Lithosaphonecrus puigdemonti sp. nov. from China (Hymenoptera: Cynipidae)

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Abstract: A new species of *Lithosaphonecrus* from China, *L. puigdemonti* Pujade-Villar **sp. nov.**, is described. A key to *Lithosaphonecrus* species is provided.

Key words: Synergini; *Lithosaphonecrus*; taxonomy; key

中国胸横刻瘿蜂一新种（膜翅目：瘿蜂科）

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摘要：记述中国瘿蜂科胸横刻瘿蜂属 1 新种：蒲氏胸横刻瘿蜂 *Lithosaphonecrus puigdemonti* Pujade-Villar **sp. nov.**，编制了该属种的检索表。

关键词：客瘿蜂族；胸横刻瘿蜂属；分类；检索表

Introduction

Gall wasps (Hymenoptera: Cynipidae) constitute one of the largest radiations of gall-inducing organisms with approximately 1400 described species (Liljeblad & Ronquist 1998; Ronquist 1999). Most species occur in temperate areas of the Holarctic Region and develop as gall makers on different host plants (Ronquist *et al*. 2015). But about 200 species are inquilines of galls induced mainly by woody rosid gallers within the Cynipidae (except for *Rhoophilus loewi* Mayr, 1881).

Inquilines of the tribe Synergini that attack galls initiated by Cynipini tribe (oak gall wasps) are *Agastoroxenia* Nieves-Aldrey & Medianero (Panama); *Saphonecrus* D.T. & Kieffer (Holarctic and Oriental region); *Synergus* Hartig (Holarctic, Neotropics and Oriental region); *Synophrus* Hartig (Western Palaearctic); and *Ufo* Melika & Pujade-Villar and *Lithosaphonecrus* Tang, Melika & Bozsó (Eastern Palaearctic and Oriental region). This tribe also includes *Rhoophilus* Mayr that occurs in galls induced by cecidosid moths (South Africa).

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Lithosaphonecrus Tang, Melika & Bozsó (= *Lithonecrus* Nieves-Aldrey & Butterill after Schwéger *et al*. 2015) is a genus recently described (see Bozsó *et al*. 2015) to include some inquilines obtained from Cynipini galls collected in *Lithocarpus* Blume and *Castanopsis* Spach. It is morphologically close to *Saphonecrus*, from which differs by having: 1) frons with irregular interrupted frontal carinae; 2) F1 very long (in female antenna 1.5–1.9 × longer than F2 and in male antenna 2.6–3.0 × as long as F2); and 3) syntergite 2 + 3 posteriorly punctate or reticulate, with a sculptured band extending at least 1/4–1/5 of the syntergite length, reaching the ventral edge of the tergite. Also, *Lithosaphonecrus* has the head round-shaped in frontal view; transverse from above, 1.8–2.3 × as wide as high; frons, vertex and occiput always sculptured (at least delicately coriaceous); interocellar triangle wide; in females, antenna with 11 flagellomeres and in males, with 13 flagellomeres; pedicel shorter than scapus and F2; anterior margins of pronotum rounded in dorsal view; radial cell of forewing always open; notauli complete, reaching pronotum, only very slightly wider posteriorly and with some parallel rugae on a smooth, shiny bottom; metapleural sulcus reaching mesopleuron in the upper 1/7 of its height; first metasomal tergite entirely sulcate; genae not broadened behind compound eyes in anterior view; tarsal claws simple.

Following the work of Bozsó *et al*. (2015), Nieves-Aldrey & Butterill (2014), Abe *et al*. (2014), Schwéger *et al*. (2015) and Yang *et al*. (2019), *Lithosaphonecrus* includes eight species: *L. formosanus* Melika & Tang, *L. huisuni* Tang, Bozsó & Melika and *L. dakengi* Tang & Pujade-Villar from Taiwan in *Lithocarpus* galls; *L. yunnani* Tang, Bozsó & Melika, *L. arcoverticus* Liu, Zhu & Pang and *L. decarinatus* Liu, Zhu, & Pang, from mainland China in *Lithocarpus* galls; *L. vietnamensis* (Abe, Ide, Konishi & Ueno) from Vietnam in *Castanopsis* galls and *L. papuanus* (Nieves-Aldrey & Butterill) from Papua New Guinea in *Lithocarpus* galls. Here, a new species captured using a sweeping net on vegetation is described.

Material and methods

We followed the terminology given in the following studies: Liljeblad & Ronquist (1998) and Melika (2006) for morphological structures, Ronquist & Nordlander (1989) for forewing venation terminology and Harris (1979) for patterns of cuticular sculpture. Measurements and abbreviations used herein are: F1–F13 — first and subsequent flagellomeres; POL (post-ocellar distance) — the distance between the inner margins of the posterior ocelli; OOL (ocellar-ocular distance) — the distance from the outer edge of a posterior ocellus to the inner margin of the compound eye; and LOL— the distance between posterior and frontal ocelli. The width of the forewing's radial cell is measured from the margin of the wing to the Rs vein.

SEM pictures were taken by the first author using a field-emission gun environmental scanning electron microscope (FEI Quanta 200 ESEM) for hard-resolution imaging without gold-coating the specimens, except for the dissected specimen. Optical images of the adult were taken by the third author using an Olympus SC30 camera, coupled to an Olympus U-CMAD3, adapted to a stereomicroscope Olympus SZX10 and combining multiple photographs with image processing using Helicon Focus 6.2.2.

The type material is deposited in the following institutions: UB (University of Barcelona) and ZAFU (Zhejiang Agricultural and Forestry University).

Taxonomy

***Lithosaphonecrus puigdemonti* Pujade-Villar sp. nov.** (Figs. 1–3)

Female. Body length: 1.8–3.0 mm (*n* = 4).

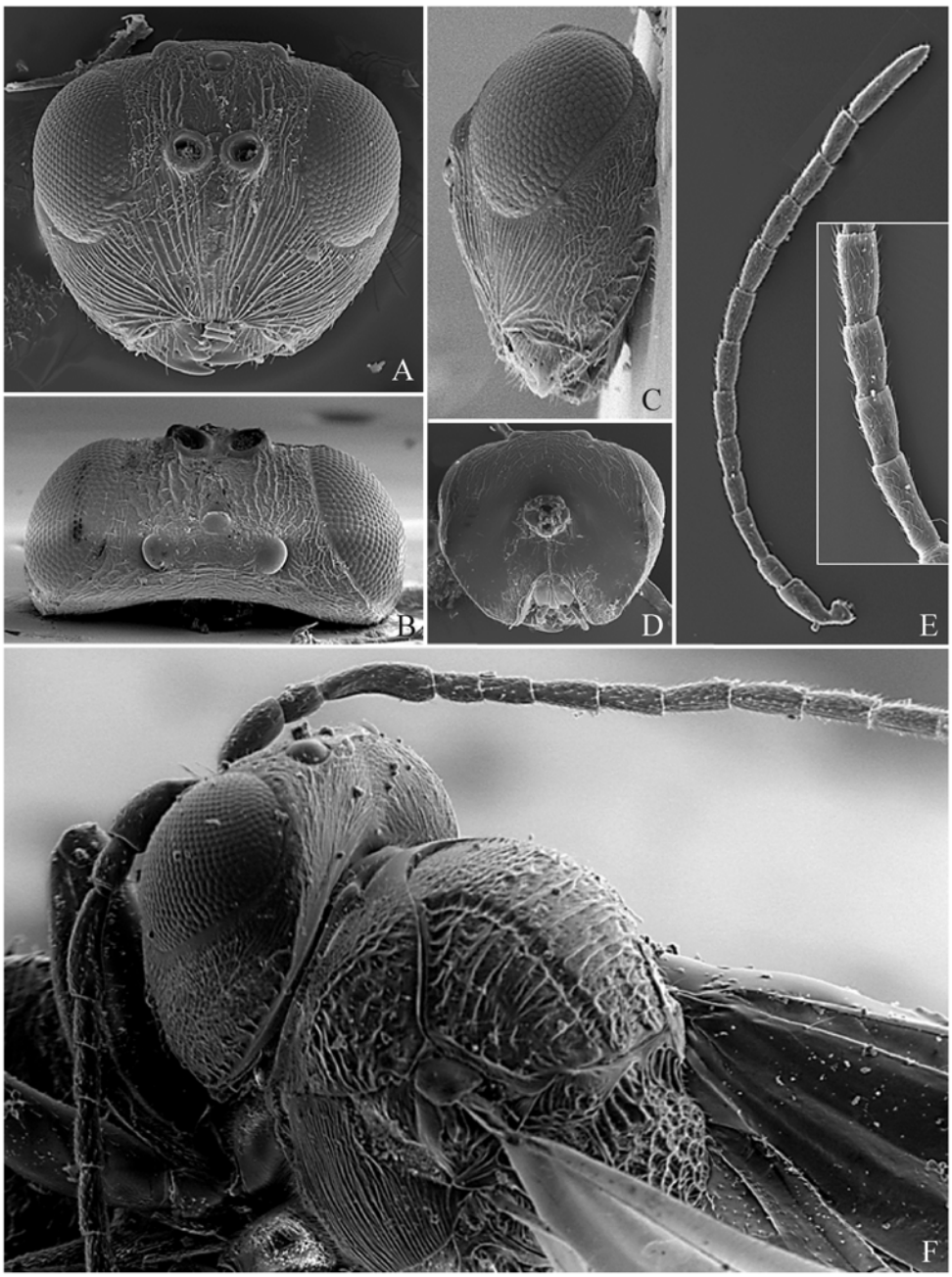

Figure 1. *Lithosaphonecrus puigdemonti* **sp. nov.** A. Head, frontal view (female); B. Head, dorsal view (female); C. Head, lateral view (female); D. Head, posterior view (female); E. Female antenna and detail of the first flagellomeres; F. Head and mesosoma, latero-dorsal view, including antenna (male).

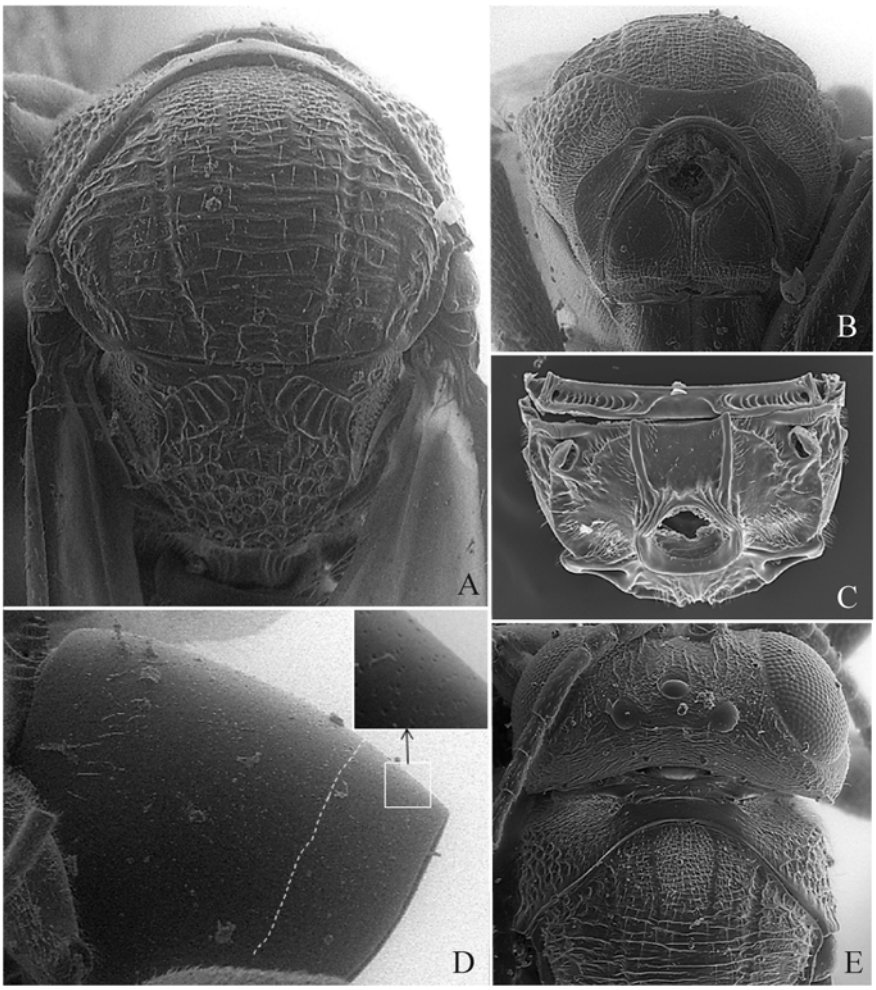

Figure 2. *Lithosaphonecrus puigdemonti* **sp. nov.** A. Mesosoma, dorsal view (female); B. Mesosoma, frontal view (female); C. Propodeum (female); D. Metasoma, lateral view (female); E. Head dorsal and mesosoma dorso-anterior view (male).

Color (Fig. 3A). Head and mesosoma dark, chestnut, face reddish brown and head posteriorly almost black; antennae uniformly testaceous; mandibles brown with black teeth; maxillar and labial palps yellowish; legs entirely and uniformly light brown; veins of wings pale, M and Rs+M veins hardly traceable; metasoma (including ventral spine and hypopygium) reddish brown to chestnut.

Head (Figs. 1A–D). Face with sparse white setae, only a few scattered setae. Head round-shaped, 1.2–1.3 × wider than high in anterior view; very slightly broader than mesosoma, 2.1–2.2 × wider than long in dorsal view. Clypeus inconspicuous, ventrally straight, not emarginated and with radiating striae; epistomal sulcus and clypeo-pleurostomal line indistinct; anterior tentorial pits small. Lower face with distinct delicate striae radiating from clypeus and extending into ventral margin of toruli and eyes; central elevated area indistinct, with striae reaching toruli. Transfacial distance equal to height of eye; distance between inner

margin of eye and antennal torulus slightly shorter than diameter of torulus; diameter of torulus 4.0 × longer than distance between them. Malar space around 0.5 × compound eye height, without malar sulcus, with numerous delicate striae radiating from clypeus and reaching eye. Genae not broadened behind compound eyes in anterior view, wide laterally, alutaceous-imbricate, with some subparallel interrupted striae radiating from malar space and reaching half the length of genae. Frons alutaceous-imbricate, shiny, with some irregular longitudinal interrupted striae radiating from both sides of toruli and reaching lateral ocelli. POL : OOL : LOL relation is 5 : 3 : 2 and lateral ocellus, 1.5. Vertex and interocellar area imbricate, strongly alutaceous to coriaceous. Occiput imbricate, shiny, with some weak carinae descending nearly vertically, not concave backwards; occipital carina absent in the upper half but sometimes with a weak carinae behind posterior ocelli, but distinctly present at level of middle of occipital foramen, separating gena and postgena. Postgena smooth, only pubescent laterally to hypostomal carina, separated from the gena by a strong carina. Posterior tentorial pits distinct, area around occipital foramen smooth and shiny. Gular sulci inconspicuous, nearly absent. Maxillary palps 5-segmented and labial palps 3-segmented.

Antenna (Fig. 1E) with 11 flagellomeres, pedicel around 1.6 × longer than broad, F1 1.4 × longer than F2 and 1.5 × longer than pedicel; F2 as long as F3, F11 2.1 × longer than F10. Antennal formula is 15 : 11(x6.5) : 16 : 12 : 12 : 15 : 15 : 16 : 16 : 16 : 16 : 15 : 32. Placodeal sensillae distinctly visible on F3–F11.

Mesosoma (Figs. 2A–C) as long as high in lateral view. Sides of pronotum almost round-shaped in dorsal view; laterally rugose with irregular striae, area between them alutaceous, shiny; lateral pronotal carina short but always present, distinct. Propleuron smooth with some carinae basally, shiny. Mesoscutum broader than long measured along the anterior edge of tegulae, with sparsely white setae, denser along pronotum; strongly transversely carinate-rugose, carinae-rugae complete, present between notauli and between notaulus and side of mesoscutum, more delicate and dense in the anterior 1/4 of the mesoscutum; area between transversal sculpture alutaceous and shiny. Notauli complete, reaching pronotum, not wider posteriorly, with some parallel rugae on a smooth, shiny bottom. Anterior parallel lines and parapsidal lines visible; parascutal carina present reaching notauli; median mesoscutal line present and short, extending into 1/10 of the mesoscutum length. Dorsoaxillar area alutaceous, shiny; lateroaxillar area joins dorsoaxillar area at an acute angle, coriaceous, with numerous white short setae. Mesoscutellum 0.6 × as long as broad, uniformly dull coriaceous, with strong irregular rugae. Scutellar foveae well-impressed, separated by very narrow median carina, bottom smooth, shiny, with strong parallel longitudinal rugae. Mesopleuron with delicate parallel longitudinal striae, slightly coriaceous anteriorly. Metapleural sulcus reaches mesopleuron in the upper 1/7 of its height. Propodeum smooth, glabrous, with sparse short white setae in the central propodeal area basally and laterally; lateral propodeal carinae distinct, uniformly thin, parallel on their entire length or very weakly convergent basally; central propodeal area shiny, smooth, almost without striae. Metascutellum very narrow, much shorter than the ventral impressed area; metanotal trough smooth, shiny, glabrous, transversely carinate; propodeal spiracle transversely ovate, with strong raised carina along anterior border. Nucha with longitudinal parallel ridges.

Wings (Fig. 3C). Fore wings longer than body, hyaline, pubescent and with distinct long, dense marginal cilia; radial cell 2.5 × longer than wide; R1 and Rs not reaching wing margin,

Rs slightly curved; areolet absent; Rs + M indistinct.

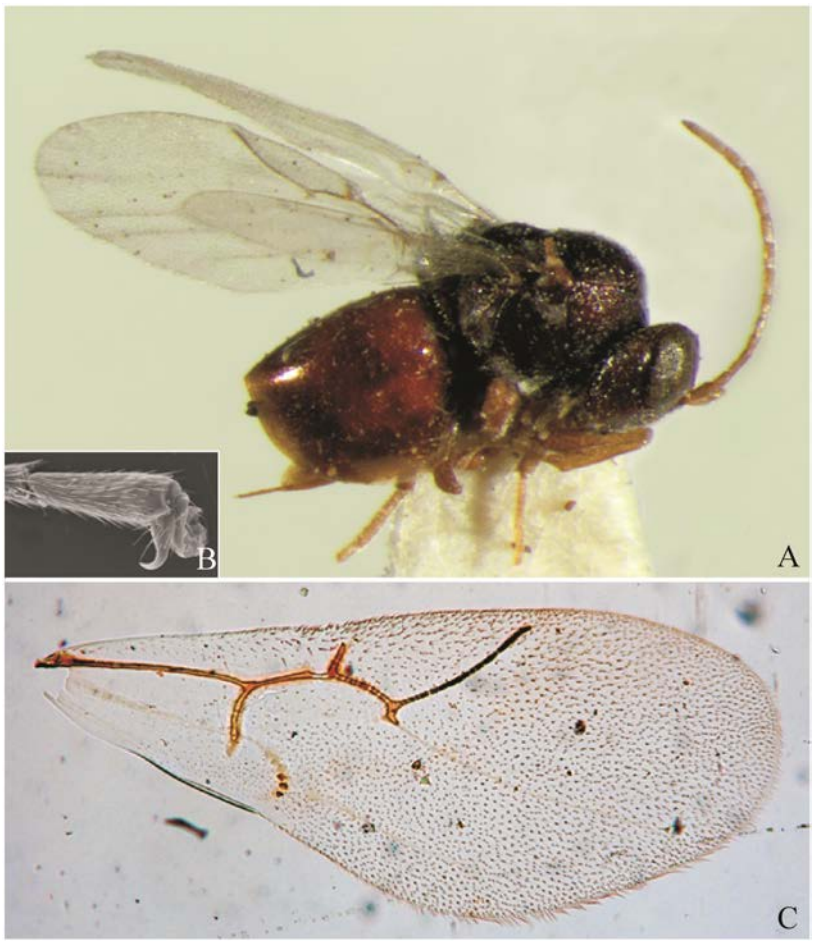

Figure 3. *Lithosaphonecrus puigdemonti* **sp. nov.** A. Habitus; B. Tarsal claws; C. Forewing.

Legs. All tarsal claws simple (Fig. 3B), without a basal lobe.

Metasoma (Fig. 2D) 1.3 × longer than high and slightly shorter than head plus mesosoma. Syntergite 2 + 3 with a few white setae anterolaterally, smooth, shiny, glabrous, posterodorsally not incised, with band of dense punctures in the posterior 1/4 extending to the ventral edge. Subsequent tergites and hypopygium micropunctate; prominent part of ventral spine of hypopygium very short and slender, with very few short white setae ventrally.

Male (Figs. 1F, 2E). Similar to female except antenna with 13 flagellomeres; F1 curved and broadened apically, 2.6 × longer than F2 and 2.3 × longer than pedicel; F1 1.2 × longer than F2 plus F3; F4 1.3 × longer than F3; F4–F11 nearly of the same length; placodeal sensillae hard to trace in stereomicroscope. Body length 1.6 mm (n = 1).

Holotype. ♀ deposited in UB with the following labels: 'Chengguan, Jianyang (Fujian Province), 20-VII-1965, Jiahua Chen col.' (white label); 'Holotype *Lithosaphonecrus puigdemonti* Pujade-Villar n. sp., desig. JP-V 2019' (red label). **Paratypes.** 1♂5♀ (1♂1♀ UB;

4♀ ZAFU), with the same data as the holotype.

Other specimen. 1♀ dissected and gold-coated for SEM pictures.

Etymology. The specific epithet is in honor of the MHP Carles Puigdemont i Casamajó.

Diagnosis. *Lithosaphonecrus puigdemonti* belongs to the group of species with broad genae laterally. It is morphologically related to a recently described species (*L. arcoverticus* Liu, Zhu & Pang, 2019) in having the occipital carina incomplete, parascutal carina reaching notauli and transfacial distance similar to height of compound eye. It differs from this species in both head and mesosoma color (chestnut), with face reddish brown (completely black in *L. arcoverticus*), in having medial frontal carina absent (present in *L. arcoverticus*), females with syntergite not incised (incised in *L. arcoverticus*) and males with F1 2.6 × longer than F2 (shorter in *L. arcoverticus*); for other characters and species, consult the *Lithosaphonecrus* key.

Biology. Unknown.

Distribution: China (Fujian).

Key to species

1. Gena behind eye much narrower at the dorsal edge than basally, almost vertical in the most posterior part, diverging ventrally away from eye margin (fig. 19 in Bozsó *et al*. 2015) ····· 2
-. Gena behind eye only slightly narrower at the dorsal edge than basally; subparallel to eye margin or not (Fig. 1C) ····· 3
2. Head round-shaped in anterior view; parapsidal lines invisible under transverse rugae; syntergite 2 + 3 with a band of indistinct micropunctures in the posterior 1/5 only; F1 of female antenna 1.8 × longer than F2; F1 of male antenna 3.0 × longer than F2 ····· *L. formosanus*
-. Head subtrapezoid-shaped in anterior view; parapsidal lines narrow, distinct; syntergite 2 + 3 with a distinct broader reticuloso-punctate band at least in the posterior 1/4. F1 of female antenna 1.5 × longer than F2; F1 of male antenna only 2.6 × longer than F2 ····· *L. huisuni*
3. Frons without carinae. POL 3.0 times as long as OOL. Occipital carina well defined and complete ····· ····· *L. papuanus*
-. Frons with some carinae or with a medial frontal carina. POL shorter. Occipital carina absent or incomplete (only distinctly present at level of middle of occipital foramen, separating gena and postgena) ····· 4
4. Parascutal carina long, reaching notauli ····· 5
-. Parascutal carina present only along tegula ····· 8
5. Transfacial distance longer than height of compound eye in females, around 1.2 ×. Mesoscutum, in lateral view, flat and abruptly vertical in the anterior part. Scutellar foveae separated by broad septum. F1 in males at most 2.2 times as long as F2 ····· *L. vietnamensis*
-. Transfacial distance equal or shorter than height of compound eye in females. Mesoscutum, in lateral vision, curved and not abruptly vertical in the anterior part. Scutellar foveae separated by very narrow median carina. F1 in males longer ····· 6
6. Longitudinal carinae on upper face not extensive, superficial laterally and medial carinae below lateral anterior ocellus lacking; antennal scrobes entirely coriarious. Propodeum punctate with long setae. F1 of male antenna narrow without visible distal swelling or very weakly expanded, 3.0 × longer than F2 ····· ····· *L. decarinatus*
-. Longitudinal carinae on upper face extensive, distinct laterally, medial carinae below lateral anterior ocellus distinctly present, and multiple irregular carinae present in upper part of antennal scrobes, which is otherwise coriacious or finely imbricate in lower half. Propodeum with sparse appressed setae to glabrous. F1 of male antenna thick with visible distal strong swelling, shorter (2.3–2.6 × longer than F2) ····· 7

7. Head and mesosoma black. Median frontal carina relatively weak, but complete from between antennal torulus to anterior ocellus. Toruli located below half the height of the compound eye. Notauli complete but obscured anteriorly. Females with syntergite posterodorsally slightly incised. Males with F1 2.3 × longer than F2 ····· *L. arcoverticus*
-. Head and mesosoma reddish to chestnut. Medial frontal carina absent. Toruli located at half of the compound eye height. Notauli strongly impressed along all length. Females with syntergite not incised. Males with F1 2.6 × longer than F2 ····· *L. puigdemonti* **sp.nov.**
8. Gena with subparallel striae radiating from malar space and extending behind compound eye; occiput and postgena smooth, glabrous. F1 in male antenna 2.6 × longer than F2 and 1.9 × longer than pedicel. Only males known ····· *L. yunnani*
-. Gena behind eye alutaceous, subparallel striae radiating from malar space extending only into the lower edge of compound eye. Occiput and postgena sculptured (alutaceous to reticulate). F1 in male antenna 1.9 × longer than F2 and 1.5 × longer than pedicel; F1 in female antenna 1.9 × longer than F2, F2 slightly longer than F3 ····· *L. dakengi*

Discussion

Lithosaphonecrus (= *Lithonecrus* Nieves-Aldrey & Butterill, 2014, after Schwéger *et al*. 2015) appears on Cynipini galls collected on two Fagaceae genera: *Lithocarpus* and *Castanopsis*.

Lithocarpus is native to East and Southeast Asia and includes about 300 species (Huang *et al*. 1999b). Only four species of gall makers are mentioned in this host (Pénzes *et al*. 2018; Nieves-Aldrey & Butterill 2014; Yang *et al*. 2019): *Cycloneuroterus formosanus* Tang & Melika, 2011 from China (Taiwan) in *L. konishii* (Hayata) Hayata; *Neuroterus haasi* Kieffer, 1904 from India in *L. elegans* (Blume) Hatus ex Soepadmo (= *Q. spicata* Smith); in an unknown gall collected in *L. celebicus* (Miq.) Rehd. from Papua (New Guinea, Indonesia) and two species that have emerged from a single unknown gall collected in *Lithocarpus glaber* (Thunb.) in mainland China. On the other hand, only seven species of inquilines belonging to the genus *Lithosaphonecrus* are known to inhabit galls on *Lithocarpus* (Table 1).

Castanopsis, also native to East and Southeast Asia, includes 120 species (Pénzes *et al*. 2018; Huang *et al*. 1999a). A total of 10 species of gall makers are mentioned in this host (Abe *et al*. 2014; Pénzes *et al*. 2018): four from mainland China, three of them in *C. echinocarpa* J. D. Hooker & Thomson ex Miquel (*Dryocosmus canonni* Schwéger & Tang, 2016; *D. harisonae* Melika & Tang, 2016; *D. quadripetiolus* Schwéger & Tang, 2006) and *D. hearni* Melika & Tang, 2016 in an unidentified species of *Castanopsis*; and six from China (Taiwan) in *C. uraiana* (Hayata) Kanehira & Hatusima or *C. carlesi* (Hemsl.) Hayata (*Cycloneuroterus uraianus* Tang & Melika, 2016; *Dryocosmus caputgrusi* Schwéger & Tang, 2016; *D. carlesiae* Tang & Melika, 2011; *D. pentagonalis* Melika & Tang, 2011; *D. testisimilis* Tang & Melika, 2016 and *D. triangularis* Melika & Tang, 2011). Lastly, one single species has emerged from a single unknown gall collected in an unidentified *Castanopsis* species in Vietnam. As for the inquilines, only one species belonging to genus *Lithosaphonecrus* is known for this host plant (Table 1).

Table 1. *Lithosaphonecrus* species: biological and distribution data

Lithosaphonecrus species	Host	Gall location	Emergence	Distribution (Fig. 4)
L. arcoverticus Liu, Zhu & Pang, 2019	*L. glaber*	new shoots catkins	$viii_1$	China (Hunan)
L. decarinatus Liu, Zhu, et Pang, 2019	*L. glaber*	new shoots catkins	vi_2	China (Hunan)
L. dakengi Tang & Pujade-Villar, 2014	*L. hancei*	buds	iv	China (Taiwan)
L. formosanus Melika & Tang, 2014	*L. glabra* *L. hancei* *L. konishii*	buds catkins stems	x-xi	China (Taiwan)
L. huisuni Tang, Bozsó & Melika, 2014	*L. glabra*	buds	x	China (Taiwan)
L. papuanus (Nieves-Aldrey & Butterill, 2014)	*L. celebicus*	petiole leaf lamina	$viii_1$	Papua New Guinea
L. puigdemonti Pujade-Villar sp. nov.	Unknown (sweeping)	unknown (sweeping)	vii	China (Fujian)
L. vietnamensis (Abe, Ide, Konishi & Ueno, 2014) Tang, Bozsó & Melika, 2014	*Castanopsis* sp.	buds	vi and ix	Vietnam
L. yunnani Tang, Bozsó & Melika, 2014	*L. fenestratus*	buds	iv	China (Yunnan)

Note. The subscripts added in the months of emergency indicate whether this occurs in the first or second year (in cases where the data are known). More explanation is in the text (discussion).

Most of the known gall-forming species occurring on *Lithocarpus* and *Castanopsis* belong to the Cynipidae genus *Dryocosmus* (*D. canonni*, *D. caputgrusi*, *D. carlesiae*, *D. harisonae*, *D. hearni*, *D. pentagonalis*, *D. quadripetiolus*, *D. testisimilis* and *D. triangularis*). However, one species of *Neuroterus* (*N. haasi*) and two *Cycloneuroterus* (*C. formosanus* and *C. uraianus*) have also been recorded. Nevertheless, all species of gall makers from which *Lithosaphonecrus* species have emerged remain unknown. *Lithosaphonecrus* species mainly appear in bud galls; however, they have been collected in galls produced on catkins, stems, shoots and leaves (Table 1). The only bivoltine species known until this date is *L. vietnamensis*, according to Abe *et al*. (2014), and the only species that emerges after one year after the gall was formed is *L. decarinatus*, according to Yang *et al*. (2019). All species appear from a single gall model except for *L. formosanus* (according to Bozsó *et al*. 2014) and probably *L. arcoverticus* and *L. decarinatus* (according to Yang *et al*. 2019).

When comparing the *Lithosaphonecrus* present in galls found on both *Lithocarpus* and *Castanopsis* (Table 1), the only coincident species is *L. gabra*.

In summary, and according to all the previously mentioned data, it is probable that the number of *Lithosaphonecrus* species will increase. *Lithosaphonecrus* is currently distributed in the Indo-Malay and Australian Regions (Fig. 4), but could also be found in the Southeast Palaearctic since the northern limit of *Lithocarpus* distribution is on the southern flank of the Qinling Mountains in China (Huang 1999b), and *Castanopsis* also occurs in Korea and Japan (according to Flora Malesiana: http:// portal. cybertaxonomy. org/flora-malesiana/node/ 12872#distribution).

The new species here described was collected in 1965 using a sweeping net. It is morphologically close to *L. arcoverticus* that emerged from galls in 2010 and was described in 2019. Both species have been collected in mainland China; however, *L. puigdemonti* was collected in the province of Fujian and *L. arcoverticus*, in the province of Hunan, more than 1,000 km away from each other (Fig. 4), but with similar collecting data (Table 1). Nevertheless, there is no possible confusion between both species according to the colour pattern (head and mesosoma completely black in *L. arcoverticus*, reddish to chestnut in the new species) and the medial frontal carina (present in *L. arcoverticus* but absent in the new species), among other traits. The biology of this new species is unknown.

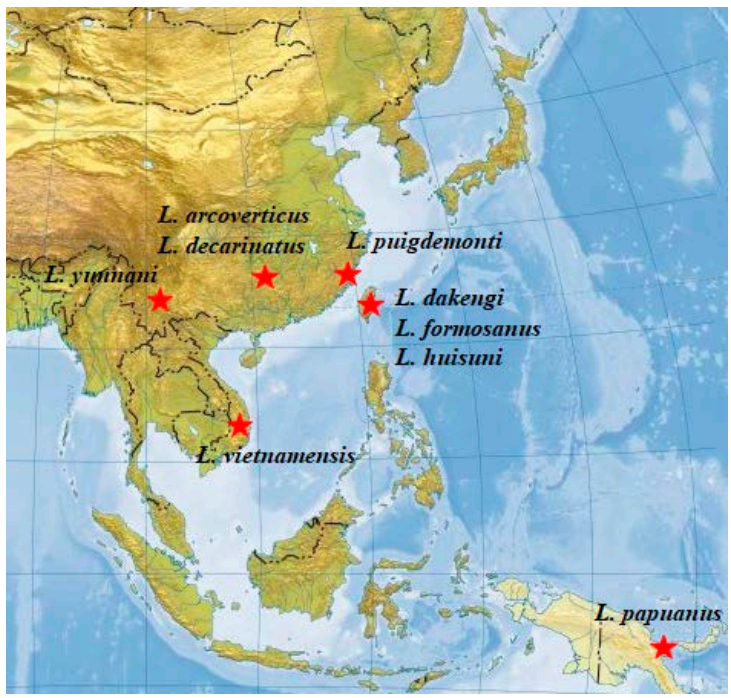

Figure 4. Distribution of *Lithosaphonecrus* species. Map obtained from https://proyectomapamundi.com/mapas-del-continente-de-asia/

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