Orsis 31, 2017 **79-97**

Review of the oak gall-wasp genus *Zapatella* Pujade-Villar & Melika with the description of two new species from Colombia (Hymenoptera, Cynipidae, Cynipini)

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Reception date: 29 September 2017
Acceptance date: 19 October 2017
Publication date: 22 November 2017

Abstract

Two new species of *Zapatella* from the Colombian departments of Boyacá and Cundinamarca are here described: *Z. cupulae* Fernández-Garzón, Caicedo, Rodríguez & Pujade-Villar n. sp. and *Z. migueli* Pujade-Villar & Fernández-Garzón n. sp. The new species are agamic and sexual generations respectively, inducing galls in *Quercus humboldtii* acorns. The principal morphological characters of these new species are exhibited and illustrated. After this study, *Zapatella* includes a total of 13 species distributed in American continent from Nearctic and Neotropical regions. A key of *Zapatella* species is also included.

Keywords: Cynipini; *Zapatella*; revision; new species; taxonomy; *Quercus humbodtii*; Colombia

Resum. *Revisió del gènere de cinípid* Zapatella *Pujade-Villar & Melika amb la descripció de dues espècies noves de Colòmbia (Hymenoptera, Cynipidae, Cynipini)*

Es descriuen dues espècies noves de *Zapatella* dels departaments colombians de Boyacá i Cundinamarca: *Z. cupulae* Fernández-Garzón, Caicedo, Rodríguez & Pujade-Villar n. sp. i *Z. migueli* Pujade-Villar i Fernández-Garzón n. sp. Les noves espècies corresponen respectivament a una generació d'agàmiques i a una altra de sexuals que provoquen gales als aglans de *Quercus humboldtii*. Es mostren i il·lustren els principals caràcters morfològics d'aquestes noves espècies. Després d'aquest estudi, *Zapatella* inclou un total de tretze espècies distribuïdes en el continent americà tant a la regió holàrtica com a la neotropical. També s'hi inclou una clau d'espècies de *Zapatella*.

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ISSN 0213-4039 (imprès), ISSN 2014-9727 (en línia) https://doi.org/10.5565/rev/orsis.46

Paraules clau: cinípids; *Zapatella*; revisió; espècies noves; taxonomia; *Quercus humboldtii*; Colòmbia

Introduction

Zapatella Pujade-Villar & Melika, 2012 is a genus of oak gall wasps characterized by galling red oaks (*Quercus* of the Section *Lobatae*). This genus includes 13 species, two of them described here. Currently, most part of the Cynipini known species do not cause important damage to the oak tree on which they develop (Pujade-Villar, 2013). Nevertheless, three *Zapatella* species can be dangerous: *Z. quercusmedullae* Ashmead, 1885 in North America (Burks, 1979) on *Quercus incana, Q. marilandica* and *Q. myrtifolia*; *Z. davisae* Bufington & Melika, 2016 also in North América (Buffington et al., 2016) on *Q. velutina*; and the recently described *Z. petiolata* Pujade-Villar & Caicedo, 2017 in Colombia (Pujade-Villar et al., 2017) on *Q. humboldtii*.

Since the erection of *Zapatella* from several *Callirhytis* species misplaced from the Nearctic and Netropical areas, the number of newly described has constantly increased (Buffington et al., 2016; Pujade-Villar et al*.,* 2012, 2015, 2017). The genus is characterized by (Pujade-Villar et al., 2012): the absence of malar sulcus; metasoma as long as broad and strongly arched in lateral view; pronotum and mesoscutum delicately reticulate laterally; metascutelum rugose-reticulae; dorsoposterior surface of hind coxa with dense white setae; tarsal claws simple, without basal lobe; 2nd metasomal tergite with a dense ring of white setae, interrupted dorsally and few setae scattered on lateral surface of tergite; forewing venation pale yellow, indistinct, R1 inconspicuous, hardly traceable; and a prominent ventral spine of the hypopygium, 6.0–13 times longer than broad, with very few short white setae in two rows, directed ventrally.

In the Nearctic and Neotropical areas 11 species are included, six (*Z. quercusmedullae* Ashmead, 1885; *Z. cryptica* Weld, 1922; *Z. herberti* Weld, 1926; *Z. oblata* Weld, 1952; *Z. quercusphellos* Osten Sacken, 1961; *Z. davisae* Bufington & Melika, 2016) in North America (Pujade-Villar et al., 2012; Buffington et al., 2016), one (*Z. grahami* Pujade-Villar & Melika 2012) present in Central and South America (Colombia, Fernández-Garzón et al., 2017) and four (*Z. nievesaldreyi* Melika & Pujade-Villar, 2012; *Z. inflata* Pujade-Villar & Rodríguez, 2015; *Zapatella tuberosa* Pujade-Villar & Caicedo, 2015; *Z. petiolata* Pujade-Villar & Caicedo, 2017) only in Colombia (Pujade-Villar et al*.,* 2012, 2015, 2017). Here two new species galling in acorns on *Q. humboldtii* belonging to *Zapatella* are described from Colombia.

Material and methods

Adults of the new species were obtained from collected galls of *Q. humboldtii* (*Lobatae* section). Insects emerged from galls preserved in breeding boxes under laboratory conditions.

Morphological descriptions have been made according to the current terminology of morphological structures as given in the following studies: Liljeblad & Ronquist (1998) and Melika (2006) for adult's morphological structures, Ronquist & Nordlander (1989) for forewing venation terminology and Harris (1979) for patterns of cuticular sculpture. The measurements and abbreviations used herein are the ones that follow: F1-F12, the first and the following flagellomeres; POL (post-ocellar distance), the distance between the inner margins of the posterior ocelli; OOL (ocellar-ocular distance), the distance from the outer margin of the lateral ocellus to the inner margin of the compound eye; LOL (lateral-ocular distance), the distance between lateral and frontal ocellus; transfacial line, distance between inner margins of compound eyes measured across toruli; width of radial cell, measured as the distance between the upper margin of the forewing and the Rs vein.

Electron microscope images were taken using a Scanning Electron Microscope (FEI Quanta 200 ESEM) at Universitat de Barcelona (Catalonia), using high voltage with gold coating for *Z. cupulae* n. sp. and low voltage without gold coating for *Z. migueli* n. sp. The *Z. cupulae* n. sp. habitus optical image was taken by Pedro Rodríguez with a Nikon DS-Fi2 camera on a Nikon SMZ1000 stereoscope, combining 10 photographs with the software «Combine ZP», in the Fruit flies' laboratory of Instituto Colombiano Agropecuario ICA- Tibaiatá. Finally, the habitus and forewings from *Z. migueli* n. sp. and galls of *Z. cupulae* n. sp. and *Z. migueli* n. sp. were taken by the first author (SF-G) using an Olympus SC30 digital microscope camera coupled with an Olympus U-CMAD3 adapter to a binocular microscope Olympus SZX10, combining, 22 photographs from *Z. migueli* n. sp. forewing, 20 photographs from *Z. migueli* n. sp. female habitus and 28 photographs from *Z. migueli* n. sp. male habitus, with the software «Helicon Focus 6.7.1»; forewings and habitus of *Z. cupulae* n. sp. were taken by the third author (P.R.) with a Nikon DS-Fi2 camera on a Nikon SMZ1000 stereoscope, combining 18 photographs with the «Combine ZP» program.

Type material for the species that are here described were deposited in the following institutions:
IAvH Instituto Alexander von Humboldt, Villa de Leyva, Colombia (Diana Espitia Reina).
UB Universitat de Barcelona, Catalunya (col. Juli Pujade-Villar).
ICA-Tibaitata Instituto Colombiano Agropecuario, Mosquera, Colombia (Pedro A. Rodríguez).

Results

Zapatella cupulae **Fernández-Garzón, Caicedo, Rodríguez & Pujade-Villar n. sp.** (Figs. 1-13)

Diagnosis. Most similar morphologically species are *Zapatella grahami, Z. nievesaldreyi* and *Z. petiolata*, by having the median mesoscutal line absent (or present in a very short triangle), and head and mesosoma partially dark brown to black.

Zapatella cupulae n. sp. differs from *Z. grahami* in POL:OOL relation (equal in the new species, 1.4 times as long as OOL in *Z. grahami*) and in the scutellar fovea (smooth and without rugae in the new species, rugose in *Z. grahami*). *Zapatella cupulae* n. sp. differs from *Z. nievesaldreyi* in the F1:F2 length relation (F2 longer than F1 in the new species, equal length in *Z. nievesaldreyi*) and head in dorsal view (2.2 times las long as wide, 1.6-1.8 in *Z. nievesaldreyi*). *Zapatella cupulae* n. sp. differs from *Z. petiolata* in the POL:OOL relation (equal in the new species, 1.6 times as long as OOL in *Z. petiolata*) and in head in frontal view (1.9 times as long as broad in the new species, 1.2 in *Z. petiolata*). Also, the new species differ from all known species, except *Z. inflata* Pujade-Villar & Rodríguez, 2015 and *Z. petiolata,* in length of ventral spine (at least 11 times as long as broad in the new species, less than 9 times in the most of *Zapatella* species); in *Z. inflata* POL<OOL and the body color is yellow to amber never dark, in contrast to new species. The only known species with acorn galls are *Z. grahami* and the species described here.

Description

Asexual female

Length 2.7-4.2 mm (n=10).

Color (Fig. 11). Head reddish brown, with the mandibles and postgena area dark. Antennae reddish brown, sometimes with the last flagellomeres darker. Pronotum laterally reddish brown, but darker anteriorly. Mesoscutum reddish brown to dark, with clear dark spots between the anterior parallel lines, and sometimes with dark spots between notauli and parapsidal lines, and between the parapsidal lines and the margin of the mesosoma; rarely mesosoma completely dark; scutellum reddish brown, occasionally with a dark spot posteriorly; mesopleuron darker, especially near coxae. Forewing hyaline, with light venation. Legs lighter than the body, coxae and trochanters darker. Metasoma reddish brown, darker distally.

Head (Figs. 1-3). Transversally oval in anterior view, uniformly and delicately reticulated, with few white setae, 2.2 times as broad as long from above, 1.9 times as broad as high in frontal view and slightly broader than mesosoma. Genae broadened behind eye, broader as transverse diameter of eye in lateral view; malar space around 0.4 times as long as height of eye, malar sulcus absent. POL:OOL:LOL = 7:7:3; OOL 3.5 times as long as length of lateral ocellus, LOL 1.5 times longer than lateral ocellus. Transfacial distance 1.3 times as broad as height of eye; diameter of antennal torulus around 1.5 times as great as distance between them; distance between torulus and inner margin of eye 1.6 times longer than diameter of torulus; inner margins of eyes parallel. Lower face delicately coriaceous, with dense white setae; median elevated area strongly alutaceous. Clypeus small, squared, smooth, impressed in basal part, ventrally straight with dense white setae; anterior tentorial pits, epistomal sulcus and clypeo-pleurostomal lines present. Frons, vertex, interocellar area and occiput microreticulate.

Antennae (Fig. 5). With 13-segmented. Longer than head + mesosoma (90:67); pedicel globose, as long as broad; F1 1.2 times longer than scapus; F2 1.2–1.3 times as long as F1; F1 slightly shorter than F3; F5–F10 sub-equal; F11

1.7 times longer than F10. The antennal formula is 6: 4: 7: 9: 8: 7: 6: 6: 6: 6: 5: 6: 10. Placodeal sensilla distinct on F6–F11, absent on F1–F5, and distinctive micropores in F11.

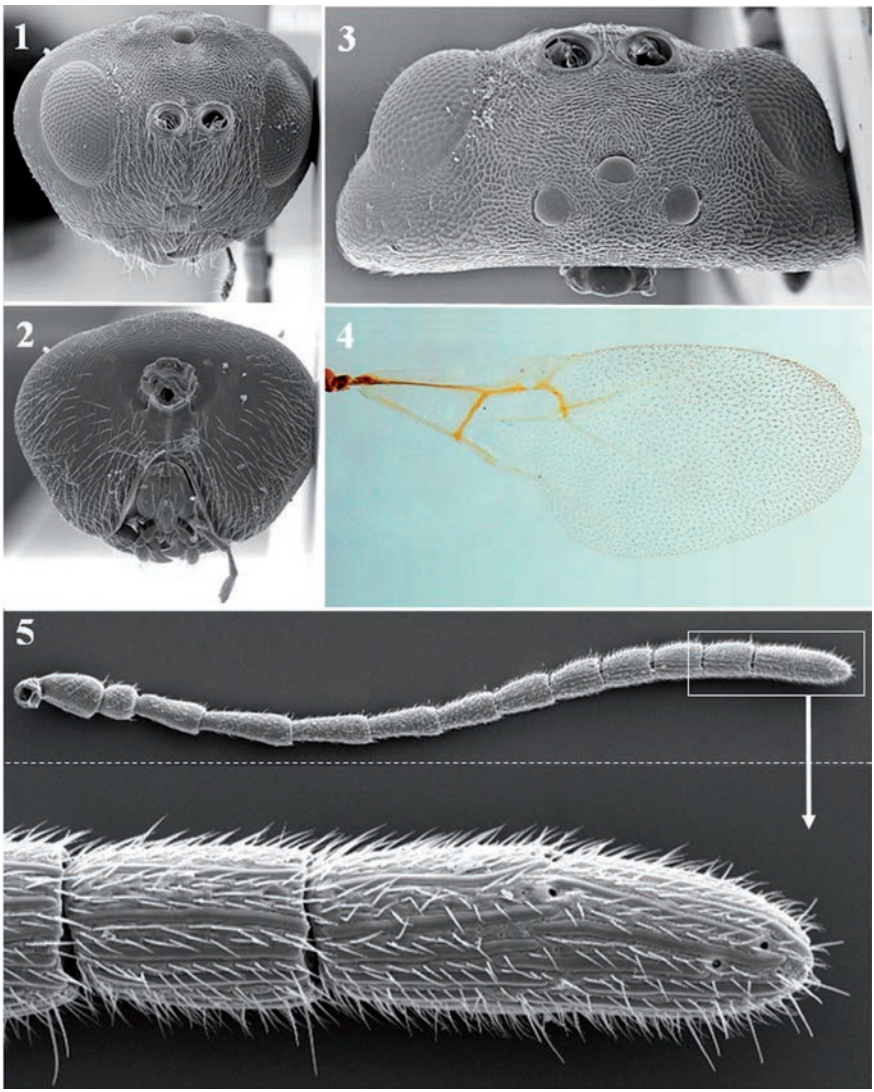
Mesosoma (Figs. 6-8). Size around 1.2 times as long as high in lateral view, with few white setae. Pronotum with white setae; uniformly micro-imbricate sculpture laterally; dorsally shiny and almost smooth; without pronotal lateral carina. Mesoscutum slightly broader than long in dorsal view (32:30); with sparse scattered setae, microreticulate with some transverse, delicate, interrupted striae, transversal sculpture coriaceous. Notauli incomplete, extending almost 2/3 parts of mesoscutum length, converging, deep and broad posteriorly. Anterior parallel lines extending to 1/3 length of mesoscutum. Parapsidal lines distinct, starting from posterior margin and extending to 1/2 the length of mesoscutum. Median mesoscutal line absent or present by a very short triangle. Mesoscutellum around 0.5 times as long as mesoscutum, as long as broad, slightly overhanging metanotum, center of disk rugulose, sides and posterior 1/3 areolate-rugose; scutellar foveae present, ovate, not delimited posteriorly, bottom shiny and smooth; median carina thin. Mesopleuron shiny, mostly microtericulate-alutaceous with some parts partly overlapping (imbricate), and discontinuous longitudinal raised ribs in the ventral part, specullum coriaceous; mesopleural triangle with conspicuous white setae. Dorsal axillar area coriaceous with numerous setae; lateral axillar area reticulo-carinate, without setae; axillula smooth, with white setae; subaxillular bar smooth, shiny, as long as height of metanotal trough; post-alar process long, strongly reticulate; metapleural sulcus reaching mesopleuron in upper 2/3 of its height. Dorsullum areolate-rugulose, rectangular. Metanotal trough with short white setae; ventral impressed area at least twice as narrow as height of dorsellum, delicately reticulate. Propodeum setose laterally, glabrous centrally but shortly pilose anteriorly; central propodeal area smooth, shiny, with few irregular weak rugae, lateral propodeal carinae diverging anteriorly and converging in posterior 1/3. Nucha with irregular wrinkles and rugae.

Forewing (Fig. 4). Size longer than body (119: 90), hyaline, almost uniformly pubescent, without cilia on margin; radial cell open, 3.9 times as long as broad; veins hardly traceable; areolet indistinct; Rs+M, R1 and Rs little pigmented, almost non-traceable, absent or barely visible.

Legs. Tarsal claws simple (Fig. 10), without basal lobe; hind coxae with dense white setae on the dorsoposterior surface.

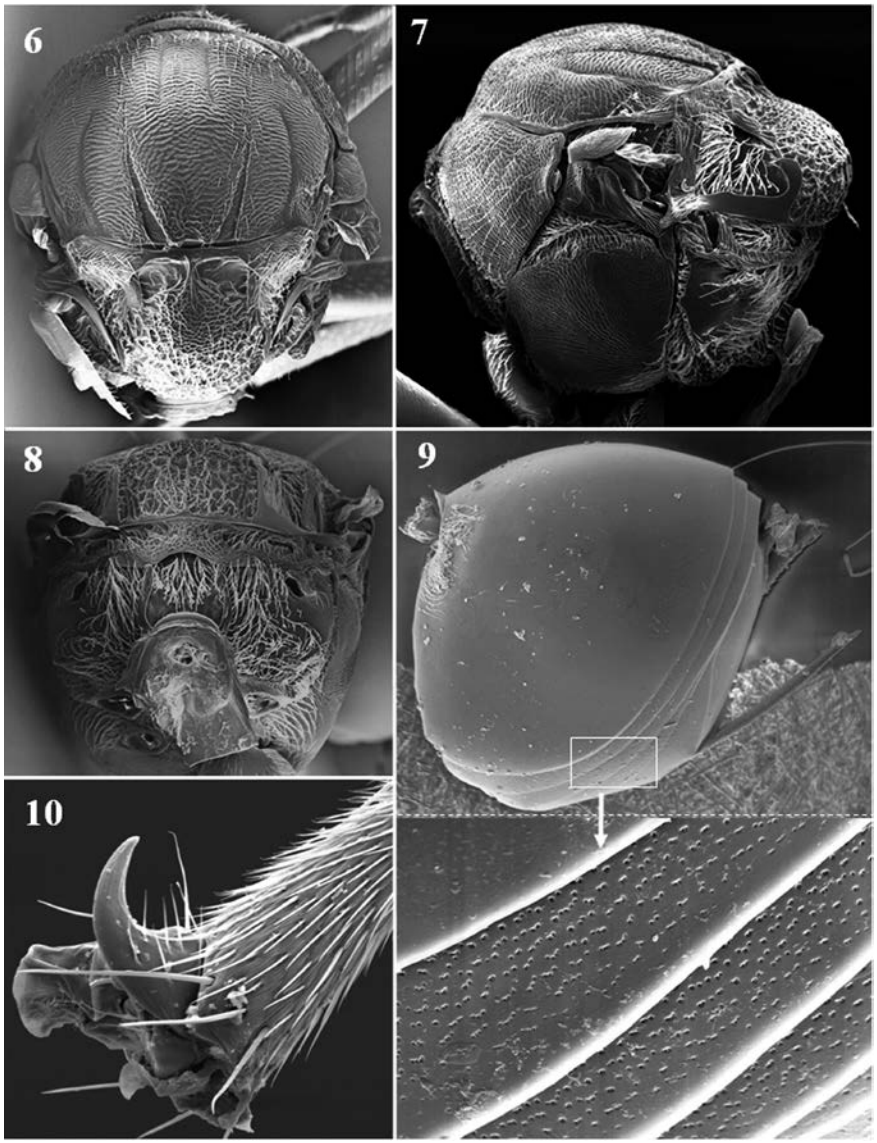
Metasoma (Fig. 9). Shorter than head+mesosoma (59:67), slightly longer than higher in lateral view; base of 2nd metasomal tergite with dense ring of white setae, interrupted dorsally and few setae scattered on lateral surface of tergite. Narrow posterior band on 3rd metasomal tergite and all subsequent tergites with very delicate dense micropunctures. Prominent part of ventral spine of hypopygium needle-like, tapering to apex, 11-12.5 (n=8) times as long as broad, with two parallel rows of short white scattered setae which do not extend beyond the apex of spine.

Type material. Holotype female deposited in IAvH with the following labels: "J. B. Celestino Mutis (Bogotá, Cundinamarca, Colombia), 4°40′4.37″ N,



Figures 1-5. *Zapatella cupulae*: (1) Female head in anterior view, (2) female head in posterior view, (3) female head in dorsal view, (4) forewing, (5) female antennae.

74º5′59.2″ W, 2.551 msnm," (white label); "*Q. humboldtii*, (13.iv.2015) 1-10.v.2015, JP-V & G. Caicedo leg., desig. JP-V" (white label); "*Zapatella cupulae* Fernández-Garzón, Caicedo, Rodríguez & Pujade-Villar n. sp." desig. JP-V(red label). Patatypes 20ŏ: with the same data of holotype 10ŏ (6ŏ in UB; 4ŏ in IAvH); (12.iii.2017) 13.iii.2017: 1♀ (UB, G. Caicedo leg.); (24.i.2017) 12.ii.2017: 7 ♀ (UB, G. Caicedo leg.); (27.ii.2017) 27.ii.2017: 2 ♀ (UB, G. Caicedo leg.).



Figures 6-10. *Zapatella cupulae*: (6) mesosoma in dorsal view, (7) mesosoma in lateral view, (8) propodeum, (9) metasoma in lateral view, (10) tarsal claws.

Additional material. Same data from holotype: 1♀ (with gold coating); same data, (29.vii.2016) 8.viii.2016: 1♀ (UB, G. Caicedo leg); (2.viii.2016) 23.viii.2016: 1♀ (UB, G. Caicedo leg); (4.viii.2016) 25.viii.2016: 1♀ (UB, G. Caicedo leg), 16.ix.2016: 1♀ (UB, G. Caicedo leg.); (2.ii.2017) 9.ii.2017: 3 ♀

Figures 11-13. *Zapatella cupulae*: (11) female habitus in lateral view, (12) larval cell in acorn cupule, (13) aborted acorn and cupule with emergence trues.

(UB, G. Caicedo leg); Cruce de San Miguel (Chiquinquira, Boyacá, Colombia), 5º37'22" N 73º46'11" W, 2.578 msnm., *Q. humboldti*, (09.i.2012) 10.ii.2012: 5♀ (P. Rodríguez) (4♀ ICA-Tibaitata, 1♀ UB).

Gall (Figs. 12-13). Inconspicuous galls in the cupule of the acorn, generally causing the abortion of the gland fruit, just lingering a small part of pericarp and the remains of style while the rest is covered by the cupule. Surface of the cupule with pin-size exit holes, sometimes hard to see due the cupule scales, made by emerging wasps. Diameter of the cupule can vary from 10-30mm, with a wall around 4mm, where the larval cells are nested. Semi-oval larval cells, around 3.3-3.8mm long and 1.4-1.9 broad (n=10), with an inner wall almost white.

Host plant. *Quercus humboldtii* Bonpl. 1909 (secion *Lobatae*).

Distribution. Department of Cundinamarca and Boyacá (Colombia).

Biology. It is an asexual generation inducing galls in the cupule of the acorns on *Q. humboldtii.* Adult wasps emerge between October or March in different years (see discussion). Trying to evaluate if there were any different species of gallwasps between the tomentose or glabrous phenotype oaks, galls from both kind were collected, but all specimens correspond to *Z. cupulae*. The acorns develop fully or sometimes the nut could be aborted.

Etymology. The specific name refers to the location inside the acorn where the larval chambers are present, inside of the cupule in glans.

***Zapatella migueli* Pujade-Villar & Fernández-Garzón n. sp.** (Figs. 14-26)

Diagnosis. Is the *Zapatella* species with longest ventral spine of hypopygium; it is similar morphologically to *Z. cupulae* n. sp., but in *Z. migueli* n. sp. the length of the ventral spine of the hypopygium is 12-13 times longer than broad, less than 12 times in *Z. cupulae* n. sp., and less than 9 times in most of the described species, except *Z. inflata* and *Z. petiolata* with at least 10 times as long as broad; *Z. migueli* n. sp. with POL slightly larger than OOL (*Z. cupulae* n. sp. with POL

equal than OOL, *Z. inflata* n. sp. POL shorter than OOL, *Z. petiolata* POL 1.6 times longer than OOL).

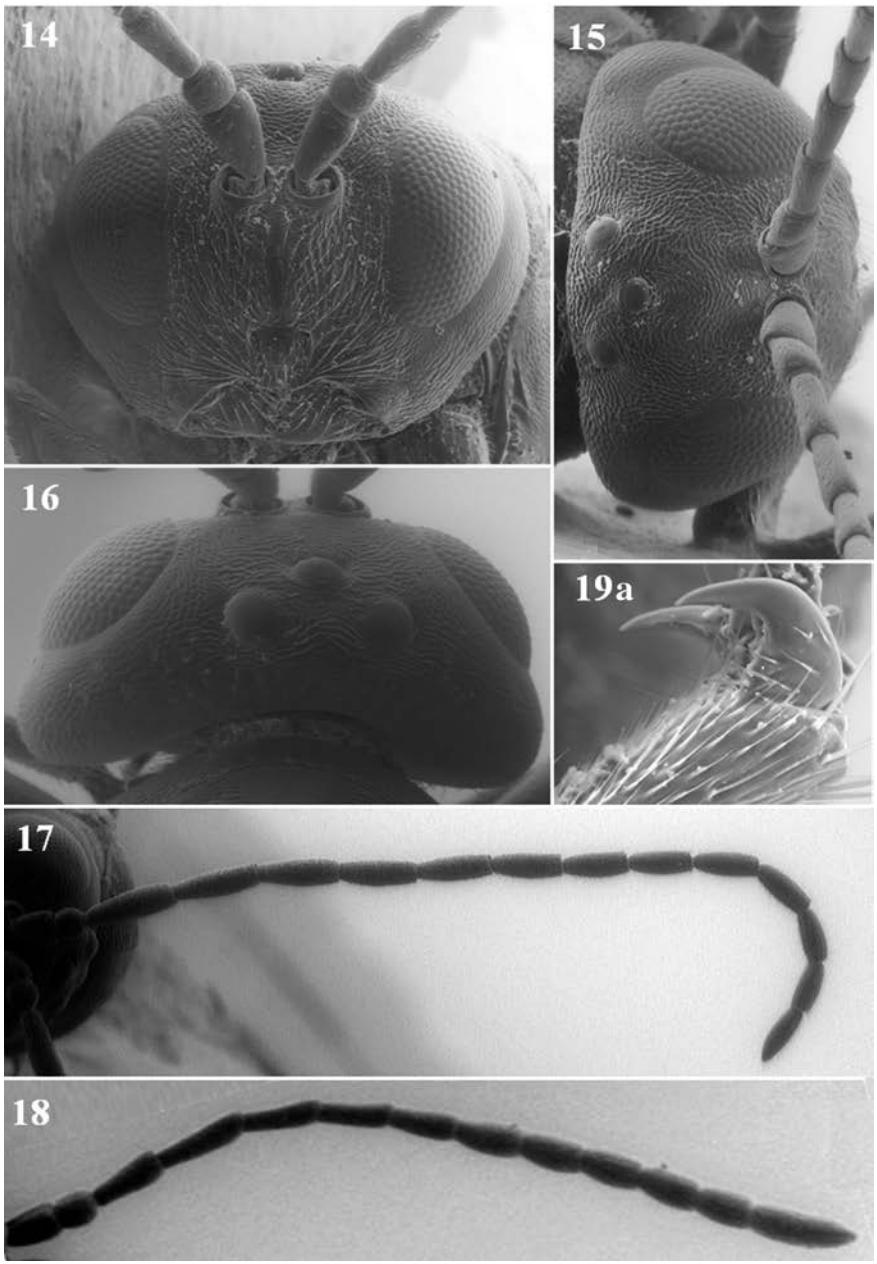
Description
Sexual female
Length. 2.6 mm (n=4).

Color (Fig. 25). Head and mesosoma reddish dark brown to dark, without clear dark spots, mesopleuron darker; metasoma reddish brown, darker distally. Antennae and legs are lighter in color than the body, but darker at the base of coxae II, also coxae III and the external margin of trochanter, femora and tibiae of metathoracic legs, and last segments of antenna. Forewing hyaline, with light venation.

Head (Figs. 14-16). Transversally oval in anterior view, uniformly and delicately reticulated, with few white setae. 2.2 times as broad as long from above, 1.2-1.3 times as broad as high in frontal view and slightly broader than mesosoma. Genae broadened behind eye, broader as transverse diameter of eye in lateral view; malar space around 0.36 times as long as height of eye, with delicate striate radiating from clypeus and reaching eye margin and toruli, malar sulcus absent. POL equal in length or slightly larger OOL (1.1-1.2); OOL 2.3 times as long as length of lateral ocellus, and 3 times as long as LOL; LOL as long as length of lateral ocellus. Transfacial distance nearly 1.1-1.2 times as broad as height of eye; diameter of antennal torulus around 4.0 times as great as distance between them, distance between torulus and inner margin of eye slightly shorter than diameter of torulus; inner margins of eyes parallel; lower face delicately coriaceous, with dense white setae, the median elevated area strongly alutaceous. Clypeus small, squared, smooth, impressed in basal part, ventrally straight; anterior tentorial pits, epistomal sulcus and clypeo-pleurostomal lines present. Frons, vertex, interocellar area and occiput microreticulate.

Antennae (Fig. 18). 13-segmented, the antennal formula is 12: 7: 12: 16: 13: 13: 13: 13: 11: 11: 11: 11: 20; longer than head+mesosoma (52:32); pedicel globose, as long as broad; F1 as long as scapus; F2 1.3 times as long as F1; F1 slightly shorter than F3; F3–F6 sub-equal, F7–F10 sub-equal and shorter; F11 near to twice as long as F10; placodeal sensilla distinct on F6–F11, indistinct but present on F5, absent on F1–F4. F11 sometimes with an inconspicuous suture.

Mesosoma (Figs. 19b-21). Around 1.1 times as long as high in lateral view, with few white setae. Mesoscutum broader than long in dorsal view (19:16); with sparse scattered setae and transverse, delicate, interrupted striae, interspaces alutaceous. Notauli incomplete, extending almost 2/3 parts of mesoscutum length, converging, deep and broad posteriorly. Anterior parallel lines extending to 1/3 length of mesoscutum; parapsidal lines distinct, starting from posterior margin and extending to 1/2 length of mesoscutum; median mesoscutal line absent or present by a very short triangle. Mesoscutellum around 0.5 times as long as mesoscutum, as long as broad, slightly overhanging metanotum, center of disk reticulate, sides and posterior 1/3 dull rugose; scutellar foveae present, ovate, not delimited posteriorly, bottom shiny and smooth; median carina broad. Mesopleuron dull, uniformly



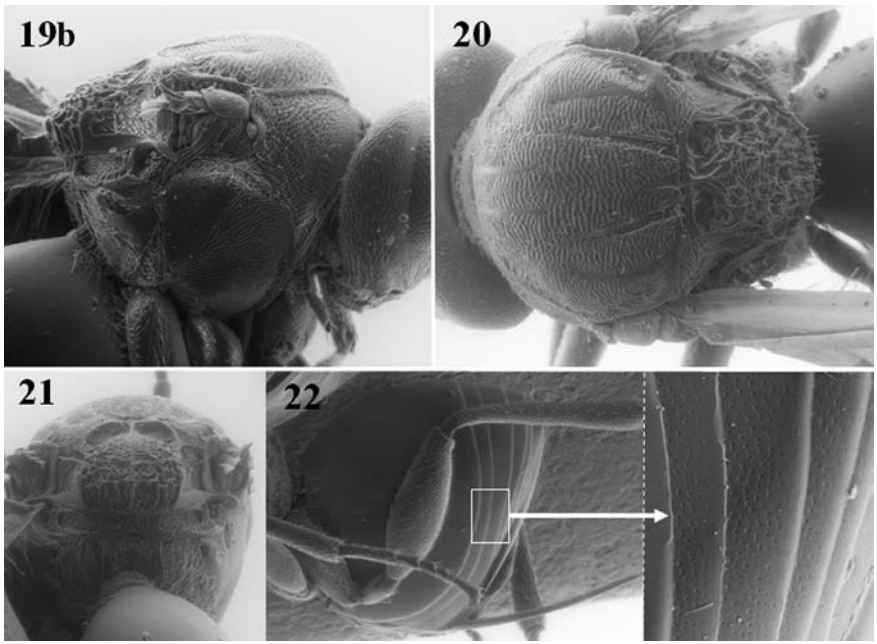
Figures 14-19a. *Zapatella migueli*: (14) Female head in anterior view, (15) female head in dorsal view, (16) male head in dorsal view, (17) male antennae, (18) female antennae, (19a) tarsal claws.

delicately carinate-reticulate, specullum microreticulate; mesopleural triangle conspicuously setose; dorsal axillar area coriaceous with numerous setae, lateral axillar area reticulo-carinate, without setae; axillula smooth, with white setae; subaxillular bar smooth, shiny, as long as height of metanotal trough; post-alar process long, strong, reticulate; metapleural sulcus reaching mesopleuron in upper 2/3 of its height. Metascutellum strongly reticulate, rectangular. Metanotal trough with short white setae; ventral impressed area at least twice as narrow as height of metascutellum, delicately reticulate. Propodeum setose laterally, glabrous centrally but shortly pilose anteriorly; central propodeal area smooth, shiny, with many irregular weak rugae, lateral propodeal carinae diverging anteriorly and converging in posterior 1/3. Nucha with irregular wrinkles and rugae.

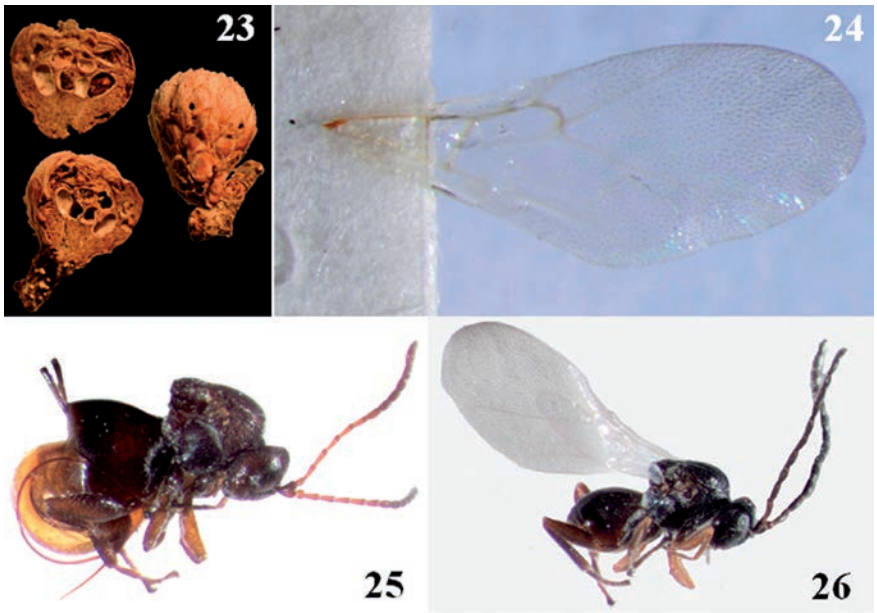
Forewing (Fig. 24). Longer than body (62:45), hyaline, almost uniformly pubescent, with cilia on margin; radial cell open, around 4 times as long as broad; veins hardly traceable; areolet indistinct; Rs+M, R1 and Rs very inconspicuous.

Legs. Tarsal claws simple (Fig. 19a); hind coxae with dense white setae on the dorsoposterior surface.

Metasoma (Fig. 22). Shorter than head+mesosoma (25:32), slightly higher than long in lateral view; base of 2nd metasomal tergite with dense ring of white setae, interrupted dorsally and few setae scattered on lateral surface of tergite. Narrow posterior band on 3rd metasomal tergite and all subsequent tergites with



Figures 19b-22. *Zapatella migueli*: (19b) mesosoma in lateral view, (20) mesosoma in dorsal view, (21) propodeum, (22) metasoma in lateral view.



Figures 23-26. *Zapatella migueli*: (23) acorn galls, (24) forewing, (25) female habitus in lateral view (wings cut), (26) male habitus in lateral view.

very delicate dense micropunctures. Prominent part of ventral spine of hypopygium needle-like, tapering to apex, 12-13 times as long as broad, with two parallel rows of short white scattered setae which do not extend beyond the apex of spine.

Male (Fig. 26). Length 2.5 mm (n=2). Similar to female, except in the following characters: Predominantly dark brown body with yellow legs; head 2 times as broad as long from above, 1.7 times as broad as high and no broader than mesosoma in frontal view; malar space 0.2 times as long as height of eye; POL 1.3-1.5 times as broad as OOL; OOL 1.2 times as long as diameter of lateral ocellus, and 1.7 times as long as LOL. Antennae (Fig. 17) with 13 flagellomeres (10: 7: 23: 23: 20: 19: 19: 18: 16: 16: 16: 16: 14: 13: 16); longer than body (80:55); pedicel 0.9 as long as broad; F1 slightly longer than F2, distinctly curved, dorsally flattened and excavate; subsequent flagellomeres shorter in length; F3 shorter than F2; placodeal sensilla on all flagellomeres. Scutellar foveae present, ovate, bottom shiny with rugae; median carina thin.

Type material. Holotype. Female, deposited in IAvH, with the following labels: "La Colorada (Villa de Leyva, Boyacá, Colombia), 2.200 m., 5º38'47" N 73º30'29" W" (white label); "*Q. humboldtii*, (10.iv.2014) 23.iv.2014. JP-V & M. A. Torres leg." (white label); "*Zapatella migueli* Pujade-Villar & Fernández-Garzón n. sp., desig. JP-V" (red label). Paratypes (2♂ & 3♀): same data of holotype (2♀ & 1♂ in IAvH; 1♀ & 1♂ in UB).

Gall (Fig. 23). Inconspicuous galls in aborted acorns. Surface of cupule with pin-size exit holes, made by emerging wasps, often present on galls. A transversal cut from infested acorn exposes 4-7 oval chambers (n=3) located inside nut. The semi-oval larval cells, around 2x3mm, are nested one next to another, but not fused.

Host plant. *Quercus humboldtii* Bonpl. 1909 (secion *Lobatae*).

Distribution. Department of Boyacá (Colombia).

Biology. It is a sexual generation inducing galls in acorns on *Q. humboldtii.* Adult wasps emerge in April, shortly after having collected the acorns. The acorn aborts because the larval chambers are inside nut.

Etymology. The specific name is derived from Miguel Angel Torres, the entomology curator from the "Instituto de Investigación de Recursos Biológicos Alexander von Humboldt" (IAvH), in recognition of his great labor.

Key of *Zapatella* species (modified from Pujade-Villar et al., 2012)

1. Female, antenna with 11 flagellomeres 2
– Male, antenna with 13 flagellomeres 14
2. Median mesoscutal line extending to 1/2-2/3 of mesoscutum length, deeply impressed 3
– Median mesoscutal line very short or absent 5
3. Median mesoscutal line impressed to 1/2 of mesoscutum length, indicated beyond this by dark line; prominent part of ventral spine of hypopygium around 6 times as long as broad in ventral view. Stem swelling galls ..... ***Z. quercusphellos***
– Median mesoscutal line extending to 2/3 of mesoscutum length; prominent part of ventral spine of hypopygium at least 8.0–8.5 times as long as broad in ventral view. Bud galls 4
4. Head and mesosoma uniformly reddish brown; scutellar foveae quadrangular, as long as broad ..... ***Z. cryptica***
– Head and mesosoma with large dark brown to black patches; scutellar foveae transverse, broader than high ..... ***Z. oblata***
5. Dark reddish brown to dark brown body, without or with darker spots; POL longer than OOL 6
– Body never uniformly dark, without or with very few darker spots; POL equal or smaller than OOL 9
6. Distal flagellomeres F5-F11 forming a slight club; F1 subequal or longer than F2; metasomal T2 and followings with very delicate dense micropunctures 7
– Antennae different from above; F2 longer than F1; metasomal T2 with narrow posterior band and followings with very delicate dense micropunctures 8
7. Escape longer than broad; F1 1.3 times longer than F2; mesopleuron with a relatively smooth area just ventral to the mesopleural triangle; propodeal carinae parallel; metasoma with a ring of overly dense white setae at the base of the 2nd metasomal tergite forming a dense band. Twig galls ..... ***Z. davisae***
– Globular escape; F1 subequal to F2; mesopleuron uniformly microreticulate;

propodeal carinae slightly bent outwards in posterior 1/3; metasoma with a ring of white setae at the base of the 2nd metasomal tergite not forming a dense band. Galls in petioles ..... ***Z. petiolata***

8. Body uniformly dark brown; ventral spine of hypopygium 12-13 times as long as broad; POL similar in lenth to OOL; bottom of scutellar fovea smooth and shiny. Acorn galls ..... ***Z. migueli* n. sp.**
– Body darker, head and mesosoma always with large dark brown to black spots; ventral spine of hypopygium 7.5-8.5 times as long as broad; POL 1.4 times as broad as OOL; bottom of scutellar foveae with rugae. Acorn galls ... . ***Z. grahami***
9. Ventral spine of hypopygium 6-8 times as long as broad..... 10
– Prominent ventral spine of hypopygium, at least 10 times as long as broad 13
10. Amber body; F2 1.2 times longer than F1; bottom of scutellar foveae coriaceo-alutaceous; scutellar foveae separated by very thin, line-like median carina; propodeal carinas slightly bent outwards in posterior 1/3. Twig galls..... ..... ***Z. tuberosa***
– Body entirely and uniformly light reddish brown, without or with very few darker spots; F2 equal to F1; bottom of scutellar foveae smooth, without rugae; scutellar foveae separated by broad bar; parallel propodeal carinas. Twig or stem galls..... 11
11. Notauli complete, always reaching pronotum, deeply impressed; median mesoscutal line short, extending to 1/4 of the mesoscutum length. Stem swelling galls with larval chambers nested in the peripheral layer of wood. Twig galls ..... ***Z. herberti***
– Notauli incomplete, extending to 1/2 of mesoscutum length, never reaching pronotum; median mesoscutal line absent or very short. Galls in twigs with larval chambers nested in the wood 12
12. Head in anterior view ovate, less robust and transverse from above; scutellar foveae separated by very thin, line-like median carina; lateral propodeal carinae subparallel, extending the entire length. Stem swelling galls..... ..... ***Z. quercusmedullae***
– Head in anterior view rounded, robust and less transverse; scutellar foveae separated by broad bar; lateral propodeal carinae slightly bent outwards in posterior 1/. Inconspicuous galls in twigs ..... ***Z. nievesaldreyi***
13. Bottom of scutellar foveae coriaceous-alutaceous, sometimes with some rugae; ventral spine of hypopygium 10 times as long as broad; mesopleuron uniformly microreticulate; body yellow to amber, never dark. Twig galls .... ***Z. inflata***
– Bottom of scutellar foveae smooth, without rugae; ventral spine of hypopygium 11-12 times as long as broad; mesopleuron mostly microtericulate-alutaceous, with coriaceous specullum; reddish brown body. Acorn galls..... ..... ***Z. cupulae* n. sp.**
14. Body dark reddish brown, while the metasoma is slightly lighter; gena width no more than 1/3 of transverse diameter of eye; scutellar foveae with smooth

shiny bottom. Stem swelling galls. ..... ***Z. quercusphellos***

– Body black or dark brown, with a few lighter areas; gena width nearly equal to transverse diameter of eye; scutellar foveae with reticulate bottom. Acorn galls 15

15. Body predominantly black with few brown areas; POL 2.0 times as broad as OOL; head 1.2 times as broad as high and broader than mesosoma in frontal view ..... ***Z. grahami***

– Body predominantly dark brown; POL 1.3-1.5 times as broad as OOL; head 1.7 times as broad as high and no broader than mesosoma in frontal view .... ***Z. migueli* n. sp.**

Discussion

After this review, *Zapatella* includes a total of 13 species. The taxa here described increases to seven the known species of *Zapatella* that occur in Colombia. These species are distributed in the departments of Boyacá (three species), and Cundinamarca (four species). Interestingly, these departments represent nearly 2% of the Colombian territory. Based on this, we suggest that both, the current species richness and geographic distribution of Colombian *Zapatella*, are largely underestimated (Pujade-Villar et al., unpublished data). However, estimate the species richness of this group is a difficult task due the inaccessibility and danger of some areas in Colombia.

In *Zapatella* species, the geographical distribution shows a high degree of endemism that might relate to the distribution of red oaks (Section *Lobatae*, subgenus *Quercus*). Generally, red oak species are widely distributed in the American territory, with nearly 220 oak species, occurring from Canada to South America (Pujade-Villar et al., 2012; Pulido et al., 2006; Rodríguez-Correa et al., 2015). However, Mexico holds the highest diversification and endemism of red oaks, the species richness decreases with latitude from here. In Central and South America, most red oaks are restricted to montane areas and only a single species is known from Colombia (*Quercus humboldtii*; Torres-Miranda et al., 2011; Rodríguez-Correa et al., 2015). The geographical distribution red oaks showing many co-distributed species is likely to suggest that the species richness of *Zapatella* is underestimated, as well as the broad spectrum of oak hosts that they could be using, since oaks provide habitats for a diverse group of organisms and has multiple types of interactions with gall-forming insects (Walker et al., 2002). Therefore, their geographic distribution may be broader than expected, causing an overestimation of their endemicity due poor sampling in the group, just as recently happened with *Z. grahami* (Fernández-Garzón et al., 2017).

Quercus humboldtii, the only *Quercus* species that is known to occur in Colombia is distributed between 800 m a.s.l. and 3500 m a.s.l., occupying both wet to dry environments (788mm/year-2681mm/year), and growing at localities with mean temperature ranging from 9.3ºC to 27.1ºC (González-Orozco et al., 2011; Rodríguez-Correa et al., 2015). This variability in climatic conditions that *Q. humboldtii* can tolerate provide different environments that influence gall-in-

Table 1. Gall characters and geographic distribution of *Zapatella* species

Area	*Zapatella* species	Gall location	Type of gall	Gall appearance	Oaks host	Distribution
Holarctic	*Z. cryptica* (Weld)	Bud	unilocular	Visible	*Q. myrtifolia*	USA
					Q. falcata	
	Z. herberti (Weld)	Branch	Plurilocular	Inconspicuous	*Q. agrifolia*	USA
					Q. kellogii	
					Q. wislizeni	
	Z. oblata (Weld)	Bud	Unilocular	Visible	*Q. coccinea*	USA
					Q. falcata	
	Z. quercusmedullae (Ashmead)	Twigs	Plurilocular	Conspicuous	*Q. incana*	USA
					Q. marilandica	
					Q. myrtifolia	
	Z. quercusphellos (Osten Sacken)	Twigs	Plurilocular	Conspicuous	*Q. incana*	USA
					Q. falcata	
					Q. ilicifoliia	
					Q. imbricaria	
					Q. myrtifolia	
					Q. phellos	
	Z. davisae Buffington et al.	Twigs	Plurilocular	Conspicuous	*Q. velutina*	USA
Neotropic	*Z. grahami* Pujade-Villar & Melika	Acorn	Uni/plurilocular	Inconspicuous	*Q. costaricensis*	Costa Rica
					Q. humboldtii	Colombia
	Z. nievesalgreyi Melika & Pujade-Villar	Twigs	Plurilocular	Inconspicuous	*Q. humboldtii*	Colombia
	Z. inflata Pujade-Villar & Rodríguez	Twigs	Unilocular	Conspicuous	*Q. humboldtii*	Colombia
	Z. tuberosa Pujade-Villar & Caicedo	Twigs	Plurilocular	Conspicuous	*Q. humboldtii*	Colombia
	Z. Petiolata Pujade-Villar & Caicedo	Petioles	Plurilocular	In/Conspicuous	*Q. humboldtii*	Colombia
	Z. cupulae Fernández-Garzón, Caicedo, Rodriguez & Pujade-Villar n. sp.	Acorn (cupule)	Plurilocular	Inconspicuous	*Q. humboldtii*	Colombia
	Z. migueli Pujade-Villar & Fernández-Garzón n. sp.	Acorn	Plurilocular	Inconspicuous	*Q. humboldtii*	Colombia

ducing populations around the country (Yukawa, 2000), and at the same time allows the so called '*super-host'* characteristic (plant species host to many galling species) found in the Colombian *Zapatella* species (Pujade-Villar et al., 2012, 2015, 2017) compared from other regions like North America, which have a broad spectrum of oaks host (de Araújo et al., 2013).

Emergency data for *Z. cupulae* shows an anomalous behavior that might be associated to periods of extreme drought. Optimal conditions for emergency happens before rainy periods (i.e., May-April as happened in 2015); nevertheless, in 2016 the emergency occurred later (after August) and 2017 has occurred earlier (January-February). This behavior was also observed in *Z. petiolata* as mentioned in Pujade-Villar et al. (2017).

One of the most interesting characteristics of gall-inducing wasps is their remarkably specificity to particular tissues. This aspect makes super-hosts excellent models to study morphological variations and phenological comparisons (Oliveira et al., 2008) in order to avoid overestimations. When different gall-inducers are on the same host plant, as in *Q. humboldtii*, competition for the space and time distribution are expected. One of the possible ways to avoid competition is the usage of different plant tissues to gall (Toma & de Souza Mendonça, 2014). However, which is our case, four of the seven species have their gall located in the twigs, and three gall in the acorn. Consequently, we suggest that further analysis are required to understand the influence of gall phenological patterns and partitioning niche of these wasps. A similar study carried out by Oliveira et al. (2013), revealed the influence of environmental factors in gall-inducer populations across time. Upcoming samplings must be made in order to consider the temporal and space variation in the oaks, as well as increase the sampling effort to more areas of Colombia where the oaks are distributed.

Apparently, the species display a high level of endemism on their respective area (Table 1), with the only specie described from Central America (*Z. grahami*) now recently reported from South America (Colombia) in Cindinamarca department (Fernández-Garzón et al., 2017), and with the North American and South American species only known from their respective distributional areas.

Acknowledgements

We are very grateful to our colleagues Marcos Roca-Cusachs (University of Barcelona) and Nadia Calderon (University of el Valle) for the revision and comments in the manuscript, also, the authors would like to thanks Cristian Roman-Palacios (University of Arizona) for giving a critical revision of the manuscript.

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