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Description of *Torymus lasallei*, sp. nov. (Hymenoptera: Torymidae), a species with an unusual ovipositor

Kristýna Bubeníková^a, Juli Pujade-Villar^b and Petr Janšta^a

^aFaculty of Science, Department of Zoology, Charles University, Prague, Czech Republic; ^bDepartment of Evolutionary Biology, Ecology and Environmental Sciences, University of Barcelona, Barcelona, Catalonia

ABSTRACT

Torymus lasallei, sp. nov., a species with an unusual ovipositor, reared from galls of *Amphibolips* spp. (Hymenoptera: Cynipidae) on *Quercus* spp. (*Lobatae* section) from Mexico, is described. The placement of this new species within the genus *Torymus*, and the morphology and function of its ovipositor, are discussed.

<http://www.zoobank.org/urn:lsid:zoobank.org:pub:0B9F9B11-DD95-465D-A98C-53742A8099CC>

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Chalcidoidea; Toryminae; Torymini; *fullawayi* species group; parasitoid of Cynipidae

Introduction

Torymus is the most species-rich genus of the family Torymidae (Hymenoptera: Chalcidoidea). Currently, there are more than 380 species described (Matsuo 2020), and species are known from all geographical regions except Antarctica (Noyes 2019). Most of the species are ectoparasitoids of final-instar larvae of Cynipidae and Aculeata (both Hymenoptera) and Cecidomyiidae (Diptera). Several subgenera and species groups have been proposed within the genus (Grissell 1976; Graham and Gijswit 1998; Zavada 2003; Zerova and Seryogina 2003), and some genera have been repeatedly synonymised with *Torymus* (Graham and Gijswit 1998; Janšta et al. 2018). However, almost all aforementioned studies have been conducted based on morphology only. Recently, Janšta et al. (2018) studied the genus using molecular markers, and showed that the subgeneric and infrageneric classification of *Torymus* is not so clear. They proposed that *Torymus*, as currently defined, is a polyphyletic group within Torymini, evolving at least three different clades independently. However, this study has not yet resulted in any taxonomic changes, as further detailed examination, and a broader, more even taxon sampling from all the areas of distribution is required. Examination of more samples from the New World region could clarify the phylogenetic relationships.

The aim of this study is to describe a new species of the genus *Torymus* from Mexico, which has an extraordinary external morphology of the ovipositor. The species has been reported as a parasitoid of an oak gall wasp, and apparently belongs to the New World clade of *Torymus*, in the *fullawayi* species group. This species was previously mentioned in Flores-Mercado et al. (2019) as *Torymus* sp. nov., in a study of entomofauna associated with galls on *Quercus*

crassipes. However, a very similar species (mentioned as *Torymus* sp. 1 and reared from *Amphibolips castroviejoi* (Medianero and Nieves-Aldrey, 2010) was recorded by Sánchez et al. (2013) from Panama. It could actually be the same species based on the habitus image (Sánchez et al., 2013: Figure 3j) including the basal part of a heavily pubescent ovipositor, one of the main diagnostic characters of the new *Torymus* described herein.

Material and methods

All specimens were stored in 96% alcohol and most of them were mounted. DNA of two specimens (females PJ17056_0101 and PJ17056_0102) was extracted 'non-destructively' using the DNeasy Blood & Tissue Kit from Qiagen (Cruaud et al. 2019). One female (PJ17056_0102) was successfully sequenced for the COI barcode fragment using MChaf1 (5'-CCT CGA ATA AAT AAT ATA AGA TT-3') and HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3') primers (Fusu and Polaszek 2017), which was amplified under the following conditions: 2 min at 94°C followed by 40 repeats of 94°C for 30 s, 44°C for 120 s and 72°C for 30 s, then a final elongation step for 10 min at 72°C (Fusu and Polaszek 2017). Editing of sequences was done using Geneious Prime 2019.2.1 (Biomatters Ltd.). The COI sequence of the species described herein is deposited at the National Center for Biotechnology Information (NCBI) under the accession number (MT416480). A second female (PJ17056_0101) was sequenced for anchored hybrid enrichment (AHE) following the protocol of Baker et al. (2020), and those results will be published elsewhere.

Terminology of morphological structures in this study mostly follows Gibson et al. (1997) and Janšta et al. (2016), except as follows: Cl₂₋₃ = claval segment 2–3 (3 = most apical). Terms for surface sculpture follow Harris (1979). Photographs were taken using a Leica Imaging System with a Z16 APO A microscope and stacked using Zerene Stacker (version 1.04, ©Zerene Systems, LLC). All photographs were then digitally optimised (artefact removal, background standardisation) using Corel Photo-Paint 2019 and built in plates in CorelDRAW 2019.

Collection abbreviations used are:

CUPC: Charles University in Prague, Faculty of Science, Department of Zoology, Prague, Czech Republic.

UB: University of Barcelona, Department of Department of Evolutionary Biology, Ecology and Environmental Sciences, Barcelona, Catalonia.

Results

Torymus lasallei Bubeníková, Pujade-Villar and Janšta, sp. nov. (Figures 1–3)

Diagnosis. Head transverse, 2.2–2.3× as broad as long; ocelli large, POL 1.8–2.0× OOL, OOL 1.1× LOD; clypeus with anterior margin broadly bilobed; funicular 'segments' (antennomeres) elongate, about 1.5× as long as broad; frenum present, weakly costulate; frenal line developed only laterally, reaching to about 1/3 of metascutellum breadth; propodeum with complete median carina and submedian fovea apically; hind coxa carinate and dorsally setose; metafemur with conspicuous subapical tooth; wings slightly infumate,

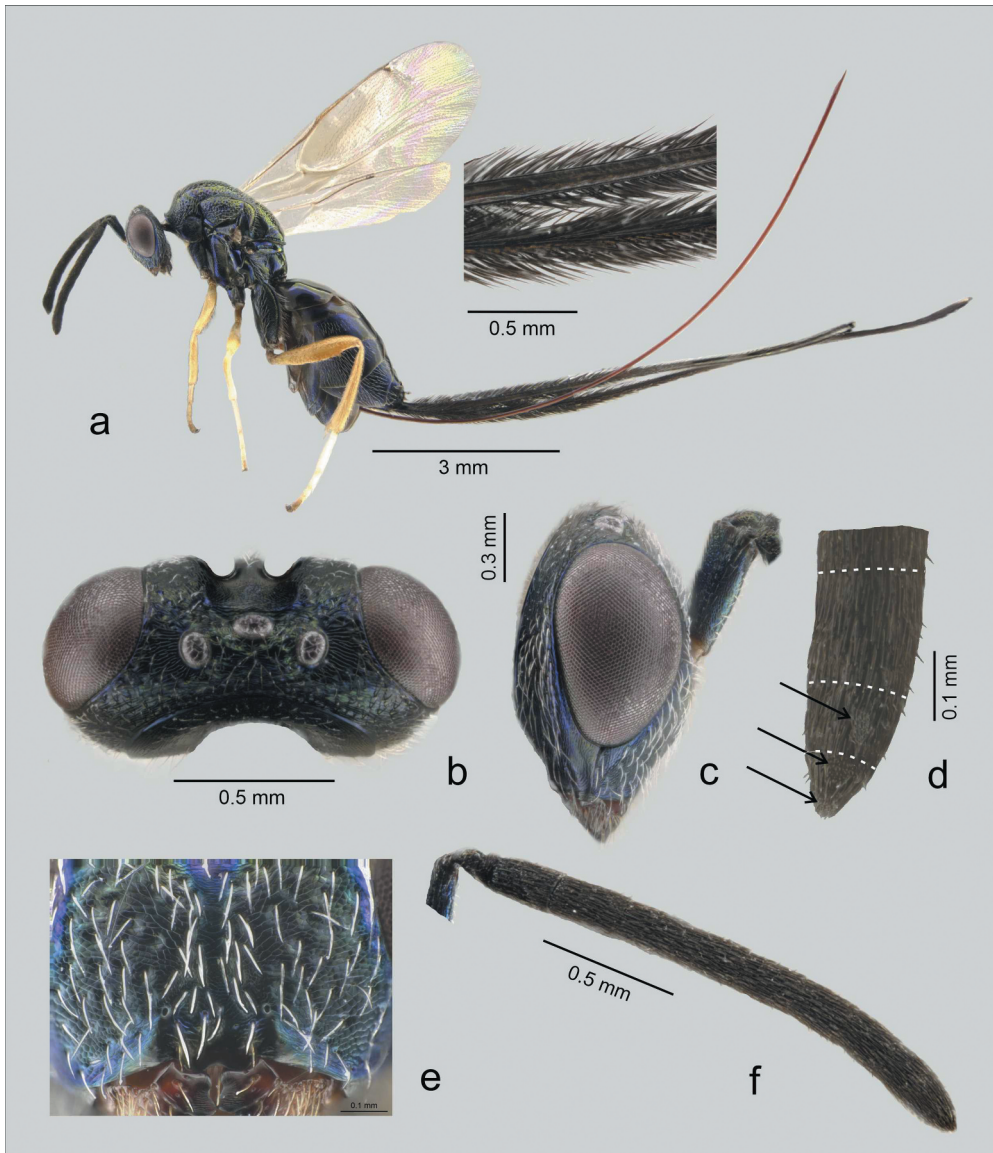


Figure 1. (a–f) *Torymus lasallei*, holotype female. (a), habitus, lateral (inset - detail of ovipositor setation); (b), head, dorsal; (c), head, lateral; (d), antennal clava, arrows indicate micropilosity areas; (e), head, detail of lower face; (f), antenna, lateral.

most distinctive on costal cell, beneath and along cubital setal line, and on speculum extending to stigmal vein and with narrow brown stripe in medial part of posterior margin of fore wing; Gt1–Gt4 incised medially; Gt1 strongly emarginate mediolaterally; Gt5 slightly emarginate medially; tip of hypopygium almost reaching apex of gaster; ovipositor sheaths covered by conspicuously long brown setae in their basal two-fifths.

Description. Female. Body length excluding ovipositor 5.3–6.9 mm; length of ovipositor 10–15.4 mm. Colour. Funicle and clava dark brown to black with dark brown setation. Head, scape, pedicel, mesosoma including all coxae, and metasoma dark with metallic blue, violet, and green reflections; green reflection more apparent on mesosoma laterally and dorsally. All coxae, tibiae, and tarsi yellow except yellow-brown apical part of metabasitarsus; all claws and pulvilli dark brown. Body setation pale. Wing setation and venation brown, wings slightly infumate; infumation most distinctive on ‘costal cell’, beneath and along cubital setal line and on speculum extending to stigmal vein, slightly more brown around stigmal vein, and with narrow brown stripe in medial part of posterior margin of fore wing. Ovipositor sheaths dark brown, covered by brown setae, ovipositor stylets brown.

Head. Head 1.3–1.4× as broad as high; 2.2–2.3× as broad as long (Figure 1b,c); 2.0–2.3× as broad as mesonotum at its widest part in dorsal view. Temples short, strongly converging, one-fifth as long as eyes. Eye 1.4–1.5× as high as long. Head coriaceous with shallow setose punctations; setae thin, as long as diameter of torulus; punctations on vertex denser; scrobes more finely coriaceous, without setae. Clypeus with anterior margin broadly bilobed; lobes smooth and exerted relative to corners of oral fossa; rest of the clypeus and lower part of supraclypeal area densely reticulate, diameter of meshes of reticulation minute (Figure 1d). Malar space 0.4–0.5× as long as width of oral fossa and 0.3× as long as eye height; malar sulcus present in its entire length. Occipital carina present; dorsally arched, about 2× closer to posterior ocelli than to dorsum of occipital foramen, ventrolateral edge of occipital carina extending below dorsal margin of hypostomal foramen and not joining hypostomal carina above base of mandible. Antenna with scape and pedicel 4.1× and 1.2× as long as broad, respectively; the former reaching or almost reaching dorsal margin of anterior ocellus; lower margin of toruli above 1/3 eye height from ventral level of eye. Combined length of pedicel and flagellum 1.5× as long as width of head. Flagellum with one anellus; remaining flagellomeres distinctly elongated, with F7 the smallest, 1.3× as long as broad, F1–F6 between 1.4× and 1.7× as long as broad (Figure 1e); micropilosity area on clava divided into three minute parts, placed ventroapically and ventrodistally on Cl₃ and ventrodistally on Cl₂ (Figure 1f). POL 1.8–2.0× OOL, OOL 1.1× LOD.

Mesosoma. Mesosoma 1.8–2.0× as long as broad (Figure 2a,b). Pronotum in dorsal view 0.7–0.8× as broad as mesoscutum. Mesoscutellum 1.2–1.3× as long as broad (Figure 2c). Collar of pronotum, mesoscutum and metascutellum weakly rugose and foveolate; foveoles hairy; their distance about 2 times and length of hairs about 2–3 times foveoles’ diameter; posterior part of mid lobe mesoscutum and metascutellum, except central part of metascutellum anterior to frenal line, more densely foveolated; distance between foveoles up to their diameter. Frenum weakly costulate; frenal line present only laterally reaching to about 1/3 of its breadth; metascutellum rim complete, punctulate in its entire length. Notauli deeply impressed; their distance anteriorly about 0.8–0.9× pronotum breadth and posteriorly about 0.5–0.6× metascutellum breadth. Propodeum delicately costulate with complete median carina and submedian fovea apically (Figure 2c). Mesotibia 2.1–2.4× as long as mesobasitarsus length. Hind leg with coxa carinate and hairy dorsally, alutaceous, 2.1–2.3× as long as broad; metafemur 4.4–4.5× as long as broad, with conspicuous subapical tooth; metatibia 6.2–6.9× as long as broad;

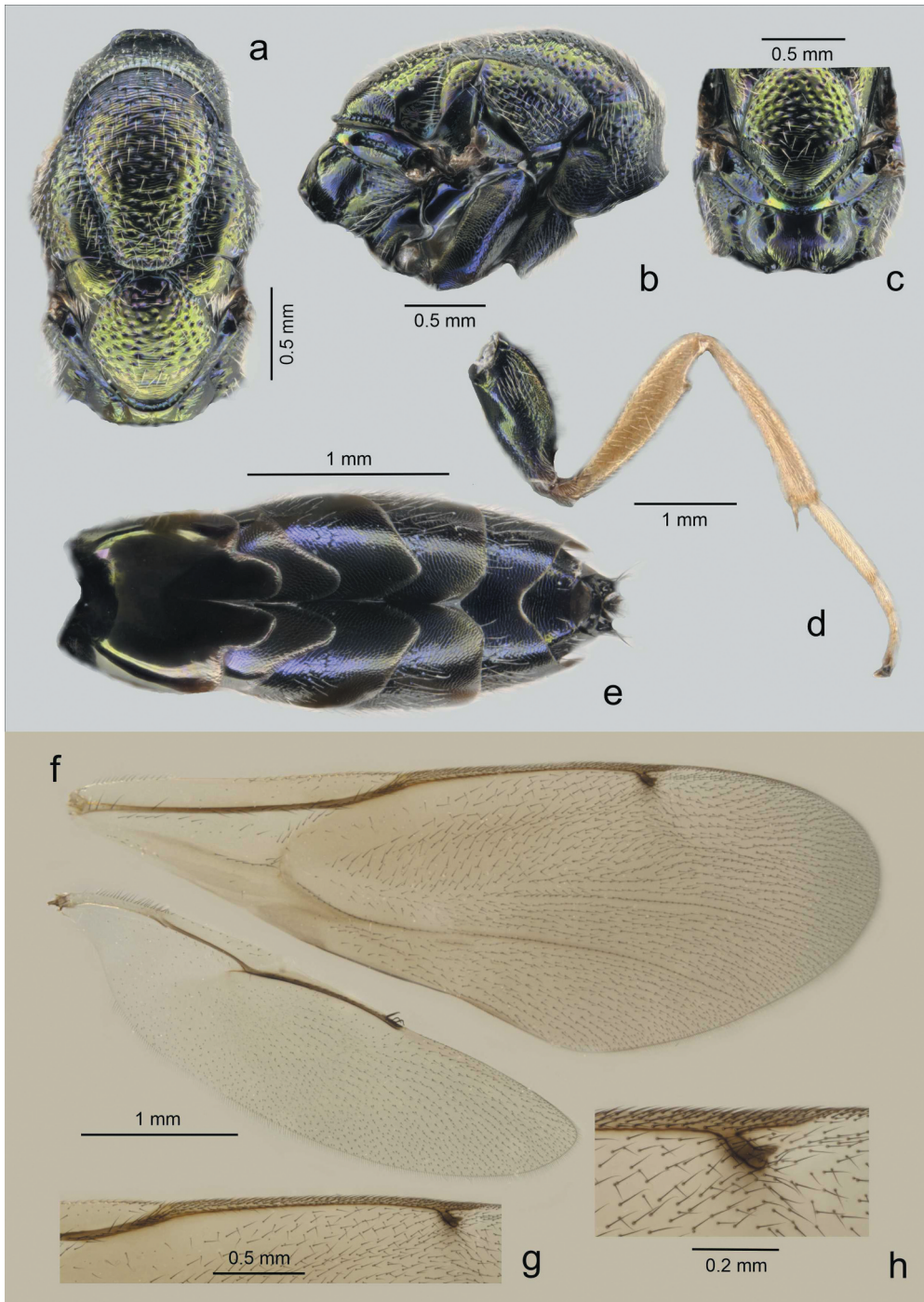


Figure 2. *Torymus lasallei*, holotype female (a–c, e–h), paratype female (d). (a), mesosoma, dorsal; (b), mesosoma, lateral; (c), metascutellum and propodeum, dorsal; (d), left hind leg, outer aspect; (e), metasoma, dorsal; (f), right wings, dorsal; (g), part of submarginal, marginal, postmarginal and stigmal vein, dorsal detail; (h), part of marginal, postmarginal and stigmal vein, dorsal detail.

metabasitarus 1.8–2.0× as long as metatibia (Figure 2d). Fore wing 3.1–3.3× as long as wide; speculum narrow, reaching anterior part of marginal vein; costal cell dorsally with one incomplete row of setae along apical third of anterior margin, ventrally with one row of setae in basal third and one to three incomplete rows of setae along apical third of anterior margin of cell; basal and cubital cells almost bare; basal setal line complete; cubital setal line incomplete with setae only in apical half (Figure 2f); marginal vein 6.2–7.3× as long as postmarginal vein (Figure 2g) and 10.9–11.8× as long as stigmal vein (Figure 2i).

Metasoma. Metasoma 2.5–2.6× as long as broad (Figure 2e). Petiole very short, strongly transverse. Gaster with Gt1 almost smooth, at most very shallowly, delicately alutaceous; other tergites alutaceous; Gt1–Gt4 incised medially; Gt1 strongly emarginated mediolaterally; Gt5 slightly emarginated medially (Figure 2e); tip of hypopygium almost reaching apex of gaster (Figure 1a). Ovipositor 1.9–2.2× as long as body; OI (ovipositor index) = 6.6–7.1; ovipositor conspicuously hairy in basal third to two-fifths; hairs about as long as breadth of ovipositor sheath (Figure 1a – detail).

Variation. There is not much variation except what is mentioned above. Some females are more violet on the surface of the metascutellum and propodeum.

Male (N = 2). Length of body 2.1–2.6 mm. Similar to females except as follows: Head and mesosoma, entire coxae, femora and metatibia, and fore- and mesotibia medially dark with mostly metallic blue-green reflections; metasoma dark with metallic purple-blue-green reflections; basal part of femora and apical parts of femora and tibiae yellow. Funicular segments elongate, but broader than in females; relative measurements are: anellus 5:2, F1 13:8, F2 15:8, F3 13:8, F4–F6 12:8, F7 12:8.5, clava 23:9; no visible area of micropilosity on clava.

Type material. Holotype female (deposited in CUPC) with the following labels: 'MEXICO, Estado de México, San Felipe del Progreso, Rancho la Concepción, ex galls of *Amphibolis hidalgoensis* on *Quercus conspersa*, (14.vii.2016) 3.iv.2017 (Moemí Flores leg., ref. 3B1), PJ17056_0101'. Paratypes. Same data as holotype except: '24.ii.2017 (ref. 8B6), 1♂ (UB)'; '7. ix.2016 (ref. 8A1), on *Q. crassipes*, 1♀ (UB)'; '21.ix.2016 (ref. 8A1), 1♀ (UB)'; '28.x.2016 (ref. 10A13), PJ17056_0102, 1♀ (CUPC)'; '31.x.2016 (ref. 2A3), 1♀ (UB)'; '10.iii.2017 (ref. 10A12), PJ17056_0103, 2♂♂ (CUPC)'; '20.iii.2017 (ref. 8A2), 1♂ (UB)'. 'MEXICO: Estado de Tlaxcala, Tlaxco, ex galls of *A. hidalgoensis* on *Q. conspersa*, (19.vi.2018) 1–15.vii.2018, 1♀ (UB) (Pujade-Villar and Equihua leg, ref. 334)'; 'Estado de Puebla, Aquixtla, Ctra. Aquitsla-Chichicaxtla, ex galls of *A. hidalgoensis*, *Q. crassifolia* (16.vi.2018) 16–30.vi.2018, 2♀♀ (UB) (Pujade-Villar leg, ref 353)'; 'Estado de Zacatecas, Monte Escobedo, ex galls of *A. zacatecaensis* on *Q. eduardi*, (31.v.2012) viii.2012, 1♀ (UB) (C. Carrillo leg, MEX 277)'; 'Estado de Morelos, San Felipe Neri, ex galls of *Amphibolips* sp on *Quercus* sp. (29.v.2012) viii.2012, 1♀ (UB) E. Estrada and A. Equihua leg. (ref. 278)'.

Additional material. The second author has examined several images of females (Figure 3) belonging to this species that were collected by Leticia Valencia in the Parque Ecológico El Huixteco (Guerrero State, Mexico) on *Q. castanea* from *Amphibolips* nr *hidalgoensis* galls.



Figure 3. *Torymus lasallei*, female. Habitus of female collected in Parque Ecológico El Huixteco (Guerrero State, Mexico) on *Quercus castanea* from *Amphibolips* nr *hidalgoensis* galls (photo by Leticia Valencia).

Etymology. Named in honour of our colleague Dr John La Salle.

Holotype condition. Holotype female HMDS (hexamethyldisilasane) dried and glued by left side on grey triangular card; right wings detached and glued on rectangular card placed below.

Distribution. Mexico (Central Mexico region: in Guerrero, Mexico, Morelos, Puebla, Tlaxcala and Zacatecas states).

Biology. All specimens studied were reared from galls of *Amphibolips hidalgoensis* and *A. zacatecaensis* (Cynipidae) on *Quercus acutifolia* Née (= *Q. conspersa* Benth.), *Q. castanea* Née, *Q. crassipes* Humb. and Bonpl., *Q. crassifolia* Humb. and Bonpl. and *Q. eduardi* Trel., all of them belonging to the *Lobatae* section.

Taxonomic remarks. Morphology as well as AHE results (unpublished) place this species within the *Torymus fullawayi* species group. This group is characterised by rugose to granulose mesosoma dorsally, with occasional large foveae (punctures *sensu* Grissell 1976), denticulate metafemur and foveated propodeum. The *fullawayi* species group was considered for a long time to be closely related to *Diomorus*, another genus with denticulate metafemur (Grissell 1976). However, Janšta et al. (2018) showed this group to be more closely related to other Nearctic species of *Torymus* rather than to *Diomorus*, even if sampling in this study is not dense enough and statistical support is not high in all nodes. Denticulation on the metafemur within *Torymus* outside the *fullawayi* group is

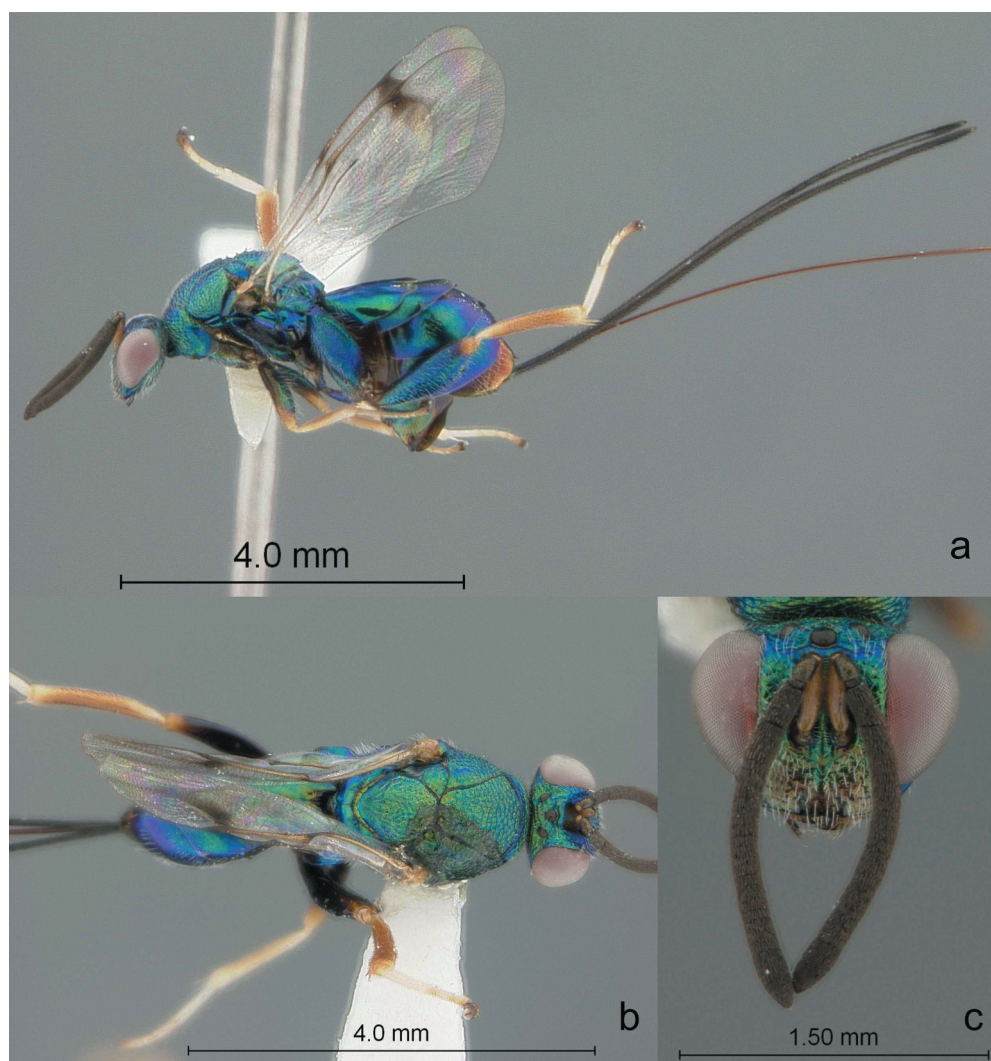


Figure 4. (a–c) *Torymus texanus*, female. (a), habitus, lateral; (b), habitus, dorsal; (c), head, anterior.

quite rare (known only in *T. kononovae* Zerova and Seryogina 1991, so far); however, some nonrelated genera of Torymini (*Diomorus*, *Ecdamua*, *Mesodiomorus*, *Nannocerus*, *Physothorax*, *Plesiostigmodes*) have it (Bouček 1988; Janšta et al. 2018) and, therefore, denticulation of the metafemur is rather homoplastic.

In the key of Grissell (1976), *T. lasallei* would key out to *T. texanus* (Hoffmeyer, 1930, couplet 1, p. 40), which is the most similar (Figure 4a–c) species but differs in colouration, wing pattern, and having long conspicuous setae along basal third to two-fifths of the ovipositor sheath. As well as other species of the *fullawayi* group, *T. lasallei* has been reported as a parasitoid of gallmaker larvae. Nevertheless, the two species of *Amphibolips* from which *T. lasallei* has been obtained cause galls with a loose spongy tissue, giving a soft touch to the gall, unlike other species with similar galls in which the spongy tissue is dense and thus the galls are hard as in *A. tarasco* (Nieves-Aldrey and Pascual, 2012). This

suggests that *Torymus lasallei* also occurs in *A. dampfi* (Kinsey, 1937) causing a very soft gall. Further, *Torymus* sp. 1 (Sánchez et al. 2013), probably conspecific with *T. lasallei*, has been reared from *A. castroviejo*.

The long setation of the ovipositor sheath seems to be rare within Chalcidoidea. Only one other species has been described so far with a similarly formed ovipositor, *Critogaster pinnata* Mayr, 1906 (Pteromalidae: Sycoryctinae) from Brazil. The biology of *C. pinnata* is not clear, but it could be a parasitoid of *Tetrapus* (Agaonidae) pollinators associated with the *Ficus* subgenus *Pharmacosycea* (J.-Y. Rasplus, pers. comm.). According to images of *C. pinnata* (kindly sent to us by J.-Y. Rasplus), the ovipositor sheath of *T. lasallei* is not so broad, and setation is even longer basally. We also know of another type of appendages on the ovipositor sheath of the genus *Cameronella* (Pteromalidae: Colotrechninae) (Bouček 1988; Wang and Cook 2012), a parasitoid of gall-inducing scale insects of the genus *Apiomorpha* Rübsaamen, 1894 (Hemiptera: Eriococcidae). The ovipositor of *Cameronella* resembles the tail of a dart and is derived from the modified epipygium of the adult female. However, the function of dart-tail appendages of *Cameronella* and the function of setation in *T. lasallei* or *C. pinnata* are unclear.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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ORCID

Juli Pujade-Villar  <http://orcid.org/0000-0001-7798-2717>

Petr Janšta  <http://orcid.org/0000-0001-6409-3603>

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