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Research article

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A new species of *Ormyrus* Westwood (Hymenoptera, Ormyridae) developing in figs of *Ficus microcarpa* in Europe

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Abstract. Known by many names, the Chinese banyan (*Ficus microcarpa* L.) is a monoecious plant species originating from south-eastern Asia which has been introduced as an ornamental in numerous areas outside its native range, including the Mediterranean. Like every species of *Ficus*, it is associated with a series of chalcid wasp species, known as fig wasps. These species are distributed in the families Agaonidae, Epichrysomallidae, Eurytomidae, Ormyridae and Pteromalidae. In this publication, we describe a new species of *Ormyrus* Westwood, 1832 (Hymenoptera, Chalcidoidea, Ormyridae), *O. microcarpae* Askew & Koutsoukos sp. nov., reared from figs of *F. microcarpa* collected from Greece and Cyprus. The new species is compared with *O. lini* and *O. watshami*. This species is likely to be a parasitoid of *Meselatus bicolor* Chen, 1999 (Hymenoptera, Epichrysomallidae). In addition, the previously unknown female of *O. lini* is also described and illustrated. This publication constitutes the first report of species of *Ormyrus* associated with figs in Europe.

Keywords. Greece, Cyprus, *Ormyrus*, new species.

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Introduction

Globalisation and international trade have contributed to the translocation and establishment of an increasing number of species far beyond their distributional boundaries (Hulme 2009). The introduction of plant species beyond their native range for ornamental purposes has been an increasing trend in the Mediterranean since its suitable climate allows numerous exotic species to establish (Lopez-Vaamonde *et al*. 2010; Bella 2014). Following their host plants, a series of insect species from other continents have managed to reach these introduced areas (Lopez-Vaamonde *et al*. 2010; Compton *et al*. 2019).

Ficus microcarpa L. (also known as the Chinese Banyan) is a large evergreen tree, native to south-east Asia from India and Sri Lanka through southern China to Malaysia and north-east Australia, but widely introduced elsewhere as a shade or ornamental tree (Chen *et al*. 1999; Bhandari & Cheng 2016). As with other species of *Ficus*, *F. microcarpa* has host-specific fig wasp pollinators. *Eupristina verticillata* Waterston, 1921 (Hymenoptera, Agaonidae) is the recorded pollinator, but recent research suggests this taxon comprises an aggregate of closely related species, all associated with *F. microcarpa* (Wang R. & Rasplus J.-Y., pers. com.). Adult females pollinate the flowers in the figs and also gall some of them. Their larvae then feed on the galled ovules within the figs (Cook & Rasplus 2003). This mutualistic relationship is exploited by a series of chalcid wasps distributed in the families Epichrysomallidae Hill & Riek, 1967, Eurytomidae Walker, 1832, Ormyridae Förster, 1856 and Pteromalidae Dalman, 1820, known collectively as non-pollinating fig wasps (NPFW). They have various trophic regimes (phytophagous, parasitoids, inquilines) and do not all need the figs they occupy to have been pollinated (van Noort *et al*. 2013; Wang *et al*. 2015a). Many of these species (along with the pollinator) have managed to follow their host plant as it has been transported around the world and has reached multiple Mediterranean countries (Compton 1989; Mifsud *et al*. 2012; Wang *et al*. 2015a).

In Greece, the first report of fig wasps associated with *F. microcarpa* dates back to the discovery of *Odontofroggatia galili* Wiebes, 1980 (Hymenoptera: Epichrysomallidae) (Compton 1989), followed by Wang *et al*. (2015a) with a total of seven species from the Dodecanese, a number that is about to double (Koutsoukos *et al*. pers. com.). Regarding Cyprus, samples throughout the last decade yielded twelve fig wasp species associated with *F. microcarpa*, amongst them an undescribed species of the genus *Ormyrus* (Demetriou *et al*. 2023).

Ormyridae is a small family of chalcid wasps, distinctive and easily recognised but with affinities to Torymidae. It is considered to include the genera: *Asparagobius* Mayr, 1905, *Hemadas* Crawford, 1909 and *Ormyrulus* Bouček, 1986, which are monotypic, and *Ormyrus* Westwood, 1832, including 142 species (Noyes 2019; Burks *et al*. 2022; Cruaud *et al*. in press) of which 60 are recorded from the Palaearctic region (31 from Europe) and another 60 from the Indo-Australian region (Narendran 1999). A further 14 species are listed from the Afrotropical region, 20 from the Nearctic region and just four from the Neotropical region (Noyes 2019).

The species of *Ormyrus* for which biological information is available are all parasitoids in insect galls, particularly in galls induced by Cynipidae, although their precise trophic relationships within the galls are often unknown. Described European species have been reared from galls of Cynipidae Latreille, 1802 (Hymenoptera), Cecidomyiidae Newman, 1835 and Tephritidae Newman, 1834 (Diptera) and rarely from those of Eurytomidae (Hymenoptera) (Askew & Blasco-Zumeta 1998). Most species are restricted to galls on a single genus of host plants. Outside Europe, a species of *Ormyrus* has been

Table 1. Collections of *Ficus microcarpa* L. figs.

Country	Province	Town	Coordinates	Sampling date(s)
Greece	Attica	Egina	37.743° N, 23.430° E	16 Aug. 2022
Greece	Attica	Piraeus	37.945° N, 23.640° E	28 Aug. 2021; 21 Jun. 2022
Greece	Attica	Perama	37.963° N, 23.576° E	6 Aug. 2021
Greece	Attica	Nea Peramos	38.003° N, 23.422° E	25 Jul. 2021; 8 Aug. 2021
Greece	Peloponesse	Agioi Theodoroi	37.927° N, 23.143° E	25 Jul. 2021
Greece	Peloponesse	Nafplio	37.566° N, 22.800° E	30 Nov. 2021
Greece	Cyclades	Milos	36.724° N 24.444° E	4 Sep. 2021
Greece	Crete	Heraklion	35.336° N, 25.137° E	22 Aug. 2022
Cyprus	Limassol	Limassol	34.683° N, 33.029° E	2 Apr. 2022

found to parasitise a gall-forming weevil (Coleoptera: Curculionidae) on *Celtis* L. in China (Yao & Yang 2004). Cynipid, cecidomyiid, agromyzid and tephritid hosts have all been reported (Noyes 2019). In addition, a group of species is associated with fruits of *Ficus* spp., inside which they are known or presumed to be parasitoids in the galls of other fig wasps (Noyes 2019).

Zerova & Seryogina (2006) reviewed 34 species of Palaearctic *Ormyrus,* but none was reported to be associated with species of the genus *Ficus*. Bouček *et al*. (1981) described three species of *Ormyrus* reared from figs of *Ficus thonningei* Blume (= *F. burkei* (Miguel)) in the Ethiopian region, and Narendran (1999) cited 21 species that are certainly or probably associated with various species of *Ficus* in his account of 60 species of *Ormyrus* from the Indo-Australian region. Subsequently, *O. lini* Chen, 1999 was described as a presumed parasitoid in *F. microcarpa* figs in Taiwan (Chen *et al*. 1999). *Ormyrus fernandinus* Nieves-Aldrey, Hernández & Gómez, 2007*,* from Africa (Equatorial Guinea) may also be a fig wasp parasitoid (Nieves-Aldrey *et al*. 2007). None of the Nearctic or Neotropical species of *Ormyrus* is known to be associated with figs.

The edible fig *F. carica* L. is the only fig tree native to Europe, but numerous exotic species have been planted, especially around the Mediterranean. To date, there has been no European record of a *Ficus*-associated *Ormyrus*. Although Timberlake (1922) reported three unnamed species of *Ormyrus* reared from *F. microcarpa* [as *F. retusa*] figs from Hong Kong, only *O. lini* has been described previously (Chen *et al*. 1999). Here, we describe a new *Ormyrus* associated with *F. microcarpa*, and compare it with *O. watshami*, a closely related species from Africa and *O. lini*, which was reared from *F. microcarpa* within its native Asian range. We also describe the female of *O. lini* for the first time.

Material and methods

Collections were made throughout the southern parts of Greece and Cyprus, with an emphasis on areas where *F. microcarpa* is abundant (touristic and urbanised regions). Sampling started in July 2021 and continued until August 2022 (Table 1).

Figs were collected from *F. microcarpa* individuals with late-C to early D phase figs following Galil & Eisikowitch (1968), as the exit of adult fig wasps predominantly takes place during these stages (Wang 2014). Collected figs were stored in sealed polyethylene bags to allow the fig wasps, including some *Ormyrus* individuals, to emerge. Afterward, the specimens were stored in 90% ethanol. The figs were also stored in ethanol. These were later transferred to plastic boxes filled with water for ten minutes and were afterward dissected in four parts for the examination of galls (Wang *et al*. 2015a). Observed

galls were removed from the figs, and carefully opened with the use of entomological forceps to remove any adult insects. Reared fig wasps were stored in either 70% or 90% ethanol, before identification under a stereo microscope and molecular treatment. Specimens were air-dried, and card-mounted. Initial identification was carried out with a combination of descriptions and keys (Bouček *et al*. 1981; Chen *et al*. 1999; Narendran 1999; Zerova & Seryogina 2006). Terminology follows Gibson (1997).

In addition to the morphological identification, three specimens of *Ormyrus* stored in 95% ethanol were sent to the Laboratory of Forest Entomology (Forest Research Institute – HAO Demeter, Greece) for molecular identification. DNA was extracted from each individual using PureLink® Genomic DNA kit (Invitrogen), following the instructions of the manufacturer. Amplification was carried out in 25 μl volume using MyTaq™ Red Mix (BioLine) with two different primer pairs, namely i) LCO/HCO) (Folmer *et al*. 1994) and ii) Pat/Jerry (Simon *et al*. 1994) that amplify two fragments of mtDNA's Cytochrome Oxidase subunit I gene (COI). Conditions of the first (i) PCR consisted of an initial denaturation stage at 94˚C for 3 minutes, and then 45 cycles of 30 seconds at 94˚C, 30 seconds at 47˚C and 90 seconds at 72˚C with a final extension at 72˚C for 5 minutes. The second (ii) PCR amplification included an initial denaturation stage at 94˚C for 3 minutes, and then 5 cycles of 60 seconds at 94˚C, 90 seconds at 45˚C and 75 seconds at 72˚C, followed by 40 cycles of 60 seconds at 94˚C, 90 seconds at 51˚C and 75 seconds at 72˚C, with a final extension at 72˚C for 5 minutes. Purification of PCR products was carried out with PureLink® PCR Purification Kit (Invitrogen) according to the manufacturer's protocol. Purified products were sequenced in the automated sequencer ABI3730XL of CeMIA Company (Larisa, Greece), using the same primers with PCR. Finally, sequences were initially visualised with Chromas software ver. 2.6.6 (Technelysium Pty Ltd.) to avoid any wrong identification of nucleotides and then blasted in the NCBI GenBank database.

Images were all acquired by SvN at SAMC with a Leica LAS 4.9 imaging system, comprising a Leica® Z16 microscope with a Leica DFC450 Camera and 0.63× video objective attached. The imaging process, using an automated Z-stepper, was managed using the Leica Application Suite ver. 4.9 software installed on a desktop computer. Diffused lighting was achieved using a Leica LED 5000 Dome. All images included in this paper, as well as additional images, will be made available on WaspWeb (https://www.waspweb.org) (van Noort 2023).

Morphological abbreviations

C1	=	basal claval (club) segment
Fu1, Fu2…Fu6	=	antennal funicular segments between 2nd anellus and clava
Gt1, Gt2…Gt5	=	first (basal) gastral tergite, second gastral tergite, etc.
OD	=	long diameter of the anterior ocellus
OOL	=	minimum distance between margin of posterior ocellus and eyes
POL	=	distance separating inner margins of the posterior ocelli

Repository abbreviations

MICO	=	M.-D. Mitroiu's personal collection., Faculty of Biology, the Alexandru Ioan Cuza University of Iași, Romania
NHMUK	=	The Natural History Museum, London, England
RRA	=	R.R. Askew's personal collection
SAMC	=	Iziko South African Museum, Cape Town, South Africa (Simon van Noort)

Results

Sequences obtained for both mitochondrial primer pairs (Accession Numbers will be provided) were blasted in NCBI Genbank. They clearly clustered with already-deposited sequences belonging to species of *Ormyrus*, without matching identically with any of these sequences. Sequences obtained for both

mitochondrial primer pairs (Accession Number OQ98061 for the locus amplified with LCO/HCO and OQ980660 with Pat/Jerry) were blasted in NCBI Genbank.

A new species of *Ormyrus* reared from *F. microcarpa* is described, illustrated and compared to closely allied species. The female of *O. lini* is also described and illustrated since this species was previously known only from one male individual.

Class Insecta Linnaeus, 1758
Order Hymenoptera Linnaeus, 1758
Suborder Apocrita Latreille, 1810
Superfamily Chalcidoidea Latreille, 1817
Family Ormyridae Förster, 1856

Genus ***Ormyrus*** Westwood, 1832

Ormyrus Westwood, 1832: 127 (type species: *Ormyrus punctiger* (Westwood 1832: 127), by monotypy).
Siphonura Nees, 1834: 81. (type species *Siphonura variolosa* (Nees 1834: 81), by subsequent designation of Gahan & Fagan (1923)). Synonymy by von Dalla Torre (1898): 282.
Periglyphus Boheman, 1838: 378 (type species *Periglyphus gastris* (Boheman 1838: 378), by monotypy). Synonymy by von Dalla Torre (1898): 282.
Cyrtosoma Perris, 1840: 96. (type species *Cyrtosoma papaveris* (Perris 1840: 96) by monotypy). Synonymy by Bouček (1988): 155.
Monobaeus Förster, 1860: 95. Type species *Monobaeus cingulatus* (Förster 1860: 95) by subsequent designation by Ashmead (1904): 245. Synonymy by Bouček (1988): 155.
Tribaeus Förster, 1860: 93. Type species *Tribaeus punctulatus* (Förster 1860: 93), by monotypy. Synonymy by Bouček (1988): 155.
Chrysoideus De Stefani, 1898: 172. Type species *Torymus* (*Chrysoideus*) *chrysidiformis* (De Stefani 1898: 172), designated by Gahan & Fagan (1923): 34. Synonymy by Bouček (1988): 155.
Wania Risbec, 1951: 294. Type species *Wania ornata* (Risbec 1951: 294), by monotypy. Synonymy by Risbec (1954): 535.
Avrasyamyrus Doganlar, 1991: 7. Type species *Ormyrus orientalis* Walker, 1871, by original designation. Synonymy by Hanson (1992): 1335–1336.

Ormyrus microcarpae Askew & Koutsoukos sp. nov.
urn:lsid:zoobank.org:act:D3786F91-F4A6-4C7D-A7D9-A4FA3FD226F1
Figs 1–6

Diagnosis (both sexes)

Body length 1.4–1.7 mm. Colour dark metallic greenish blue, without testaceous colouration except about the wing bases (Figs 3A–B, 5A–C). Antennae placed higher than the lower level of eyes (Figs 3C, 5E). Flagellum with 2 anelli present, length of flagellum 1.16× height of eye, Fu1 at most 0.5× width of Fu6 (Figs 3C, 5E). Mouth margin metallic (Fig. 3C). Vertex without long setae (Figs 1C–E, 5B–C). Gt3 with two, Gt4 with three irregular transverse rows of exposed large foveae (Fig. 3F). In females, gaster with distinct mid-dorsal carina (Fig. 3F). Epipygium directed almost vertically upwards (Fig. 3D). In males, gaster dorsoventrally compressed (Fig. 5F).

Etymology

Ormyrus microcarpae Askew & Koutsoukos sp. nov. is named after the insect's host plant, *Ficus microcarpa.*

Material examined

Holotype

GREECE • ♀; Attiki, Nea Peramos; 38.003° N, 23.422° E; 8 Aug. 2021; V. Koutsoukos leg.; ex figs of *Ficus microcarpa* L.; Imaged WaspWeb LAS 4.9 SAMC 2023; NHMUK.



Fig. 1. *Ormyrus microcarpae* Askew & Koutsoukos sp. nov., holotype, ♀ (NHMUK). **A**. Habitus, lateral view. **B**. Habitus, dorso-lateral view. **C**. Head and mesosoma, anterio-lateral view. **D**. Body, lateral view. **E**. Head and mesosoma dorsal view. **F**. Body, dorsal view.

Paratypes

GREECE • 3 ♀♀, 3 ♂♂; same collection data as for holotype; 8 Aug. 2021; NHMUK • 1 ♀, 1 ♂; same collection data as for holotype; 8 Aug. 2021; RRA • 3 ♂♂; same collection data as for preceding; 25 Jul. 2021; NHMUK • 1 ♂ (dissected on card point); same collection data as for preceding; 25 Aug. 2021; Imaged WaspWeb LAS 4.9 SAMC 2023; NHMUK • 2 ♀♀, 1 ♂; Attiki, Perama; 37.963° N, 23.576° E; 6 Aug. 2021; V. Koutsoukos leg.; ex fruit *Ficus microcarpa* L.; NHMUK • 1 ♀, 1 ♂; same collection data as for preceding; 6 Aug. 2021; RRA • 5 ♀♀, 5 ♂♂; Kyklades, Milos, Adamas; 36.724° N, 24.444° E; 4 Sep. 2021; 2 m; V. Koutsoukos leg.; ex fruit *Ficus microcarpa* L.; NHMUK • 2 ♀♀, 1 ♂; same collection data as for preceding; ZMUA • 2 ♀♀, 2 ♂♂; same collection data as for preceding; MICO • 1 ♀, 1 ♂; same collection data as for preceding; RRA • 3 ♀♀, 3 ♂♂; same collection data as for preceding; Imaged WaspWeb LAS 4.9 SAMC 2023; SAM-HYM-P095396 to SAM-HYM-P095401; SAMC.

Additional material

GREECE • 2 ♂♂, 2 ♀♀; Attiki, Nea Peramos; 38.003° N, 23.422° E; 8 Aug. 2021; V. Koutsoukos leg.; ex fig *Ficus microcarpa* L.; RRA • 1 ♂; same collection data as for preceding; 25 Aug. 2021; RRA • 1 ♀; same collection data as for preceding; 29 Aug. 2021; RRA • 1 ♀; Attiki, Perama; 37.963° N, 23.576° E; 6 Aug. 2021; V. Koutsoukos leg.; ex fruit *Ficus microcarpa* L.; RRA • 7 ♀♀, 6 ♂♂; Kyklades, Milos, Adamas; 4 Aug. 2021; V. Koutsoukos leg.; ex fruit *Ficus microcarpa* L.; RRA. CYPRUS • 1 ♀, 1 ♂; Limassol; 34.683° N, 33.029° E; 2 Apr. 2022; V. Koutsoukos leg.; ex fruit *Ficus microcarpa* L.; RRA.



Fig. 2. *Ormyrus microcarpae* Askew & Koutsoukos sp. nov., holotype, ♀ (NHMUK). **A**. Head and mesosoma, anterio-lateral view. **B**. Metasoma, dorsal view. **C**. Fore wing. **D**. Labels.

Description

Female

Colour. Dark metallic greenish blue, scutellum posteriorly violet, face bluish green, anterior foveate parts of gastral tergites 2–4 purple; antenna light brown, scape and pedicel paler than flagellum; legs testaceous with metacoxa metallic dark green with purple tints and metafemur weakly metallic, front and middle femora darkened medially, tibiae testaceous with metatibia and apices of its spurs darkened, tarsi pale testaceous only terminally dark brown; wings hyaline, tegula and venation testaceous.

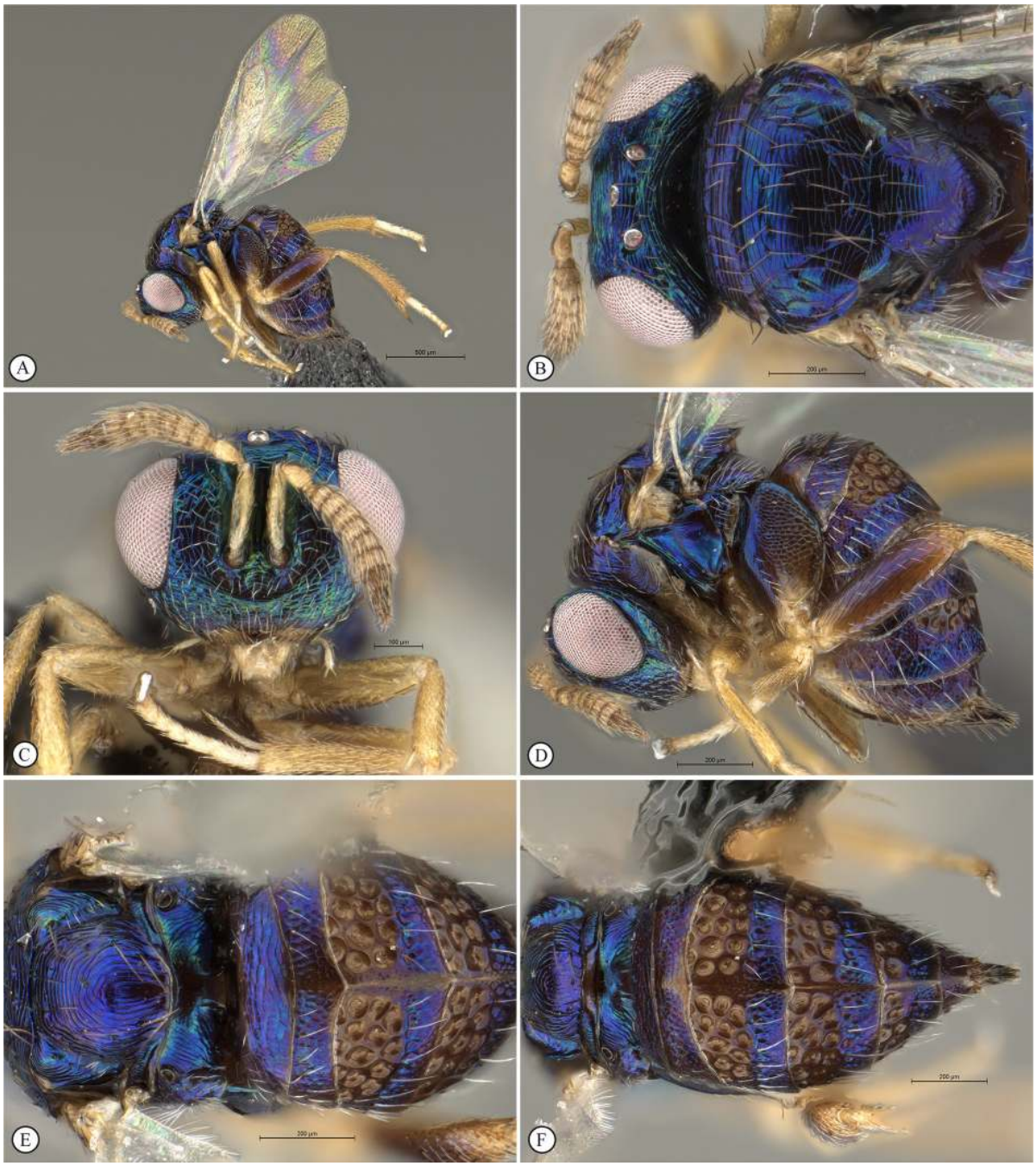


Fig. 3. *Ormyrus microcarpae* Askew & Koutsoukos sp. nov., paratype, ♀, SAM-HYM-P095397 (SAMC). **A**. Habitus, lateral view. **B**. Head and mesosoma, dorsal view. **C**. Head anterior view. **D**. Body, lateral view. **E**. Scutellum, propodeum and metasoma, dorsal view. **F**. Metasoma, dorsal view.

Body length. 1.4–1.7 mm.

Head. In dorsal view 2.2× as broad as long, eye length 0.9× head length with temple dorsally only about 0.07× head length; ocelli in obtuse triangle of about 140°, POL 3.1× OOL, OOL about 1.4× diameter of posterior ocellus; vertex transversely striate, abruptly down-turned just behind posterior ocelli; occipital carina low and about 2× OD behind posterior ocelli. Head in front view 1.4× as broad as high, eye length almost 0.8× height of head; scrobal grooves narrow, smooth, upwardly divergent and extending to about an ocellar diameter below level of anterior ocellus, scrobal area triangular, depressed and transversely striate; parascrobal area with poorly defined, mostly vertical striation and rather dense piliferous punctures with short, white setae; eyes with inner margins very weakly divergent ventrally, their minimum separation 0.55× head width; toruli with lower margins just above lower eye margin; clypeus small, its anterior margin produced as two very small lobes; malar space about 0.6× width of oral fossa, malar sulcus straight; mandibles each with two small, acute teeth. Antenna with scape about 5× as long as broad and 0.62× height of eye, scape apex much below anterior ocellus; pedicel plus flagellum 0.6× width of head, pedicel about 1.5× as long as broad and as long as three basal flagellars; flagellum fusiform, short, only 1.16× height of eye; two discoid anelli, the second less than 0.3× width of pedicel; six transverse funicle segments, Fu1 about as broad as pedicel and 2× as broad as long, Fu6



Fig. 4. *Ormyrus microcarpae* Askew & Koutsoukos sp. nov., paratype, ♀, SAM-HYM-P095397 (SAMC). **A**. Hind leg, lateral view. **B**. Terminal metasomal segments and ovipositor valves, lateral view. **C**. Fore wing. **D**. Labels.

about 1.5× as broad as Fu1 and about 2.5× as broad as long; linear sensilla in a single transverse row on each funicle segment; clava with 3 clavomeres, slightly shorter than the combined length of the three preceding funicle segments, C1 as broad as Fu6, clava thence tapering to blunt apex.

Mesosoma. Mesosoma dorsally convex, in dorsal view 1.28× as long as wide; pronotum transversely striate, its anterior near-vertical face descending abruptly from the broad collar but lacking a distinct

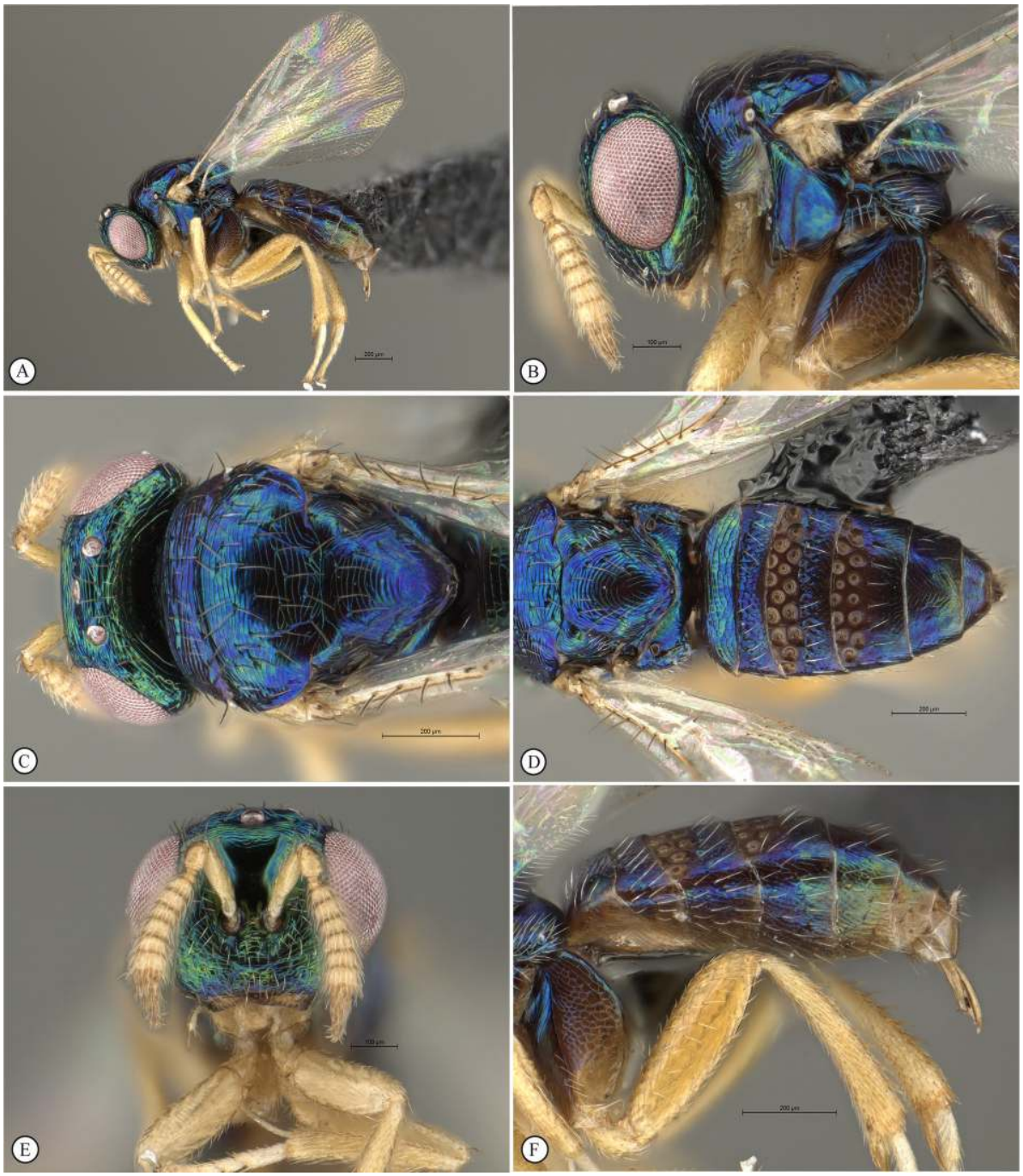


Fig. 5. *Ormyrus microcarpae* Askew & Koutsoukos sp. nov., paratype, ♂, SAM-HYM-P095400 (SAMC). **A**. Habitus, lateral view. **B**. Head and mesosoma, lateral view. **C**. Head and mesosoma, dorsal view. **D**. Scutellum, propodeum and metasoma, dorsal view. **E**. Head, anterior view. **F**. Metasoma, lateral view.

pronotal carina, laterally with two irregular vertical rows, reduced to a single row dorsally, of rather long, white setae; mesoscutum twice as broad as long, transversely striate with notauli shallow but evident at least near transscutal suture (traceable throughout in one paratype), mid-lobe with about 20 irregularly arranged setae, each seta arising from a quite large puncture, the setae longest towards transscutal suture; scutellum 1.25× length of mesoscutum, concentrically striate, smooth and shining between the striae, with five or six setae on each side, apical rim of scutellum protruding over the vertical metanotum and most of the propodeum which slopes at an angle of about 60° to the plane of the scutellum. Propodeum

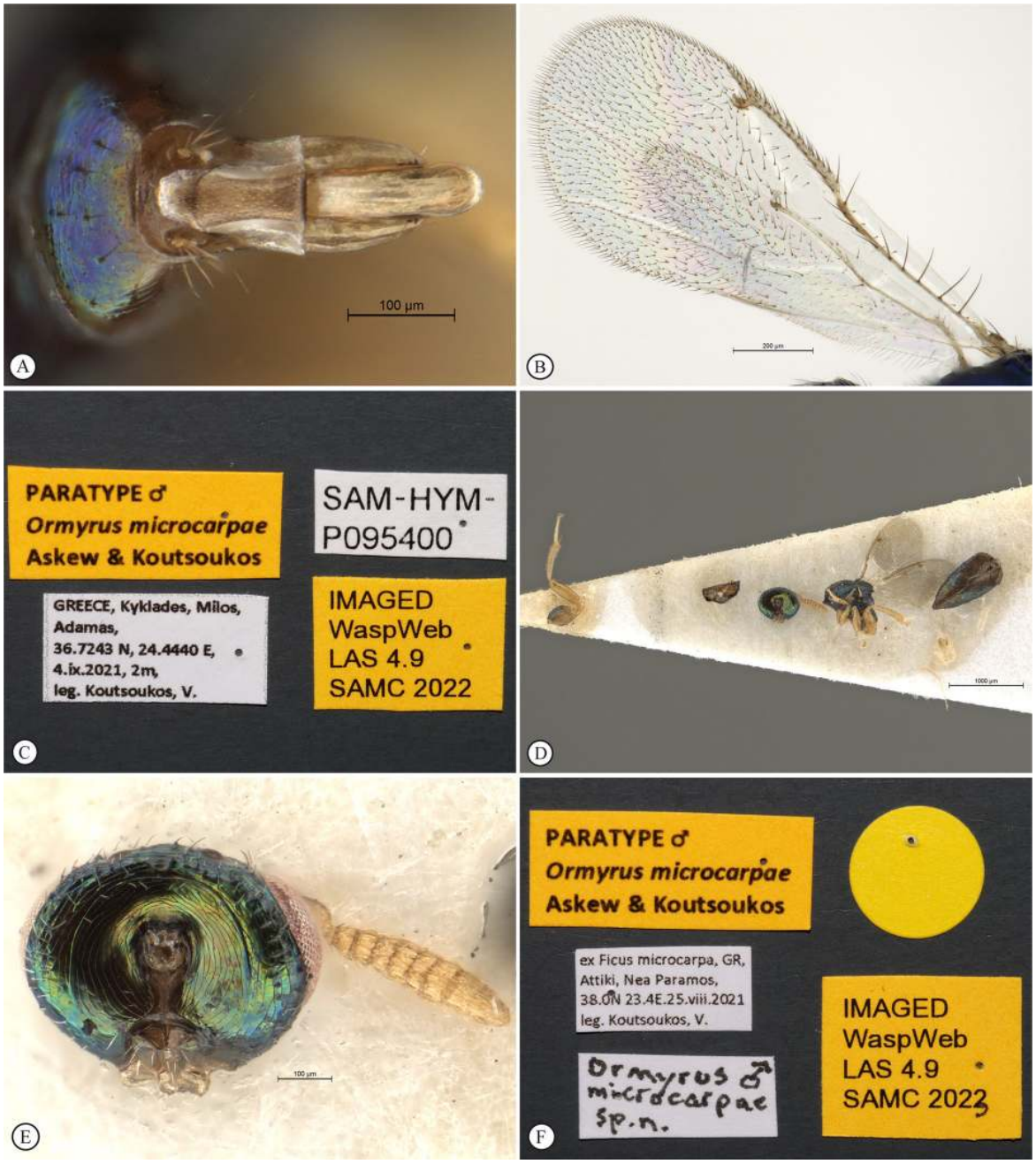


Fig. 6. *Ormyrus microcarpae* Askew & Koutsoukos sp. nov., paratype, ♂, SAM-HYM-P095400 (SAMC). **A**. Genitalia, dorsal view. **B**. Wings, dorsal view. **C**. Labels. Paratype, ♂ (NHMUK). **D**. Dissected specimen on card point. **E**. Head, ventral view. **F**. Labels.

smooth medially, weakly striate laterally, callus abundantly pilose, spiracle round and separated from metanotum by less than half its diameter. Hind leg coxa enlarged, about 2× as long as broad with flat, reticulate outer face; metafemur 2.8× as long as wide; metatibia slightly curved, its posterior edge with about 12 spines (stout setae) which are longest on distal half and almost 0.5× tibial width, the longer tibial spur about 1.5× apical width of tibia and slightly shorter than 0.9× length of metabasitarsus. Fore wing with lengths costal cell: marginal vein: stigmal vein: postmarginal vein as 69:41:7:17; short stigmal vein bent at base of stigma which is 2× as long as the base of the vein; submarginal vein with 8 to 10 long setae which mostly are longer than width of costal cell; costal cell upper surface bare, lower surface with a sparse row of short setae in distal half; basal cell bare except 0 to 3 setae near junction of basal and cubital folds; speculum large, open below and extending behind marginal vein almost or quite to stigmal vein, pilosity of disc sparse beyond this bare area.

Metasoma. Gaster about 1.3× as long as mesosoma, laterally compressed, in profile rectangular and truncate, upturned epipygium forming 90° angle to dorsal surface, median dorsal longitudinal carina on all gastral tergites except Gt1; Gt3–5 each basally with one to three exposed transverse rows of large foveae with additional foveae partly concealed by preceding tergites, the non-foveate apical areas finely punctured.

Male

Body length 1.4–1.6 mm. Bluish green, brighter than female and lacking purplish tints on mesosoma; antennae and legs a little paler than in female; gaster bluish green with foveate areas of Gt3 and Gt4 dull purple. Head (including antenna) and mesosoma much as in female. Gaster dorsoventrally compressed, as long as head and mesosoma together, in dorsal view 1.7× as long as wide, widest at Gt1 thence tapering to rounded apex; Gt1 transversely striate, Gt2 short and shallowly punctured, Gt3 and Gt4 long, each with two irregular transverse rows of large and deep foveae on their anterior halves, remaining tergites vaguely sculptured, partly smooth and shining.

Hosts

Reared from figs of *Ficus microcarpa* that contained galls produced by *Meselatus bicolor* Chen, 1999 (Hymenoptera, Epichrysomallidae). *Meselatus bicolor* prevents pollination and seed production by creating conspicuously large ovule galls (Wang *et al*. 2015b). All individuals of *Ormyrus microcarpae* Askew & Koutsoukos sp. nov. were found inside these galls. As such, we consider *O. microcarpae* a parasitoid of *M. bicolor. Ficus microcarpa* and *M. bicolor* are introduced species in Greece and Cyprus, and almost certainly *O. microcarpae* as well.

Distribution

Cyprus, Greece.

Ormyrus lini Chen, 1999
Figs 7–8

Ormyrus lini Chen, 1999: 57–59, figs 10–11.

Diagnosis (both sexes)

Body length 1.38–1.6 mm. Colour dark metallic greenish blue, with violet reflections in front of mesoscutum (Fig. 7A–B). Antennae placed nearly below the lower level of eyes (Fig. 7C). Mouth margin testaceous (Fig. 7C). Funicle with one anellus present (Fig. 7C–D). Vertex with several pairs of relatively long setae (Fig. 7B–D). In females, gaster acarinate, with oblique epipygium (Fig. 7E–F).

In females, sides of mesosoma testaceous sometimes. In males, sides of mesosoma with testaceous colouration (Fig. 8E).

Material examined

TAIWAN • 1 ♂; Taipei; 11 Apr.–4 Dec. 2012; S.G.A. Compton leg.; ex *F. microcarpa*, (collection of fig 11 Apr. 2012, emergence of individuals 4 Dec. 2012); Imaged WaspWeb LAS 4.9 SAMC 2023; SAM-HYM-P095394; SAMC • 1 ♀; 13 Jan. 2012; *F. microcarpa*, *Ormyrus ?lini*; *Ormyrus lini* det.



Fig. 7. *Ormyrus lini* Chen, 1999, non-type ♀, SAM-HYM-P095393 (SAMC). **A**. Habitus, lateral view. **B**. Head and mesosoma, dorsal view. **C**. Head, anterior view. **D**. Head and mesosoma lateral view. **E**. Metasoma, lateral view. **F**. Scutellum, propodeum and metasoma, dorsal view.

R.R. Askew; Imaged WaspWeb LAS 4.9 SAMC 2023; SAM-HYM-P095393; SAMC. CHINA • 1 ♀, 1 ♂; Guangzhou; 7 May 2012; S.G. Compton and Yu Hui leg.; ex fruits of *F. microcarpa*; RRA.

Description

Female

Colour. Dark metallic greenish blue, front of mesoscutum with violet reflections; gaster with Gt2 only shortly exposed, anterior parts of Gt3, Gt4 and Gt5 with the transverse foveate bands violet,



Fig. 8. *Ormyrus lini* Chen, 1999, non-type ♀, SAM-HYM-P095393 (SAMC). **A**. Fore wing, dorsal view. **B**. Labels. *Ormyrus lini*, non-type, ♂ SAM-HYM-P095394 (SAMC). **C**. Habitus, lateral view, (inset: labels). **D**. Head and mesosoma, dorsal view. **E**. Head, anterior view. **F**. Propodeum and metasoma, dorsal view.

the anterior sternites partly, the hypopygium and ovipositor testaceous; scape and pedicel testaceous, flagellum brown; clypeus, mouth margin and mouthparts testaceous; legs with metacoxa metallic bluish green, front and middle coxae brown, all tibiae brown dorsally but shading to testaceous ventrally; tarsi testaceous with brown claws; wings hyaline, tegulae, axillary sclerites and venation testaceous.

Body length. 1.6 mm.

Head. In dorsal view 2.05× as broad as long, eye length 0.7× head length with temple 0.15× head length; ocelli in obtuse triangle of about 140°, POL 3.9× OOL, OOL about 1.7× diameter of posterior ocellus; vertex transversely striate with four pairs of setae of differing length near posterior edge, the outermost pair (behind eyes) and a pair behind posterior ocelli the longest, each seta about 3× OD and inclined forwards, another pair of long setae near inner eye margins behind posterior ocelli. Head in front view 1.3× as broad as high, eye length 0.6× height of head; eyes with inner margins weakly divergent ventrally; upper face vertically striate with a row of about five short setae near inner margin of eye; toruli below eyes with upper margins at about level of lower eye margins; lower face with several short white setae in small punctures and with weak reticulate sculpture. Antenna with scape about 5.5× as long as wide, 0.8× height of eye, not quite reaching anterior ocellus; pedicel plus flagellum 0.7× width of head, pedicel about 1.7× as long as broad and three times as long as the two short and very transverse anelli together; flagellum fusiform, all six funicle segments transverse, each with a single transverse row of linear sensilla, Fu1 1.7× as broad as long, Fu2 about 1.9× as broad as long, Fu3–Fu6 each of about equal length and twice as broad as long, clava ovoid, about 2.5× as long as but scarcely broader than Fu6.

Mesosoma. Mesosoma dorsally convex, in dorsal view 1.27× as long as wide, very shiny with transverse striae which are most narrowly spaced on pronotum; mesoscutum 1.8× as broad as long, notauli traceable throughout and quite deeply impressed at posterior ends, setation very sparse, the mid-lobe with only two pairs of relatively long setae in posterior half and the side-lobes with a few setae laterally; scutellum 1.25× as long as mesoscutum, concentrically striate with three long setae on each side, apical rim protruding over vertical metanotum and almost occluding propodeum in dorsal view. Propodeum sloping at an angle of about 120° to tangential plane of scutellum, callus thickly pilose. Metacoxa about twice as long as wide, its flat outer face reticulate; metafemur 2.8× as long as wide; metatibia with about eight white spines on posterior edge, longest tibial spur slightly longer than metabasitarsus. Fore wing with lengths costal cell: marginal vein: stigmal vein: postmarginal vein as 72:37:5:10, stigmal vein widening almost from its base; submarginal vein with about 10 dorsal setae, each 1.5–2.0× width of costal cell; basal cell bare, basal fold with two setae; speculum large, open below, extending behind about 0.75× length of marginal vein.

Metasoma. Gaster 1.6× as long as mesosoma, ovate in dorsal view and 1.7× as long as wide, in lateral view 1.4× as long as deep; median dorsal carina absent; ovipositor slightly exserted, epipygium and ovipositor directed obliquely upwards forming an angle of about 120° with dorsal plane of Gt5; Gt3 dorsally with maximally three exposed transverse rows of foveae, Gt4 with four and Gt5 with three, the narrow apical non-foveate parts of these tergites almost smooth and very shiny.

Host

Reared from figs of *F. microcarpa*; however, its precise biology is unknown.

Distribution

China (mainland), Taiwan.

Remarks

This species was originally described from a single male reared from *F. microcarpa* collected in Taiwan (Chen *et al*. 1999). The female is described here, also based on a specimen collected in Taiwan. Additionally, a male and female from Guangzhou, China have been examined.

All the material was reared from figs of *F. microcarpa*. No significant structural differences between individuals from the two localities were detected and the most noticeable difference concerned colouration, with specimens from mainland China being more extensively yellowish testaceous. The female from mainland China is yellowish testaceous on the face below the level of the toruli, sides of the mesosoma, legs including coxae, propodeum and entire ventral surface of gaster. There is less of a colouration difference between males, but the specimen from mainland China is testaceous on the entire face below the level of the upper margins of the toruli whereas the Taiwanese male has a triangular testaceous area with apex between the toruli and extending to the lateral corners of the mouth opening.

Ormyrus watshami Bouček, 1981
Figs 9–11

Ormyrus watshami Bouček, 1981: 224–226, fig. 157.

Material examined

Holotype
ZIMBABWE • ♀; "Holotype"; "Rhodesia, Makumba Mission, nr. Salisbury, A. Watsham. xii.1976, 240, 264."; "HOLOTYPE ♀ *Ormyrus watshami* sp. n. det. Z. Bouček, 1979."; "B.M. TYPE HYM 5.2876"; NHMUK 010835121; Imaged WaspWeb LAS 4.9 SAMC 2021.

Paratypes
ZIMBABWE • 1 ♀; "Paratype"; "Rhodesia, Salisbury, Chishawasha on *F[icus] burkei*, iii.1976, A. Watsham."; "♀ Ormyrus watshami sp. n. det. Z. Bouček, 1980."; NHMUK 013457329. • 1 ♂; "Paratype"; "Rhodesia, Salisbury distr. ex *Ficus burkei*, A. Watsham. Makumba Mission xii.1976."; "♂ *Ormyrus watshami* sp. n. det. Z. Bouček, 1980."; NHMUK 013457330.

Host Plant

Ficus burkei Miquel.

Distribution

Zimbabwe.

Remarks

Ormyrus watshami is a parasitoid in galled ovules of *Ficus burkei*. A resemblance between *O. microcarpae* Askew & Koutsoukos sp. nov. and the description of *O. watshami*, especially the figure (Bouček *et al*. 1981: 225, fig. 157) depicting the female gaster, prompted an examination of the female holotype (images provided in Figs 9–11), and male and female paratypes of *O. watshami* from the Natural History Museum (London).

The female paratype of *O. watshami*, body length 2.0 mm, is larger than the usual size of *O. microcarpae* Askew & Koutsoukos sp. nov., the body is brighter green to greenish blue with weaker sculpture and the legs are somewhat darker with metallic tints on the front and hind femora, the outer face of the metacoxa is shiny with weakly raised reticulate sculpture, and the spines on the posterior edge of the metatibia are fully half as long as the tibial width. The antennal flagellum of *O. watshami* is longer (1.47× length

of eye compared to 1.16× in *O. microcarpae*) and stouter (Fu1 about 0.65× width of Fu6 compared to hardly 0.5× width of Fu6) than in *O. microcarpae*. The mesoscutum of *O. watshami* is less setose than in the new species with a few setae only on its mid-lobe and these are restricted to the sides of the posterior half. Gasters of *O. watshami* and *O. microcarpae* have the same characteristic shape but differ significantly in that *O. watshami* has large foveae fully exposed only on Gt3.



Fig. 9. *Ormyrus watshami* Bouček, 1981, holotype, ♀, B.M. TYPE HYM 5.2876 (NHMUK). **A**. Habitus, lateral view. **B**. Habitus, dorsal view. **C**. Body, lateral view. **D**. Body, dorso-lateral view. **E**. Head and mesosoma, lateral view. **F**. Head and mesosoma, dorsal view.

The male paratype of *O. watshami* differs from male *O. microcarpae* Askew & Koutsoukos sp. nov. in that the gaster is less dorsoventrally compressed, its ventral surface brownish and the discs of Gt2–4 are largely pale and non-metallic, and there are about four rows of comparatively small and shallow foveae exposed on Gt3 and Gt4.



Fig. 10. *Ormyrus watshami* Bouček, 1981, holotype, ♀, B.M. TYPE HYM 5.2876 (NHMUK). **A**. Head and pronotum, antero-lateral view. **B**. Head and antennae, lateral view. **C**. Head and mesosoma, dorso-lateral view. **D**. Scutellum and propodeum, dorsal view. **E**. Propodeum and metasoma, dorso-lateral view. **F**. Metasoma, lateral view.

Comparison of Ormyrus inhabiting seeds of Ficus microcarpa

The two species of *Ormyrus* reared from figs of *F. microcarpa* have the relatively sparse but strong and suberect mesosomal setation and large fore wing speculum characteristic of most species of *Ormyrus* inhabiting *Ficus,* but *O. microcarpae* Askew & Koutsoukos sp. nov. and *O. lini* differ from each other in several respects. *Ormyrus lini* is testaceous at least on the mouth margin, and often on the sides of the mesosoma, especially in males, whereas the body of *O. microcarpae* is without testaceous colouration except about the wing bases.

The antennae are placed lower on the head in *O. lini* than in *O. microcarpae* Askew & Koutsoukos sp. nov. with toruli entirely below the lower level of the eyes in the former.

Several pairs of relatively long setae are borne on the vertex of *O. lini*, absent in *O. microcarpae* Askew & Koutsoukos sp. nov., but the mid-lobe of the mesoscutum bears more setae in *O. microcarpae* than in *O. lini* (see descriptions). The female gaster of *O. microcarpae* has a distinct mid-dorsal carina, the epipygium is directed almost vertically upwards and Gt3 and Gt4 have respectively about two and three irregular transverse rows of exposed large foveae. The female gaster of *O. lini* is acarinate, the epipygium is oblique, and there are rather more exposed foveae.

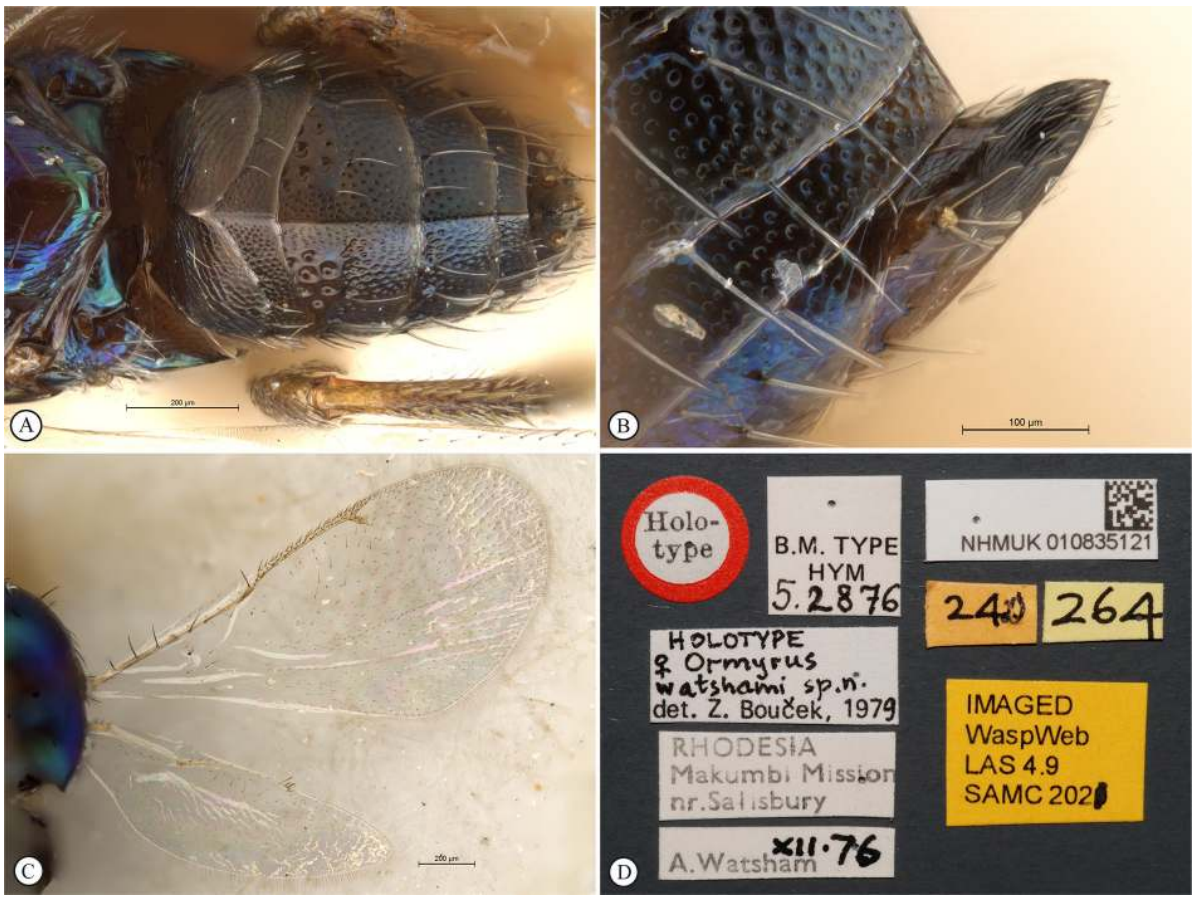


Fig. 11. *Ormyrus watshami* Bouček, 1981, holotype, ♀, B.M. TYPE HYM 5.2876 (NHMUK). **A**. Propodeum and metasoma, dorsal view. **B**. Terminal terga and ovipositor valves, lateral view. **C**. Wings, dorsal view. **D**. Labels.

Discussion

We have described a new species of the genus *Ormyrus* from the eastern Mediterranean, probably far outside its unknown native range. The description of chalcid wasps associated with introduced ornamentals outside their host's native range is not a rare phenomenon. For instance, the leaf galler of *F. microcarpa, Josephiella microcarpae* Beardsley & Rasplus 2001 (Hymenoptera: Epichrysomallidae), was originally described from California, the Canary Islands and Hawaii (Beardsley & Rasplus 2001). Parasitoids have similarly followed their host insect and host plant. *Monoksa dorsiplana* Bouček, 1991 (Hymenoptera: Pteromalidae), for example, has been described far away from its natural distribution (South America) (Bouček 1991). This is the first report of a species of *Ormyrus* associated with *F. microcarpa* outside its native distributional range, and only the second *Ormyrus* known from this host.

There is an indication that many of the species of *Ormyrus* associated with figs share morphological characteristics. All of the *Ficus*-associated species in Narendran's (1999: 8) key to Indo-Australian species fall into the section of the key distinguished by the 'scutellum bearing no adpressed pilosity but with pairs of setae [...] separated in middle by median bare area or strip; speculum usually open'. Bouček (1988: 155) recognised a small group of species of *Ormyrus*, based upon *O. watshami*, an African species associated with figs and characterised by sparse but long and suberect mesonotal setae, particularly on the mesoscutum. In contrast, *Ormyrus* that are parasitic in galls on other host plants have relatively dense, short and more adpressed setae on the mesoscutum and anteriorly on the scutellum. *Ormyrus lini* was described from a single male specimen reared from *F. microcarpa* in Taiwan (Chen *et al.* 1999) and it is the only species of *Ormyrus* recorded by Wang *et al*. (2015a) in a wide-ranging survey of *F. microcarpa*, its fig wasps and associated fauna. *Ormyrus lini* has rarely been collected; possibly *F. microcarpa* is not its principal host fig. Alternatively, this apparent rarity may be linked to having an uncommon specific insect host within the figs of *F. microcarpa.*

In its introduced range, *F. microcarpa* has been reported to affect building infrastructure, and even escape from urban habitats, becoming an invasive species (McKey 1989; Beardsley 1998; Wang *et al*. 2015a). Assisted by the introduction of its pollinator, it has managed to become invasive in Bermuda, Florida and Hawaii, while germination of seedlings away from planted trees has been reported even from Greece (Rhodes) (Galanos 2015; Wang *et al*. 2015b; Compton *et al*. 2017). Various non-pollinating fig wasps inhabiting *F. microcarpa* figs are known to compete with the pollinator, thus reducing the reproductive success of the plant, and have been discussed as potential biocontrol agents against their host species, in case it is deemed invasive (Dunn *et al*. 2008; Segar & Cook 2012; Wang *et al*. 2015b; Compton *et al*. 2017).

Meselatus bicolor was regarded as the most promising species for biological control of *F. microcarpa*, since the galls it creates prevent pollination and by extension seed production (Wang *et al*. 2015b). Although previous works (Wang *et al*. 2015a, 2015b) revealed a limited distribution of the species in the Mediterranean (i.e., the Dodecanese Islands), the absence of the *M. bicolor* parasitoid *Bruchophagus sensoriae* Chen, 1999 in these introduced areas was encouraging (Wang *et al*. 2015b). Nevertheless, the report of *O. microcarpae* Askew & Koutsoukos sp. nov. as a possible parasitoid of *M. bicolor*, could be a limiting factor in any schemes of biological control that include the latter. While *M. bicolor* has a wide distribution in Southern Greece and Cyprus (Koutsoukos *et al*. in prep.), the impact *O. microcarpae* on *M. bicolor* should be considered in case *F. microcarpae* becomes invasive and its delimitation through biological control is regarded as necessary.

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