



***Andricus Barriosi*: a new species of oak gall wasp (Hymenoptera: Cynipidae: Cynipini) from Panama**

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Abstract

A new species of *Andricus* Hartig 1840 (Hymenoptera: Cynipidae: Cynipini) is described from Panama: *Andricus barriosi* **sp. nov.** The new species induces galls on *Quercus bumelioides* Liebm. and *Q. insignis* M. Martens & Galeotti (Fagaceae, sect. *Quercus*) and is the first species of the genus *Andricus* ‘sensu lato’ recorded from Panama. *Andricus barriosi* is part of a species complex that includes *A. nievesaldreyi* Pujade-Villar, *A. georgei* Pujade-Villar and *A. maesi* Pujade-Villar, which differ from the other species of the genus *Andricus* by having a characteristic striate-reticulate sculpture on the second metasomal tergum that is typically smooth in the other *Andricus* species. The diagnostic characters, gall description, distribution and biological data of the new species are given, and a key for the differentiation of the new species from related species is also provided.

Key words: Cynipidae, oak gall wasps, *Quercus*, Chiriquí, Panama

Introduction

The species of the family Cynipidae are biologically peculiar because they are associated with plant galls. These species either induce the galls themselves or live inside the galls caused by other insects, most frequently other cynipids but also, although more rarely, Chalcidoidea and Lepidoptera (Nieves-Aldrey 2001; Van Noort *et al.* 2007; Nieves-Aldrey *et al.* 2009; Nieves-Aldrey & Blas 2015; Ronquist *et al.* 2015;). *Andricus* Hartig 1840, with more than 100 species described, is the most species-rich and ecologically diverse genus within the Cynipini, one of the twelve tribes included in the Cynipidae (Insecta: Hymenoptera: Cynipoidea) (Ronquist *et al.* 2015). More than 300 species have been described worldwide (Csóka *et al.* 2005; Melika 2006), of which more than 100 have been recorded from America (Nearctic and Neotropical regions) (Weld 1952; Burks 1979; Melika & Abrahamson 2002).

As occurs with most genera of Cynipidae, the genus *Andricus* is primarily distributed in the Holarctic region (Liljeblad *et al.* 2008; Stone *et al.* 2009; Melika *et al.* 2010;). However, four species have been described from the Neotropical region: two are old descriptions from only the gall, *Andricus guatemalensis* (Cameron 1883) and *A. imitator* (Cameron 1883), both from Guatemala; the other two are more recent: *Andricus costaricensis* Pujade-Villar & Melika from Costa Rica and *A. maesi* Pujade-Villar from Nicaragua (Kinsey 1920; Melika *et al.* 2009; Medianero & Nieves-Aldrey 2011; Pujade-Villar 2015).

As revealed by recent phylogenetic analysis based on morphology (Liljeblad *et al.* 2008) and because of the high diversity, wide geographic distribution and high morphological and biological variability of the genus, it is currently accepted that the genus *Andricus* is not monophyletic. The genus is thus a true “catch-all” genus and in need, as is also the case for other Cynipini genera, of deep taxonomic revision (Nieves-Aldrey 2001; Melika 2006; Liljeblad *et al.* 2008;).

Despite the fact that the generic taxonomic limits of *Andricus* are not clear and the absence of morphological synapomorphies, the genus is currently defined by the presence of three consistent character states regarded as symplesiomorphies: transscutal articulation well defined, malar sulcus absent and irradiating carinae from clypeus short and barely perceptible (Nieves-aldrey 2001; Pujade-Villar *et al.* 2017).

As part of a continued study of the oak gall wasps (Cynipidae) of Panama (Medianero & Nieves-Aldrey 2011), this paper includes the description of a new species ascribed to *Andricus*, which represents the first *Andricus* species recorded from Panama and the fourth belonging to the group of *Andricus* species with a sculptured metasoma.

Material and methods

Study material. The adults studied were reared from galls collected on *Quercus bumelioides* Liebm. and *Q. insignis* M. Martens & Galeotti. Samplings of galls were made from Dec 2007 to May 2009 and June 2016 to January 2018 at Volcán Barú and Alto Quiel, Boquete, Chiriquí Province, Panama. The adult insects emerged in the laboratory from rearing cages. Vouchered adult specimens and their galls were deposited in the entomological collections of the Museo Nacional de Ciencias Naturales, Madrid (Spain) and Maestría en Entomología, Universidad de Panamá (MEUP). The identification of the *Quercus* species was based on several key references (Breedlove 2001; Burger 1977) as well as on comparisons with materials from the collections of the University of Panama and the Smithsonian Tropical Research Institute.

Specimen preparation. For observation under a scanning electron microscope (SEM), adult cynipids were dissected in 96% ethanol, air dried, mounted on a stub and coated with gold. Micrographs were taken by an FEI Quanta 200 microscope (high vacuum technique) of several standardized views. The forewings were mounted on slides in Euparal and were later examined under a Wild MZ8 stereomicroscope. Images of the adult habitus and gall dissections were taken with a Nikon Coolpix 4500 digital camera attached to a Wild MZ8 stereomicroscope. Measurements were performed with a calibrated micrometer scale attached to an oculus of the light microscope. The terminology of morphological structures and abbreviations follows Ronquist and Nordlander (1989), Ronquist (1995), Nieves-Aldrey (2001) and Liljeblad *et al.* (2008). For the cuticular sculpture, we follow Harris (1979). The measurements and abbreviations used include the following: the postocellar distance (POL) is the distance between the inner margins of the posterior ocelli; and the ocellar-ocular distance (OOL) is the distance from the outer edge of a posterior ocellus to the inner margin of the compound eye.

Andricus barriosi Medianero & Nieves-Aldrey, new species

Figs 1–6

Type material. HOLOTYPE ♀ (Fig. 3A) [in Museo Nacional de Ciencias Naturales, Madrid, Spain (MNCN), card mounted. Cat. no. 2859]: PANAMA, Chiriquí, Volcán Barú, 8°47'50.8" N, 82°29'35.9" W, 1,800–2,070 m; ex gall on leaf of *Quercus bumelioides* Liebm. (Fagaceae); gall collected 08-V-2008; insect emerged V-2008, E. Medianero & J. L. Nieves leg.

Paratypes: 5♀, PANAMA, Chiriquí, Volcán Barú, 8°47'50.8" N, 82°29'35.9" W, 1,800–2,070 m; ex gall on leaf of *Quercus bumelioides* Liebm. (Fagaceae); gall collected 8-V-2008; insect emerged VI-2008, E. Medianero & J. L. Nieves leg. 1♀, same data but collected 30-I-2008; insect emerged ii-2008, E. Medianero leg.; 4♀, PANAMA, Chiriquí, Alto Quiel, Boquete, 8°49'01.7" N, 82°28'32.3" W, 1,600 m; ex gall on leaf of *Quercus insignis* M. Martens & Galeotti (Fagaceae); gall collected 27-XI-2008; insect emerged I.2009. 1♀, same data but collected 19-XII-2008; insect emerged I-2009, E. Medianero leg. Paratypes in Maestría en Entomología, Universidad de Panamá (MEUP).

Additionally, 2♀ paratypes of the type series were dissected for SEM observation (in MNCN).

Etymology. Named after our colleague and friend Dr. Héctor Barrios for his contribution to the development of entomology in Panama.

Diagnosis and comments. The new species is closely allied to *A. nievesaldreyi* Pujade-Villar (= *A. mexicanus* Kinsey) and *A. georgei* Pujade-Villar, both from Mexico, and to *A. maesi* Pujade-Villar from Nicaragua. All these species induce similar galls and share the majority of diagnostic morphological characters of the adults, including a

sculptured metasoma. However, *A. barriosi* may be readily distinguished from the other three species by the characters presented in the identification key.

The new species differs from all the other mentioned species by its darker coloration with head and body being predominantly brown to black, while the other species are predominantly reddish to amber. *A. barriosi* may be distinguished from *A. georgei* by the complete notauli, which are faint anteriorly in *A. georgei*. In *A. barriosi*, the scutellar foveae are not well differentiated on the posterior edge, whereas in *A. georgei*, the scutellar foveae are well differentiated and separated by a trapezoidal area. *A. barriosi* differs from *A. maesi* in the sculpture of the second metasomal segment and the type of gall. The striated sculpture in the second metasomal tergum is weak in *A. maesi* but strongly marked and extended in the new species. The galls of the two species are also different – galls of the new species are formed on leaves while that of *A. maesi* are on stems or twigs. *A. barriosi* differs from *A. nievesaldreyi* not only in its darker adult coloration but also in the relative extension and definition of the striated sculpture on T2, which is much more marked in the new species, and in the presence of a smooth area in the mesopleura, which is missing in *A. nievesaldreyi*.

The gall of the new species is similar to that of *Cynips guatemalensis* Cameron (1883) (cited as *A. guatemalensis* by Medianero & Nieves-Aldrey 2011), a species that has been considered *incertae sedis* by Pujade-Villar *et al.* (2011).

General Description. Body length, 3.5 mm (range 2.9–4.1 mm; $N = 7$) for females. Female body predominantly brown. Head with vertex, occiput and central area of face dark brown to black. Mesosoma dark brown to black (in some individuals). Metasoma dark brown. Scape, pedicel, legs (except the tibiae and metatarsomeres), area postero-lateral of protorax and area lateral-ventral of the tergites of metasoma yellow brown. Forewings hyaline with all the veins dark brown.

Female. Head, with frons and face rugose, genae alutaceous. Face with radiating striae from clypeus, reaching basal and lateral margin of eye. Face and occiput moderately pubescent, front with only one row of setae lateral, genae without setae. Head in dorsal view approximately 2.52 times wider than long (Fig. 1A). POL 2.0 times longer than OOL; posterior ocellus separated from inner orbit of eye by 1.3 times its longest diameter (Fig. 1A). Head in anterior view generally oval (Fig. 1B), 1.24 times wider than high. Genae slightly expanded behind eyes. Clypeus trapezoidal, 1.6 times wider than high, alutaceous, moderately pubescent, ventral margin slightly sinuate and projecting over mandibles. Anterior tentorial pits conspicuous; epistomal sulcus and clypeo-pleurostomal lines distinct. Malar space 0.3 times height of compound eye, without a distinctive malar sulcus. Distance between antennal rim and compound eye 1.2 times width of antennal socket including rim. Ocellar plate raised. Head, posterior view (Fig. 1C). Gula relatively short; distance between occipital and oral foramina as long as the occipital foramen. Without an occipital carina.

Mouthparts (Fig. 1C). Mandibles strong and exposed, moderately pubescent; right mandible with three teeth, left with two teeth. Cardio of maxilla visible, maxillary stipes approximately 2.6 times longer than wide. Maxillary palp five-segmented. Labial palp three-segmented.

Antennae (Fig. 2E) of moderate length, as long as 1/2 body length, with 14–15 segments; flagellum not broadening toward apex, with short, erect setae and elongate placodeal sensilla visible only on flagellar segments 2–12. Relative lengths of antennal segments 13:15:33:25:24:22:21:20:16:14:13:13:11:24. Pedicel globose, small, 0.9 times as long as scape; F1 1.3 times as long as F2 (Fig. 2G); F12 2.6 times longer than wide and 2.2 times as long as F11 (Fig. 2F).

Mesosoma (1D–H). Uniformly alutaceous, moderately pubescent, in lateral view 1.2 times as long as high, strongly convex dorsally (Fig. 1H). Pronotum, densely pubescent; with long and dense white setae, lateral surface of pronotum with longitudinal wrinkles; (Fig. 1H). Pronotum short medially, ratio of length of pronotum medially/laterally = 0.2. Pronotal plate indistinct dorsally (Fig. 1D).

Mesonotum. Mesoscutum alutaceous, only slightly pubescent with scattered setae anterior, lateral and posteriorly, with a row of setae along the notauli. Notauli percurrent, smooth, well impressed along entire length, reaching pronotum, convergent posteriorly, with an indistinct median mesoscutal impression. Anteroadmedian signa clearly visible. Parapsidal signa broad, smooth. Transscutal fissure narrow (Fig. 1E). Scutellum (Fig. 1F), rounded, approximately 0.7 times as long as mesoscutum, rugose, posterior margin not emarginate. Scutellar foveae not well differentiated, shallow, smooth and indistinct margins posteriorly. Scutellum, overlapping the dorsellum posteriorly in lateral view. Axillula moderately pubescent, their anterior margins and posterior marked. Mesopleuron medially with some longitudinal rugae, the sculpture being weak or almost smooth basally and posterodorsally; the pubescence is moderate, with the mesopleural triangle densely pubescent (Fig. 1H).

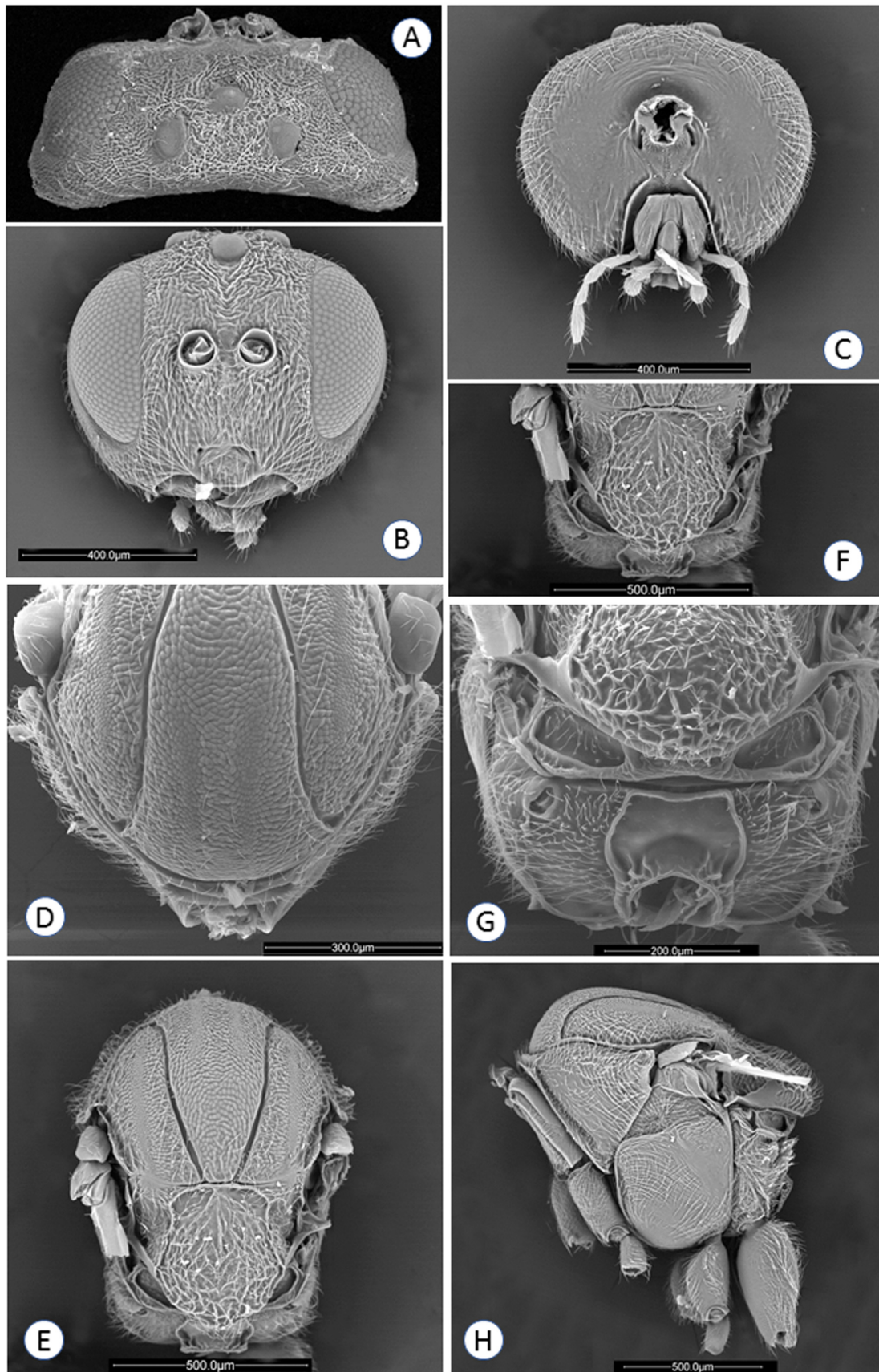


FIGURE 1 *Andricus barriosi*, new species, asexual female (A) Head, dorsal view. (B) Head, anterior view. (C) Head, posterior view. (D) Pronotum, antero-dorsal view. (E) Mesosoma, dorsal view. (F) Scutellum. (G) Propodeum. (H) Mesosoma, lateral view.

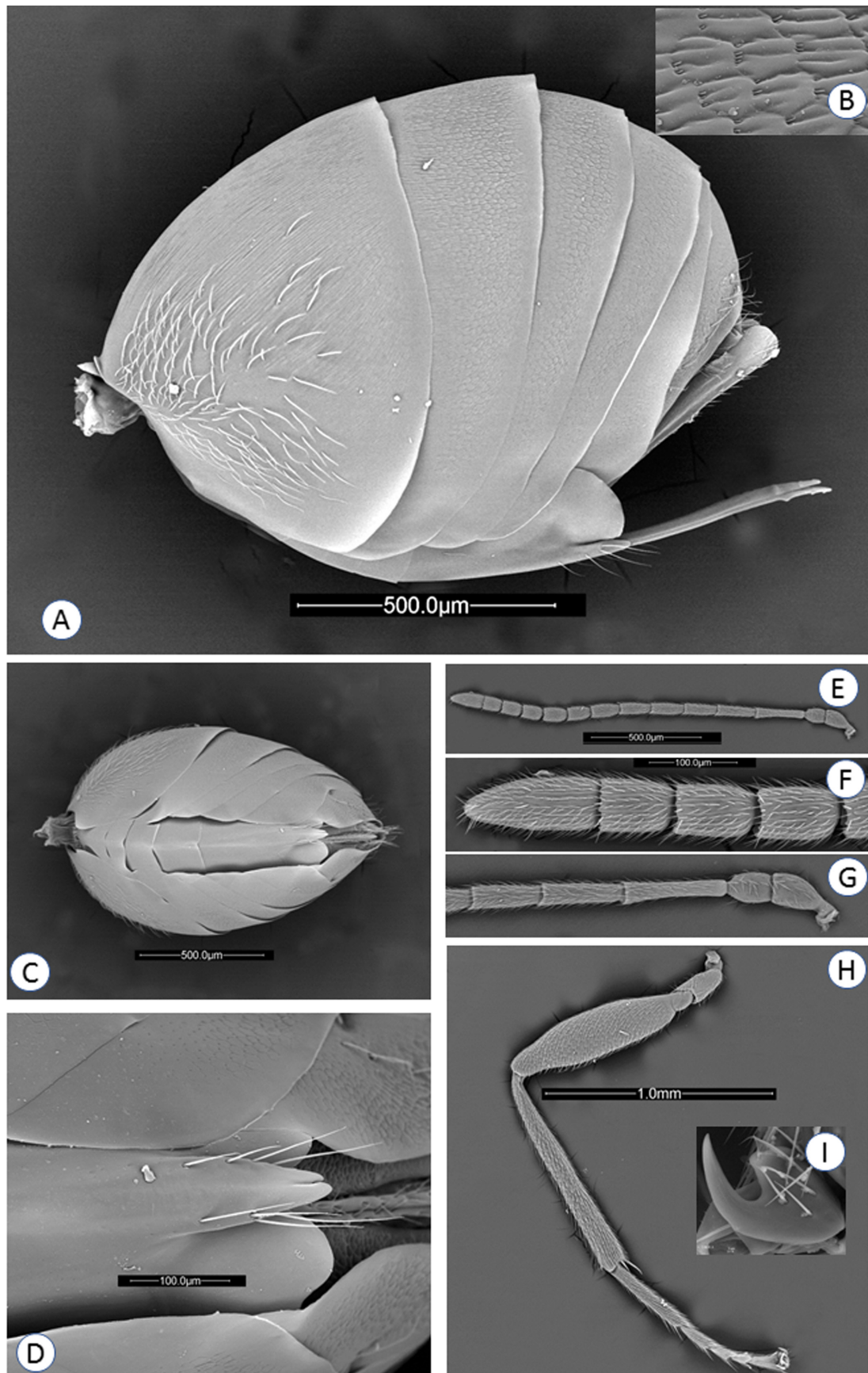


FIGURE 2 *Andricus barriosi*, **new species**, asexual female (A) Metasoma, lateral view. (B) Detail of the reticular area of the metasoma. (C) Metasoma, ventral view. (D) Detail of the ventral spine of the hypopygium, ventral view. (E) Female antenna. (F) Detail of the last flagellomeres. (G) Detail of basal flagellomeres. (H) Legs. (I) Metatarsal claw.

Metanotum (Fig. 1G and H). Metapectal-propodeal complex. Metapleural sulcus reaching posterior margin of mesopectus at mid-height of metapectal-propodeal complex (Fig. 1H). Lateral propodeal carinae distinct, strong and arched in their medial portion (Fig. 1G). Median propodeal area wide and bare (Fig. 1G). Lateral propodeal area densely pubescent. Nucha rugose.

Legs (Fig. 2H). Moderately pubescent, metatarsal claws with an acute basal lobe or short tooth (Fig. 2I).

Forewing (Fig. 3A). As long as body, veins strongly pigmented. Radial cell 4.0 times longer than wide, open along anterior margin, areolet large, triangular, closed. Rs slightly bowed, reaching wing margin. M nearly straight, not reaching wing margin. Rs+M reaching basalis at mid-height. First abscissa of radius (2r) slightly curved, 2r-m straight. Basal cell pubescent. Apical margin of wing with moderately long hair fringe.

Metasoma (Fig. 2A). Large, as long as head and mesosoma combined, 1.3 times as long as high in lateral view. T2 covering approximately 2/3 of metasoma and strongly and longitudinally striated, with a group of sparse short setae anteromedially; following tergites with well marked reticulate sculpture, with one to three short setae in each cell (2B). Projecting part of hypopygial spine, beyond attachment of lateral flap, relatively short (Fig. 2C); approximately 2.0 times as long as basal height of the spine; lateral margins of hypopygial spine with long setae projecting over apical end of the spine (2D).

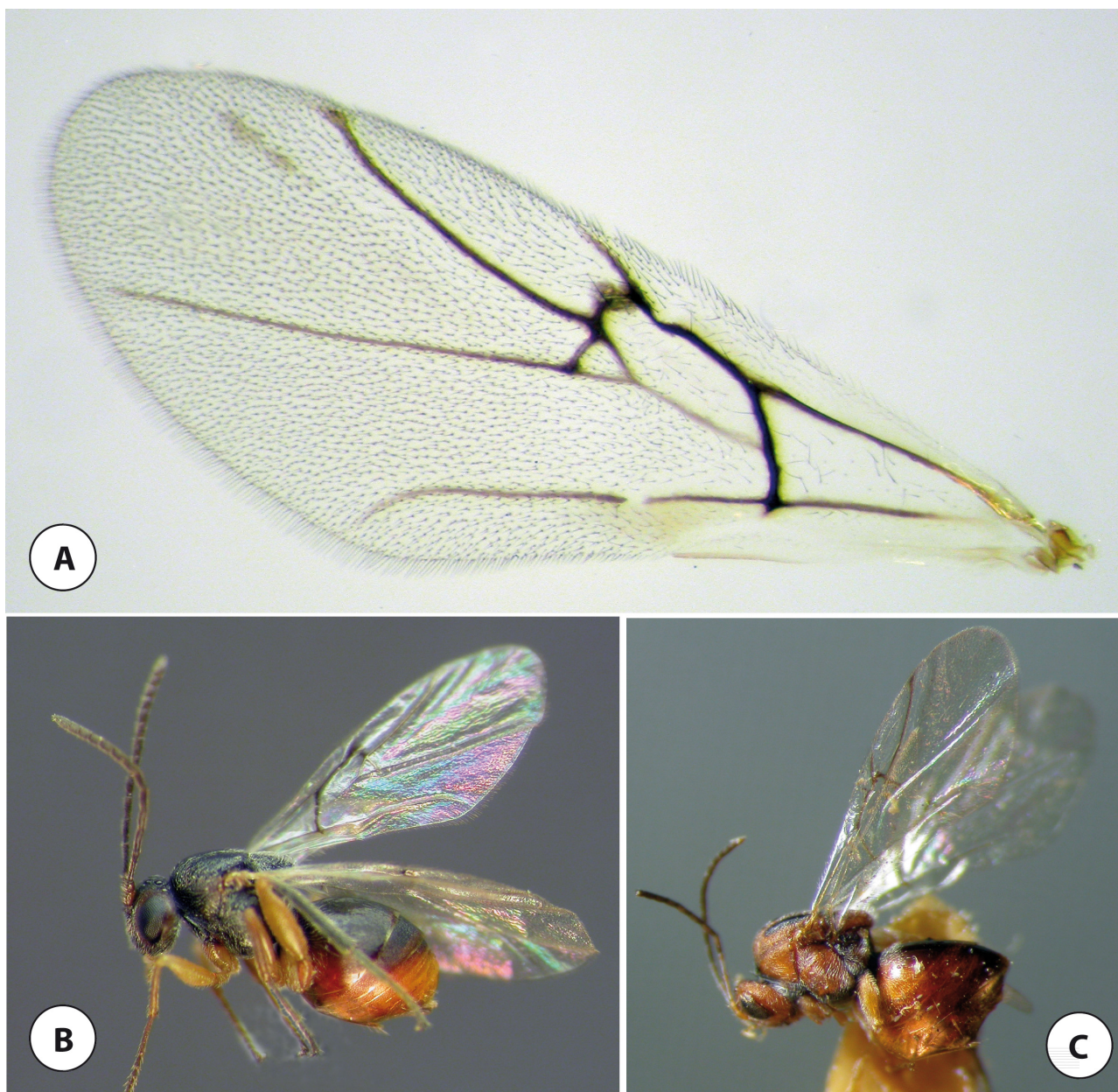


FIGURE 3 *Andricus barriosi*, new species, asexual female: (A) Forewing. (B) Habitus. (C) *Andricus nievesaldreyi*, habitus of female.

Gall (Figs. 4 A–D). Galls present as dense, spherical masses covered with light brown hairs on the midrib of leaves (Fig 4A and B). The gall is first orange, becoming dark brown when mature (Fig. 4C). Diameter measures 2.09 to 2.16 cm. The majority of galls are solitary and develop indistinctly on the upper or lower surface of the leaf blade. The internal structure of the gall shows a highly lignified core enclosing several larval cells (Fig. 4D and E)

Distribution. *Andricus barriosi* was found between 1,000–2,070 m asl at Volcán Barú and Alto Quiel, Chiriquí Province, Panama.

Biology. Only the asexual generation of *A. barriosi* is known, which induces galls on leaves of *Quercus bumelioides* Liebm. and *Q. insignis* M. Martens & Galeotti (Fagaceae, sect. *Quercus*). The galls are found between December and May, during the dry season, when new leaves of *Q. bumelioides* and *Q. insignis* begin to emerge. The adult insects emerge from mature galls from June to July.

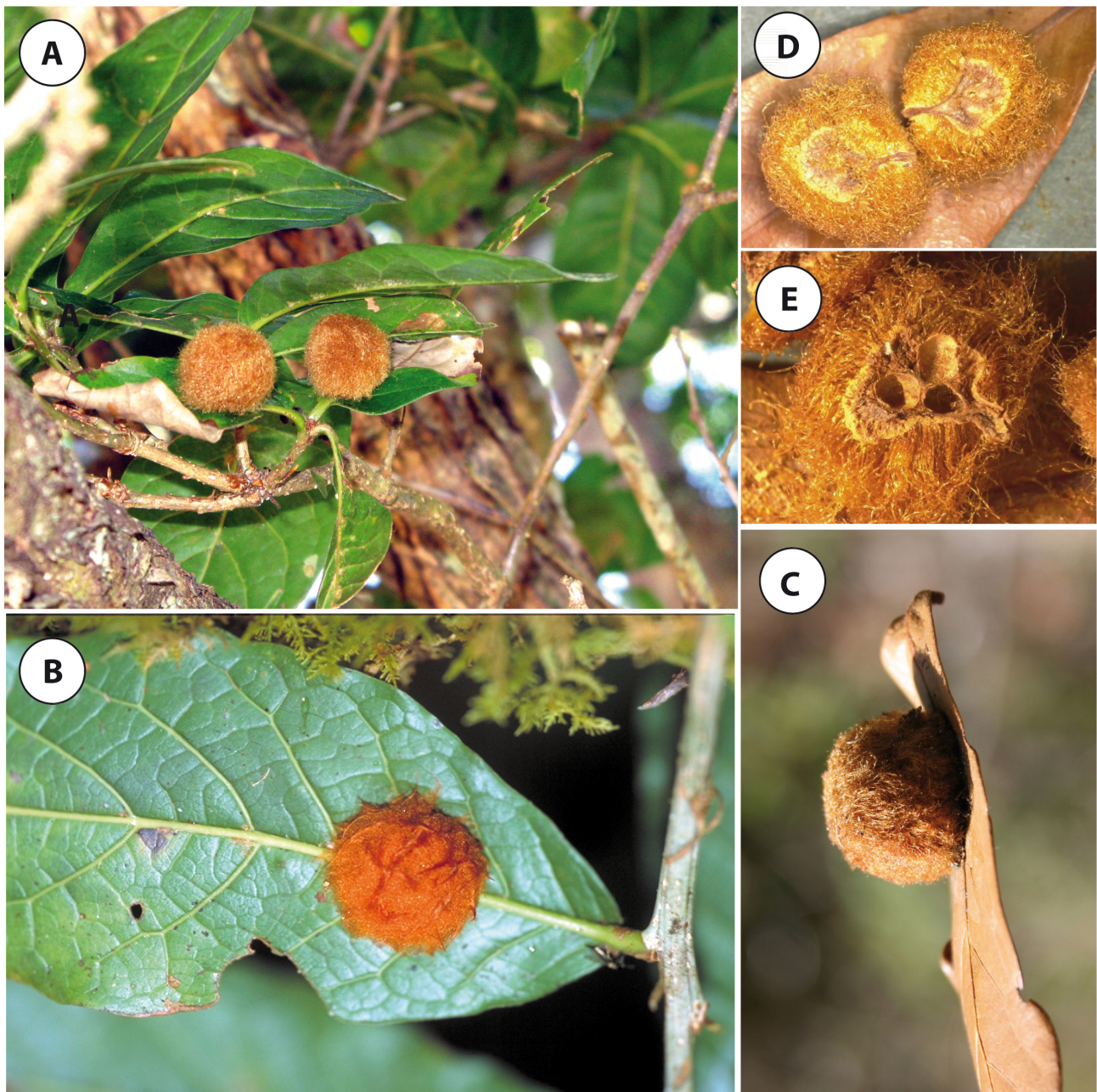


FIGURE 4 Galls of *Andricus barriosi*, new species, (A), (B) and (C) mature galls on *Quercus bumelioides*. (D) and (E) Sections of galls showing the inner structure.

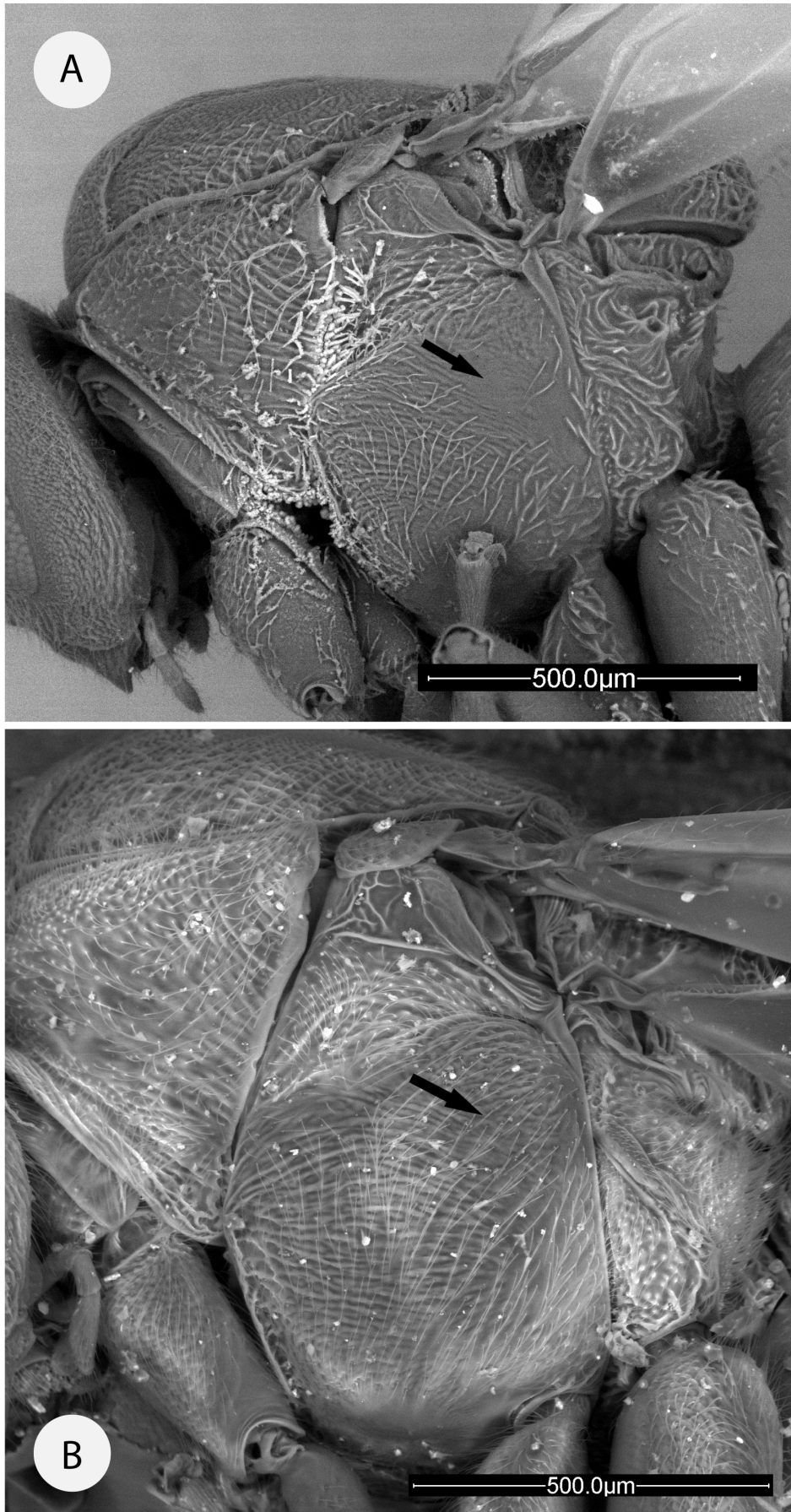


FIGURE 5 Detail of the sculpture of the mesopleuron in (A) *Andricus barrosi* and (B) *Andricus nievesaldreyi*.

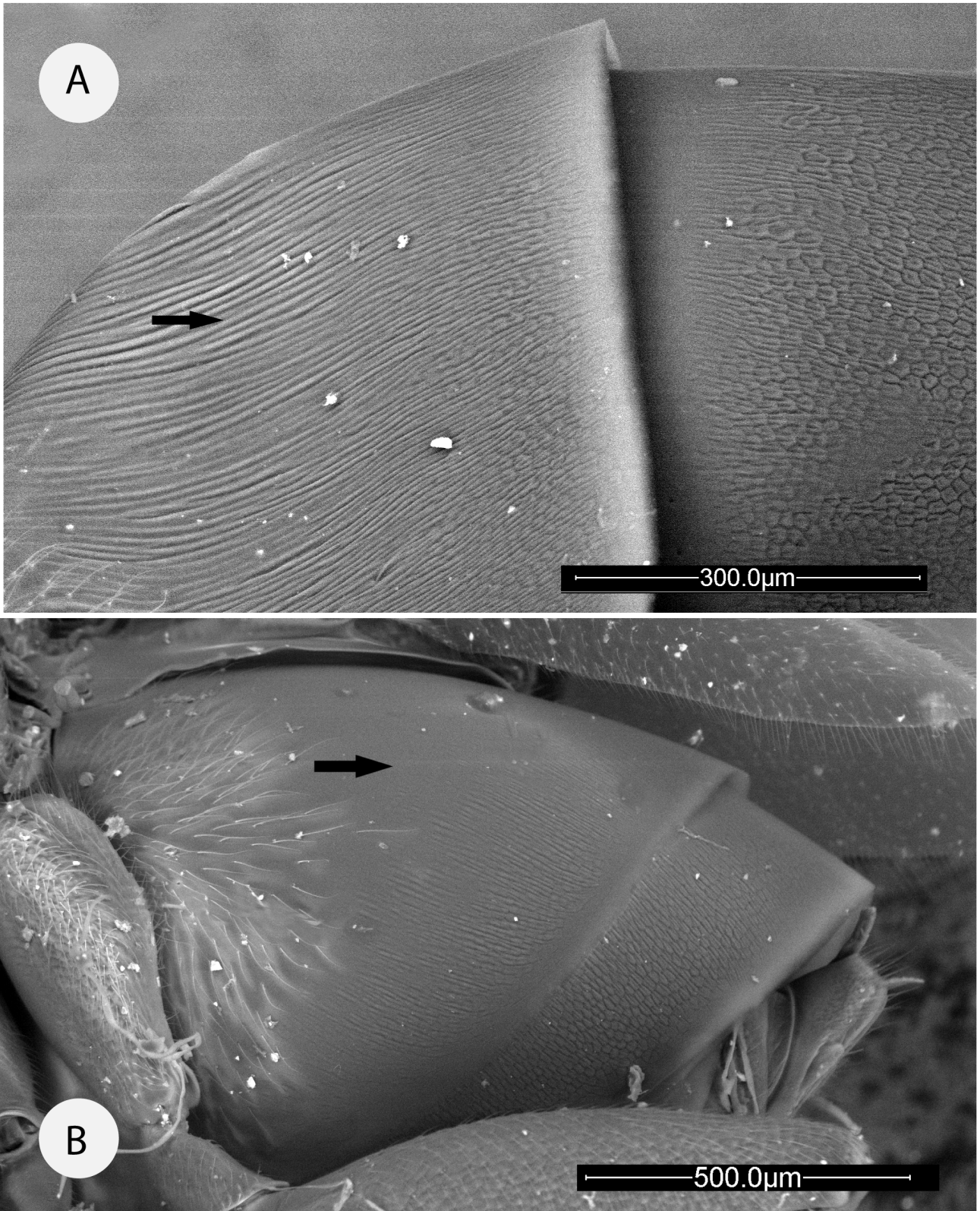


FIGURE 6 Detail of the sculpture of the metasoma in (A) *Andricus barrosi* and (B) *Andricus nievesaldreyi*.

Key for the identification of the species of genus *Andricus* with a striated metasoma

- 1. Notauli percurrent, distinctly marked along all the mesoscutum (Fig. 1E) 2
- Notauli incomplete, only distinct posterior and medially, faint in anterior part of mesoscutum *A. georgei*

2. Antennal pedicel globose, as long as broad; F1 as long as F2. Second metasomal tergite with the reticulate sculpture covering almost the entire tergite, longitudinal striated sculpture very reduced or absent. Galls on stems or twigs *A. maesi*
- Antennal pedicel longer than broad; F1 clearly longer than F2 (Fig. 2E and G). Second metasomal tergite with extended longitudinal striated sculpture more or less marked, but the area of reticulate sculpture being much narrower and weak. Galls on leaves. 3
3. Longitudinal striae on second metasomal tergite strong, well marked and visible, almost reaching posterior margin of metasomal tergite (Figs 2A, 6A). Dorsal area of mesopleuron weakly sculptured to smooth (Fig. 5A). Coloration of adult predominantly dark brown to black (Fig. 3B). *A. barriosi*
- Longitudinal striae on second metasomal tergite weak, slightly marked and incomplete, not reaching margin of metasomal tergite (Fig 6B). Mesopleuron entirely sculptured (Fig. 5B). Coloration of the adult predominantly reddish to amber (Fig. 3C) *A. nievesaldreyi*

Discussion

The new species described here is closely allied to *A. nievesaldreyi* Pujade-Villar 2011 (= *A. mexicanus* Kinsey 1920), *A. georgei* Pujade-Villar 2011 and *A. maesi* Pujade-Villar 2015, but the taxonomic position of these four species within the genus *Andricus* is a topic of discussion. The species of *Andricus* typically present a smooth metasoma or show only weak micropunctures (Nieves-aldrey 2001; Melika 2006; Liljeblad *et al.* 2008;). However, the above-mentioned species, all from Mexico and the Neotropical region, present a typically sculptured metasoma and may be grouped into a different, undescribed genus. These species have been provisionally grouped under the name “tectucnarum” and are in the process of being studied (Pujade-Villar *et al.* 2011, 2015; Ferrer-Suay *et al.* 2017;). Eventually, a new genus for these species must be established (Melika, Nieves-Aldrey and Pujade-Villar in prep.). Many species from Mexico share the same morphological and biological characters that may define the new genus (Nieves-Aldrey, unpublished). However, because the limits of the genus *Andricus* are very broad, further detailed studies are required for the precise and natural division of *Andricus*, especially for the Nearctic and Neotropical species (Melika 2006). In a recent study, a new genus was described based on combined evidences from morphological, ecological and molecular data (Nicholls *et al.* 2018), and such approach is probably the most adequate for describing the possible new genus discussed here.

Acknowledgments

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