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Description of the first species of gall wasp (Hym., Cynipidae: Cynipini) and other unknown galls on *Quercus macdougalii* (Fagaceae)

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Abstract

A new species of oak gallwasp, *Neuroterus chinanteco* Pujade-Villar & Clark n. sp., known only from its sexual generation that induces galls on the leaves of *Quercus macdougalii* Martínez, (section *Quercus*) is described. *Quercus macdougalii* is a poorly known species, endemic to Oaxaca and rare (located between 2700-3000 m a.s.l.), endangered (included in the IUCN Red List). Diagnosis, distribution and data on biology of the new species are given. *Neuroterus chinanteco* Pujade-Villar & Clark n. sp. represents the first species mentioned on this oak host. Other galls collected on *Q. macdougalii* from which only inquilines and/or parasitoids have been obtained are also illustrated.

Keywords: Cynipini, taxonomy, morphology, distribution, biology.

Resum

Descripció de la primera espècie de cinípid (Hym., Cynipidae: Cynipini) i altres agalles desconegudes a *Quercus macdougalii* (Fagaceae)

Es descriu de Mèxic una nova espècie de cinípid de roures, *Neuroterus chinanteco* Pujade-Villar & Clark n. sp., coneguda només a partir de la seva generació sexual que indueix gales a les fulles de *Quercus macdougalii* Martínez (secció *Quercus*). *Quercus macdougalii* és una espècie poc coneguda, endèmica d'Oaxaca i poc comú (localitzada entre els 2700-3000 m), en perill d'extinció (inclosa a la Llista Vermella de la UICN). Es donen dades referents a la diagnosi, la distribució i la biologia d'aquesta nova espècie. *Neuroterus chinanteco* Pujade-Villar & Clark n. sp. representa la primera espècie esmentada en aquest hostatger. També s'illustraven altres gales col·lectades en *Q. macdougalii* de les quals només s'han obtingut inquilins i/o parasitoides.

Paraules clau: Cynipini, taxonomia, morfologia, distribució, biologia.

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Introduction

The genus *Neuroterus* was erected by Hartig (1840) to include several European species without the transscutal articulation, which separates the mesoscutum from the scutellar-axillary complex. According to the current classification (Melika *et al.*, 2010), six Cynipini genera lack totally or partially this articulation, which from only *Neuroterus* Hartig, 1840 is found in America.

Kinsey (1923) mentioned high levels of heterogeneity within this group by subdividing *Neuroterus* into six subgenera based on morphology, geographic distribution, gall structure, and adult life history, underscoring the fact that this group is biologically diverse and is not monophyletic (Liljeblad *et al.*, 2008; Stone *et al.*, 2009; Melika *et al.*, 2010). *Neuroterus* is a problematic genus, especially with regard to its generic limits and in particular to the American fauna, which has not been reviewed since Kinsey (1923).

Eleven species of *Neuroterus* are known from Mexico (Pujade-Villar *et al.*, 2018; Martínez-Romero *et al.*, 2022). The first species of the genus were described by Kinsey (1938), all of them in asexual generations induce galls on leaves: *N. junctor*, *N. reconditus*, *N. tumba*, *N. visibilis*, *N. volutans* and *N. vulpinus*. Recently, five more species have been described (Pujade Villar *et al.* 2014, 2016, 2017 & 2018): *N. acrotrichias* Pujade-Villar 2017; *N. ellongatum* Pujade-Villar & Melika, 2014; *N. eugeros* Pujade-Villar, 2018; *N. fusifex* Pujade-Villar & Ferrer-Suay, 2016 and *N. verrucum* Pujade-Villar, 2014.

Kinsey (1938) incorrectly suspected that *N. junctor* could be a sexual generation, however, the only known sexual generation is *N. fusifex*, a species that produces galls on catkins. This study describes a new *Neuroterus* species from Mexico based on the sexual generation only, that induces conspicuous leaf galls on an endemic Mexican oak species, *Quercus macdougalii* Martínez.

Materials and methods

Sexual adult gallwasps were reared from galls collected on *Q. macdougalii* belonging to the *Quercus* section of oaks (Govaerts & Frodin, 1998). They were preserved in the laboratory and the adults emerged shortly after.

We follow the current terminology of morphological structures (Liljeblad & Ronquist, 1998; Melika, 2006). Abbreviations for the fore wing venation follow Ronquist and Nordlander (1989). Cuticular surface terminology follows that of Harris (1979).

Measurements and abbreviations used here include: F1–F11, 1st and subsequent flagellomeres; POL (post-ocellar distance) is the distance between the inner margins of the posterior ocelli; OOL (ocellar-ocular distance) is the distance from the outer edge of a posterior ocellus to the inner margin of the compound eye; LOL, the distance between lateral and frontal ocelli. The width of the forewing radial cell is measured from the margin of the wing to the Rs vein.

The SEM pictures were made by first author in Barcelona University using field-emission gun environmental scanning electron microscope (FEI Quanta 200 ESEM), with for low-resolution imaging without gold-coating the specimens. Galls and habitus images were taken by the second author; galls images with a Canon digital camera PowerShot SX510 HS and adults images with a digital camera associated to Carl Zeiss microscopy III followed by processing with GIMP 2.8 program.

The type material is deposited in the next institutions: UB, Universidad de Barcelona, Catalonia (J. Pujade-Villar); ColPos, Colegio de Postgraduados de Montecillo, Estado de México, México (A. Equihua), PHDNRL, the Plant Health Diagnostic National Reference Laboratory, National Food Chain Safety Office, Budapest, Hungary (G. Melika), AMNH, American Museum Natural History, USA (J. Carpenter) and USNM, Smithsonian Institution, USA (M. Buffington).

Results

Neuroterus chinanteco Pujade-Villar & Clark-Tapia n. sp. Figs. 1-3)

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Type material

Holotype sexual female labelled as “MEX, El Mirador, Santiago Comaltepec (Chinantec community, Oaxaca), 17°10'01”N – 93°35'58”W, *Q. macdougalii*, (27.vi.2023) 27.vi-9.vii.2023”, JP-V col. (black label); Holotype *Neuroterus chinanteco* Pujade-Villar & Clark-Tapia n. sp., desig. JP-V 2023” (red label). The holotype female is deposited in the collection of JP-V (University of Barcelona, UB). Paratypes (20 ♂ & 30 ♀): 15 ♂ & 30 ♀ same data as the holotype; 5 ♂ same data holotype 16-31.vii.2023. Holotype and 10 ♂ & 15 ♀ paratypes deposited in UB, 2 ♂ & 4 ♀ paratypes in ColPos, 3 ♂ & 5 ♀ paratypes in PHDNRL, 3 ♂ & 3 ♀ paratypes in AMNH and 2 ♂ & 3 ♀ paratypes in USNM.

Additional material

4 ♂ & 8 ♀ with same labels as Holotype (3 ♂ & 3 ♀ were dissected for taking SEM photos); 5 ♂ & 4 ♀ with the same data as the holotype 16-31.vii.2023. Pozuelos, Ixtlán de Juárez (Zapotec community, Oaxaca), 17°22'42”N – 96°26'46”W, (3.viii.2023) 3-20.viii.2023: 1 ♂ & 5 ♀; Cerro Zacate, San Pedro Yolox (Chinanteco community, Oaxaca), 17°36'35”N – 96°31'09”W (2.viii.2023) 3-21.viii.2023: 6 ♂ & 25 ♀.

Diagnosis

According to Kinsey's descriptions and keys (Kinsey, 1923), *Neuroterus chinanteco* Pujade-Villar & Clark-Tapia n. sp. belongs to the *Diplobius* subgenus, known from the Nearctic only, with seven species described from Mexico: *N. tumba*, *N. visibilis*, *N. reconditus*, *N. volutans*, *N. vulpinus*, *N. verrucum* and *N. fusifex*. All Kinsey Mexican *Neuroterus* (*Diplobius*) species are asexual forms having the mesoscutum smooth, glabrous, without surface sculpture, while in the sexual forms of *Neuroterus fusifex* and *N. chinanteco* Pujade-Villar & Clark-Tapia n. sp. the mesoscutum is alutaceous to delicately coriaceous at most partially. The new species is morphologically similar to *N. fusifex*, nevertheless, in the new species the maxillar palps with four segments and labial palps with two, while *N. fusifex* with five and three segments respectively; galls of the new species are on leaves while in *N. fusifex* on catkins. In the new species the gena not broadened behind eye in females (slightly broadened in *N. fusifex*), hind femurs are completely yellowish in females (with a brown spot in *N. fusifex*), POL 1.2× OOL (2.5× in *N. fusifex*), OOL 3.0× diameter of lateral ocellus (1.3× in *N. fusifex*) and the central propodeal area with a median carina (without the median carina in *P. fusifex*); in males the mesoscutum is brown at least along sides and in the upper half (with three longitudinal dark spots in *N. fusifex*), the OOL longer than diameter of lateral ocellus (OOL subequal to

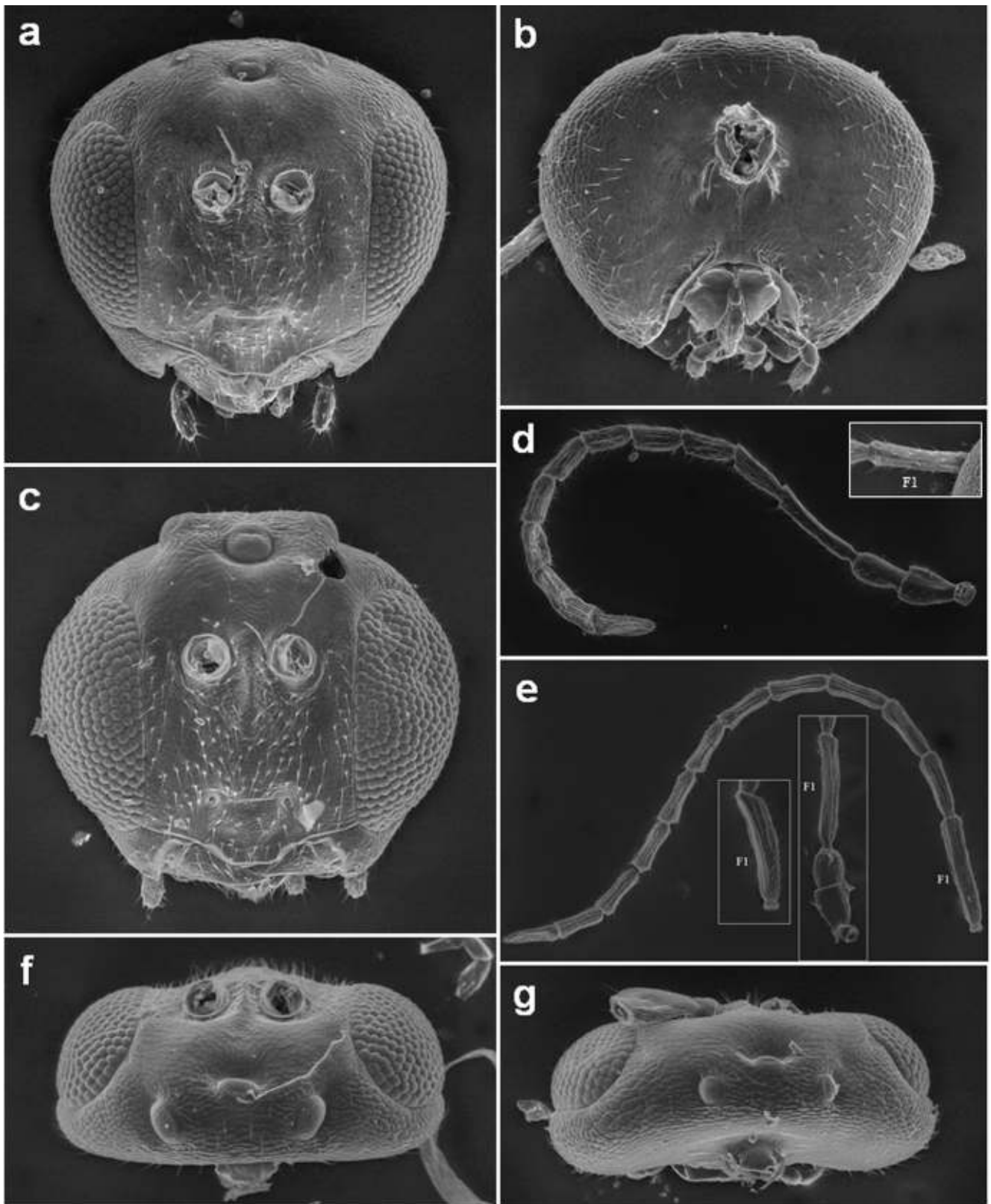


Figure 1. *Neuroterus chinanteco* n. sp.: a) female head in frontal view; b) female head in posterior view; c) male head in frontal view; d) female antenna; e) male antenna; f) male head in dorsal view; (g) female head in dorsal view. F1 = first flagellomere.

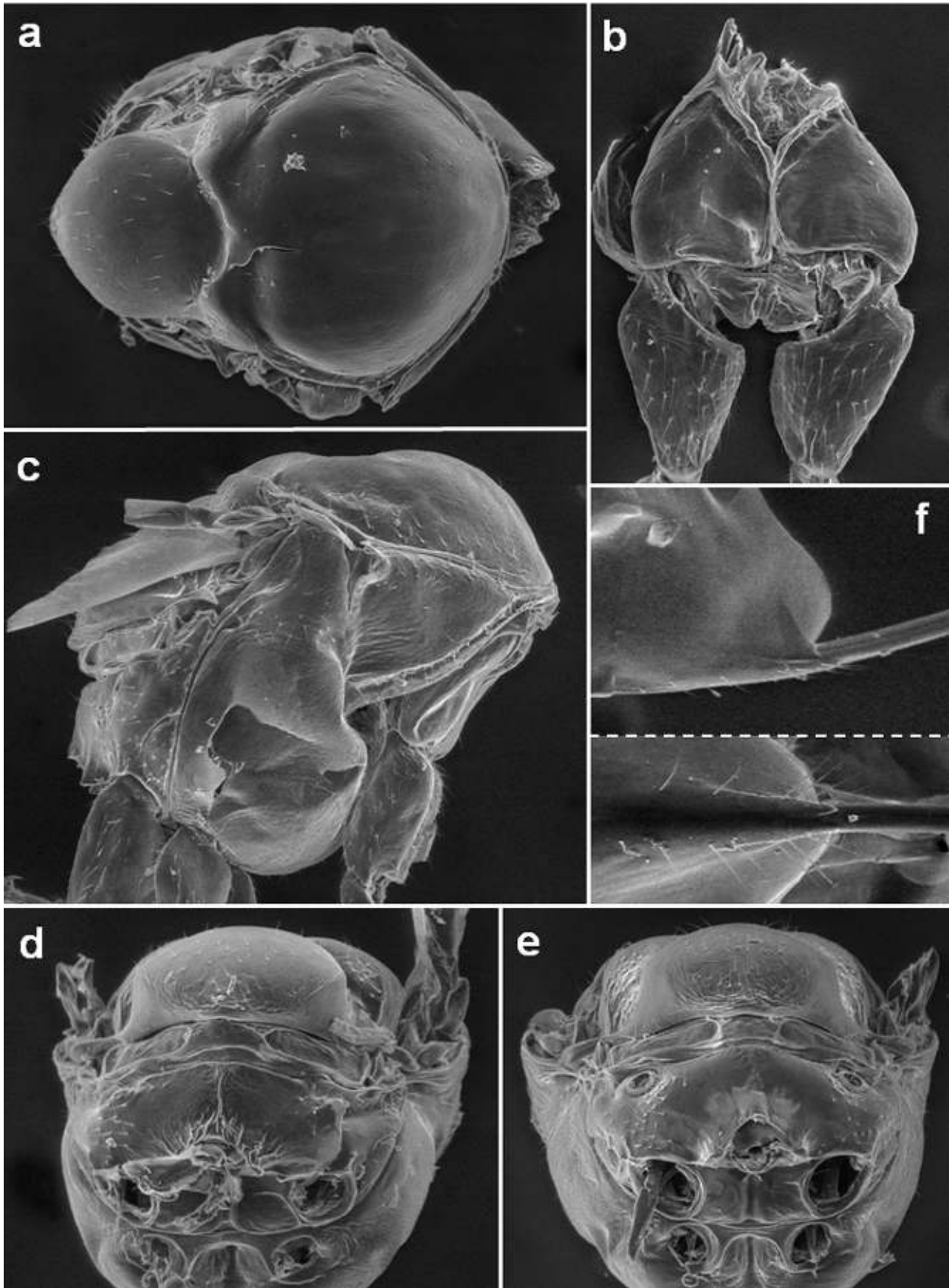


Figure 2. *Neuroterus chinanteco* n. sp.: a) female mesoscutum in dorsal view; b) propleuron female; c) mesoscutum in lateral view; d) female propodeum; e) male propodeum; f) ventral spine in lateral and ventral view.

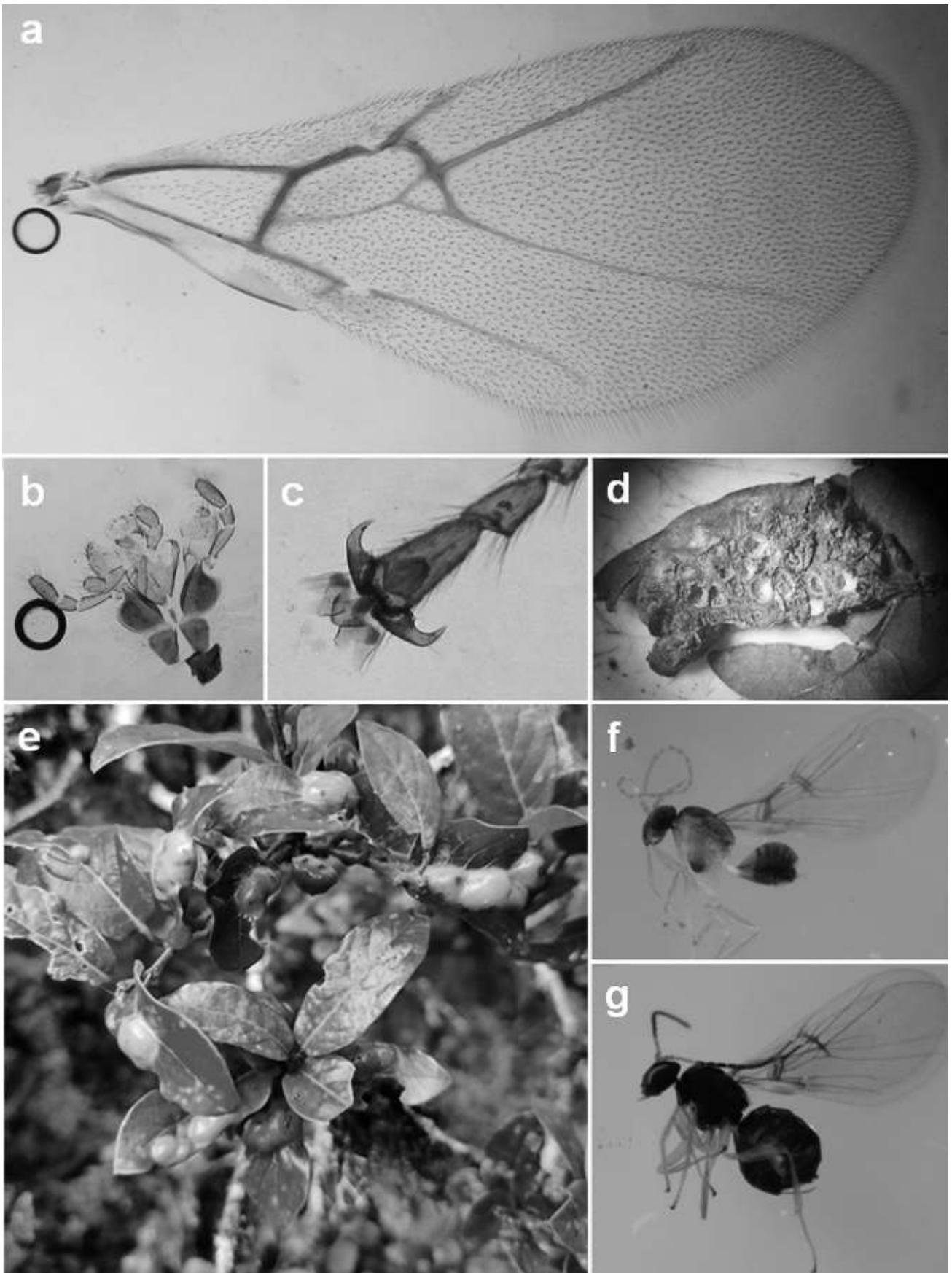


Figure 3. *Neuroterus chinanteco* n. sp.: a) fore wing; b) maxillar and labial palps; c) tarsal claws; d) dissected gall; e) galls on *Q. macdougalii*; f) male habitus; g) female habitus.

diameter of ocellus in *P. fusifex*), F1 not broadened distally (slightly broadened distally in *P. fusifex*), F1 is 3.1× as long as pedicel (2.4× in *P. fusifex*).

Etymology

The name «*chinanteco*» is a noun in apposition, invariable, referring to the language spoken by the indigenous community where the galls were collected (Santiago Comaltepec, Oaxaca, México).

Description. Sexual female.

Length

1.6–2.2 mm (n=20).

Colour (Fig. 3g)

Body dark brown to black. Head and mesosoma chestnut brown to black; metasoma lighter. Mandibles yellowish, with darker tooth. Antenna brown, except yellow scape, pedicel and F1. Tegula light brown. Legs yellow except last tarsomere. Wing veins brown.

Head (Fig. 1a-b, 1g)

Around 2.8× as wide as long from above, 1.2× as wide as high in front view and as wide as mesosoma. Lower face alutaceous, with sparse setae, without striae radiating from clypeus. Gena not broadened behind eye, around 0.7× as wide as transverse diameter of eye; malar space very short 0.2× as long as eye height, malar sulcus present. Ocellar area not elevated; POL:OOL:LOL equal 36:30:14, lateral ocellus 10. Transfacial distance 1.1× as long as height of eye; diameter of torulus (including rims) slightly longer than distance between toruli (15:13), distance between torulus and inner margin of eye longer than diameter of torulus (22:15); inner margins of eyes slightly converge ventrally. Clypeus trapezoid, alutaceous centrally, smooth laterally, ventrally almost straight, without median incision; anterior tentorial pits present, epistomal sulcus distinct, clypeo-pleurostomal line inconspicuous. Frons, vertex and interocellar area alutaceous-imbricated, shiny and glabrous. Occiput and postgena alutaceous-imbricated, with sparse setae. Postocciput around occipital foramen impressed, alutaceous, glabrous; posterior tentorial pits relatively large and oval; hypostomal carina emarginate, gular sulcus absent; occipital foramen shorter than height of postgenal bridge.

Antenna (Fig. 1d)

Antenna longer than head+mesosoma and shorter than body, with 13 antennomeres; pedicel 1.6× as long as wide; F1 slightly curved, 2.2× as long as pedicel; F2 straight; F3–F11 nearly subequal; F1 slightly shorter than scape+pedicel (37:40) and 1.7× as long as F2; antennal formula: 20: 18: 37: 22: 20: 19: 19: 19: 19: 19: 17: 15: 23; placodeal sensilla on all flagellomeres, less numerous on F1.

Mesosoma (Figs 2a-d)

Around 1.1× as long as high in lateral view, glabrous. Pronotum shiny, alutaceous, laterally with few carinae along posterior margin. Propleuron with weak sculpture, alutaceous-imbricate. Mesoscutum as long as wide in dorsal view,

weakly alutaceous, with very few sparse setae anteriorly and laterally. Notaulus absent, anterior parallel and parapsidal lines absent. Parascutal carina reaching the anterior part of the mesoscutum, mesoscutum emarginate and elevated postero-laterally, fused with mesoscutellum. Mesoscutellum weakly alutaceous laterally and posteriorly, almost smooth centrally, around 0.6× as long as mesoscutum, slightly longer than broad (10:9), very slightly overhanging metanotum, with some sparse short setae, rounded posteriorly; mesoscutellar foveae in a form of anterior superficial mesoscutellar depression, shiny. Mesopleuron and mesopleural triangle alutaceous with some weak carinae, almost without setae; axillula alutaceous, glabrous; subaxillular bar smooth, shiny, very wide posteriorly; postalar process absent; metapleural sulcus reaching mesopleuron at 1/2 of its height, dorsal part of sulcus absent. Metascutellum smooth, subrectangular. Metanotal trough alutaceous to smooth, with some longitudinal carinae, glabrous; ventral impressed area very short, smooth. Propodeum alutaceous, glabrous, with some setae laterally; posterolateral process absent; propodeal spiracle big; propodeal carinae absent, but with some basal weak rugae next to nucha and with a median longitudinal carina. Nucha short alutaceous to smooth with carinae.

Legs

Tarsal claws with a short tooth associate with a single seta (Fig. 3d).

Forewing (Fig. 3c)

Longer than body (6:5), transparent, with brown veins, with cilia on margins, without dark spots; radial cell around 4.5× as long as wide; 2r slightly curved; R1 not reaching wing margin; Rs conspicuous, straight, not reaching forewing margin and not project parallel to margin; areolet present, triangular; Rs + M reaching basal vein in posterior 1/3 of its height.

Metasoma (Figs 2f, 3g)

Shiny, shorter than head + mesosoma, slightly longer than high in lateral view, second metasomal tergum smooth, with very few sparse setae laterally; subsequent terga without setae, smooth and shiny. Prominent part of ventral spine of hypopygium short, tapering to apex, around 2.0× as long as wide, with very few long sparse setae laterally which extend beyond apex of spine but not forming a tuft.

MALE (length 1.4-2.2 mm; N = 15)

Similar to female except in: body lighter (Fig. 3f); antennae lighter, all flagellomeres yellowish to light brown; metasoma yellowish, mesoscutum brown, yellowish basally, next to transscutal articulation, mesopleuron black inferiorly; malar space slightly shorter (0.15× as long as eye height), transfacial distance shorter, 0.9× as long as height of eye (Fig. 1c); ocellar area strongly elevated (Fig. 1c); POL:OOL:LOL equal 35:16:13, lateral ocellus 14 (Fig. 1f); antenna as long as body, with 14 segments (Fig. 1e), F1 slightly curved and not broadened distally, 3.1× as long as pedicel and 1.7× as long as F2; antennal formula 13: 11: 35: 20: 19: 18: 18: 18: 18: 18: 16: 16: 15: 17; mesoscutum alutaceous, more conspicuous than in female; propodeum with-

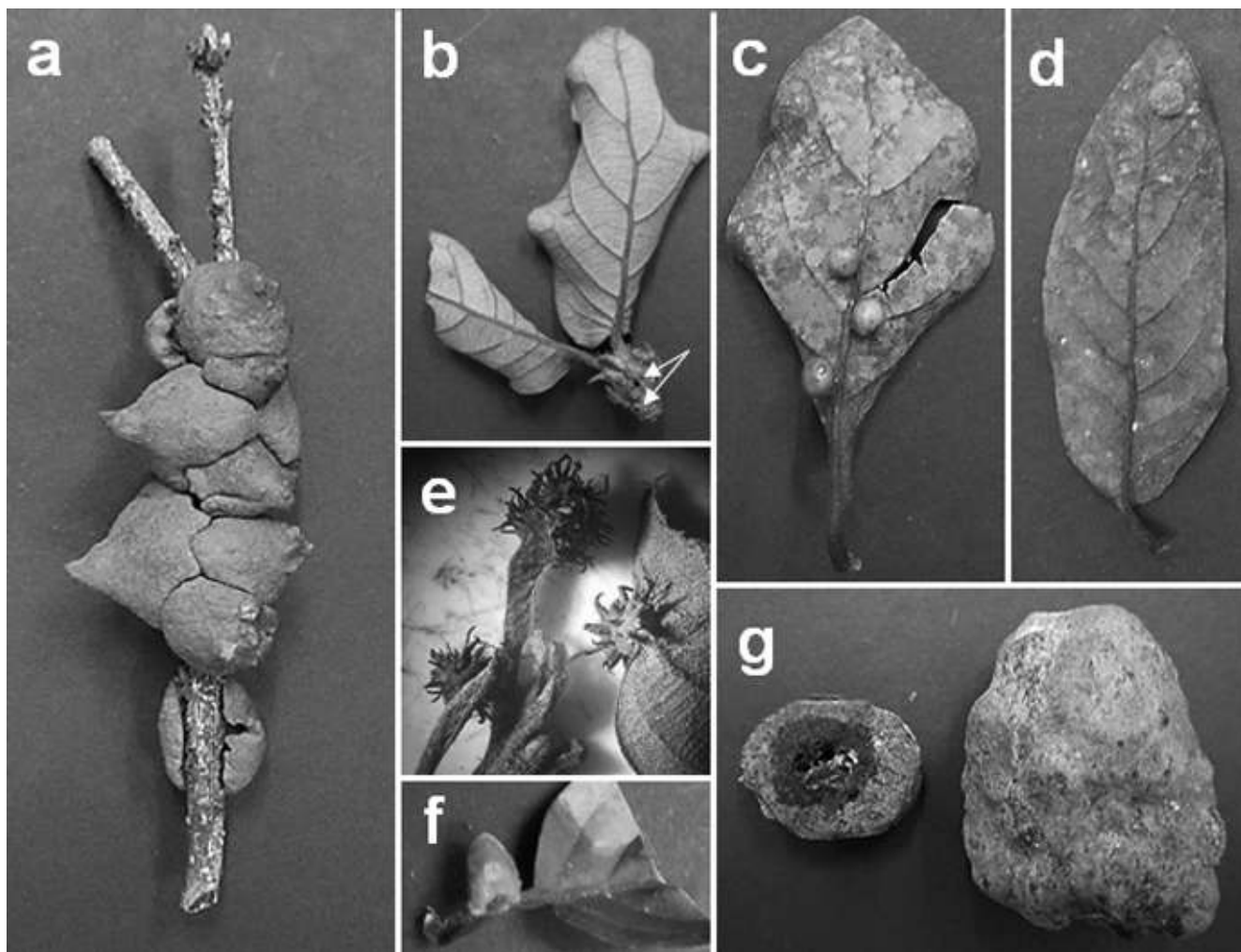


Figure 4. Different undescribed galls found on *Q. macdougalii*: a) *Disholcaspis* sp.; b) probably *Andricus* sp., sexual generation; c) near *Disholcaspis*; d-f) unknown; g) *Andricus* tuberous group.

out median longitudinal carina, without basal carinae (Fig. 2e); nucha without carinae (Fig. 2e); metasoma with long (Fig. 3f).

Gall (Figs 3d-e)

Multilocular gall, ovoid (4-17 mm long and 3-7 mm wide), located aside the leaf midrib, occupying a greater area with the increase in larval chambers, deforming both the upper and lower part of the leaf. Green in colour when young, turning yellowish or yellowish-red when mature. The surface is smooth and shiny, without pubescence. Inside the numerous rounded larval chambers (0.7-0.9 mm in diameter) are closely disposed one to another, with a hard tissue between chambers. The space between larval chambers almost does not exist.

Host plant

Quercus macdougalii Martínez (section *Quercus*) endemic in Oaxaca (Mexico).

Distribution

Mexico (El Mirador, Santiago Comaltepec, Oaxaca).

Biology

Only the sexual generation is known. The galls appear in

May-June on leaves. Adults emerge in late June to late August. The galls remain on the tree for several months after the emergence of adults. These galls are highly attacked by lethal inquilines and parasitoids (73 %), having obtained multiple specimens from inquilines of the genus *Synergus* Hartig, 1840 (Cynipidae: Synergini), as well as parasitoids mostly from the family Eulophidae (Chalcidoidea) and few specimens of *Eurytoma* Illiger, 1807 and *Sycophila* Walker, 1871 (Eurytomidae, Chalcidoidea).

Discussion

Neuroterus chinanteco produces leaf galls, morphologically and chromatically very similar to *N. fusifex*, which produces galls on catkins. In fact, at first we thought that the adults obtained from the leaf galls collected on *Q. macdougalii* corresponded to *N. fusifex*, since in the Western Palearctic there is one species, *N. quercusbaccarum* (Linnaeus, 1758), known to induce galls both catkins and leaves. The only significant difference, insufficient from our point of view to consider it as a valid species, was chromatic; females emerged from leaf

galls of *Q. macdougallii* and have no brown spot on the femur of the hind legs as in *N. fusifex*; males have no three spots on the mesoscutum as *N. fusifex* males (they have a single big band). A more detailed examination showed that these specimens could be separated by other minor characters (see diagnosis), and finally the difference in the number of segments of the labial and maxillary palps confirmed unequivocally that they are different species.

Oaxaca presents both species; *N. fusifex* on *Q. obtusata* according to Martínez-Romero *et al.* (2022) and *Q. glaucoides* (new record) while *N. chinanteco* only on *Q. macdougallii*. The appearance of galls and the emergence of adults are different in both species. The galls of *N. fusifex* appear in April on catkins and the adults emerge in late April till early May, while the galls of *N. chinanteco* appear by the end of May till June and the adults emerge from the end of June till the end of August.

Quercus macdougallii is a rare oak endemic to Oaxaca (located between 2800-3000 m a.s.l.), endangered (included in the IUCN Red List). *Neuroterus chinanteco* is the first species mentioned on this oak, but it is not the only gall we collected (Fig. 4). Unfortunately, we did not obtain Cynipini adults from these other morphologies, only parasitoids and/or inquilines. However, these collections confirm that *Q. macdougallii* has a complex of associated gall species that has yet to be described.

In Mexico the section *Quercus* (white oaks) of oaks is represented by 77 species (Valencia-A, 2004), while cynipid galls were found only on 37 of them (if we include *Q. macdougallii*). Moreover, the total number of oak species in Mexico exceeds 160, of which more than half (86) are endemic, with more than 200 Cynipini species described (Martínez-Romero *et al.*, 2022), than we can conclude that there are still many species to be described. We estimate that the number of species in Mexico could approach to the 1000 species if we consider that almost 500 species of Cynipini are known in northern Mexico (Burks, 1979) in a diversity of oaks close to 90 species (Nixon, 2008).

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