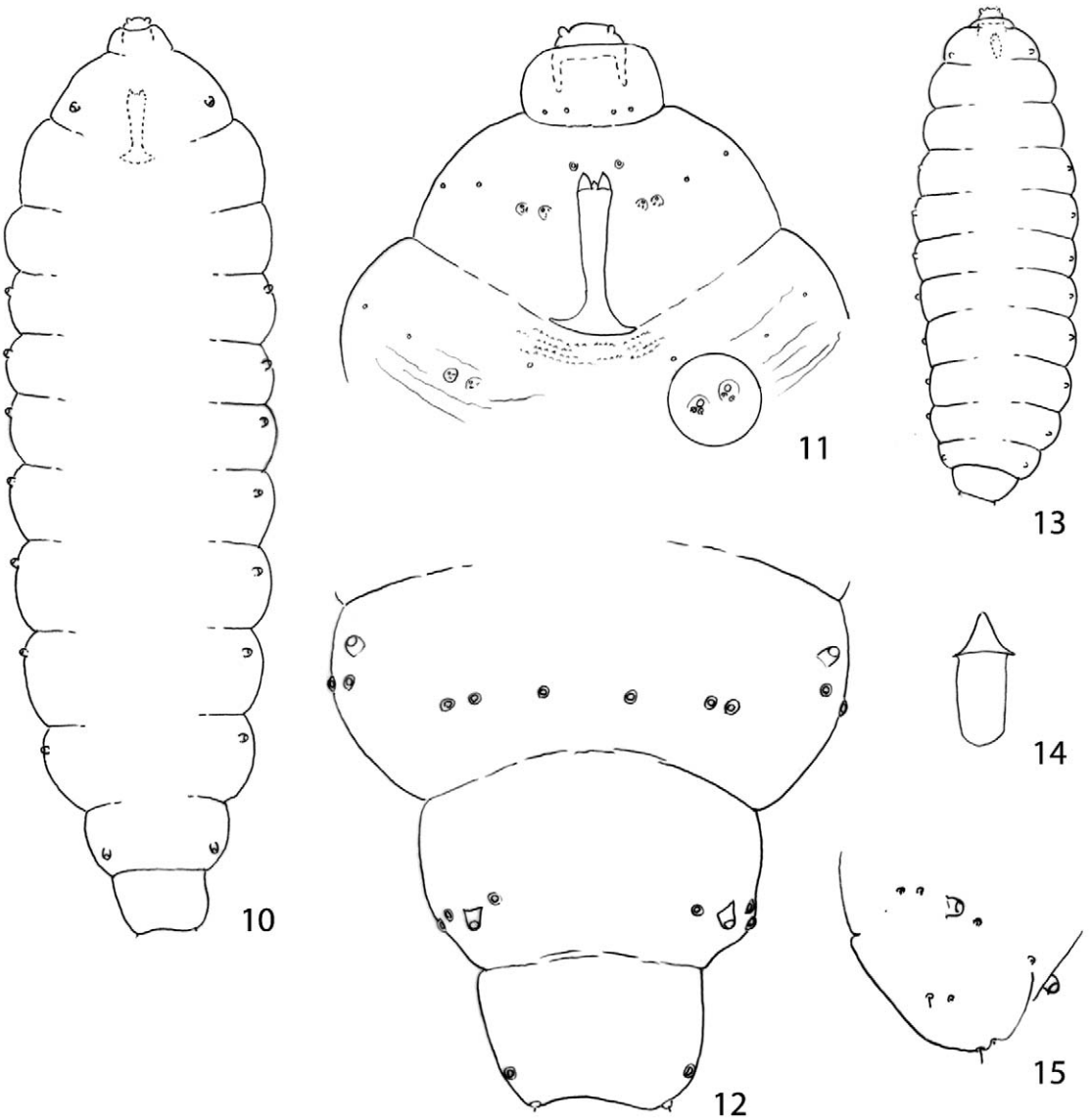
Figs. 5-9. *Lophodiplosis trifida*, third instar. 5, Entire larva (dorsolateral). 6, Anterior segments (anteroventral). 7, First thoracic segment with details of spatula and papillae (ventral). 8, Posterior segments showing anus at center of terminal segment (lateroventral). 9, Detail of eighth and terminal segments (laterodorsal). Abbreviations: lp = triplets of lateral papillae; spat = spatula; spir = spiracle; tp = terminal papillae.

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apodemes as long as capsule; antennae short, as long as wide. Spiracles present on prothorax and on first through eighth abdominal segments. Integument with horizontal rows of minute spicules ventrally on anterior third of 2nd and 3rd thoracic and all abdominal segments, remainder smooth if not weakly and irregularly lined. Spatula (Figs. 6, 11) widest posteriorly when fully sclerotized, with long shaft, anteriorly with 2 large, triangular teeth and a shorter tooth between. Full complement of papillae present except only 2 pairs on terminal segment, 1 corniform, the other setiform. Setae present on 2 of 3 of each of the 4 groups of lateral papillae and on 1 of the pairs of terminal papillae.

Second Instar (Figs. 13-14)

Length, 0.6-0.9 mm (n = 10). Body shape, head, spiracles, integument and papillae as for third instar. Spatula present, short, the acutely triangular anterior tooth up to half length of shaft. As with third instar, full complement of papillae is present except for 2 pairs on terminal segment



Figs. 10-15. *Lophodiplosis trifida*. 10-12, Third instar: 10, entire larva (dorsal), showing position of sternal spatula on venter; 11, detail of anterior segments with inset showing 2× detail of lateral papillae (ventral); 12, detail of posterior segments (dorsal). 13-14, Second instar: 13, entire larva (dorsal view), showing position of sternal spatula on venter; 14, sternal spatula (ventral). 15, First instar, eighth and terminal segments (laterodorsal).

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and setae present on only 2 of 3 of each of the 4 groups of lateral papillae and on 1 pair of terminal papillae.

First Instar (Fig. 15)

Length, 0.3-0.5 mm (n = 10). Body shape, head, and integument as for second and third instars. Spiracles present only on prothorax and eighth abdominal segment. Spatula absent. Presence of papillae as for second and third instars except that pleural and dorsal papillae and the non-setose pair of terminal papillae of second and third instars all with minute seta.

Comments on Larval Stage of *L. trifida*

The first and second instars of this species are unusual among Cecidomyiidae for the almost complete absence of papillar setae. Setae occur on only 2 papillae in each of the 4 sets of lateral triplets and on 2 terminal papillae. The first instar, on the other hand, has tiny setae, no longer than the diameter of their papillae, on all pleural and dorsal papillae, in addition to the setae already mentioned for the third and second instars. The only other example known of the lack of papillar setae generally is the genus *Caryomyia*, a North American genus, in which most of species completely lack papillar setae, even those on the lateral and terminal papillae (Gagné 2008). The integument is remarkably smooth in *L. trifida*, with the anteroventral horizontal bands of spicules the only sculpturing.

Discussion

The 5 species originally placed in *Lophodiplosis* come from simple to complex galls of *Melaleuca* spp. (Gagné et al. 1997). These species are an eclectic mix that, besides having a host genus in common, share the distinguishing pupal character of vertexal extensions that are evidently used in cutting through gall tissue prior to adult emergence. Many gall midges have variously shaped prominences on the head for that purpose, but they are almost always extensions of the antennal bases, not of the vertex. Larvae of *Lophodiplosis* are diverse, but this is not unusual in genera with a variety of gall shapes (Gagné 2008). Larvae of *L. trifida* are unique in *Lophodiplosis* for the lack of setae on most papillae, their long, narrow, tridentate spatula in the third instar, and mostly smooth integument. The other species of *Lophodiplosis* for which larvae are known, *L. bidentata* Gagné, *L. cornuata* Gagné, and *L. indentata* Gagné, have short setae on most papillae, a short, wide, bidentate spatula, and a rugose integument. The type species, *L. indentata*, and *L. trifida* both have only 4 papillae on the terminal segment, but all 4 papillae have setae on *L. indentata* while only 2 have setae on *L. trifida*. Both species have a spatula in the second instar. In gall midges, a second instar spatula occurs only in some gall-making genera where it seems to have arisen *de novo* in each of the genera where it appears (Gagné 2008).

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