



New records of whiteflies (Hemiptera, Aleyrodidae) and their host plants from Colombia

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Abstract

More than half of all species of whiteflies (Aleyrodidae) are distributed in the tropics. Very little is known of the whitefly fauna of Colombia. This situation causes limitations in the study of basic and applied entomology of these sap-sucking insects, which are of considerable importance in agriculture as they affect many cultivated and wild plants. In this work, we provide new distribution records for six species of whitefly in Colombia. We also provide maps depicting the distribution of these species in the country and data on their host plants.

Keywords

Aleurocerus, *Aleurodicus*, *Aleurotrachelus*, *Bakerius*, *Nealeurodicus*, Sternorrhyncha

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Introduction

Whiteflies constitute an increasing problem for farmers around the world (Martin 2004). By extracting considerable quantities of phloem sap, these insects directly affect many cultivated and wild plants, which can result in a yield reduction of more than 50% in cultivated plants. Furthermore, whiteflies also indirectly cause damage by the secretion of honeydew that serves as a medium for sooty mold fungi (Byrne and Bellown 1991).

More than 1500 species of whiteflies have been described worldwide (Martin 2004, 2005); of these, about 63% of species are distributed in the tropics and about 37% are distributed in the temperate regions (Dooley

2014). Some species of Neotropical origin have increased their geographic range and have become invasive pests in other regions of the world (Martin 2004). Mound and Halsey (1978) recorded 1200 species of whiteflies in the world, including only three from Colombia. However, Evans (2007, 2008) reported 18 genera and 31 species of Aleyrodidae from the country. Moreover, Saldarriaga and Posada (1993) reported the largest inventory of Aleyrodidae for Colombia, where they included 34 whitefly species on cultivated and wild plants, and at least 64 samples of whiteflies not determined, with data of their host plants and distribution in Colombia.

Considering the high dispersion of whiteflies and the lack of taxonomic studies for over 20 years in Colombia, the number of aleyrodid species is estimated to be higher than what Saldarriaga and Posada (1993) reported. Likewise, it is probable that the high dispersal capacity of whiteflies allows for the entry of species into the country from other regions. Understanding the diversity of the whitefly fauna present in Colombia will provide the baseline data for the early detection of invasive species whose populations could reach economic levels of damage.

Methods

To prepare specimens for slide-mounting, we employed a protocol modified from the those of Caballero (1992), Dooley (2002), Martin (1987), and Sirisena et al. (2013) using fewer steps in the preparing the samples. Our modified protocol thereby avoided loss of setae and the deterioration of the cuticle. The use of highly toxic reagents, such as carboxylene and glacial acetic acid, was avoided. Identifications were carried out using a Nikon Eclipse E600 phase-contrast microscope and species-level keys and descriptions published by Martin (2004, 2008), Russell (1986), and Dooley and Smith-Pardo (2016). Identification of each species is based on characters of the puparium.

All whitefly specimens collected in this study are deposited in the Entomological Museum of the Universidad Nacional Agronomía Bogotá (UNAB), Bogotá, Colombia.

For each species, host plants were recorded. New host and expanded distributions were determined using publications and global catalogs of Aleyrodidae by Evans (2007, 2008), Mound and Halsey (1978), Ouvrard and Martin (2019), Martin and Mound (2007), and Saldarriaga and Posada (1993).

ArcGIS-software v. 10.5 was used to prepare distribution maps. Photographs were taken with an Infinity 1 camera adapted to a Nikon Eclipse E600 phase-contrast microscope and edited with Photoshop CS6 software.

Results

Based on our study, six species of Aleyrodidae are newly recorded from Colombia and nine new host plant associations are reported.

Aleurocerus flavomarginatus Bondar, 1923

New records. COLOMBIA – Antioquia • Carepa, Finca Tulenapa, Universidad de Antioquia; 07°46'00"N, 076°39'00"W; alt. 27 m; 31 Mar. 2014; F. Serna leg.; on leaves of *Coccoloba padiformis* Meins. (Polygonaceae); 5 pupae, UNAB 1884.

Identification. This species differs from *Aleurocerus palmae* Russell, 1986 by the submargin (Fig. 1C) which has narrowly conical submarginal glands (Fig. 1D), and their margins strongly convergent. The ends of

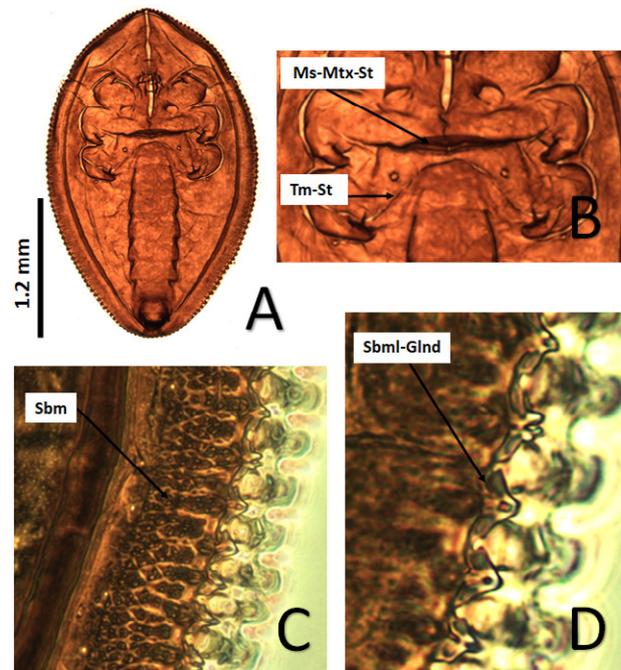


Figure 1. *Aleurocerus flavomarginatus* Bondar, 1923. **A.** Habitus. **B.** Transverse moulting suture (Tm-St) and meso-metathoracic suture (Ms-Mtx-St). **C.** Submargin (Sbm). **D.** Submarginal glands (Sbml-Glnd). Abdominal compound pores.

the transverse molting suture are opposite to the meso-metathoracic suture (Fig. 1B). In *A. palmae*, the submarginal glands varying from broadly conical with margins moderately convergent and apices moderately curved to thimble-shaped with lateral margins nearly parallel and apices broadly curved (Russell 1986).

Distribution. Previously recorded from Brazil, Cuba, and Guatemala (Evans 2007, 2008; Martin and Mound 2007; Ouvrard and Martin 2019). Our new data is the first record of *A. flavomarginatus* from Colombia; it was collected in the department of Antioquia (Fig. 7A).

New plant host. This is the first record of *A. flavomarginatus* on *C. padiformis* (Polygonaceae). This species of whitefly has previously been recorded on *Chamaedorea* Willd. sp. (Arecaceae) and *Gardenia jasminoides* J. Ellis (Rubiaceae) (Evans 2007, 2008).

Aleurodicus capianga Bondar, 1923

New records. COLOMBIA – Caquetá • Florencia, Centro de Investigaciones Amazónicas CIMAZ, Macagual; 01°30'04"N, 075°36'23"W; alt. 250 m; 27 Sep. 2016; J. Díaz leg.; on leaves of *Zygia longifolia* (Humb. & Bonpl. ex Willd.) Britton & Rose (Fabaceae); 2 pupae, UNAB 4002.

Identification. This species has four pairs of submedian cephalothoracic setae (Fig. 2B) and so differs from *Aleurodicus maritimus* Hempel, 1923 which has three pairs. It differs from *Aleurodicus dugesii* Cockerell, 1986 and *Aleurodicus inversus* Marin, 2004 in having two pairs of cup-shaped caudal compound pores (Fig. 2C), whereas the latter have bell-shaped pores. In addition, *A. capianga* has evenly spaced, double-rimmed

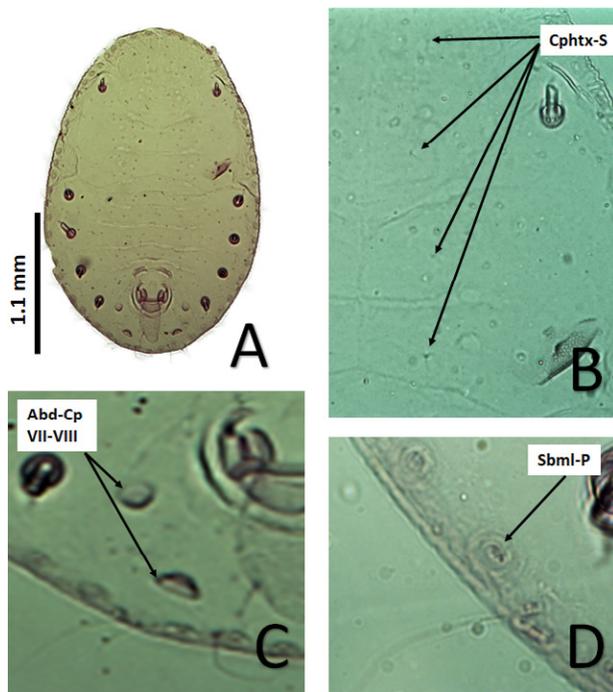


Figure 2. *Aleurodicus capiangae* Bondar, 1923. **A.** Habitus. **B.** Position of the cephalothoracic setae (Cphtx-s). **C.** Abdominal compound pores (Abd-Cp). **D.** Submarginal pores (Sbml-P).

pores in a single row very close to the puparial margin (Fig. 2D) (Martin 2008).

Distribution. Previously recorded from Brazil, Costa Rica, Ecuador, Guyana, Nicaragua, Panamá, Surinam, and Trinidad (Evans 2007, 2008; Martin and Mound 2007; Martin 2008; Ouvrard and Martin 2019). Our new data is the first record of *A. capiangae* from Colombia (Fig. 7B).

New plant hosts. This is the first record of *A. capiangae* on *Zygia longifolia* (Fabaceae). This species of whitefly has been previously recorded on *Vismia brasiliensis* Choisy (Hypericaceae), *Inga* sp. (Fabaceae), *Cecropia palmata* Willd. (Urticaceae), *Musa sapientum* L. (Musaceae), *Theobroma cacao* L. (Malvaceae), *Citharexylum* L. sp. (Verbenaceae), *Canna indica* L. (Cannaceae), *Annona muricata* L. (Annonaceae), and *Aristolochia trilobata* L. (Aristolochiaceae) (Evans 2007, 2008; Martin 2004, 2008).

Aleurodicus magnificus Costa Lima, 1928

New records. COLOMBIA – **Caquetá** • Florencia, Centro de Investigaciones Amazónicas CIMAZ, Macagual; 01°24'59"N, 075°39'45"W; alt. 300 m; 12 Sep. 2014; J. Díaz leg.; on leaves of *Theobroma grandiflorum* (Willd. ex Spreng.) K. Schum. (Malvaceae); 4 pupae, UNAB 1208 • Florencia, Centro de Investigaciones Amazónicas CIMAZ, Macagual; 01°30'04"N, 075°36'23"W; alt. 250 m; 24 Sep. 2016; J. Díaz leg.; on leaves of a plant associated with a cocoa agroforestry system; 4 pupae, UNAB 1208 • Florencia, Centro de Investigaciones Amazónicas CIMAZ, Macagual; 01°30'04"N, 075°36'23"W; alt. 250 m; 23 Sep. 2016; J. Díaz leg.; on leaves of *Piper* L.

(Piperaceae); 5 pupae, UNAB 1208 • Florencia, Centro de Investigaciones Amazónicas CIMAZ, Macagual; 01°30'04"N, 75°36'23"W; alt. 250 m; 27 Sep. 2016; M. Prieto leg.; on leaves of *Theobroma grandiflorum* (Malvaceae); 6 pupae, UNAB 1208 – **Putumayo** • Mocoa, Jardín Botánico Amazónico Tropical; 01°08'00"N, 076°38'00"W; alt. 650 m; 18 Sep. 2015; J. Díaz leg.; on leaves of *Cecropia peltata* L. (Urticaceae); 6 pupae, UNAB 1208 • Mocoa, Vereda Pueblo viejo, Finca Villa Loca; 01°11'15"N, 076°35'58"W; alt. 620 m; 19 Sep. 2015; J. Díaz leg.; on leaves of *Annona cherimola* Mill. (Annonaceae); 4 pupae, UNAB 1208 – **Antioquia** • Carepa, Finca Tulenapa, Universidad de Antioquia; 07°46'00"N, 076°39'00"W; alt. 27 m; 31 Mar. 2014; J. Díaz leg.; on leaves of *Annona muricata* L. (Annonaceae); 4 pupae, UNAB 1208 – **Nariño** • Ricaurte, Vereda Palpis, El Chorro del amor; 01°13'35"N, 078°03'04"W; alt. 940 m; 21 Sep. 2015; H. Arévalo leg.; in leaves of *Vismia* Vand. sp. (Hypericaceae); 3 pupae, UNAB 1208.

Identification. This species has numerous septate pores (Fig. 3C) in transverse segmental bands. It is similar to *Aleurodicus neglectus* Quaintance & Baker, 1913 but differs in having double-rimmed pores in two irregular rows and simple, large, notched pores only posterior to the cephalic compound pores (Fig. 3B) (Martin 2008). In *A. neglectus* the notched pores surround the cephalic compound pores.

Distribution. Previously recorded from Belize, Brazil, Ecuador, and Panama (Evans 2007, 2008; Martin and Mound 2007; Martin 2008; Ouvrard and Martin 2019). Our new records are the first from Colombia (Fig. 7C).

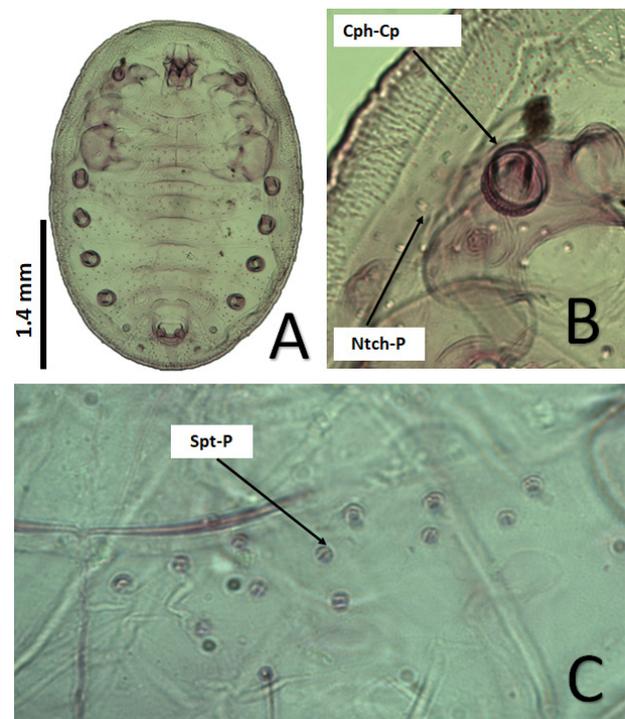


Figure 3. *Aleurodicus magnificus*, Costa Lima, 1928. **A.** Habitus. **B.** Cephalic compound pore (Cph-Cp) and simple pores notched (Ntch-P). **C.** Simple pores septate (Spt-P).

New plant hosts. We report for the first time *A. magnificus* in *T. grandiflorum* (Malvaceae), *Piper* sp. (Piperaceae), *C. peltata* (Urticaceae), *A. muricata*, and *A. cherimola* (Annonaceae). This whitefly species was previously recorded on *Citrus* sp. (Rutaceae), *Tetracera* sp. (Dilleniaceae), *Annona* sp. (Annonaceae), *Nectandra* sp. (Lauraceae), *Unonopsis* sp. (Annonaceae), and *Vismia* sp. (Hypericaceae) (Evans 2007, 2008; Martin 2004, 2008).

Comments. *Aleurodicus magnificus* occurs in Colombian departments bordering on Ecuador and Panama, where this species has been previously reported (Evans 2007, 2008; Martin and Mound 2007; Martin 2008). Five new host plants are reported, of which *T. grandiflora* (Malvaceae), *A. muricata*, and *A. cherimola* (Annonaceae), are important to Colombian agriculture.

Aleurotrachelus theobromae Bondar, 1923

New records. COLOMBIA – Antioquia • Medellín, Barrio Florida Nueva; 06°15'10.5"N, 075°35'24.3"W; alt. 1485 m; 1 Ene. 2011; E. Vergara leg.; on leaves of *Bauhinia variegata* L. (Fabaceae); 5 pupae, UNAB 5225.

Identification. This species differs from other *Aleurotrachelus* species in having dark marginal teeth with wavy edges and forked apices (Fig. 4B). Each tooth has a pore at its base (Fig. 4B). The submarginal area has a grainy appearance in the ventral view (Fig. 4B). The rachis has a median line of pores present on segments II–IV, VI, and VII (FIG. 4C) and abdominal pores lateral to the rachis (Bondar 1923).

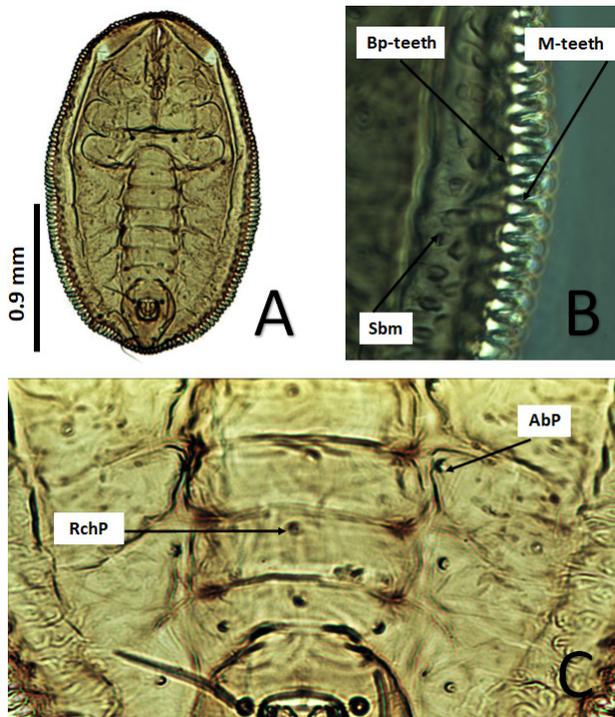


Figure 4. *Aleurotrachelus theobromae* Bondar, 1923. **A.** Habitus. **B.** Marginal teeth (M-teeth), pore at the base of each tooth (Bp-teeth) and submargin (Sbm). **C.** Pores in the midline of the rachis (Rch-P) and lateral abdominal pores to rachis (Ab-P).

Distribution. Previously recorded from Brazil and Guyana (Bondar 1923; Evans 2007, 2008; Martin and Mound 2007; Ouvrard and Martin 2019). Our new data is the first record of *A. theobromae* from Colombia (Fig. 7D).

New plant host. This is the first record of *A. theobromae* on *Bauhinia variegata* (Fabaceae). This whitefly species was previously recorded on *Anacardium occidentale* L. (Anacardiaceae) and *Theobroma cacao* L. (Malvaceae) (Bondar 1923; Evans 2007, 2008).

Bakerius sanguineus Bondar, 1928

New records. COLOMBIA – Caquetá • El Doncello, Vereda Anayacito, Finca. Buena Vista; 01°40'59"N, 075°18'34"W; alt. 580 m; 08 Sep. 2014; J. Díaz leg.; on leaves of *Borreria* L. sp. (Rubiaceae); 3 pupae, UNAB 3989.

Identification. This species has large dorsal loculate pores each with 3–4 locules (Fig. 5C), arranged in clusters on the cephalic region and below the vasiform orifice and in rows on the thoracic and abdominal segments 1–8. When present, the central, spine-like processes are elongated, narrowly acute, and extending beyond the margin of each compound pore by more than twice the diameter of the compound pore (Fig. 5B). The cuticle is pale (Dooley and Smith-Pardo 2016).

Distribution. Previously recorded for Brazil and Panama (Evans 2007, 2008; Dooley and Smith-Pardo 2016; Ouvrard and Martin 2019). Our new record is the first of *B. sanguineus* from Colombia (Fig. 7E).

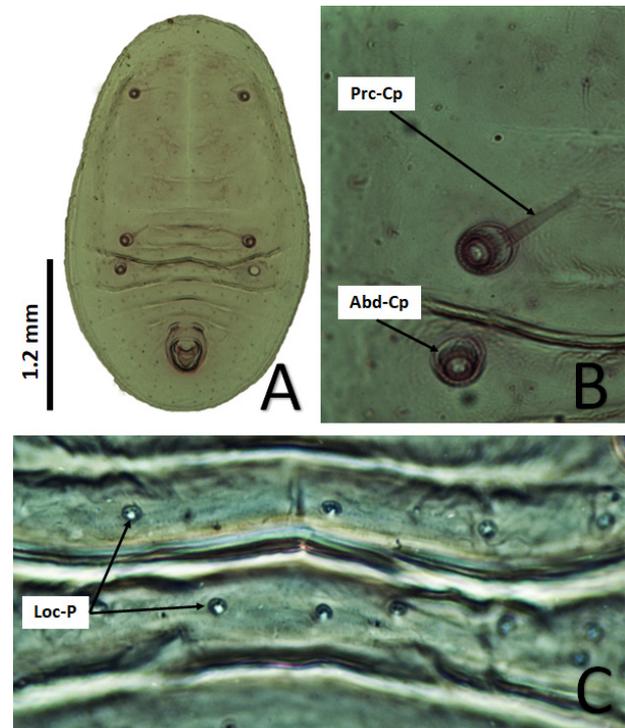


Figure 5. *Bakerius sanguineus* Bondar, 1928. **A.** Habitus. **B.** Abdominal compound pore (Abd-Cp) and compound pore process (Prc-Cp). **C.** Loculated pores (Loc-P).

***Nealeurodicus bakeri* (Bondar, 1923)**

New records. COLOMBIA – **Huila** • Campoalegre, Parador Los Rosales; 02°35'55"N, 075°24'55"W; alt. 525 m; 29 Sep. 2016; J. Díaz leg.; on leaves of *Licania tomentosa* (Benth.) Fritsch (Chrysobalanaceae); 11 pupae, UNAB 3990 • Aipe, road to Neiva; 03°13'03"N, 075°14'57"W; alt. 424 m.; 13 May. 2017; J. Díaz leg.; on leaves of *Annona squamosa* L. (Annonaceae); 4 pupae, UNAB 3990.

Identification. This species differs from other species of *Nealeurodicus* Hempel, 1923 in having the cephalic and abdominal compound pores similar in shape (Fig. 6B, C). *Nealeurodicus bakeri* is characterized by having abdominal compound pores present only on segments two, four, and eight, and in having the median part of abdominal segment eight (Fig. 6D), between the vasiform orifice and the pockets, usually without simple pores (Martin 2004).

Distribution. Previously recorded from Belize, Brazil, Costa Rica, Guatemala, Nicaragua, Panama, Trinidad, and Venezuela (Evans 2007, 2008; Martin and Mound 2007; Ouvrard and Martin 2019). Our new records are the first of *N. bakeri* from Colombia (Fig. 7F).

New plant hosts. We report *N. bakeri* on *L. tomentosa* (Chrysobalanaceae) and *A. squamosa* (Annonaceae) for the first time. This whitefly species was previously recorded on *Inga* Mill. sp. (Fabaceae), *Cecropia* Loeffl. sp. (Urticaceae), *Terminalia amazonia* (J.F. Gmel.) Exell (Combretaceae), and *Protium copal* Engl. (Burseraceae) (Martin 2004; Evans 2007, 2008).

Discussion

More than 1500 species of whiteflies are known worldwide (Evans 2007), and of these, Evans (2007, 2008) and Saldarriaga and Posada (1993) reported 31 and 34

species, respectively, as occurring in Colombia. Based on the present study carried out at UNAB, we found six aleyrodid species newly recorded from the country. We predict that the number of species in Colombia could increase due to the high dispersal capacity of Aleyrodidae. The species recorded herein were previously known from Brazil by Bondar (1923, 1928) and Costa Lima (1928), and most of these species are known from several other countries bordering Colombia, such as Venezuela, Panama, and Ecuador (Evans 2007, 2008; Martin and Mound 2007; Ouvrard and Martin 2019).

The polyphagous capability of whiteflies has allowed them to establish in countries around the globe, where they have had an impact on the production of economically important crops. The spread of whitefly species to other regions of the world has been due primarily to the international trade of plants or parts of plants.

Species of Aleyrodidae with fewer records, such as *A. flavomarginatus* and *A. theobromae*, have increased their host plant associations, mostly with wild plants. Several aleyrodid species are exotic pests, and several of these are Neotropical species that have spread to other regions of the world and have impacted agricultural commodities. For this reason, determining the species of whiteflies present in Colombia, their host plant distributions, and natural enemies are important information to know. These data provide the necessary tools for early detection and assessing the threat to Colombian agriculture that species pose, and taking the appropriate actions to stop whitefly introductions and establishment.

Surveys of the aleyrodids and other taxa and maintaining a reference collection, such at the UNAB museum, are fundamental tools for research, especially in countries like Colombia that suffer from having few specialists in the taxonomy of insects of agricultural importance.

Acknowledgements

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Authors' Contributions

Conceptualization: JLDS, FS. Date curation: JLDS. Investigation: JLDS. Methodology: JLDS, FS. Resources: JLDS, FS. Supervision: FS. Visualization: FS, MZA. Writing – original draft: JLDS. Writing – review and editing: JLDS, FS, MZA.

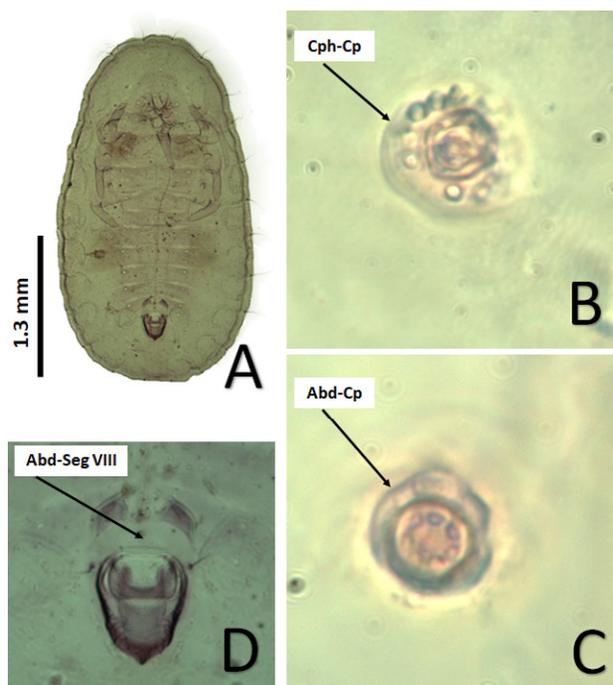


Figure 6. *Nealeurodicus bakeri* (Bondar, 1923). **A.** Habitus. **B.** Cephalic compound pore (Cph-Cp). **C.** Abdominal compound pore (Cph-Cp). **D.** Abdominal segment VIII.

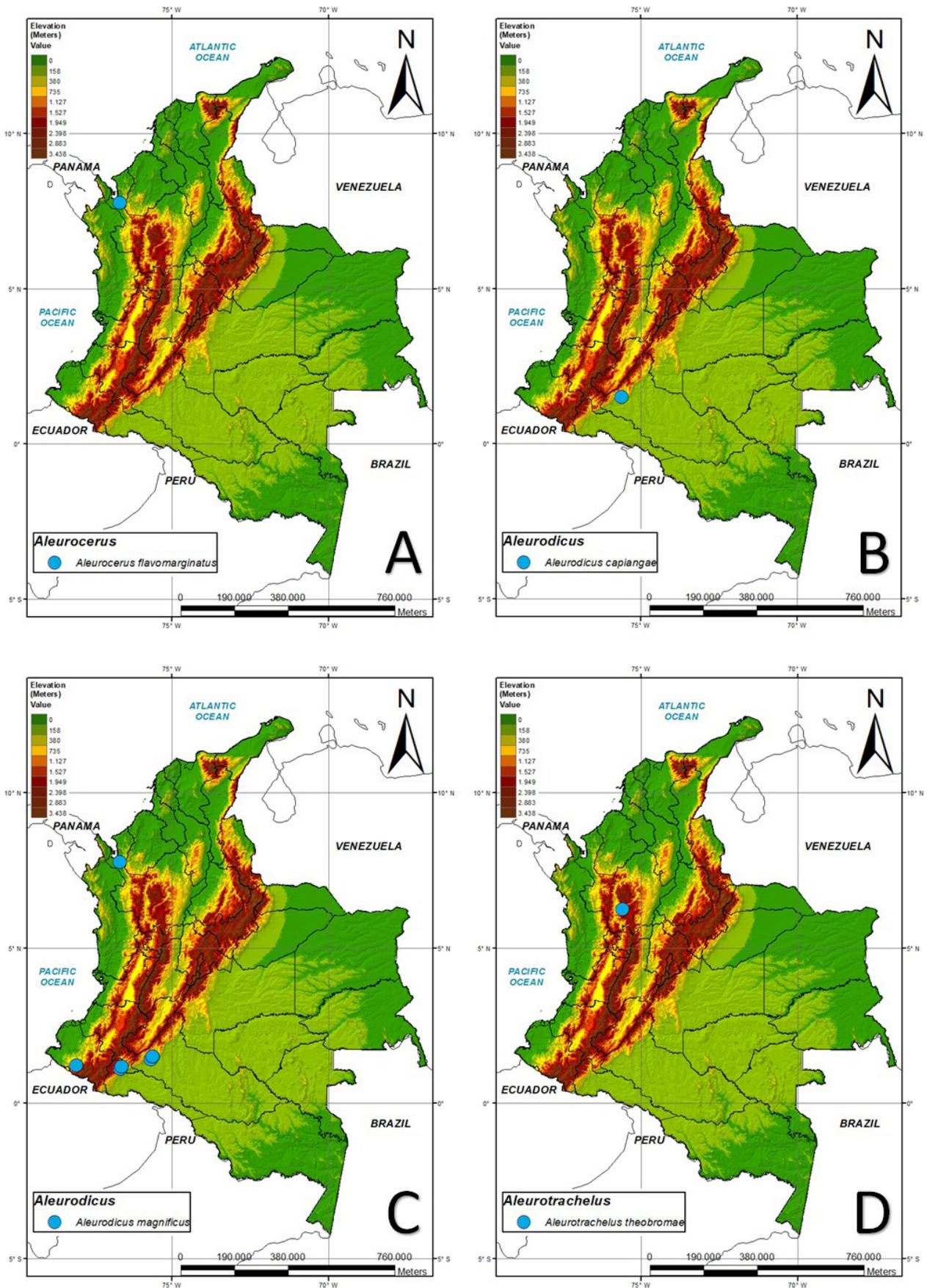


Figure 7. Local distribution maps for the new records of Aleyrodidae species in Colombia. **A.** *Aleurocerus flavomarginatus*. **B.** *Aleurodicus capianga*. **C.** *Aleurodicus magnificus*. **D.** *Aleurotrachelus theobromae*.

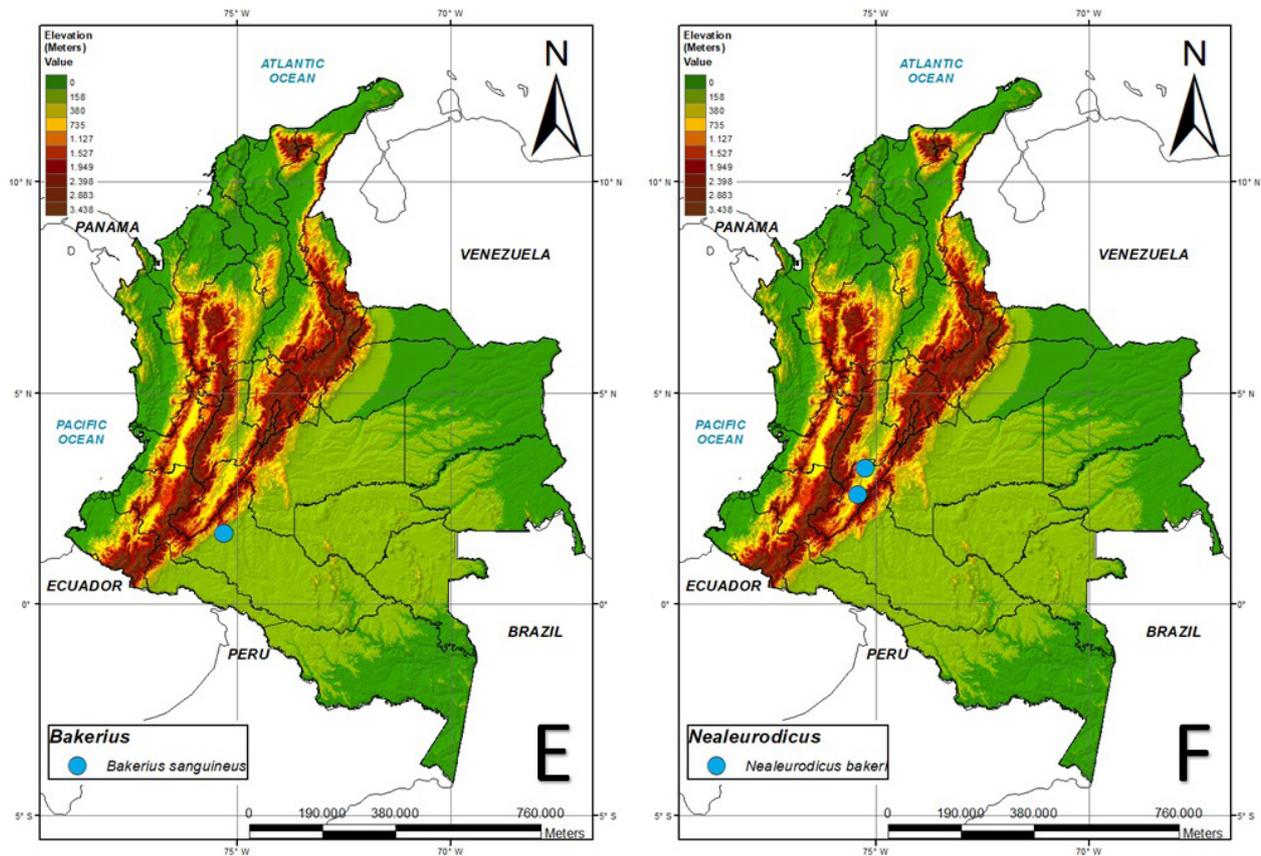


Figure 7 (continued). Local distribution maps for the new records of Aleyrodidae species in Colombia. **E.** *Bakerius sanguineus*. **F.** *Nealeurodicus bakeri*.

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