



A new genus of gall-dwelling thrips from Costa Rica (Thysanoptera: Phlaeothripidae: Phlaeothripinae)

Un género nuevo de tisanóptero morador de agallas en Costa Rica (Thysanoptera: Phlaeothripidae: Phlaeothripinae)

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Abstract. A new genus and species of thrips, *Fourbethrips fiorella*, inhabiting stems, petioles and leaf vein galls of a Melastomataceae from Costa Rica is described. The galls are induced by an unidentified gall midge larva (Cecidomyiidae). This new thrips can be distinguished from other genus and species of Phlaeothripinae by the shape of the pelta, the position of maxillary stylets in the head, the reduced and acute anterior pair of postocular setae, the long and capitate posterior pair of postocular setae, the presence of a group of minute setae, and a pair of short ventral setae in the middle area of the abdominal sternites II-VII. The tergites II-VII have a pair of campaniform sensillae.

Key words: gall, Cecidomyiidae, Melastomataceae, Neotropics, new species, taxonomy.

Resumen. Se describen una especie y un género nuevos de tisanóptero, *Fourbethrips fiorella*, que habita en agallas en tallos, peciolos y venas de la hoja de una Melastomataceae de Costa Rica. Las agallas son inducidas por una especie no identificada de Cecidomyiidae. Este nuevo tisanóptero se puede diferenciar de otros géneros y especies de Phlaeothripinae por la forma de la pelta, la posición de los estilotes maxilares en la cabeza, la presencia de 2 pares de setas postoculares, 1 par reducido y de puntas agudas y 1 par posterior largo y capitado, la presencia de un grupo de setas pequeñas y 1 par de setas cortas en los esternitos abdominales II-VII. Los terguitos con un par de sensilas campaniformes.

Palabras clave: agalla, Cecidomyiidae, Melastomataceae, neotrópico, nueva especie, taxonomía.

Introduction

Thysanoptera comprise approximately 6 000 described species and are divided into 2 suborders, Tubulifera and Terebrantia (Mound and Marullo, 1996; Crespi et al., 1997). Tubulifera include about 3 500 species, which are classified in a single family, Phlaeothripidae. Of these species, 700 feed only on fungal spores and are placed in the subfamily Idolothripinae, with the remaining 2 800 comprising the biologically diverse subfamily Phlaeothripinae (Crespi et al., 2004). About 300 species of thrips in 57 genera are known to form galls (Mound, 1994). Most of them are in the subfamily Phlaeothripinae (Crespi et al., 1997). Other thrips are related to host plants like domicile-builders, opportunists and exploiters, including inquilines and kleptoparasites (Crespi et al., 2004). Some

species opportunistically invade galls, e.g. *Grypothrips* Karny and *Dactylothrips* Bagnall. These species invade any space which provides refuge and food. Other thrips, e.g. species of *Koptothrips* Bagnall, are kleptoparasitic that invade galls and kill or displace original occupants (Crespi et al., 2004). Others co-inhabit with other thrips causing no harm to each other (inquilines) (Crespi et al., 2004). Common examples of such inquiline thrips are *Mallothrips indicus* Ramakrishna and Margabandhu in galls of *Trioza jambolanae* Crawford (Trioziidae) on *Syzygium* (Myrtaceae); *Haplothrips atriplicis* Priesner in galls of *Asphondylia conglomerate* Stefani (Cecidomyiidae); *Dolichothrips inquilinus* Ananthakrishnan in galls of a psyllid on *Ziziphus* sp. (Rhamnaceae); *Liothrips interlocatus* Karny in galls of *Trichilogaster acacia-longifolia* Froggatt (Psyllidae) on *Acacia floribunda* (Vent.) Willd. (Fabaceae) (Ananthakrishnan, 1984); and *Advenathrips inquilinus* described by Morris, Mound and Schwarz (2000) that is considered a true inquiline, entering another thrips domicile

and raising its own offspring without undue disturbance to the host. Opportunistic species have been recorded from Australia in *Acacia* trees where they inhabit galls that have been abandoned by gall-inducers or phyllode domiciles created by thrips or lepidopteran larvae. There are large-sized opportunists (*Domeothrips* Crespi, Morris and Mound; and *Grypothrips* Karny and *Warithrips* Mound) and small to minute that are found in any crevice on *Acacia* (*Brakothrips* Crespi, Morris and Mound; *Corroboreethrips* Mound and Moritz; *Dactylothrips* Bagnall; *Katothrips* Mound and *Rhopalothripoides* Bagnall) (Mound and Morris, 2000; Crespi et al., 2004). One of the opportunists, *Katothrips flindersi* Crespi, Morris and Mound, lives in groups within abandoned, hollow, blister-shaped phyllode mines created by a weevil on *Acacia acrademia* (Crespi and Mound, 1997).

In this paper we describe a new genus and species of Tubuliferan thrips that inhabits galls induced by a Cecidomyiidae on stems, petioles and leaf veins.

Materials and methods

In February 2003, galls were collected by Paul E. Hanson in a Premontane Moist Forest in Monteverde region, at Estación Poco Sol of Bosque Eterno de los Niños/Children's Eternal Rainforest (10°20' N, 84°40' W, 700 to 800 m elevations), Alajuela, Costa Rica. The second author dissected the galls and photographed the galls and live thrips using a Nikon Coolpix 4500 digital camera. The digital images of mounted adult specimens were captured with an Olympus IX-51 microscope. The holotype is deposited in CIT-CIEMIC. Paratypes are deposited in CIT-CIEMIC, CNI- IBUNAM, INBio, SMF, BMNH and UNA.

Abbreviations. CIT-CIEMIC: Colección Institucional de Thysanoptera, Centro de Investigación en Estructuras Microscópicas. Universidad de Costa Rica, San José, Costa Rica. CNI-IBUNAM: Colección Nacional de Insectos del Instituto de Biología, Universidad Nacional Autónoma de México, Mexico City, Mexico. INBio: Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica. SMF: Senckenberg Museum of Frankfurt, Frankfurt, Germany. BMNH: British Museum of Natural History, London, England. UNA: Colección de Entomología, Universidad Nacional, Heredia, Costa Rica. PO: postocular setae.

Description

Fourbethrips Soto-Rodríguez and Retana-Salazar n. gen.
Type species *Fourbethrips fiorella* Soto-Rodríguez and Retana-Salazar.

Macropterous or apterous Phlaeothripinae. Head longer than tube; with 2 pairs of postocular setae (PO), anterior pair reduced and acute and posterior pair long and capitate. Holoptic eyes. Cheeks parallel. Antennae 8-segmented, III and IV with 2 sense cones each one. Antennal segment II with sensorium in apical third. Antennal segment III longer than IV. Antennal segment VIII shorter than the remaining segments. Maxillary stylets about one-third of the head width apart without a maxillary bridge. Mouth cone short and rounded. Pronotum with 5 pairs of capitate major setae variable in length. Probasissternum well developed. Prosternal basantra absent. Mesonotum weakly reticulated. Metanotum reticulated with a pair of short setae in the middle. Sternopleural sutures complete. Fore femora enlarged and expanded with an apical tubercle in both sexes, femora more developed in females. Fore tibiae with tubercle at inner apex and fore tarsus with developed tarsal tooth in both sexes. Mid and hind tarsi with a small tooth. Pelta longer than wide, elongate, with reticulation pronounced in the basal part and a pair of campaniform sensilla. Forewing pale, duplicated cilia absent. Abdominal tergites II-VII with 3 pairs of sigmoid wing-retaining setae. Sternites II-VII with a group of minute setae in the middle and a pair of short and acute setae. Abdominal tergites II-VII with a pair of campaniform sensillae. Tergite IX setae B2 shorter than B1 and B3 in both sexes. All setae of tergite IX shorter than tube. Tube shorter than head.

Remarks. This new genus can be distinguished from other genera in Phlaeothripinae by the elongate pelta, the position of the maxillary stylets in the head, the abdominal sternites II-VII with minute setae or microtrichia, and the pair of short discal setae. Microtrichiae are also present ventrally on mesonotum and metanotum. The anterior pair of PO setae are reduced and acute and the posterior pair are long and capitate; the head is longer than tube; the mouth cone is short and rounded; and the fore tibiae have a developed tarsal tooth in both sexes. Abdominal tergites II-VII have sculptured reticles in anterior position. Similar reticles are present in *Kladothrips nicolsoni* McLeish, Chapman and Mound and *K. rugosus* Froggat (McLeish et al., 2006) and in *Johansenthrips galligena* Retana and Soto (Retana-Salazar and Soto-Rodríguez, 2008), however, in *Kladothrips* they are present only in abdominal segments II-III (McLeish et al., 2006). In *Fourbethrips* n.g. these structures are present in tergites II-VII.

When compared to the original descriptions of related genera (Table 1), there are clearly separating characters of *Fourbethrips*, among the most important ones: the oral cone size, the structure of sense cones on antennal segments, the distance between length and wide of segment

Table 1. Central and South America genera with distal sense cones on antennal segments II and well development holoptic eyes

<i>Generic characters</i>	<i>Macrophthalthothrips</i>	<i>Eupatithrips</i>	<i>Sedulothrips</i>	<i>Fourbethrips</i>
Distance between posterior inner margins of eyes less than distance between posterior pair of ocelli	+	+	+	+
Mouth cone long, extending to mesosternum	+	+	+	-
Mouth cone not extending beyond to mid mesosternum	-	-	-	+
Antennal segment III, 2.5 times as long as wide	+	-	-	-
Antennal segment III, 4 times as long as wide	-	+	+	-
Antennal segment III, 2.8-3 times as long as wide	-	-	-	+
Head with cheek setae on prominent tubercles	-	+	-	-
Head without cheek setae on prominent tubercles	+	-	+	+
Body usually multicoloured, brown and yellow	+	-	-	-
Body brown to dark brown	-	+	+	+
Antennal segments with sense cones broad and stout	-	-	+	-
Antennal segments with sense cones largely	+	+	-	+
Anterior margin of pronotum prominent and recurved	-	-	+	-

III, as well as the shape of pelta. Other characters that can be considered are that *Eupatithrips* has not a basantra on prosternum, it has a tubercle on the inner edge of the femur, a small tarsal tooth and a cheek setae on tubercles. Besides, *Macrophthalthothrips* has bright contrasting colors which are usually yellow to brown, while *Sedulothrips* presents the anterior margin of pronotum strongly concave; the highly developed oral cone extends to mesosternum, the sensory cones on antennal segments are short and stout otherwise to genera on this study. This genus shares many characters with *Fourbethrips*. The latter also presents a different biology than *Eupatithrips*, *Sedulothrips* and *Macrophthalthothrips*, which are found in dead branches where they feed on fungal hyphae (Mound and Marullo, 1996) while *Fourbethrips* is a guest of Cecidomyidae galls inhabiting galls within live tissue.

Generic diagnosis: macropterous or apterous Phlaeothripinae. Head longer than tube; 2 pairs of postocular setae (PO), anterior pair reduced and acute and posterior pair long and capitate. Antennae 8-segmented, III and IV with 2 sense cones each one. Maxillary stylets about one-third of the head width apart. Without maxillary bridge. Pelta elongate, longer than wide. Three pairs of sigmoid wing-retaining. A campaniform sensilla in the abdominal tergites II-VII. Sternites II-VII with a group of minute setae. Fore tibiae with developed tarsal tooth in both sexes.

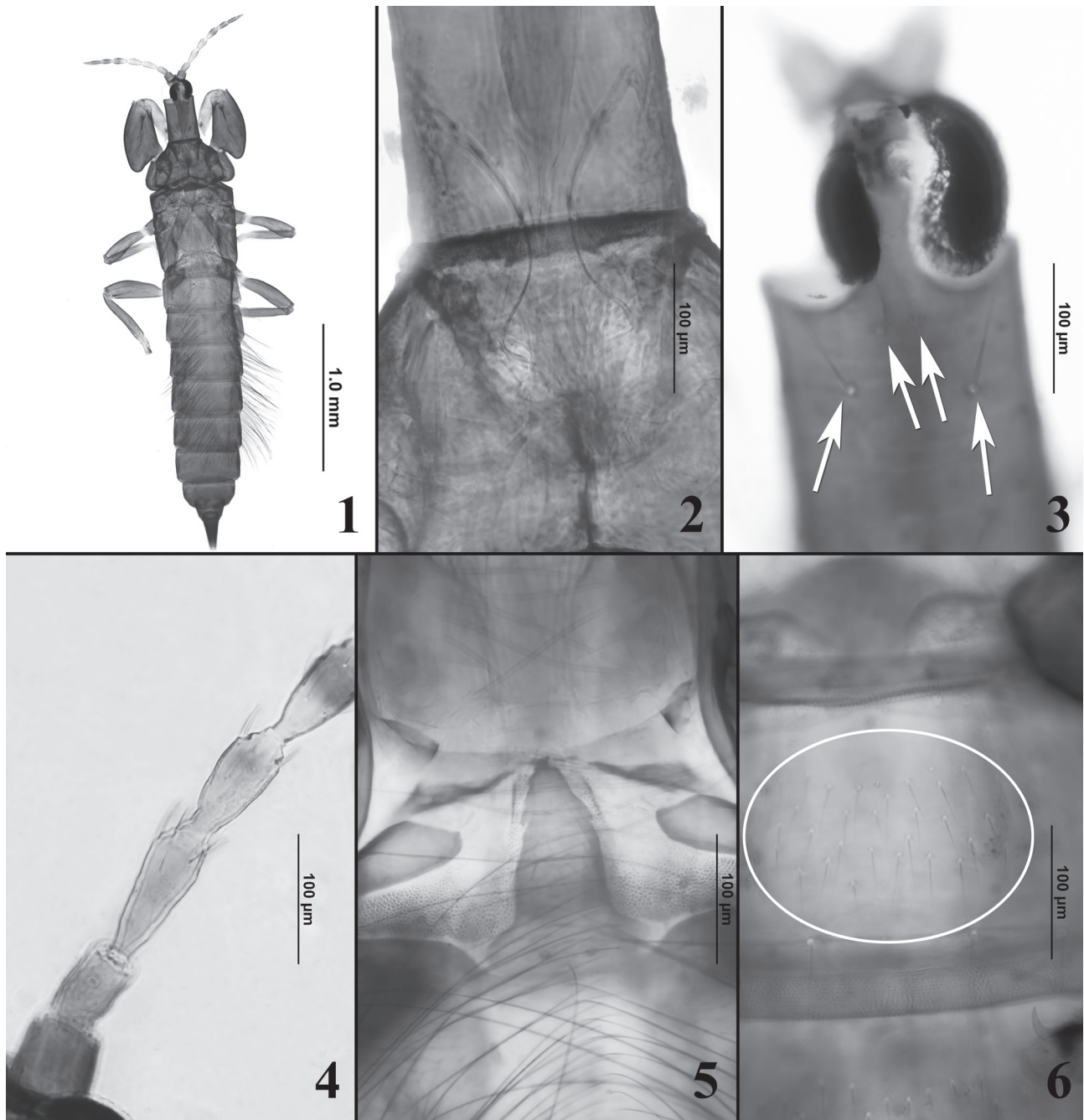
Etymology. The prefix of the generic name is derived from the French word *fourbe*, meaning deceitful or misleading.

Fourbethrips fiorella Soto-Rodríguez and Retana-Salazar n. sp. (Figs. 1-6, 10)

Female macroptera. Coloration. Body brown; antennal segments: I brown, II shaded brown and light brown at

apex, III and IV pale yellow, V brown with basal yellow, VI brown with basal third yellow, VII and VIII brown. All femora brown. Tibiae pale yellow; tube dark brown (Fig. 1). Morphology. Head longer than wide, 1.5 times longer than tube; with 2 pairs of postocular setae, the anterior pair are reduced and acute and the posterior pair are long and capitate (Fig. 3). Holoptic eyes. Cheeks parallel. Antennae 8-segmented, III and IV with 2 sense cones each. Antennal segment II with sensorium in apical third. Antennal segment III longer than IV (Fig. 4). Antennal segment VIII shorter than the remaining segments. Maxillary stylets about one-third of the head width apart without a maxillary bridge (Fig. 2). Mouth cone short and rounded. Pronotum with 5 pairs of capitate major setae variable in length, with anteromarginal setae short and posteroangular, anteroangular, epimeral and midlateral setae long and capitate. Probasissternum well developed. Prosternal basantra absent. Mesonotum weakly reticulated. Metanotum reticulated with a pair of short capitate setae in the middle. Sternopleural sutures complete. Fore femora enlarged and expanded, with apical tubercle. Fore tibiae with tubercle at inner apex and fore tarsus with developed tarsal tooth. Pelta longer than wide, elongate, with reticulation pronounced in the basal part and a pair of campaniform sensilla (Fig. 5). Forewing pale, duplicated cilia absent. Abdominal tergites II-VII with 3 pairs of sigmoid wing-retaining setae. Sternites II-VII with a group of minute setae in the middle (Fig. 6) and a pair of short and acute setae. Abdominal tergites II-VII with a pair of campaniform sensilla. Tergite IX setae B1, B2 and B3 capitate. Setae B2 shorter than B1 and B3 in both sexes. All setae of tergite IX shorter than tube. Tube shorter than the head.

Measurements of female holotype in μm : Total length 3 175; head length 430; PO setae anterior pair 40; PO setae



Figures 1-6. 1, female holotype, dorsal view; 2, maxillary stylets, dorsal view; 3, postocular setae, arrows pointing at each seta respectively; 4, right antennal segments I-V, dorsal view; 5, pelta, dorsal view; 6, group of minute setae on abdominal sternite II, indicated by circle.

posterior pair 95; antennal segments I 70, II 85, III 140, IV 115, V 110, VI 100, VII 95 and VIII 55. Pronotum setae length: anteromarginal setae 57,5; anteroangular setae 40; mid-lateral setae 110; posteroangular setae 90, epimeral setae 155. Fore femora basal width: 240. Tarsal tooth: 70. Abdominal tergite IX setae: B1 180, B2 55 and B3 130. Tergite X (tube) length 275, basal width 100, apical width 55.

Male: Apterous. Similar to female in coloration and structure but smaller than the female, collected with the holotype. Material deposited in CIT-CIEMIC.

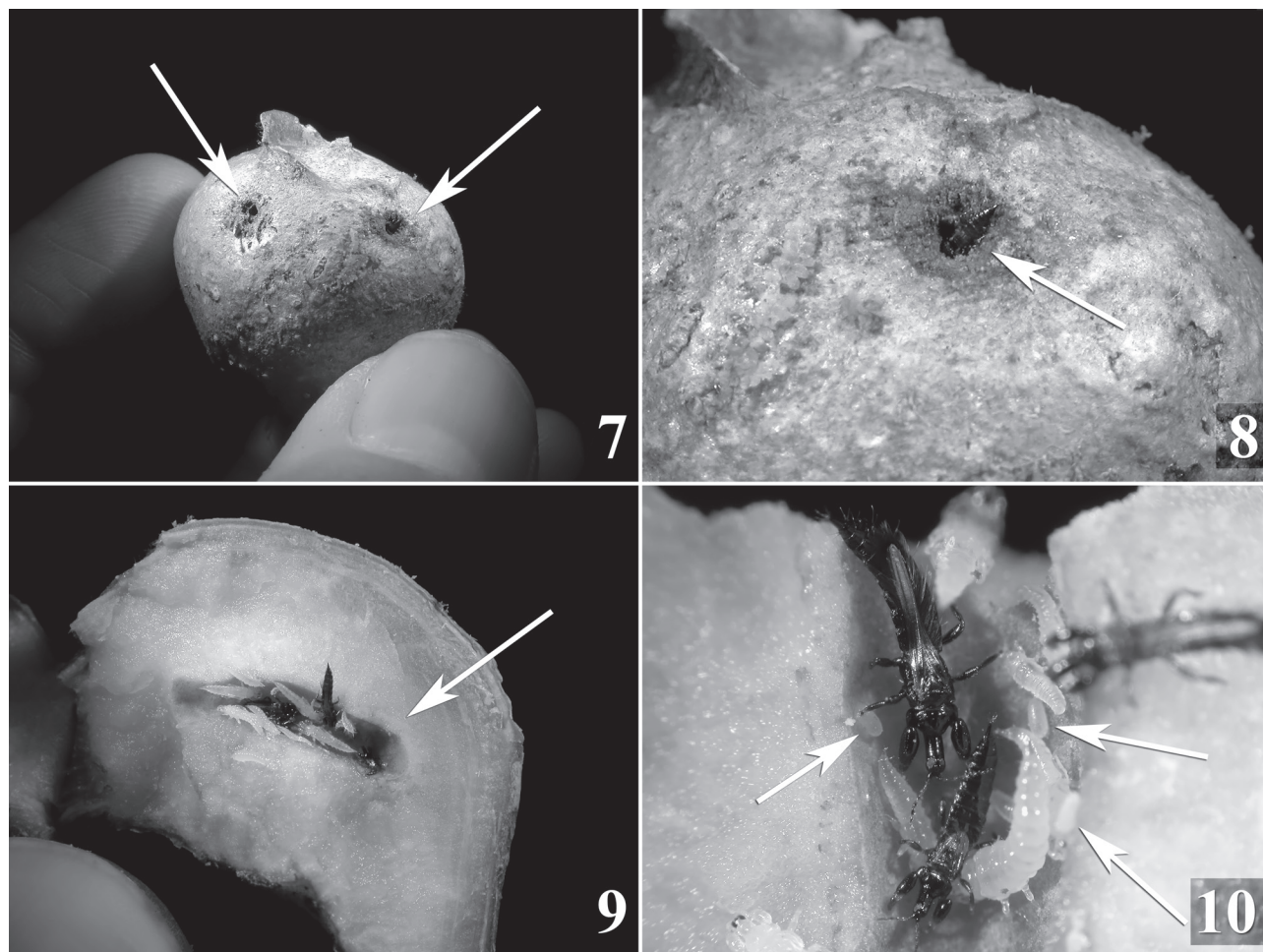
Taxonomic summary

Holotype: Macropterous female. COSTA RICA: Alajuela, Monteverde region, Estación Poco Sol of Bosque Eterno de los Niños/Children's Eternal Rainforest (10°20'N, 84°40'W, 700 to 800 m elevations. 13.ii.2003 (Paul E. Hanson). Host plant: cecidomyiid gall on stems, petiole or

leaf vein of an unidentified Melastomataceae. Paratypes: 21 females and 3 males, body length range 3175-3600 μm , same locality as holotype.

Etymology. The first author dedicates this species to Fiorella Jiménez Muñoz, for her invaluable support and love over many years.

Biology. The thrips were found inside galls (Figs. 7-10) induced by an unidentified cecidomyiid (the adult cecidomyiid has not been reared). The gall chamber occupied by the thrips did not contain the cecidomyiid larva or pupa. Instead most of the chamber contained eggs, young and mature larvae, and adult thrips (Figs. 9-10). The gall shape was ovoid to globose. Its size varied depending on the position, e.g. galls on stems were 20 to 30 mm long ($n=2$), whereas galls in petioles were larger than those on leaf veins (8 mm long, $n=1$). The gall chamber sized approximately 15 mm long and



Figures 7-10. 7, the cecidomyiid gall on leaf petiole of the Melastomataceae (arrows pointing at exit holes of gall chamber. In this case, 2 galls were fused); 8, adult thrips positioned at gall exit hole (arrow) protruding its post abdominal segments; 9, cut-opened gall showing the chamber (arrow) and thrips in different life stages. White individuals are nymphs; 10, close-up view of the gall chamber showing adults, nymphs and eggs (arrows).

1.5 mm wide in cylindrical form (n= 2). Although the feeding behavior was not observed, nymphs and adults most likely feed inside the chamber on the gall walls. Under captive conditions, inside a plastic bag, some of the adults exited and entered the gall via an exit hole (ca. 1 mm diameter) (Figs. 7-8). At the exit hole of the gall, an adult thrips abdomen was observed (n= 2) (Fig. 8). It is unknown whether this species is a kleptoparasite or is just occupying 'abandoned' galls of the Cecidomyiidae; however, it seems to be quite specific to the gall, because it has not been found in any other galls in the same habitat (K. Nishida, pers. observ.). The species of Melastomataceae appears to belong to the tribe Blakeeae. No plant sample was preserved or vouchered.

Species diagnosis. Body brown; antennal segments I brown, II shaded brown and light brown at apex, III and IV pale yellow, V brown with basal yellow, VI brown with basal third yellow, VII and VIII brown. All femora brown. Tibiae pale yellow; tube dark brown. Head 1,5 times longer than tube. Pronotum with anteromarginal setae short and posteroangular, anteroangular, epimeral and midlateral setae long and capitate. Pelta longer than wide, elongate. Setae B1-B3 shorter than tube.

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Literature cited

- Ananthakrishnan, T. N. 1984. Bioecology of thrips. Indira Publishing House. 233 p.
- Crespi, B. J., D. A. Carmean and T. W. Chapman. 1997. Ecology and evolution of galling thrips and their allies. Annual Review of Entomology 42:51-71.
- Crespi, B. J. and L. A. Mound. 1997. Ecology and evolution of social behavior among Australian gall thrips and their allies. In The evolution of social behaviour in insects and arachnids, J. C. Choe and B. J. Crespi (eds.). Cambridge University Press. p. 166-180.
- Crespi, B. J., D. C. Morris and L. A. Mound. 2004. Evolution of ecological and behavioural diversity: Australian *Acacia* thrips as model organisms. 321 p.
- McLeish, M. J., T. W. Chapman and L. A. Mound. 2006. Gall morpho-type corresponds to separate species of gall-inducing thrips (Thysanoptera: Phlaeothripidae). Biological Journal of the Linnean Society 88:555-563.
- Morris, D. C., L. A. Mound and M. P. Schwarz. 2000. *Advenathrips inquilinus*: A new genus and species of social parasites (Thysanoptera: Phlaeothripidae). Australian Journal of Entomology 39:53-57.
- Mound, L. A. 1994. Thrips and gall induction: a search for patterns. In Plant Galls. Systematics Association Special Volume No. 49, Clarendon Press, Oxford. p. 131-149.
- Mound, L. A. 2002. Thysanoptera biodiversity in the Neotropics. Revista de Biología Tropical 50:477-484.
- Mound, L. A. and R. Marullo. 1996. The thrips of Central and South America: an introduction (Insecta: Thysanoptera). Memoirs on Entomology. 1-487 p.
- Mound, L. A. and G. Moritz. 2000. *Corroboreethrips*, a new genus of minute apterous thrips (Insecta: Thysanoptera: Phlaeothripinae) from the bark of Australian *Acacia* trees. Invertebrate Taxonomy 14:709-716.
- Mound, L. A. and D. C. Morris. 2005. Gall-inducing thrips: an evolutionary perspective. In Biology, ecology and evolution of gall-inducing arthropods, A. Raman, C. W. Schaefer and T. M. Withers (eds.). Enfield, New Hampshire (Science Publ.). p. 59-72.
- Retana-Salazar, A. P. and G. A. Soto-Rodríguez. 2008. A new genus and species of gall-inducing thrips (Thysanoptera: Tubulifera) from the neotropical region. Brenesia 69:59-64.