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Description of a new species of *Toumeyella* Cockerell
(Hemiptera: Coccoomorpha: Coccidae)
on *Crataegus mexicana* Moc. and Sessé ex DC. (Rosaceae)

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Description of a new species of *Toumeyella* Cockerell (Hemiptera: Coccoomorpha: Coccidae) on *Crataegus mexicana* Moc. and Sessé ex DC. (Rosaceae)

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Abstract. A new species of soft scale from Mexico, *Toumeyella crataegi* Kondo and González sp. nov., (Hemiptera: Coccoomorpha: Coccidae) collected on *Crataegus mexicana* DC. (Rosaceae), is described and illustrated based on the adult female. An updated taxonomic key to the soft scale insects of the genus *Toumeyella* Cockerell known from Mexico is provided. The specific epithet of *Toumeyella martinezi* Kondo and González is here emended to *T. martinezae*. A checklist with information on geographical distribution, host plants and brief notes of all 18 currently known species of *Toumeyella* is provided.

Key words. Tejojote, coccid, soft scale, *Toumeyella crataegi*.

Resumen. Una nueva especie de escama blanda de México, *Toumeyella crataegi* Kondo y González sp. nov., (Hemiptera: Coccoomorpha: Coccidae) colectada sobre *Crataegus mexicana* DC. (Rosaceae) es descrita e ilustrada con base en la hembra adulta. Se provee una clave taxonómica actualizada para las especies de escamas blandas del género *Toumeyella* Cockerell registradas en México. Se corrige también la terminación del epíteto específico de *Toumeyella martinezi* Kondo y González, como *T. martinezae* debido a que la especie fue descrita en honor de una entomóloga. Se proporciona un listado con información sobre la distribución geográfica, plantas hospederas y notas breves de las 18 especies de *Toumeyella* actualmente conocidas.

Palabras clave. Tecojote, cóccido, escama blanda, *Toumeyella crataegi*.

Introduction

In Mexico, the genus *Crataegus*, commonly known as hawthorns, contains 15 species distributed in the northern and central regions (Nuñez Colin et al. 2012). *Crataegus mexicana* Moc. and Sessé ex DC. (Rosaceae), known locally in Mexico as “tejojote”, is also cultivated in Costa Rica, Ecuador, Guatemala, Honduras, Peru, South Africa and the USA (Arizona, California) (Nuñez Colin et al. 2012). Tejojote is the common name for *Crataegus* trees in Mexico and refers to the Nahuatl name “te-xocotl” meaning stone and sour fruit (Nieto-Ángel et al. 1996). *Crataegus* species have been used as rootstock for various genera in the Rosaceae, such as *Cydonia*, *Malus*, *Mespilus* and *Pyrus* (Borys and Leszczyńska-Borys 2004). Tejojote fruits are rich in carotene, vitamin C, calcium, iron, phosphorus, and also have a high content of pectin (Vivar-Vera et al. 2007). Pectins have several uses in the food, pharmaceutical and cosmetic industries, as well in the production of edible coatings and films for packing materials (Aldana-Villarruel et al. 2011).

Most species of the soft scale genus *Toumeyella* Cockerell (Hemiptera: Coccidae) are oligophagous, usually being found on one or very few plant families. According to Kondo and Pellizzari (2011), the *Toumeyella* species in Mexico have been recorded on Fabaceae (*T. erythrinae* Kondo and Williams, *T. mirabilis* (Cockerell) and *T. fontanai* Kondo and Pellizzari), Pinaceae (*T. parvicornis* (Cockerell)) and Cactaceae (*T. martinezae* Kondo & González), with the host plant of *T. sallei* (Signoret) being unknown.

Toumeyella is endemic to the New World, with the highest diversity reported from North America [the USA (9 spp.) and Mexico (6 spp.)] (Kondo and Pellizzari 2011; Kondo 2013; Kondo and González 2014). Recently, the Brazilian species *T. ferum* (Hempel) was transferred to *Neotoumeyella* Kondo and Williams by Kondo (2018) based on the presence of ventral tubular ducts found on mid areas of the abdomen and the area lateral to both spiracular pore bands.

Since 2003, three new *Toumeyella* species have been described from Mexico, namely *T. erythrinae* Kondo and Williams, 2003a, *T. fontanai* Kondo and Pellizzari, 2011, and *T. martinezae* Kondo and González, 2014. In this paper we describe and illustrate a new species of soft scale insect found on *Cra-taegus mexicana* and provide an updated key to the seven *Toumeyella* species known from Mexico. For all species currently included in *Toumeyella*, details of the geographical distribution and host plants, and brief notes with other information are presented in Table 1.

Moreover, according to Article 31.1.2 of the International Code of Zoological Nomenclature (ICZN 1999), the epithet of *T. martinezi* Kondo and González, 2014, is herein amended to *T. martinezae*, since the species was named in honor of Diana Y. Martinez Hernandez, a woman entomologist who collected the insect.

Materials and Methods

Williams and Kondo (2008) provided a diagnosis for the genus *Toumeyella*, but this included features of the closely-related genus *Neotoumeyella* Kondo and Williams, 2009. Herein we have selected only those features relevant to *Toumeyella*, and added other features listed in the key for separating the genera of the *Toumeyella*-group (Kondo 2013) as well as information from the recently described *T. fontanai* and *T. martinezae* in order to improve the diagnosis.

The soft scale specimens were slide-mounted according to the procedure described by Williams and Granara de Willink (1992). The terminology for describing the morphological features follows that of Kondo and Pellizzari (2011). The line drawing of the adult female (Fig. 2) illustrates the dorsum on the left and the venter on the right side. Enlargements of important morphological features were drawn around the margin. Abbreviations used in Figure 2 are as follows: aplt = anal plate; ant = antenna; dmic = dorsal microduct; dset = dorsal setae; mset = marginal setae; sp = simple pore; pdp = pregenital disc-pore; prop = preopercular pores; spdp = spiracular disc-pore; spset = spiracular setae; vmic = ventral microduct; vset = ventral setae; vtd = ventral tubular duct.

Data on distribution and host plants are taken from ScaleNet (García Morales et al. 2016), if devoid of citation.

Type material depositories

CNIN: Instituto de Biología, Departamento de Zoología, Universidad Nacional Autónoma de México, Apartado Postal 70-153, Mexico City 04510, Mexico.

USNM: The Coccoidea collection of the United States National Museum of Natural History housed at the U.S. Department of Agriculture, Beltsville, Maryland, USA.

Results

Genus *Toumeyella* Cockerell

Type species. *Lecanium (Toumeyella) mirabile* Cockerell 1895: 2.

Generic diagnosis. The genus *Toumeyella* can be diagnosed within the family by the following combination of features: i) body of adult female convex to globular, often heavily sclerotized at maturity; ii) dorsal setae generally sharply spinose, rarely bluntly spinose or lanceolate; iii) eyes absent; iv) sclerotic pores, tubercles, pocket-like sclerotizations and tubular ducts absent on dorsum; v) preopercular pores well developed; vi) dorsal microducts variable in structure (either unilocular or bilocular depending on the species), all of similar size, evenly scattered on dorsum; vii) anal plate setae 3–25 in number, usually less

than 10 on each plate; viii) anal plates located at about 1/5 to 1/4 of body length from posterior margin; ix) sclerotized crescent around anal plates present or absent; x) stigmatic clefts shallow or absent; xi) stigmatic setae usually in 3 pairs (rarely 2 or 4, or absent in some species); xii) perivulvar and spiracular pores with 4–7 loculi, species with 5 loculi common; xiii) anterior and posterior spiracular pore bands extending in a continuous row from area around spiracles to margin; xiv) ventral tubular ducts of one type, restricted to perivulvar region and posterior abdominal segments, but not extending anteriorly in a mediolateral line, nor present elsewhere; and xv) antennae and legs greatly reduced.

Taxonomic key to the *Toumeyella* species of Mexico based on the adult female (modified from Williams and Kondo 2008; Kondo and Pellizzari 2011; Kondo and González 2014).

1. With aggregations of 2–15 fused bilocular pores scattered over dorsum *Toumeyella parvicornis* (Cockerell)
- Without such aggregations of bilocular pores scattered over dorsum 2
- 2(1). Width of posterior spiracular peritreme about same or longer than length of anal plates; anal ring with 12–14 setae *Toumeyella erythrinae* Kondo and Williams
- Width of posterior spiracular peritreme much shorter than length of anal plates; anal ring with 10 setae 3
- 3(2). Spiracular pore bands widening broadly towards body margin, about 30–50 pores wide at broadest point 4
- Spiracular pore bands of same width or narrowing near body margin, about 5 pores wide at broadest point 5
- 4(3). Spiracular clefts present, well developed; spiracular setae well differentiated from marginal setae, numbering 3 per spiracular cleft *Toumeyella sallei* (Signoret)
- Spiracular clefts absent; spiracular setae absent (not differentiated from marginal setae), although some specimens will occasionally have a single thicker seta in the spiracular area *Toumeyella mirabilis* (Cockerell)
- 5(3). Antennae 7-segmented. Spiracular pore bands narrowing from each spiracle to spiracular cleft. Preopercular pores present in mid-dorsal line extending from area anterior to anal plates to head near margin, and also scattered throughout most of dorsum, but absent from margin and submargin *Toumeyella fontanai* Kondo and Pellizzari
- Antennae 5- or 6-segmented. Spiracular pore bands of same width from each spiracle to spiracular cleft. Preopercular pores present in a mid-dorsal line extending from area anterior to anal plates anteriorly, absent elsewhere 6
- 6(5). Multilocular pores present on area around each leg; pregenital disc-pores and spiracular disc-pores mostly with 5 loculi; preopercular pores (2.5–5.0 µm wide) smaller than pregenital disc-pores (ca. 7.5 µm wide); on *Crataegus mexicana* (Rosaceae) *Toumeyella crataegi* Kondo and González, sp. nov.
- Multilocular pores absent from area around each leg; pregenital disc-pores mostly with 5–7 loculi; spiracular disc-pores mostly with 6 loculi; preopercular pores (6.0–11.0 µm wide) about same size or larger than pregenital disc-pores (6–7 µm wide) *Toumeyella martinezae* Kondo and González

***Toumeyella crataegi* Kondo and González, sp. nov.**

Description. Adult female (Fig. 1 and 2).

Proposed common names. *English.* Mexican hawthorn soft scale. *Spanish.* Escama blanda del tecojote.

Material studied. *Holotype.* Adult female (CNIN). **Mexico:** State of Puebla, Chiautzingo, San Nicolás Zecalacoayan, 7.iv.2014, coll. Heriberto Villada, ex *Crataegus mexicana* DC. (Rosaceae). *Paratypes.* Same data as holotype, 4 adult females (CNIN), 3 adult females (USNM).

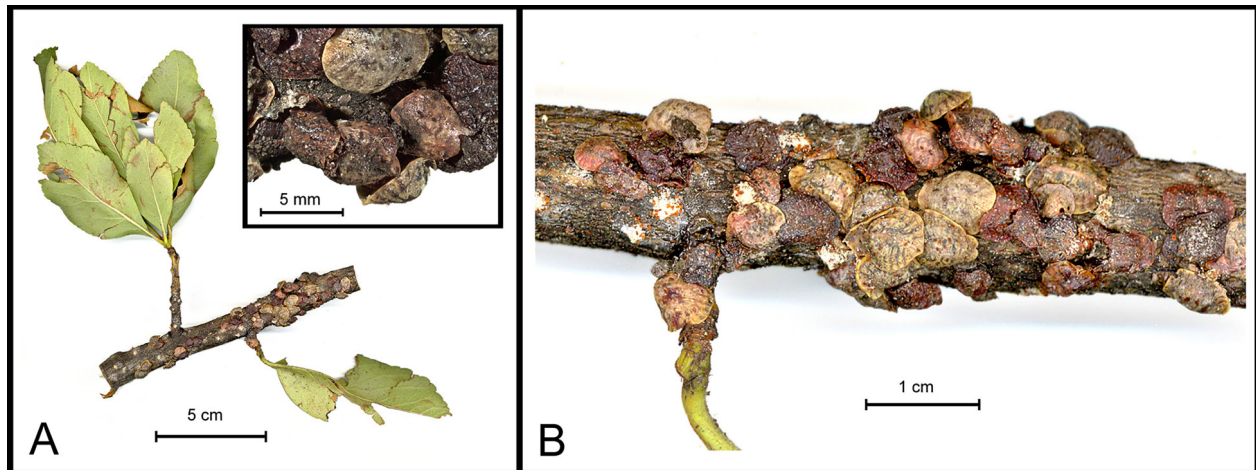


Figure 1. *Toumeyella crataegi* Kondo and González on *Crataegus mexicana*. **A.** Twig of *C. mexicana* infested with *T. crataegi*. Inset showing several adult females tightly clustered on twig. **B.** An aggregation of *T. crataegi*, with numerous adult females. Reddish brown nymphs can be seen near the base to the left of the twig (San Nicolás Zecalacoayan, Puebla, Mexico). Photos: Jorge Valdez-Carrasco.

Unmounted material. (Fig. 1A, B) Body convex, especially on mid dorsum, oval to elongate oval in shape, dorsum often rugose. Derm entirely cream, pinkish or cream with tinges of pink in color, with brown to dark slender lines radiating from mid dorsum towards body margin; anal plates brown to reddish-brown (Fig. 1B). Adult females becoming dark to reddish-brown at maturity (Fig. 1B).

Mounted material. (Fig. 2) Body outline oval to elongate oval, body 4.7–6.8 mm long, 3.8–5.7 mm wide ($n = 10$ specimens).

Dorsum. Derm membranous. Dorsal setae sharply spinose, straight, each 10–15 μm long, rather evenly scattered. Dorsal microducts each about 2.5 μm wide, with a long terminal filament, evenly scattered. Simple pores hard to detect, each about 2.0 μm wide. Preopercular pores fairly small, each pore 2.5–5.0 μm wide, pores present in a compact group on area anterior to anal plates, fused pores occasionally present. Dorsal tubular ducts, tubercles and pocket-like sclerotizations absent. Anal plates together quadrate, with rounded angles, sometimes with slightly notched angles, plates located at about 1/4 to 1/5 of body length from posterior margin, each plate 220–238 μm long, 125–150 μm wide, anterolateral margin 165–200 μm long, posterolateral margin 140–165 μm long, with about 3 apical setae, 1 long fringe seta on each side, about 5 ventral subapical setae and 10 hypopygial setae. Anal ring with 10 setae. A sclerotic area present around anal plates in older specimens.

Margin. Marginal setae sharply spinose, straight or with slightly or strongly bent apices, arranged in a single row, each 17.5–42.5 μm long, longest at posterior apex, with 15–25 on each side between anterior and posterior spiracular areas. Spiracular clefts shallow, with 2 or 3 spiracular setae per spiracular area, each seta generally sharply spinose, occasionally bluntly spinose, stout, sometimes slender through entire length, usually with broad bases, 10.0–32.5 μm long, all setae subequal in size or median spiracular seta slightly longer than lateral setae. Eyes not detected.

Venter. Derm entirely membranous. Pregenital disc-pores each about 7.5 μm wide, mostly with 5 loculi, with occasional pores with 3, 4 or 6 loculi, distributed around vulvar area, close to all 3 pairs of legs, and in a submedial line between vulva and posterior spiracle on each side. Spiracular disc-pores mostly with 5 loculi, with occasional pores with 3, 4, and 6 loculi, each pore 5.0–7.5 μm wide, present in a narrow band about 2 to 3 pores wide, extending laterally from each spiracle to body margin. Ventral microducts scattered evenly throughout, each 2.5–3.0 μm wide. Ventral tubular ducts present around vulvar region, each tubular duct with a long and slender terminal filament ending in a small gland. Ventral setae slender, straight or slightly bent, each 10–25 μm long, evenly distributed; 2 or 3 pairs of

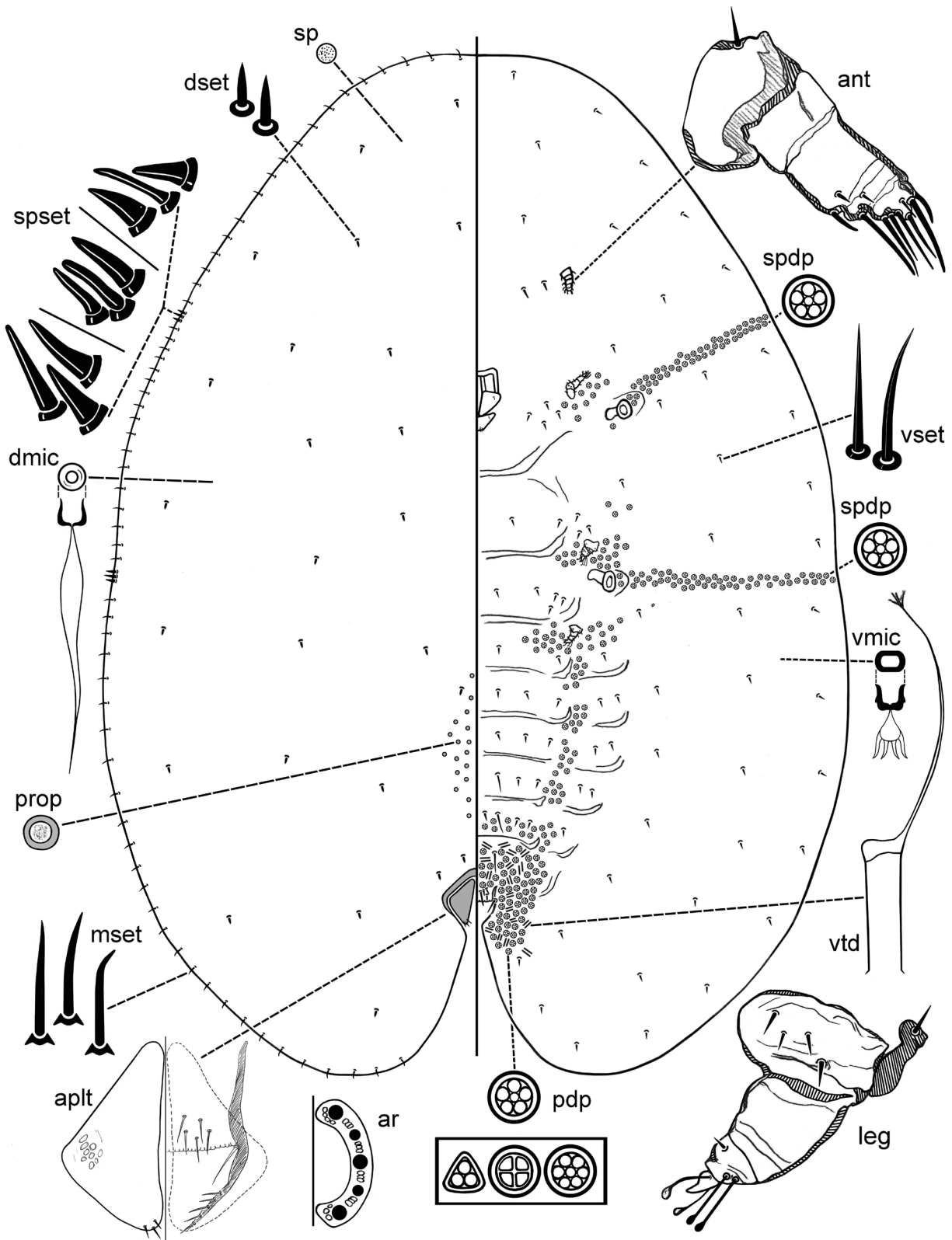


Figure 2. *Toumeyella crataegi* Kondo and González, adult female.

interantennal setae, each 25.0–62.5 μm long; and 3 pairs of long prevulvar setae, each 57.5–87.5 μm long. Spiracles well developed, anterior spiracular peritremes each 95.0–125.0 μm wide, posterior peritremes each 105.0–157.5 μm wide, with a circular depression just lateral to spiracular opening. Legs greatly reduced, but most segments usually discernible, coxa and trochanter often fused, each segment with few setae, total length each leg (including claw) at longest point 82.5–182.5 μm long, claw 10.0–17.5 μm long; metathoracic legs largest; claw denticles not detected, claw digitules, knobbed, with one thicker than the other; tarsal digitules slender, knobbed. Antennae short, each 95.0–147.5 μm long, 4 to 6 segmented, with fleshy setae present on last 2 antennal segments, but some specimens with antennae greatly atrophied and segmentation indistinct. Mouthparts well developed, clypeolabral shield 275–330 μm long, 227–258 μm wide; labium 1 segmented, 92–125 μm long, 162–173 μm wide with 4 pairs of labial setae.

Etymology. The species is named after its host, *Crataegus mexicana* DC. (Rosaceae).

Natural enemies. The aphelinid parasitoid *Coccophagus funiculatus* Myartseva, has been reared from *T. crataegi* (as *Toumeyella* sp.) (Myartseva et al. 2016).

Discussion

With the description of *T. crataegi*, the total number of species in *Toumeyella* is increased to 18 (Table 1), all of New World origin and the number of *Toumeyella* species in Mexico is elevated to seven. *Toumeyella crataegi* is the only species of the genus that has been collected from Rosaceae. This new species was collected from *Crataegus* commercial orchards, thus may be considered a potential pest for this crop. In the period between January to May, 2014, at the same area were the samples of *Toumeyella* were taken, it was observed that some *Crataegus* orchards showed varied levels of infestation by *T. crataegi*, from low levels (12% of the trees were infested) to high levels (up to 90% of the trees were infested) (H. Villada-Rosas, personal communication). Also, in the same area the aphelinid parasitoid *Coccophagus funiculatus* Myartseva, had been reared from this *Toumeyella* scale (Myartseva et al. 2016).

Table 1. Checklist of currently known species of *Toumeyella* Cockerell (Hemiptera: Coccidae) worldwide (adapted from Kondo and González 2014; Garcia et al. 2016).

<p><i>Toumeyella coffeae</i> Kondo Distribution. Neotropical region: Colombia, Venezuela. Host plants. Rubiaceae: <i>Coffea arabica</i>. Notes. <i>Toumeyella coffeae</i> is the only species in the genus known from the roots and root crown of its host.</p>
<p><i>Toumeyella crataegi</i> Kondo and González, sp. nov. Distribution. Neotropical region: Mexico. Host plants. Rosaceae: <i>Crataegus mexicana</i>.</p>
<p><i>Toumeyella cubensis</i> Heidel and Köhler Distribution. Neotropical region: Cuba. Host plants. Rutaceae: <i>Citrus sinensis</i>. Notes. <i>Toumeyella lignumvitae</i> cannot readily be separated from <i>T. cubensis</i> (Williams and Kondo 2008).</p>
<p><i>Toumeyella erythrinae</i> Kondo and Williams Distribution. Nearctic region: Mexico. Host plants. Fabaceae: <i>Erythrina</i>. Notes. This is a serious pest of coral tree <i>E. coralloides</i>, a common street tree in Mexico City (Kondo and Williams 2003a).</p>
<p><i>Toumeyella fontanai</i> Kondo and Pellizzari Distribution. Nearctic region: Mexico. Host plants. Fabaceae: <i>Acacia</i> sp.</p>

Table 1. Continued.

<p><i>Toumeyella lignumvitae</i> Williams Distribution. Nearctic region: USA. Host plants. Zygophyllaceae: <i>Guaiacum sanctum</i>. Notes. See notes under <i>T. cubensis</i> above.</p>
<p><i>Toumeyella liriodendri</i> (Gmelin) Distribution. Nearctic region: USA. Neotropical region: Cuba. Host plants. Fabaceae: <i>Cassia fasciculata</i>. Juglandaceae: <i>Carya cordiformis</i>. Magnoliaceae: <i>Liriodendron tulipifera</i>, <i>Magnolia acuminata</i>, <i>M. fuscata</i>, <i>M. grandiflora</i>, <i>M. soulangeana</i>, <i>M. stellata</i>, <i>M. virginiana</i>, <i>Michelia</i> sp. Malvaceae: <i>Sida spinosa</i>. Rubiaceae: <i>Cephalanthus</i> sp., <i>Gardenia</i> sp. Salicaceae: <i>Casearia aculeata</i>, <i>Populus</i> sp. Sapindaceae: <i>Allophylus cominia</i>. Theaceae: <i>Gordonia</i> sp. Tiliaceae: <i>Tilia</i> sp. Notes. The record of <i>T. liriodendri</i> on <i>Cephalanthus</i> sp. could be a misidentification of <i>Neotoumeyella cephalanthi</i> Kondo and Williams, a common species on that host (Kondo and Williams 2009). The record of <i>T. liriodendri</i> on coffee roots in Guatemala (Barrera 2008), is likely a misidentification (Kondo 2013). Hamon and Williams (1984) listed <i>Ascyrum</i> spp. and <i>Hypericum cistifolium</i> (Clusiaceae) as hosts of <i>T. liriodendri</i>, however, these are likely records of an undescribed species (M. L. Williams, pers. comm. in Kondo and González 2014).</p>
<p><i>Toumeyella martinezae</i> Kondo and González Synonymy. <i>Toumeyella martinezi</i> Kondo and González 2014: 1. Distribution. Nearctic region: Mexico. Host plants. Cactaceae: <i>Myrtillocactus geometrizans</i>. Notes. <i>Toumeyella martinezae</i> is the only <i>Toumeyella</i> species known to feed on a plant of the family Cactaceae.</p>
<p><i>Toumeyella mirabilis</i> (Cockerell) Distribution. Nearctic region: Mexico, USA. Host plants. Asteraceae: <i>Xanthocephalum</i> sp. Fabaceae: <i>Bauhinia macrantha</i>, <i>Prosopis juliflora glandulosa</i>, <i>P. velutina</i>, <i>Prosopis</i> sp.</p>
<p><i>Toumeyella nectandrae</i> Hempel Distribution. Neotropical region: Brazil. Host plants. Lauraceae: <i>Nectandra grandiflora</i>.</p>
<p><i>Toumeyella parvicornis</i> (Cockerell, 1897) Distribution. Nearctic region: Canada, Mexico, USA. Neotropical region: Puerto Rico, Turks and Caicos Islands (Malumphy et al. 2012). Palaearctic region: Italy (Garonna et al. 2015). Host plants. Pinaceae: <i>Pinus caribaea</i> var. <i>bahamensis</i>, <i>P. australis</i>, <i>P. banksiana</i>, <i>P. echinata</i> (Williams and Kosztarab 1972), <i>P. elliotii</i>, <i>P. glabra</i>, <i>P. mugo</i>, <i>P. palustris</i>, <i>P. pinea</i>, <i>P. sylvestris</i>, <i>P. taeda</i>, <i>P. virginiana</i>. Notes. The morphology of <i>T. parvicornis</i> differs depending on the feeding site, having bark and leaf forms (Hamon and Williams 1984; Williams and Kondo 2008). An occasional pest of pine seedlings and saplings. This is the most widely spread species in the genus. It invaded Puerto Rico, Turks and Caicos Islands (Malumphy et al. 2012) and Italy (Garonna et al. 2015).</p>
<p><i>Toumeyella paulista</i> Hempel Distribution. Neotropical region: Brazil. Host plants. Lauraceae: <i>Nectandra</i> sp.</p>
<p><i>Toumeyella pini</i> (King) Distribution. Nearctic region: Canada, USA. Host plants. Pinaceae: <i>Pinus austriaca</i>, <i>P. echinata</i>, <i>P. eliottii</i>, <i>P. mugo</i>, <i>P. palustris</i>, <i>P. resinosa</i>, <i>P. rigida</i>, <i>P. serotina</i>, <i>P. sylvestris</i>, <i>P. taeda</i>, <i>P. virginiana</i>, <i>Pinus</i> sp. Notes. The characteristic large conical preopercular pores in <i>T. pini</i> will readily separate it from any other species of <i>Toumeyella</i> on pines (Williams and Kondo 2008). It has three generations per year on <i>P. taeda</i> in Georgia, USA (Clarke et al. 1989).</p>
<p><i>Toumeyella pinicola</i> Ferris Distribution. Nearctic region: USA: California. Host plants. Pinaceae: <i>Pinus radiata</i>.</p>

Table 1. Continued.

<p><i>Toumeyella quadrifasciata</i> (Cockerell) Distribution. Nearctic region: USA: Arizona, New Mexico. Host plants. Fabaceae: <i>Robinia neomexicana</i>.</p>
<p><i>Toumeyella sallei</i> (Signoret) Distribution. Nearctic region: Mexico. Neotropical region: Guatemala. Host plants. Anacardiaceae: <i>Spondias</i> sp. Fabaceae: <i>Erythrina corallodendron</i>, <i>Erythrina</i> sp., undetermined host. Notes. <i>Toumeyella sallei</i> is a very large soft scale insect, 2.0 cm long, 1.5 cm wide and 0.5 cm tall, rugose on the sides; brownish with some pale shading, a bit yellow (Kondo and Williams 2003b). The records of <i>T. sallei</i> on <i>Erythrina</i> spp. may well be a misidentification of <i>T. erythrinae</i>, a common pest species of <i>Erythrina</i> spp.</p>
<p><i>Toumeyella turgida</i> (Cockerell) Distribution. Nearctic region: USA: Florida. Host plants. Magnoliaceae: <i>Magnolia glauca</i>. Notes. <i>Toumeyella turgida</i> appears to be identical to the tuliptree scale, <i>T. liriodendri</i> (Williams and Kondo 2008).</p>
<p><i>Toumeyella virginiana</i> Williams and Kosztarab Distribution. Nearctic region: USA. Host plants. Pinaceae: <i>Pinus caribaea</i>, <i>P. clausa</i>, <i>P. elliotti</i>, <i>P. glabra</i>, <i>P. palustris</i>, <i>P. taeda</i>, <i>P. virginiana</i>.</p>

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