

Taxonomy and biology of *Andricus morula*, a new gall-wasp species (Hymenoptera: Cynipidae: Cynipini) from Mt Hermon, Israel

EINAT SHACHAR¹, MOSHE INBAR² & NETTA DORCHIN^{1*}

¹School of Zoology, Tel Aviv University, Tel Aviv, 6997801 Israel

²Department of Evolutionary & Environmental Biology, University of Haifa, Haifa, 3498838 Israel

*Corresponding author: ndorchin@tauex.tau.ac.il

ABSTRACT

The Israeli fauna of oak galling wasps (Hymenoptera: Cynipidae) has been studied only sporadically until recently, with a focus on only two of the five native oak species in the country. As a result, numerous cynipid species in Israel are yet to be described, in particular from the northernmost parts of the country. In the present study we describe the first cynipid species from the Mount Hermon region, which harbors rich and unique flora and fauna. This region is home to *Quercus cerris* and *Q. libani*, two oak species that occur nowhere else in the country and their associated cynipid fauna has not been studied to date. *Andricus morula* n. sp. is currently known only from its sexual generation, which develops in gregarious mulberry-like catkin galls on these two oak species. Males and females of this species are described and compared to the closely related *A. cecconii* Kieffer, and data on their galls, phenology and natural enemies are reported.

KEYWORDS: Cynipidae, *Andricus*, gall wasps, Mount Hermon, *Quercus*, oak, new species, sexual generation.

INTRODUCTION

Oak gall wasps (Hymenoptera: Cynipidae: Cynipini) constitute a large tribe of gall-inducing insects. The majority of them are restricted to oaks (*Quercus* spp., Fagaceae), on which they form galls of diverse types and structures (Stone *et al.* 2002; Csóka *et al.* 2005). There are more than 1000 described Cynipini species in about 30 genera worldwide (Abe *et al.* 2007; Liljeblad *et al.* 2008; Melika *et al.* 2010; Wachi *et al.* 2011). Most species exhibit alternation of a sexual spring generation and an asexual fall generation (Stone *et al.* 2002; Csóka *et al.* 2005; Liljeblad *et al.* 2008). The largest Cynipini genus is *Andricus* Hartig, which currently contains about 300 species worldwide, mostly in the Holarctic Region (Belido *et al.* 2005; Liljeblad *et al.* 2008; Melika 2006). More than 80 *Andricus* species are known from the western Palearctic (Melika *et al.* 2004) and 28 species are currently known from Israel (Shachar, unpubl. data).

Israel lies at a crossroads between three phyto- and zoogeographical regions (Tchernov & Yom-Tov 1988) and constitutes the edge of distribution range for five native oak species; three of which (*Quercus calliprinos*, *Q. ithaburensis* and

Q. boissieri) are widely distributed (Zohary 1961; Dufour-Dror & Aytekin 2004), whereas two (*Q. libani* and *Q. cerris*) are found only on Mount Hermon, the highest and northernmost part of Israel. This region is unique for its rich fauna and flora, many elements of which can be found nowhere else in the country (e.g. Shmida & Livne 1980, Médail & Quézel 1997; Levin et al. 2007; Kravchenko *et al.* in press). *Quercus libani* and *Q. cerris* are Western Asian and Southeastern European species, respectively, which reach their southernmost area of distribution on Mt Hermon and support numerous species of cynipid wasps that have not been studied to date (Melika *et al.* 2010). Previous studies of Israeli cynipids were limited to the species associated with the much more common *Q. ithaburensis* and *Q. calliprinos* (Bytinski-Salts & Sternlicht 1967; Sternlicht 1968a, b; Shachar *et al.* 2015). Here we provide the first record of a cynipid from *Q. libani* and *Q. cerris* in Israel. We describe *Andricus morula* as new to science based on adults of the sexual generation and provide details on its galls and life history. Galls and adults of the asexual generation are currently unknown.

MATERIALS AND METHODS

Collecting, rearing, and morphological study

Galls were collected on numerous occasions in 2012–2015 from *Quercus libani* and *Q. cerris* on two sites on Mt Hermon (including Mt Kahal), Israel. The galls were either dissected under a stereomicroscope, or kept in ventilated rearing cages at room temperature until adult emergence. Adults were mounted on cardboard triangles for morphological study, and some were preserved in 96% ethanol for future molecular analysis. Specimens were studied and body parts measured with a Leica M125 stereomicroscope. Images were taken with a Leica DFC295 camera attached to a Leica M205C stereomicroscope, followed by processing in the Helicon Focus 5.3 software. All studied wasp and gall material is deposited in the Steinhardt Museum of Natural History, Tel Aviv University (SMNHTAU), except for paratypes that are deposited in the Plant Health and Molecular Biology Laboratory, Directorate of Plant Protection, Soil Conservation and Agri-environment, National Food Chain Safety Office, Budapest, Hungary (PHMB) as detailed in the species description.

Terms in the morphological description follow Liljeblad and Ronquist (1998) and Melika (2006). Abbreviations of forewing veins and cells follow Ronquist and Nordlander (1989), and terminology of cuticular surface follows Harris (1979).

Measurements and abbreviations used herein are as follows:

F1–F12 – flagellomeres 1–12;

POL (post-ocellar line) – the distance between the inner margins of the two lateral ocelli;

OOL (ocellar-ocular line) – the distance from the outer edge of a lateral ocellus to the inner margin of the compound eye;

LOL (lateral ocellar line) – the distance between the lateral and frontal ocelli;

Transfacial distance – the distance between the inner margins of compound eyes.

The mesoscutum width was measured across bases of tegulae.

The width of the forewing radial cell was measured from the margin of wing to vein Rs.

The measurements were taken on 20 females and 12 males.

TAXONOMY

Genus *Andricus* Hartig, 1840

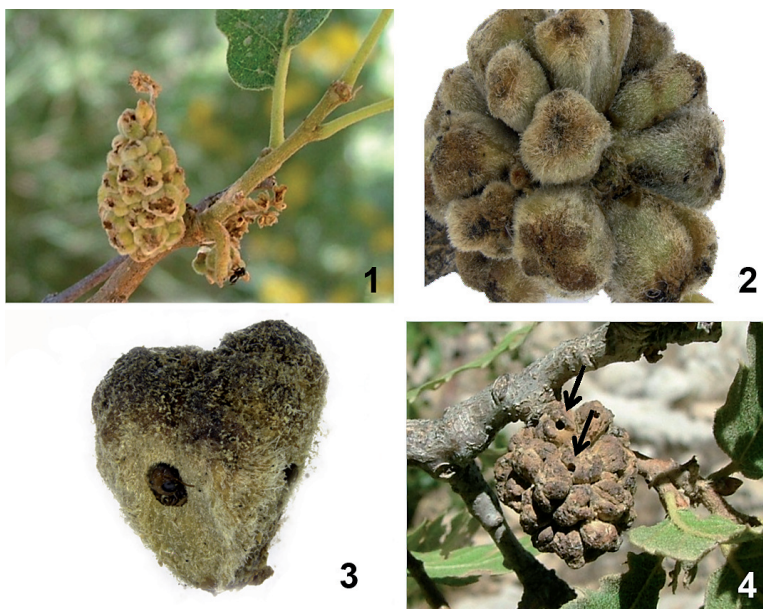
Andricus morula n. sp.

(Figs 1–27)

LSID: urn:lsid:zoobank.org:act:A7BAE87C-7E15-42E7-BF26-CE9E18E590A2.

Etymology: From Latin *morula* (diminutive of *morus*), referring to the shape of the gall that resembles a mulberry.

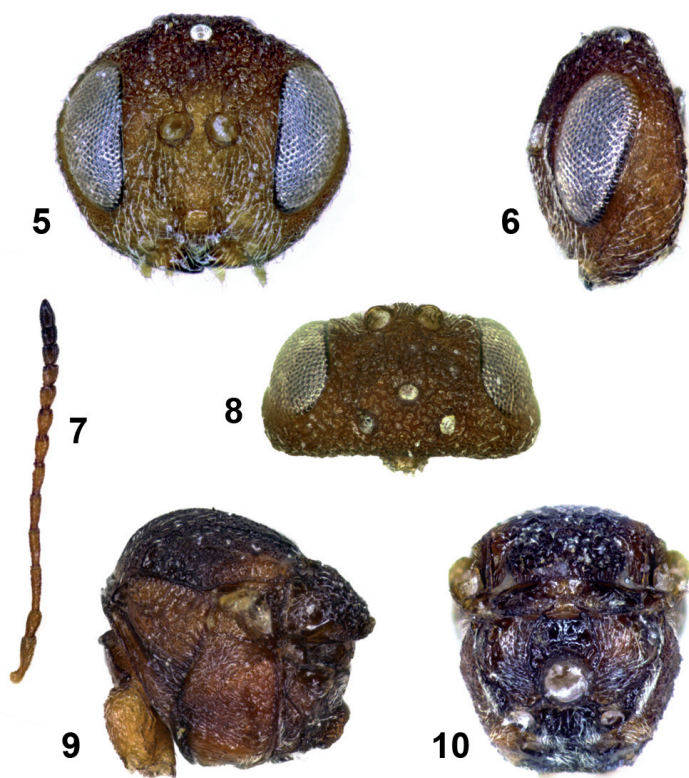
Gall and life history (Figs 1–4): Only the sexual generation of *A. morula* is known. It induces mulberry-like catkin galls, composed of 17–40 small units that are attached at their bases (Fig. 1). Young galls are soft and green to light brown at their tips, and completely covered with white fuzz (Figs 2, 3). Galls begin to develop in April and mature in June through July, when they reach their final size



Figs 1–4: *Andricus morula* n. sp., sexual-generation catkins galls on *Quercus libani*: (1) young gall; (2) mature gall; (3) individual unit of gall showing chamber with adult wasp; (4) old gall showing emergence holes (arrowed).

(12–17 mm long, 10–14 mm wide), the tip of the subunits turn darker, and the galls secrete sweet substance that attracts other insects. Each unit in the mature gall is 4–6 mm long and 3–4 mm wide (at widest point) and each contains 3–6 larval chambers at its basal part (Fig. 3). Adults emerge in July to early August, after which the galls dry up, become woody, and may remain on the tree until the following year (Fig. 4). About 35% of the adult wasps reared from the galls belonged to two unidentified species of inquiline cynipids that did not alter the gall morphology and emerged at the same time with the gall inducers. Parasitoids reared from the galls belonged to six species in five families: *Sycophila biguttata* (Swederus) and *S. variegata* (Curtis) (Eurytomidae), *Megastigmus dorsalis* (Fabricius) (Torymidae), *Ormyrus rufimanus* (Mayr) (Ormyridae), *Eupelmus annulatus* (Nees) (Eupelmidae), and *Mesopolobus fasciiventris* (Westwood) (Pteromalidae).

Female (Figs 5–16). Body length 2.2–2.6 mm. *Color pattern*: Head brown to dark brown, tip of mandibles black. Antennal flagellomeres brown, dark brown apically, 5 distalmost flagellomeres dark brown. Pronotum brown to dark brown dorsally,



Figs 5–10: *Andricus morula*, female: (5) head, frontal; (6) head, lateral; (7) antenna; (8) head, dorsal; (9) mesosoma, lateral; (10) metascutellum and propodeum, posterior view.

dark brown to black laterally. Mesopleuron brown to dark brown, mesoscutum, and mesoscutellum dark brown with black areas. Notauli, parapsidal lines and median stripes between notauli dark brown to black. Median part of lateral propodeal area dark brown to black, lateral part brown to dark brown. Scutellar foveae and metanotal trough brown to dark brown. Metasoma black, dark brown posteroventrally. Legs (Fig. 14) with long white setae; coxae dark brown to black; femora black, dark brown medially or ventrally; tibiae black, dark brown distally; tarsi brown to dark brown. Head, mesosoma and pronotum with white setae.

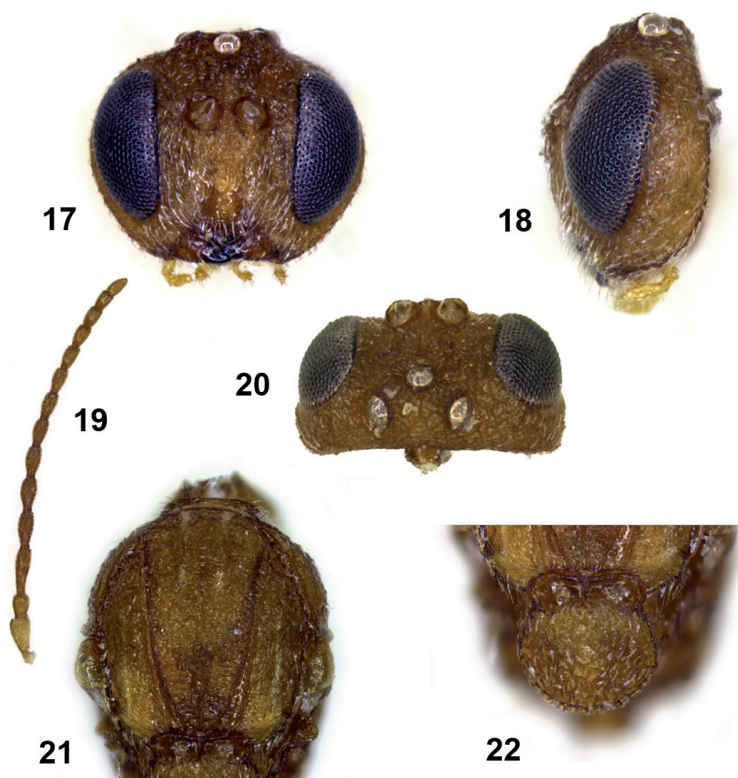
Head (Figs 5–8): Alutaceous, 2.2 times broader than long in dorsal view (Fig. 8), broadened behind eyes; lower face with white setae. Malar space with striae 0.3–0.4 times as long as height of eye, malar sulcus absent. POL 1.3–1.9 times as long



Figs 11–16: *Andricus morula*, female: (11) mesoscutum, dorsal; (12) mesoscutellum, dorsal; (13) forewing; (14) hind leg; (15) metasoma, lateral; (16) habitus.

as OOL; OOL 1.1–1.9 times as long as LOL, 1.5–2.1 times as long as diameter of lateral ocellus. Transfacial distance 1–1.2 times as long as height of eye, 1.1–1.2 times as long as height of lower face; diameter of antennal torulus 1.4–1.9 times longer than distance between antennal rims; distance between torulus and eye margin 1.6–2.1 times as long as diameter of torulus. Clypeus alutaceous, rounded, 1–1.4 times broader than high with deep, distinct anterior tentorial pits, distinct epistomal sulcus and clypeo-pleurostomal line (Fig. 5). Frons, vertex and occiput alutaceous (Fig. 8). *Antenna* (Fig. 7): 13 flagellomeres; pedicel nearly half length of scape, longer than broad; F1 1.7–2 times as long as pedicel, 1.1–1.4 times as long as F2; subsequent flagellomeres slightly shorter; F5–F13 with placoid sensillae.

Mesosoma (Figs 9–12): Broader than high in lateral view, with delicate striae and sparse white setae ventrally (Fig. 9). Pronotum with delicate striae and white setae; anterior rim narrow (Fig. 9). Mesoscutum (Fig. 11) alutaceous, broader than long; with stripes on dorsal inter-notauli area. Notauli distinct, complete, reaching pronotum, well-impressed, very broad basally (Fig. 11); median mesoscutal line



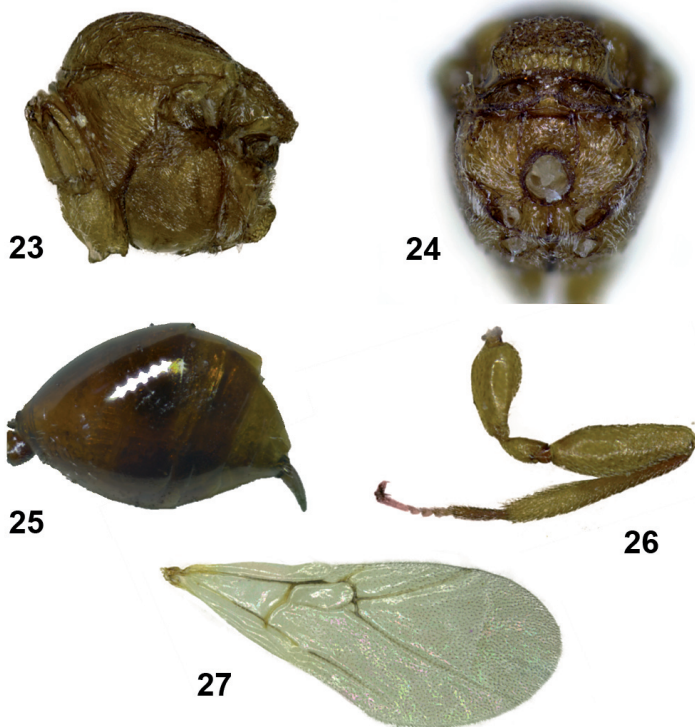
Figs 17–22: *Andricus morula*, male: (17) head, frontal; (18) head, lateral; (19) antenna; (20) head, dorsal; (21) mesoscutum, dorsal; (22) mesoscutellum, dorsal.

present; anterior parallel lines distinct, extending to $\frac{1}{3}$ of mesoscutum; parapsidal line present (Fig. 11). Mesoscutellum (Fig. 12) coreaceous, slightly broader than long, not overhanging metanotum. Scutellar foveae ovate and shiny, separated by broad elevated area. Mesopleuron (Figs 9, 10) with delicate striae and sparse white setae ventrally; mesopleural triangle with delicate striae and sparse white setae; axillar carina dark brown to black, striate; axillula dark brown to black, alutaceous; subaxillular bar smooth, shiny, dark brown black. Lateral propodeal carinae slightly curved outwards posteriorly, central area shiny, dark brown to black, wrinkled; lateral propodeal area delicately punctuate, dark brown to black medially, brown laterally, with white setae (Fig. 10).

Forewing (Fig. 13): Longer than body, hyaline, veins brown, margin with short cilia; radial cell 4–4.5 times as long as broad; R1 and Rs nearly reaching wing margin; Rs+M distinct in distal half; areolet triangular, well-defined.

Leg (Fig. 14): Evenly covered by long setae; tarsal claw with deep basal lobe.

Metasoma (Figs 15): Slightly shorter than head+mesosoma, broader than high in lateral view, shiny, with micropunctures on all tergites. First metasomal tergite



Figs 23–27: *Andricus morula*, male: (23) mesosoma, lateral; (24) metascutellum and propodeum, posterior view; (25) metasoma, lateral; (26) hind leg; (27) forewing.

with sparse white setae anteriorly. Prominent part of ventral spine of hypopygium 7.5–8.5 times longer than broad, with sparse white setae.

Male (Figs 17–27). Same as female except the following: Body length 2.2–2.5 mm. Color yellowish brown. Cuticular surface structure more delicate (Figs 21, 23). Eyes (Figs 17, 18, 20) slightly bigger than in female. Antenna (Fig. 19) yellowish brown with 14 flagellomeres; flagellomeres thinner at base, more glabrous apically than basally; placoid sensilla on F1–F14. Mesoscutum (Fig. 21), mesoscutellum (Fig. 22), mesopleuron (Fig. 23) and propodeum (Fig. 24) with dark brown margins. Metasoma (Fig. 25) brown, dark brown apically, smooth, without micro-punctures. Legs yellowish brown (Fig. 26). Forewing (Fig. 27) with Rs+M distinct throughout.

Comparison: In the existing key to *Andricus* species (Melika 2006), *A. morula* runs to the ‘non-Adleria’ species group, and most closely resembles Mediterranean and Middle Eastern individuals of *A. cecconii* Kieffer, 1901. The new species differs from them in having the brown to dark brown head as opposed to the black head of *A. cecconii*, the five apical flagellomeres that are darker brown in *A. morula* as opposed to the uniformly brown flagellomeres of *A. cecconii*, brown to dark brown mesosoma in *A. morula* as opposed to black in *A. cecconii*, sparse white setae on the mesopleuron and mesopleural triangle in *A. morula* as opposed to dense white setae in *A. cecconii*. Furthermore, the gall induced by *A. morula* is much smaller, woodier, and more elongate than that of *A. cecconii*, which is soft and spherical. *A. morula* galls always have a velvety cover and are sticky, whereas those of *A. cecconii* may or may not have a velvety cover and are never sticky. Molecular data confirm that the two species are distinct from each other (Shachar, unpubl. data).

Holotype: ♀ **Israel:** Mt Hermon, 1780 m [33°18'01.32"N 35°45'15.78"E], 15.vii.2014, E. Shachar & M. Inbar, ex catkin gall on *Quercus libani* (SMNHTAU).

Paratypes: **Israel:** 19♀ 2♂ Mt Kahal [33°17'13.51"N 35°44'10.79"E], 25.vi.2014, E. Shachar, N. Dorchin & M. Inbar, ex catkin gall on *Quercus cerris* (SMNHTAU); 20♀ 24♂ Mt Hermon, 1780 m, 15.vii.2014, E. Shachar & M. Inbar, ex catkin gall on *Quercus libani* (SMNHTAU); 5♀ 5♂ Mt Hermon, 1780 m, 15.vii.2014, E. Shachar & M. Inbar, ex catkin gall on *Quercus libani* (PHMB).

Distribution: Israel (Mt Hermon, Mt Kahal). Galls occur mostly on larger, taller trees and were most common on *Q. libani* in the first site, especially on two trees that bore a great number of galls. On *Q. cerris* only a few galls were found.

Comments: Mt Hermon is the highest mountain in the region and is considered a biodiversity hotspot in the Mediterranean Basin (Shmida & Livne 1980; Médail & Quézel 1997, 1999), with unique fauna and flora (e.g., Kugler 1974; Sivan & Werner 1992; Benyamini 1993; Gavish 1993; Médail & Quézel 1997; Levin *et al.* 2007; Kravchenko *et al.* in press). *Andricus morula* is yet another endemic species to this region. It is also the first cynipid to be described from Mt Hermon, where at least eight additional cynipid species occur on *Quercus libani* and *Q. cerris* and are yet to be described (Shachar, unpubl. data).

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