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A NEW LESTODIPLOSINE (DIPTERA: CECIDOMYIIDAE) PREYING ON THE AVOCADO LACE BUG, *PSEUDACYSTA PERSEAE* (HETEROPTERA: TINGIDAE) IN SOUTHERN FLORIDA

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ABSTRACT

A species new to science, *Tingidoletes praelonga* Gagné (Diptera: Cecidomyiidae), was recently discovered preying on the avocado lace bug, *Pseudacysta perseae* (Heidemann) (Heteroptera: Tingidae), in Florida, USA. A new genus is described to receive the new species.

Key words: gall midge, predator, avocado lace bug, *Persea americana*

RESUMEN

Una especie nueva para la ciencia, *Tingidoletes praelonga* Gagné (Diptera: Cecidomyiidae), fué descubierta recientemente depredando la chinche del aguacate, *Pseudacysta perseae* (Heidemann) (Heteroptera: Tingidae), en Florida, USA. Se describe un nuevo género que acoge la nueva especie.

Translation provided by the authors.

An undescribed cecidomyiid was discovered in Miami-Dade Co., Florida, during a survey for predators of the avocado lace bug, *Pseudacysta perseae* (Heidemann), a native pest of avocados, *Persea americana*, and redbay, *Persea borbonia*, in the USA. The avocado lace bug was considered a minor pest of avocados until the mid-1990s. Persistent outbreaks of this insect have been observed in Florida and in the Caribbean region since 1990 (Medina-Gaud et al. 1991; Abud-Antun 1991). In the United States the avocado lace bug is currently known from Florida and Georgia and more recently in California. It also is known from Bermuda, Dominican Republic, Puerto Rico, Mexico, Cuba, Surinam, and Venezuela (Mead & Peña 1991; Sandoval 2004; Morales, unpubl.). A survey for predators of this pest undertaken in Florida from 1995 through 1997 found several important natural enemies of this pest (Peña et al. 1998), but only in a recent survey was the new cecidomyiid discovered by one of us (FA) preying on nymphs of *P. perseae*.

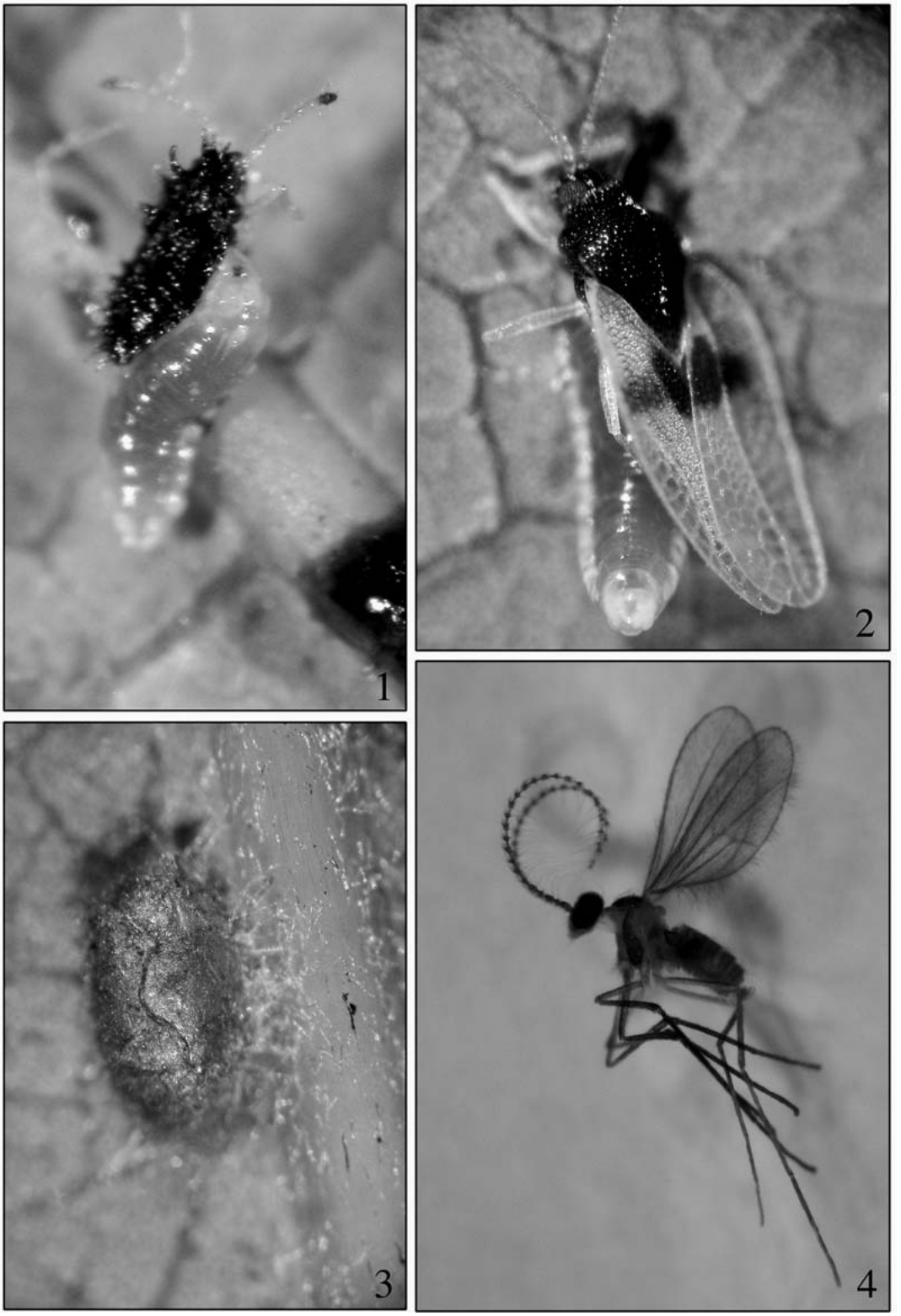
Single eggs were observed among colonies of *P. perseae* on avocado. Newly hatched amber-colored larvae crawled to the lace bugs and inserted their mouthparts usually under the more anterior abdominal segments (Figs. 1 and 2). After their initial feeding, larvae turned reddish-orange. Larvae were commonly observed feeding in a position perpendicular to the prey. A larva was once found with its mouthparts inserted into the distal antennal segment of an immobilized third instar. Larvae appeared more often to feed on lace bug nymphs, but larger larvae were also observed feeding on lace bug adults. When full grown, larvae spun orange-colored cocoons close to the leaf midvein (Fig. 3). Adults (Fig. 4) emerged 6-8 d later and lived 2-4 d under laboratory conditions.

MATERIALS AND METHODS

To obtain adults of the predator, older larvae were placed in petri dishes with lace bug nymphs so the larvae could be fully fed when they formed their cocoons. Immature stages and adults were preserved in 70% isopropyl alcohol. Specimens were mounted on microscope slides following the method outlined in Gagné (1989). Terminology for adult morphology follows usage in McAlpine et al. (1981) and for larval morphology that in Gagné (1989). The discovery of the new species and further study of its biology were made by JEP and FA, and the taxonomy of the new taxon was done by RJG.

Tingidoletes Gagné, new genus

Adult (Fig. 4).—Head: Eyes large, connate, eye bridge 12 facets long; all eye facets hexagonal and closely adjacent to one another. Occiput with short, blunt dorsal protuberance with pair of large, elongate setae. Antenna with 12 flagellom-



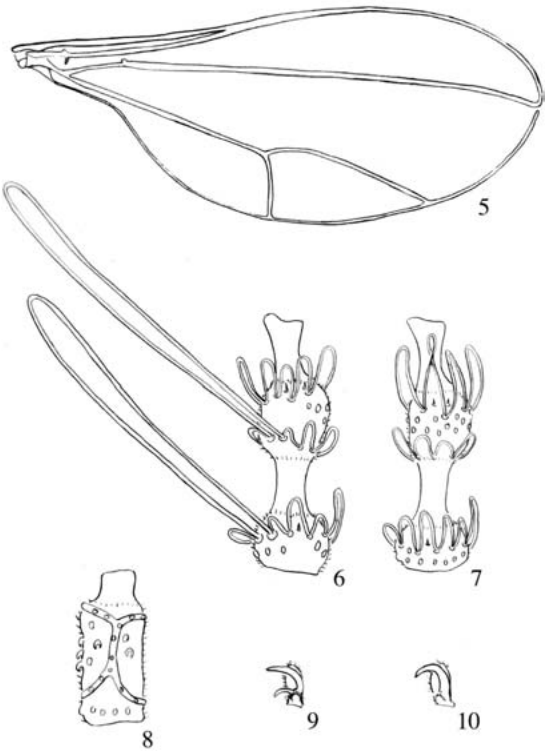
Figs. 1-4. *Tingidoletes praelonga*. 1, Larva feeding on nymph of avocado lace bug. 2, Larva feeding on adult avocado lace bug. 3, Cocoon. 4, Male.

eres, the first and second flagellomeres partly connate. Male flagellomeres (Figs. 6-7) binodal, basal node spherical with single circumfilum, distal node longer, cylindrical, with 2 circumfila, both nodes with more setae dorsally than ventrally, the setae all of generally similar length; loops of basal and middle circumfila of each flagellomere greatly uneven in length, 1 loop of each originating on dorsolateral flagellomere surface longer than entire flagellomere, the remaining loops of uneven length but much shorter, not reaching next node; distal circumfilum on each flagellomere with loops of slightly uneven length, none reaching apex of flagellomere. Female flagellomeres (Fig. 8) cylindrical with short necks, with more setae dorsally than ventrally, and 2 horizontal circumfila connected by 2 vertical strands. Frons with sparse setae and no scales. Labella covered mesad with fine, elongate setulae (Fig. 14). Hypoproct ringed along outer edge with long, wide setulae (Fig. 14). Palpus 4-segmented.

Thorax: Notum with 4 longitudinal rows of setae and no scales. Pleura with vestiture only on anepimeron. Wing (Fig. 5): C broken posteriad of its junction with R_5; R_5 slightly curved apically, joining wing just below apex; Cu forked. Legs elongate, thin, about 1 1/2 times as long as wing. Acropods (Figs. 9-10): claws strongly curved just beyond midlength, with basal tooth on fore- and midlegs, without tooth on hindlegs; empodia reaching curve of claws; pulvilli short, about 1/4 length of claws.

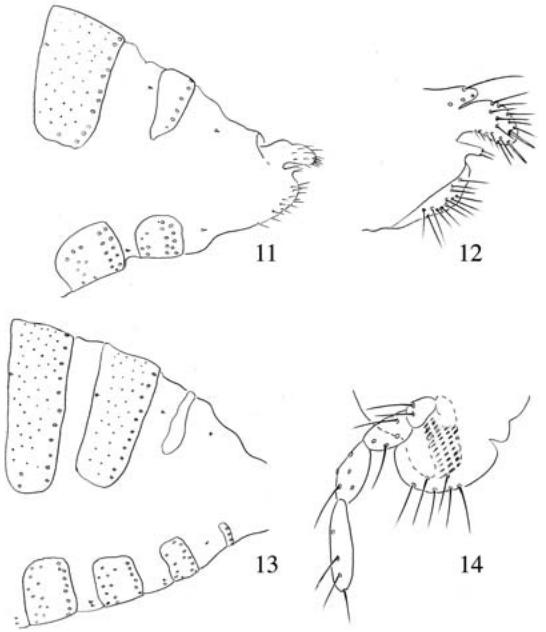
Male Abdomen (Figs. 13, 15-16): First tergite rectangular with single, sparse row of posterior setae and pair of anterior trichoid sensilla. Second through sixth tergites short-rectangular, with single, sparse posterior row of setae, 1-3 lateral setae on each side, a pair of anterior trichoid sensilla, and elsewhere with evenly distributed scales; seventh and eighth tergites unpigmented, their only vestiture the anterior pair of trichoid sensilla. Sternites second through sixth with single row of posterior setae, 2 rows of setae at midlength, and 2 closely adjacent trichoid sensilla anteriorly; seventh as for sixth except narrower and the trichoid sensilla widely separated; eighth with no to several posterior setae and widely separated pair of anterior trichoid sensilla. Genitalia (Figs. 15-16): Cerci convex apically, each with several apical and apicoventral setae; hypoproct gradually widening from midlength to apex, posterior edge nearly straight across, with several apical and apicoventral setae; aedeagus dorsoventrally flattened, in dorsoventral view widest near midlength, the apex convex, 3 pairs of papillae present on each side; gonocoxite thickset at base, with cylindrical, apically rounded, elongate-setulose mesal lobe; gonostylus broadest at base, tapering to apical tooth, setulose on basal half, ridged beyond.

Female Abdomen (Figs. 11-12): First through seventh tergites as for first through sixth in male, but seventh more diminutive than sixth; eighth tergite not pigmented, demarcated only by anterior pair of trichoid sensilla. Sternites 2 through 7 as for male except for the mostly double posterior row of setae; sternite 8 undefined except for the widely separated anterior pair of trichoid sensilla. Tenth tergum with several posterior setae. Tenth sternum with a large group of setae on each side. Cercus setose, with posterior pair of large peglike setae, setulose throughout. Hypoproct as wide as long, with a pair of apical setae, setulose throughout.

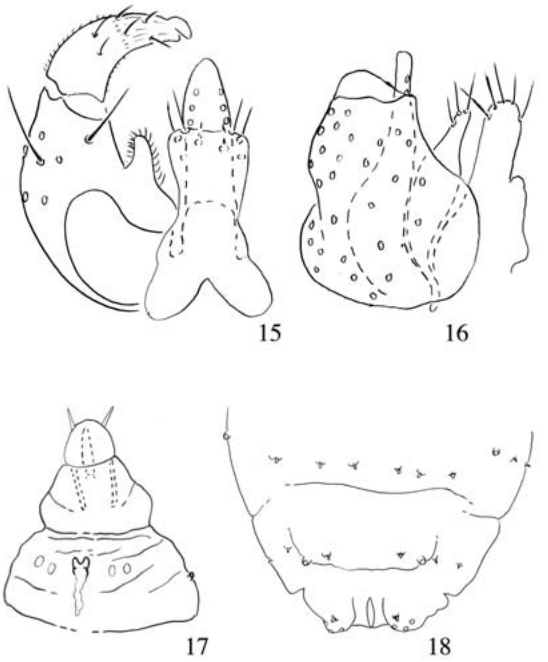


Figs. 5-10. *Tingidoletes praelonga*. 5, Wing. 6, Male third antennal flagellomere (dorsal). 7, Same. (ventral). 8, Female third antennal flagellomere. 9, Acropod of foreleg. 10, Acropod of hindleg.

Larva, Third Instar (Figs. 17-18).—Head capsule conical, antenna more than 3 times as long as basal width, apodemes as long as head capsule. Integument dorsally and laterally smooth, ventrally on anterior half of each segment with 4 convexities (traction pads) covered with rounded verrucae, posterior half smooth. Spatula (Fig. 17) with 2 rounded anterior lobes and elongate shaft. Anus located dorsoposteriorly. Papillae on venter difficult to detect, but 2 triplets evident on each side of spatula. Dorsal papillae with short, cylindrical, blunt-tipped setae, pleural papillae with setae of same length but more pointed. Terminal segment with 4 papillae on each side, 1 of each group with short, cylindrical, blunt-tipped seta, the remainder low-convex, without setae.



Figs. 11-14. *Tingidoletes praelonga*. 11, Female abdomen, sixth segment to cerci (lateral). 12, Same, detail of female tenth segment and cerci (lateral). 13, Male abdomen, fifth through eighth segments (lateral). 14, Adult mouthparts (lateral).



Figs. 15-18. *Tingidoletes praelonga*. 15, Male gonopod, hypoproct and aedeagus (dorsal). 16, Male gonocoxite, cerci, hypoproct and aedeagus (lateral). 17, Larval head and collar and prothoracic segments (ventral). 18, Larval seventh to terminal abdominal segments (dorsal).

Type Species: *Tingidoletes praelonga* Gagné.

Etymology.—The generic name *Tingidoletes* is Latin for "predator of tingids." The name is considered feminine.

Remarks.—Tingidoletes belongs to the supertribe Cecidomyiidi where it can be subsumed with most other cecidomyiid predators within the tribe Lestodiplosini as defined in Gagné (1994). The larva of the new genus is distinctive and unusual among Lestodiplosini for its short, thick, cylindrical setae on the dorsal papillae and the makeup of the terminal papillae of which 3 pairs have no setae and 1 pair has thick, short, and blunt setae similar to those on the dorsal papillae (Fig. 18). The only generally similar predaceous larva known to date is that of *Trilobia aphidisuga* Del Guercio, a European predator of aphids known from the original description of the larval stage alone (Harris 1973). The form of its terminal papillae appears generally similar to that of *T. praelonga*, except that the end of the setose pair is tapered instead of blunt. The shape of the setae on the dorsal papillae of *T. aphidisuga* remains undescribed. It is possible that *Trilobia* could serve as a generic name for the new species, but without adults we cannot know.

Tingidoletes will run to *Aphidoletes* in couplet 102 in the key to Nearctic genera in Gagné (1981a), offering a good illustration that characters effective for use in keys, in this case the presence of teeth on the tarsal claws and an extremely long circumfilar loop on each node of the male flagellomeres, are not necessarily a measure of propinquity. *Aphidoletes* is a genus of 3 species whose larvae are external predators of aphidoids. The 2 genera differ most conspicuously in that the adult abdomen of *Tingidoletes* is fusiform instead of evenly cylindrical, is much shorter due to the foreshortened instead of primatively large, rectangular sclerites, has lost most of the tergal lateral setae, and the male seventh tergite is membranous and without vestiture except for the anterior pair of trichoid sensilla. The genitalia also are very different; those of *Aphidoletes* are much more complex (Harris 1966) than those of *Tingidoletes* (Figs. 15-16).

The presence of greatly elongate individual circumfilar loops on the antenna of both genera is only a superficial similarity. The enlarged circumfilar loops of *Aphidoletes* are on the basal and distal circumfila of each flagellomere, while those of *Tingidoletes* are on the basal and middle loops. Also, unlike in *Aphidoletes*, *Tingidoletes* does not have a greatly elongate seta situated next to the long circumfilar loop. That the middle circumfilum is very long is extraordinary because in the supertribe Cecidomyiidi generally the second circumfilum is generally the first to undergo reduction or complete loss, e.g., in *Bremia*, most *Contarinia* (Gagné 1994), and some *Lestodiplosis*

(Harris 1973). An exception brought to our attention by K. M. Harris is *Lestodiplosis irregularifila* Kashyap (1989) in which that middle circumfilum also has 1 elongated loop.

As a rule more setae and circumfilar loops of gall midges are disposed on the ventral half of the flagellomeres. The significance of that arrangement, we suppose, is optimal sensory perception because the ventral surface of the antenna is the leading edge during flight (Fig. 4). Yet, where greatly elongated loops of circumfila occur, as in *Aphidoletes* and *Bremia* (Harris 1966), *Thripsobremia* (Gagné & Bennett 1993), *Lestodiplosis* (Gagné & Lill 1999) and the new genus, they are always on the dorsolateral flagellomere surface (Fig. 6). That placement makes long loops less likely to fold or to collide during flight with the corresponding circumfila of the other antenna. Elongate circumfilar loops appear in several predaceous and presumably predaceous genera, but their significance is unknown. Inasmuch as it is the female that searches for the host, it would appear the male needs its antennal sensoria only to find females. A remarkable antennal feature that can be seen in Fig. 4 is that with the antennae arched almost in a circle, the elongated circumfilar strands are evenly disposed radially. Possibly this arrangement amplifies the sensory capability of the antennae.

The mediolateral lobe of the male gonostylus of *Tingidoletes* is reminiscent of those found in *Lestodiplosis* and *Thripsobremia* (Gagné & Bennett 1993), but in those genera, the female flagellomere necks are at least twice as long as wide, and the female cerci have on their venter a field of closely placed, very short sensilla. *Tingidoletes* females have flagellomere necks that are no longer than wide and lack the group of short, ventral sensilla on the cerci.

The male hypoproct and aedeagus of *Tingidiplosis* are similar in shape to those of *Endaphis* spp. (Tang et al. 1994; Gagné 1981b), internal predators of aphids, and of *Silvestriola cincta*, a mite predator (Gagné 1994), but that resemblance is only superficial when other head characters are taken into account. *Endaphis* and *Silvestriola* have circular eye facets that are sparser at eye midheight, while *Tingidoletes* has eyes of considerably greater extent with entirely hexagonal, closely juxtaposed facets. Further, both *Silvestrina* and *Endaphis* lack a dorsal occipital protuberance, a distinctive character in *Tingidoletes*.

Tingidoletes praelonga Gagné

Adult.—Head: Antennal flagellomeres as in Figs. 6-8. Frons with 3-5 setae per side. Mouthparts as in Fig. 14, setae ringing the hypoproct long and strong. Labella hemispherical in lateral view, each with 6-8 lateral setae.

Thorax: Wing (Fig. 5): without markings; length: male, 1.4-1.6 mm (n = 4); female, 1.4-1.6 mm (n = 3). Notum with sparse setae; scutellum with 3-5 setae on each side and 4-5 anteromedially; anepimeron with 6-8 setae. Acropods as in Figs. 9-10, fore- and midclaws toothed, the hind claws simple. Male abdomen as in Figs. 13, 15-16. Female abdomen as in Figs. 11-12.

Holotype.—Male, Homestead Florida, X-10-2006, F.E. Acevedo, deposited in USNM.

Other Specimens Examined.—Six adults, all from Homestead, Florida, reared by F.E. Acevedo on the following dates: 2 males, IX-24-2006; 1 female, X-8-2006; 1 female, X-10-2006; 1 female, X-14-2006; 1 female, X-20-2006. Seven larvae, Homestead, Florida, XI-30-2006, J. E. Peña & D. Long.

Etymology.—The specific name *praelonga* is a Latin adjective meaning very long. In the present case, the name refers to the 2 elongate circumfilar strands on each of the male flagellomeres.

Remarks.—This is the only species of Cecidomyiidi with a greatly enlarged middle circumfilum on the male flagellomeres and short, stubby dorsal larval papillae. A single pair of terminal larval papillae has setae, a condition known elsewhere only in *Trilobia aphidisuga*, in which they are conical instead of cylindrical.

Summary

Insect larvae of Cecidomyiidae were discovered preying on the avocado lace bug, a great pest of avocado in Florida and elsewhere in the American tropics. The predator was determined to be a species new to science that is apparently a natural control of the lace bug. The new insect is described and a new genus is erected to receive it. This report classifies the species in its proper place, will allow identification of the species in the future, and make the information available to the scientific community.

Acknowledgments

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