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Saltbush-associated *Asphondylia* species (Diptera: Cecidomyiidae) in the Mediterranean Basin and their chalcidoid parasitoids (Hymenoptera: Chalcidoidea)

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Abstract

Numerous species of gall midges (Diptera: Cecidomyiidae) have been recorded from saltbush (Chenopodiaceae: *Atriplex*) around the world but only 11 of them belong to the large cecidomyiid genus *Asphondylia*. Of these, two species were described in the late 19th century from complex bud galls on *Atriplex halimus* in the Mediterranean Basin. In the present study *Asphondylia punica* is redescribed, *A. conglomerata* is synonymized with it, and *Asphondylia scopuli* is described from *Atriplex lanfrancoi*, an endemic plant to the Maltese Islands. Descriptions are accompanied by information about the galls and life history of the gall midges, and a review of the parasitic Hymenoptera associated with *A. scopuli* is provided. Four species of parasitoids were found and attributed to the families Eurytomidae, Pteromalidae, Eupelmidae and Eulophidae, of which the pteromalid *Mesopolobus melitensis* is described as new.

Key words: *Atriplex*, gall midges, *Mesopolobus*, Pteromalidae

Introduction

Atriplex (Chenopodiaceae) is a cosmopolitan genus comprising ca. 300 described species of annual or perennial herbs or shrubs, which spread from its Eurasian origin to North and South America, Australia and Africa (Kadereit *et al*. 2010). The minority of species in this genus are C_3 plants that are mostly distributed in Eurasia, while the much larger lineage of C_4 species radiated to all other continents (Kadereit *et al*. 2010). The Mediterranean Basin is home to numerous and diverse species of *Atriplex* and closely related chenopod genera (e.g., *Halimione*) that are dominant components of arid and salt-marsh habitats. One of these is *Atriplex halimus* (Fig. 1), a circum-Mediterranean shrub that has been the subject of numerous studies focusing on its ecology, physiology and genetics (e.g., Ben Hassine *et al*. 2008, Le Hourou 1992, Ortz-Dorda *et al*. 2005, Walker *et al*. 2005). A unique Mediterranean species is *A. lanfrancoi*, a woody shrub endemic to sheer seaside cliffs of Malta and Gozo (Fig. 5), which is currently classified as critically endangered by the IUCN Red List of threatened species (www.iucnredlist.org). Due to its unique morphology, *A. lanfrancoi* was previously accommodated in the monotypic genus *Cremnophyton*, but recent studies showed that it should be placed in *Atriplex* (Kadereit *et al*. 2010).

Several species of gall-inducing arthropods have been recorded from *Atriplex* hosts in the Mediterranean, including mites and lepidopterans, but most are gall midges (De Stefani 1900, Houard 1908, 1922, Hegazi *et al*. 1980, Elsayed et al., in press). These include the monotypic genus *Aplonyx* De Stefani from Italy (which has not been found again since its original description in 1908), four species of *Stefaniella* Kieffer, and two species of *Asphondylia* Loew (Gagné & Jaschhof 2014). Some of the original descriptions and subsequent notices provided good illustrations of the galls, making it possible to recognize the species again, but the descriptions of the gall midges were either superficial or limited to only one sex. The *Stefaniella* species from *Atriplex* were subsequently

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reviewed by Dorchin & Freidberg (2008), but taxonomy of the *Asphondylia* species has not been revisited since the early 1900's.

Asphondylia is one of the largest genera in the family Cecidomyiidae, with 320 described species, associated with diverse plant families worldwide (Gagné & Jaschhof 2014), and many additional undescribed species. All *Asphondylia* species are gall formers and the galls are almost always associated with a fungus that lines the inside walls of the gall. Life histories among species in this genus vary considerably, depending largely on zoogeographical region and host-plant phenology (Yukawa 1987, Tokuda 2012). Many species are univoltine and enter extended diapause inside the galls, while others are bi- or multivoltine and present complex host associations (review in Tokuda 2012). Like the great majority of gall-inducing cecidomyiids, most *Asphondylia* species are considered monophagous and plant-organ specific, and some groups have apparently radiated in situ on a single plant genus (Hawkins *et al*. 1986, Gagné & Waring 1990, Joy & Crespi 2007, Stokes *et al*. 2012).

Within *Asphondylia*, only 27 species have so far been described from Chenopodiaceae hosts, 11 of which are from saltbush (*Atriplex* spp.): eight species from Southern California (Hawkins *et al*. 1986), one from Australia (Kolesik & Veenstra-Quah 2008), and two from the Mediterranean Basin (Marchal 1897, De Stefani 1900, Houard 1922). The *Atriplex*-associated species are very uniform morphologically, but their gall morphologies are considered reliable indicators of species identities (Hawkins *et al*. 1986). *Asphondylia* species from other chenopod hosts (e.g., *Salsola*, *Suaeda* and *Halosarcia*) have a notably different morphology, at least in the pupal stage (Veenstra-Quah *et al*. 2007, Kolesik & Veenstra-Quah 2008, Dorchin, unpublished data). In the present work we revise the knowledge on the Mediterranean *Asphondylia* species from *Atriplex* and describe a new species from Malta, together with information on life history of the gall midges and accounts of some of their parasitoids.

Material and methods

Field collections of galls were conducted in Malta in 2011–2012 and in Israel intermittently from 1995–2013. Galls were kept in rearing cages or plastic bags in the laboratory until emergence of the adult gall midges and parasitoids, and some galls were dissected to obtain the immature stages. Adults and pupal exuviae of the gall midges, as well as adult parasitoids were preserved in 70% ethanol for morphological study. The gall midges were later mounted on permanent microscope slides in euparal according to the method outlined in Gagné (1989, 1994). Parasitoids were air-dried before mounting on cards using water-soluble glue. Gall-midge pupae were also studied under a scanning electron microscope. In the following descriptions of the gall midges, general terminology for adult morphology follows McAlpine *et al*. (1981). The length of the needle-like segment 10 of the female abdomen relative to the length of the seventh sternite is used as a measure of ovipositor length. Types designated in this study are deposited in the National Museums of Scotland, Edinburgh (NMS), the National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (NMNH), the National Collection of Insects, Zoological Museum, Tel Aviv University (TAUI), and in the private collections of DM and RA, as indicated in the relevant section of the species' descriptions. ND is responsible for the taxonomic decisions regarding the cecidomyiids and RA for those pertaining to the chalcidoids.

Results and discussion

Taxonomy of the gall midges

Asphondylia taxonomy is challenging because adults of many species show very little morphological distinction. Antennal flagellomeres in both sexes are cylindrical and neckless, females have a piercing, needle-like ovipositor and conspicuously enlarged 7th sternite, and male genitalia are compact, with spherical gonostyli that are positioned dorsally rather than apically on the gonocoxites (Gagné 1994). Larvae have a well-developed, usually 4-toothed spatula on the first thoracic segment. Pupae are characterized by well-developed horn-like antennal bases ('antennal horns' hereafter), a varying number of facial horns, and transverse, dorsal rows of spines on the abdominal segments that aid in breaking out of the galls just before adult eclosion (Gagné 1989, 1994). Pupation always takes place inside the gall. The immature stages sometimes offer useful taxonomic characters for

distinguishing among species (Hawkins *et al*. 1986, Gagné & Waring 1990) but in other cases they are as uniform morphologically as the adults and one must resort to molecular data (Yukawa *et al*. 2003, Uechi *et al*. 2004, Kolesik *et al*. 2010). An added difficulty is that *Asphondylia* species often suffer very high levels of attack by parasitic Hymenoptera, which makes it extremely hard to obtain a good number of pupae and adults for morphological descriptions.

The species described hereafter from the Mediterranean Basin generally resemble the eight known North American and one Australian saltbush-associated species by showing the same arrangement of pupal antennal and facial horns. They resemble the American species also by the ovipositors that are exceptionally short for the genus. Nevertheless, it is highly unlikely that the American and Australian species from *Atriplex* are conspecific or even related to the Mediterranean species because *Atriplex* species in the Mediterranean are of much older origin than those in other continents and are distantly related to them (Kadereit *et al*. 2010). Similarly, Fabaceae-associated *Asphondylia* species from the Old World and the New World do not appear to be monophyletic (Gagné and Wünsche 1986).

Asphondylia punica Marchal

Asphondylia punica Marchal, 1897: 20
Asphondylia conglomerata De Stefani 1900: 16—**new synonym**

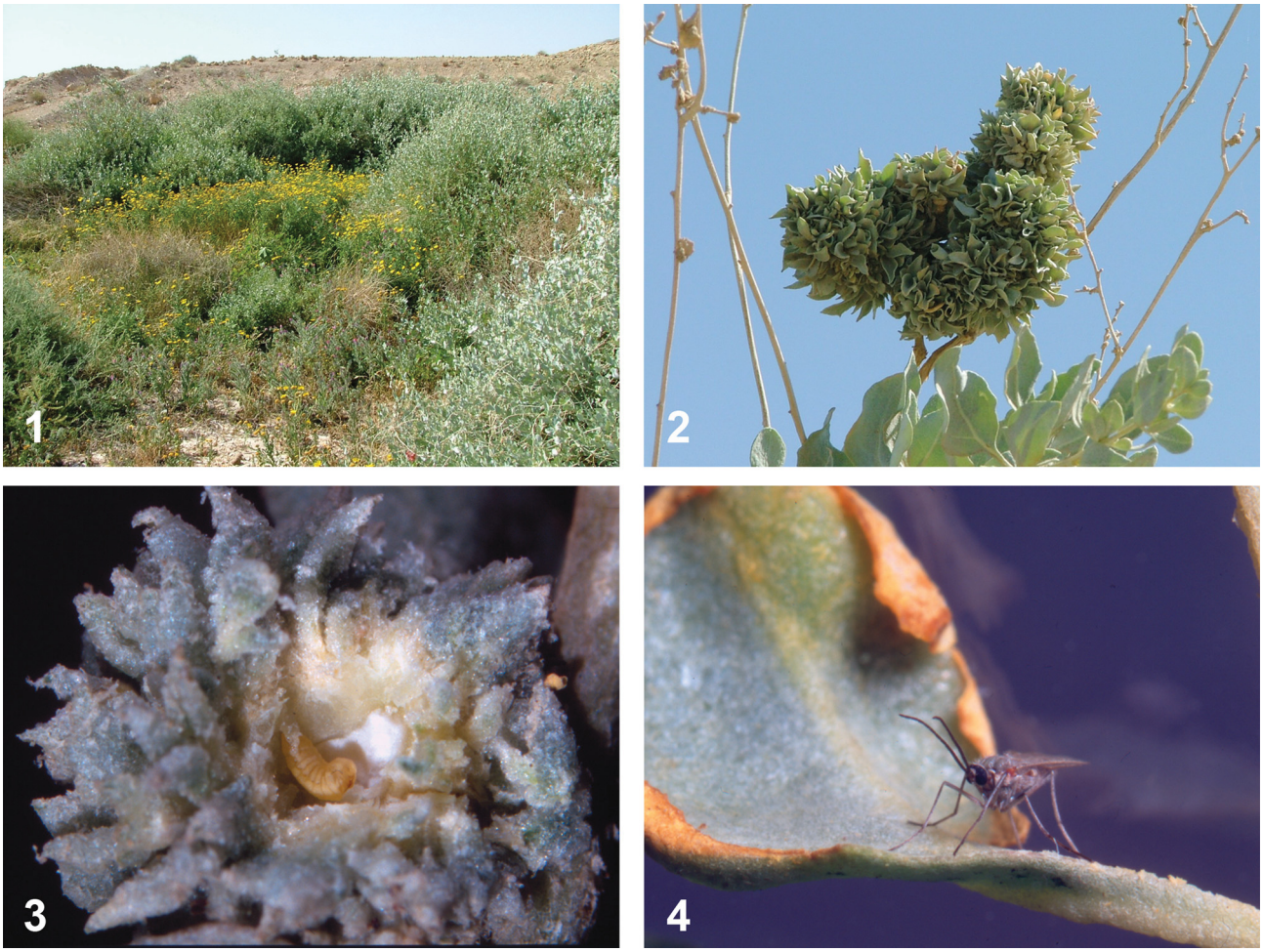
Gall and biology: *Asphondylia punica* induces one of the most common and conspicuous galls in Mediterranean desert and salt-marsh habitats. The galls develop in apical and axillary buds of *Atriplex halimus* and are composed of numerous stunted leaves that form dense, spherical rosettes of up to 3cm in diameter (Fig 2) that are clumped together along shoots. Each rosette contains up to 20 larval chambers embedded in spongy tissue and each chamber contains one larva. The internal walls of the larval chambers are lined by a thick layer of white mycelium (Fig. 3). The fresh galls are green but after emergence of the gall midges they become yellowish and may remain on the plant until the next season. In such dry galls the internal complex of larval chambers becomes very rigid and is sometimes left on the shoot after the rosette leaves are shed. The galls are so common that on some bushes they may cover most of the branches and stunt their growth. Their size depends on the number of chambers in them and apparently on the condition of the individual plant. The galls appear on the plant around November–December and reach their final size in February. Development of the second and third larval instars is rapid, and adults emerge during February–March in Israel, and apparently also elsewhere (based on the literature). The galls support a rich community of Hymenoptera parasitoids of several families (De Stefani 1900) but, despite the high mortality rates, it is easy to rear the gall midges in comparison to other *Asphondylia* species on *Atriplex*, because the galls are so numerous and widespread. Rübsaamen, who examined galls collected in Israel in 1897, found pupae of another cecidomyiid species in the galls, which he suspected of being an inquiline (Rübsaamen 1902). However, in years of collecting and rearing these galls in Israel, we never reared any species other than the gall inducer.

Very similar galls to those on *A. halimus* are found on *A. leucoclada* in Israel but are much smaller—up to 0.6 cm—and contain only 2–4 larval chambers per gall. We were able to rear only three adult gall-midges from galls on this host plant and only in October. At other times of the year galls were dry or contained tiny first instars. The differences in gall morphology and emergence times are not reflected in the gall-midge morphology, and therefore we refrain from describing the population from *A. leucoclada* as a separate species until further data become available. *Atriplex leucoclada* and *A. halimus* have overlapping distributions in salty Saharo-Arabian and Mediterranean habitats and are phylogenetically related (Kadereit *et al*. 2010), hence it is plausible that *Asphondylia punica* uses both plants as hosts.

A species belonging to the genus *Stefaniella* (possibly *S. atriplicis* Kieffer) galls stems and leaf mid-veins of *A. leucoclada*, including the leaves that compose the rosette galls of *A. punica* on this host. Thus, it may appear that adult *Stefaniella* emerge from the rosette galls, but on close examination one can find their inconspicuous galls in leaves surrounding the central *Asphondylia* chambers.

Adult: (Fig. 4) General color greyish brown. *Head* (Fig. 8): Eye facets round where not closely adjacent to hexagonal where closely juxtaposed. Palpus 3-segmented, with several strong setae and otherwise covered by microtrichia; first segment only slightly longer than wide, third segment 1.17–2.10 times as long as second. Labella rounded apically, setose and setulose. Antenna: Scape cylindrical, pedicel spherical. Male flagellomeres

cylindrical, all covered by anastomosing loops of circumfila, numerous strong setae and microtrichia; first flagellomere 1.1–1.3 times as long as second. Female flagellomeres 1–9 cylindrical, with only two whorls of circumfila and two transverse connections, numerous strong setae and otherwise covered by microtrichia; first flagellomere 1.3–1.6 as long as second; flagellomeres 7–12 successively shorter; flagellomere 10 only slightly longer than wide; flagellomere 11 as long as wide; flagellomere 12 spherical, wider than long.



FIGURES 1–4. 1.Typical habitat of *Atriplex halimus* (along with other Chenopodiaceae) in the Dead Sea area, Israel. 2. A cluster of *Asphondylia punica* rosette bud galls on *Atriplex halimus*. 3. A gall of *Asphondylia punica* on *Atriplex halimus* cut open to show the white mycelium and the third instar larva. 4. *Asphondylia punica*—adult.

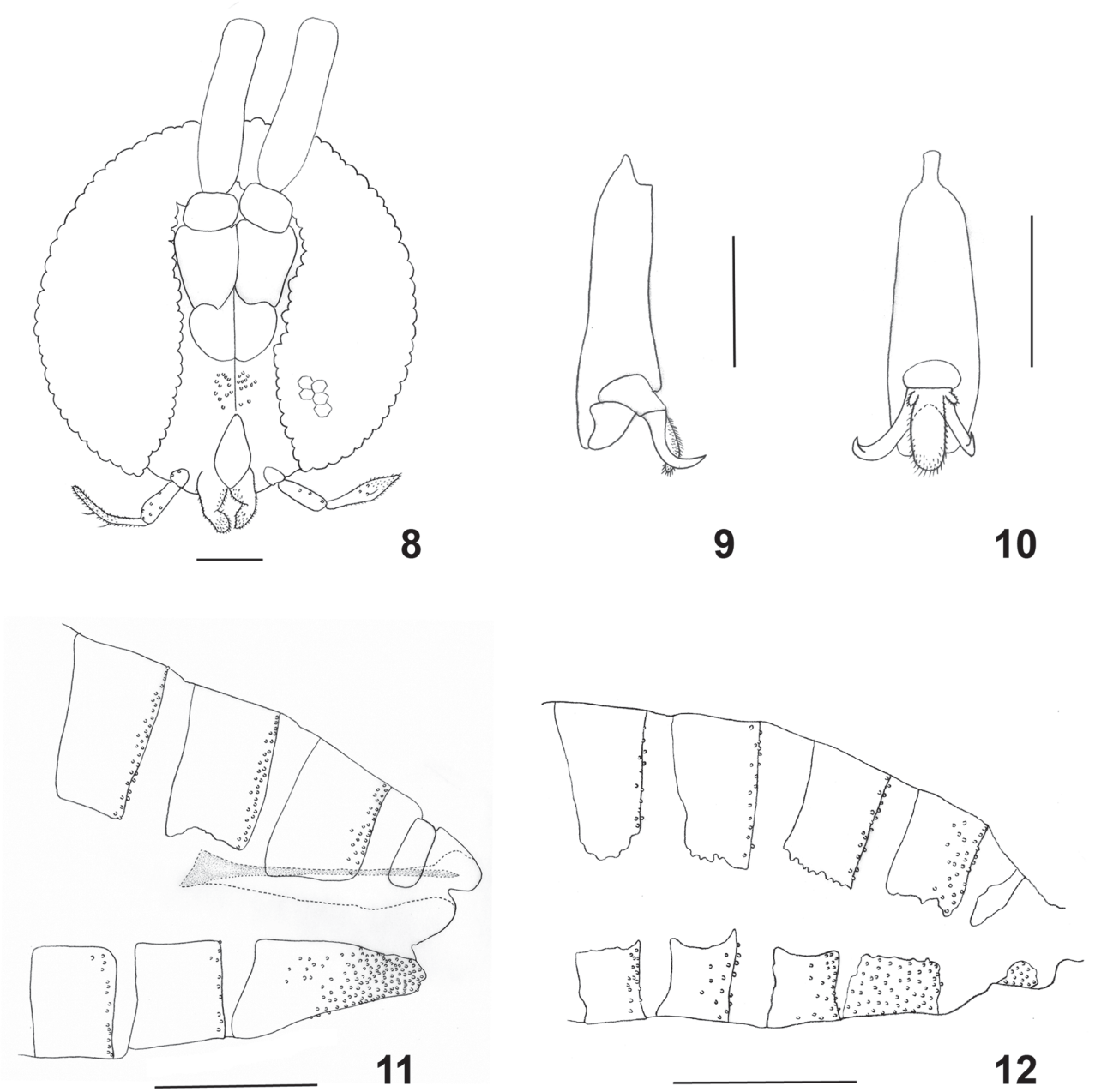
Thorax: Legs: brownish-orange, covered by dark scales and hair; ventral part with silvery hair-like scales. Tarsal claws thick, evenly curved, untoothed; empodia as long as or longer than bend in claw, pulvilli minute (Figs. 9–10). Wing: hyaline, veins brownish-orange, with sparse microtrichia; length 2.56–3.14 mm in females (n=16), 2.34–2.99 mm in males (n=16); R_1 joins C at about mid-length of wing, R_5 joins C behind wing apex, M weak, CuA forked into CuA1 and CuA2.

Female abdomen (Fig. 11): Brownish-orange, pleuron and venter with silvery hair-like scales. Tergites 1–7 with posterior 1–2 rows of strong setae; tergite 8 much shorter than preceding, without setae. Sternites 2–6, with posterior row of setae and several setae on mid part; sternite 7 much longer than preceding, strongly setose on posterior half. Ovipositor relatively short: sclerotized part 1.20–1.66 as long as sternite 7 (n=14).

Male abdomen (Fig. 12): Color pattern as in female. Tergite 1 narrower than succeeding tergites without setae; tergites 2–7 rectangular, with posterior 1–2 rows of strong setae and evenly scattered scales; tergite 7 more setose on posterior half than preceding; tergite 8 much smaller than preceding, band-like, without setae. Sternites 2–6 rectangular, with 1–2 posterior rows of strong setae and several strong setae medially, otherwise evenly covered by scales. Sternite 7 more setose than preceding. Sternite 8 with small but strongly setose sclerotized area. *Terminalia* (Figs. 13–14): Gonocoxite compact, wide and short, bearing numerous strong setae particularly along medial

margin and evenly setulose. Gonocoxal apodeme extending on both sides of aedeagus base forming elongate sclerotized structures. Gonostylus ovoid, with numerous strong setae and otherwise evenly setulose, bearing bidentate apical tooth. Aedeagus cylindrical, tapered towards rounded apex. Hypoproct deeply divided apically into two lobes, setose and setulose, with two longer apical setae on each lobe. Cerci completely or almost completely separated, bulbous, strongly setose and setulose throughout.

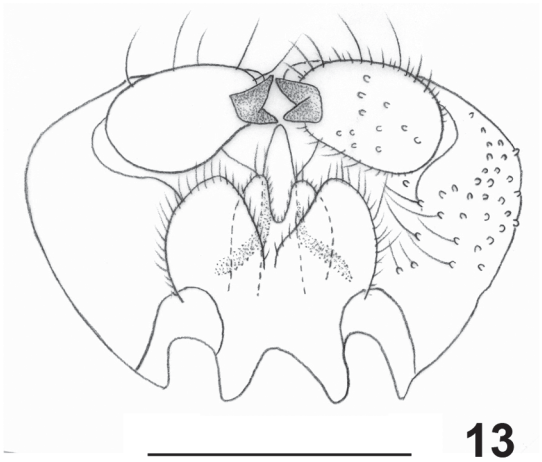
FIGURES 5–7. 5. The habitat of *Atriplex lanfrancoi*—an endemic plant of sheer seaside cliffs in the Maltese islands. 6. Fleshy bud galls of *Asphondylia scopuli* on *Atriplex lanfrancoi*. 7. *Asphondylia scopuli* gall on *Atriplex lanfrancoi* with pupal exuviae stuck in the gall.

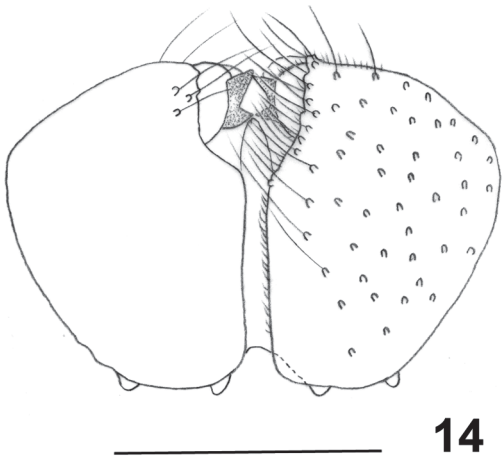


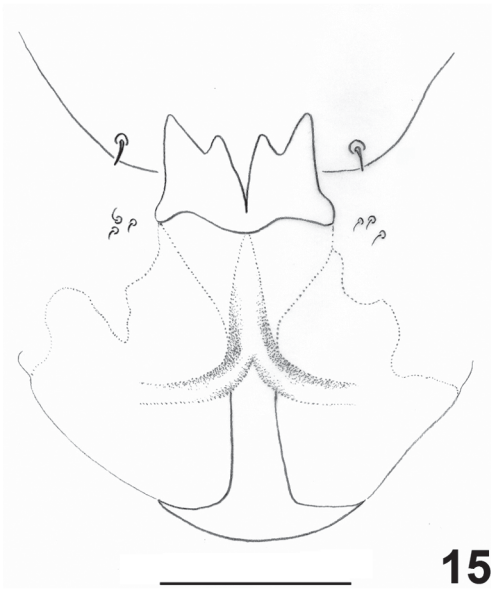
FIGURES 8–12. *Asphondylia punica*. 8. Head. frontal 9. Acropod, lateral. 10. Acropod, ventral. 11. Female post-abdomen, lateral. 12. Male post-abdomen, lateral. Scale bars = 0.1 mm.

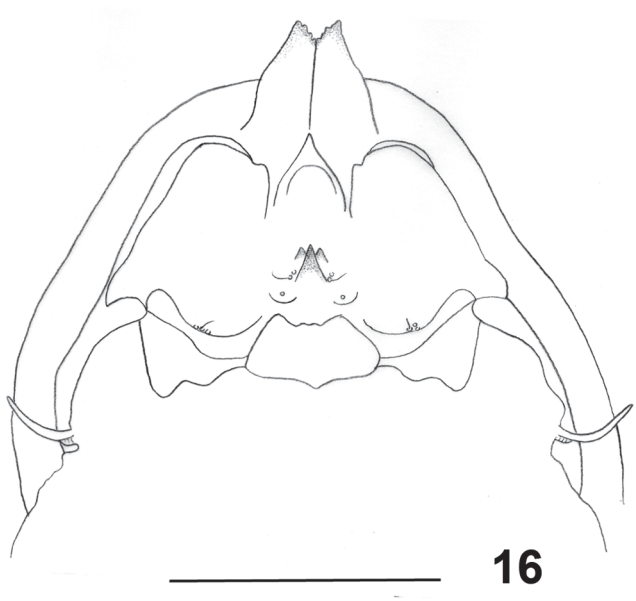
Larva (third instar) (Figs. 3, 15): 1.9–2.5 mm long (n=3). Light to bright orange. Integument with pointed, shallow bumps. Antennae three times as long as wide; cephalic apodeme longer than head capsule. Spatula quadridentate, strongly scleortized; lateral teeth longer than median teeth, gap between median teeth much deeper than gaps between lateral and median teeth. Shaft long and wide at base, with two strongly sclerotized arms at mid-length and weaker sclerotization throughout area posterior to teeth and around shaft. Three setose lateral papillae on each side of spatula. Pleural papillae with long setae.

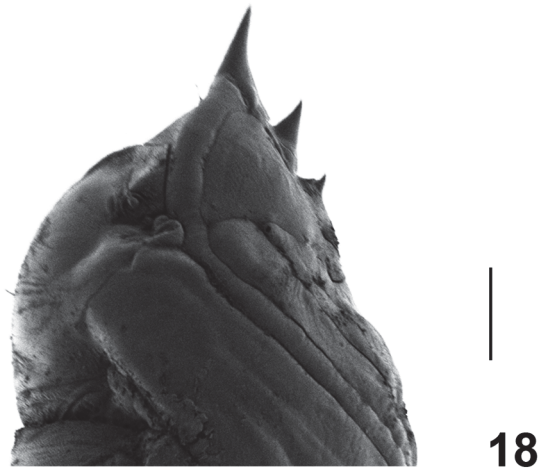
Pupa (Fig. 16): 2.8–4.0 mm long (n = 13). Antennal horns slightly arched, apices tapered and serrated in frontal view. Cephalic seta minute. Upper facial horn large and tapered. Three lower facial horns arranged in a triangle, middle one much larger than two lateral, slightly curved anteriorly; lateral horns situated anteriorly from middle horn, pointed ventrally; on each side of middle horn two papillae, one bearing long seta. One asetose papilla on each side slightly posterior to three facial horns. Posterior part of frons on each side with three lateral papillae, one setose, two asetose. Prothoracic spiracle long and slender, with trachea ending close to base. Abdominal segments except for first, each with one posterior straight row and one anterior less ordered row of spikes.











FIGURES 13–18. 13. *Asphondylia punica*, male terminalia, dorsal. 14. *Asphondylia punica*, male terminalia, ventral. 15. *Asphondylia punica*, larval spatula and associated papillae. 16. *Asphondylia punica*, exuviae, head. 17. *Asphondylia scopuli*, pupal head, frontal. 18. *Asphondylia scopuli*, pupal head, lateral. Scale bars = 0.1 mm, except Figs. 17–18 = 200µm.

Material examined. The types of *A. punica* Marchal from Tunisia could not be found in the Muséum National d'Histoire Naturelle, Paris, where they were supposedly kept, and those of *A. conglomerata* De Stefani from Sicily are considered lost (Gagné & Jaschhof 2014), hence we could not compare those types to our specimens. Nevertheless, the original descriptions and illustrations of the galls leave little doubt that the species we reared in Israel is indeed *A. punica*.

From *Atriplex halimus*: 3 exuviae, Israel, Park Yeroham, 16.iii.1995, N. Dorchin; 4♀, 3♂, 2 exuviae, Israel, Nahal Nizzana, 17.iii.1995, N. Dorchin; 2♀, 1♂, Israel, Qalya, 19.ii.1996, N. Dorchin; 6♀, 5♂, Israel, Sede Boqer, 13.iii.2002, N. Dorchin; 3♀, 4♂, Israel, Sede Boqer, 30.iii.2004, N. Dorchin; 2♂, Israel, Enot Zuqim, 10.iii.2013, N. Dorchin; from *Atriplex leucoclada*: 1♂, 2 exuviae, Israel, Be'er Sheva, Zomet Eshel, 1.x.2001, A. Freidberg; 2♀, 1 exuviae, 1pupa, Israel, Beer Sheva, Zomet Eshel, 17.x.2013, N. Dorchin.

Distribution. Circum-Mediterranean: Algeria, Tunisia, Libya, Egypt, Israel, Syria, Greece, Italy, Spain.

Comments. *Asphondylia punica* was described by Marchal (1897) from a single female that was reared in late March from galls collected in Tunisia. The description was accompanied by a good drawing of the galls. Three years later, De Stefani (1900) described *Asphondylia conglomerata* from Sicily from the same host, and attributed to it three types of galls: large rosettes on non-flowering twigs, small rosettes on flowering twigs, and round, bare galls in leaf axils. The detailed drawings of the rosette galls in that publication closely resemble those provided by Marchal, and the only morphological distinction De Stefani makes between the two species is that adults of *A. conglomerata* are generally red whereas those of *A. punica* are brown. Houard (1908, 1922), in his illustrated keys to galls of Africa, Europe, and the Mediterranean Region, separated *A. conglomerata* from *A. punica* based on the number of chambers in the galls and whether they are induced on flowering or non-flowering stems. His keys are accompanied by an excellent drawing of *A. punica* galls, showing multiple larval chambers in cross section. Yet another good description of *A. conglomerata* galls was given by Rübsaamen (1902), who examined galls that were collected in Israel, near Jericho. Rübsaamen compared these galls with those from De Stefani's collection, but he does not say why he decided that the Israeli galls and the exuviae found in them belong to *A. conglomerata* rather than to *A. punica*. Color differences between adults and the diversity in gall size are hardly reliable characters to justify separation between gall-midge species. We therefore make *A. conglomerata* a junior synonym of *A. punica*.

In Israel, there is great diversity in the size and number of chambers of rosette galls on *Atriplex halimus*, which probably reflects the condition of the plants on which they develop. This can account for the size differences mentioned by De Stefani between rosette galls on flowering and non-flowering shoots. The third type of gall attributed by De Stefani (1900) to *A. conglomerata* is a small, spherical and glabrous gall in leaf axils. This is almost certainly a misidentification of the galls induced by *Stefaniella atriplicis*, which develops in stem and leaf mid-vein galls of various sizes on the same host plant. Rübsaamen (1902) examined such galls from Israel but they were already empty when he received them.

Asphondylia scopuli Dorchin & Mifsud, n. sp.

Gall and biology. This species induces fleshy, spherical bud galls, 4–5 mm in diameter, in leaf axils of *Atriplex lanfrancoi* (Figs. 6–7). The galls are green to pinkish and covered by whitish fuzz similar to ungalled plant parts. Each gall contains a single larval chamber, the inside walls of which are lined by white mycelia. The species is apparently univoltine, with adults emerging in May. Larvae are heavily parasitized by numerous species of parasitic Hymenoptera so that repeated collecting over several years has yielded only a handful of adult gall midges. The galls superficially resemble those of *A. caudicis* Gagné in leaf axils of *Atriplex canescens* in North America (Hawkins *et al*. 1986). It is possible that, like *A. caudicis*, *A. scopuli* has more than one generation a year and induces galls in different plant parts in different seasons, but such galls have not yet been found.

Adult: As in *A. punica* except for the following: third palpal segment 1.26–1.66 times as long as second; first antennal flagellomere 1.19–1.25 times as long as second in male, 1.47–1.52 as long as second in female.

Thorax: Wing length 2.30–2.42 mm in females (n=4), 1.98–2.19 mm in males (n=3).

Female abdomen: Sclerotized part of ovipositor 1.48–1.68 as long as sternite 7 (n=4).

Larva: unknown.

Pupa (Figs. 17–18): 2.81–3.46 mm long (n = 4).

Material examined. Holotype: ♂, Malta, Migra Ferħa, 5–25.v.2012, D. Mifsud, deposited in TAUI.

Paratypes: 4♀, 2♂, 5 exuviae (2 on microscope slide, 3 glued to cardboard), same data as holotype (2♀ NMNH, others TAUI); 1 pupa (coated, on SEM stub), same data as holotype, in private collection of DM.

Distribution. Endemic to Malta.

Etymology. The specific epithet is Latin for 'of the cliff', with reference to the unique habitat (seaside cliffs) of the host plant, an endemic to the Maltese Islands.

Notes. *Asphondylia scopuli* is smaller than *A. punica* but we could not find any substantial morphological differences between adults and pupae of the two species, except for those outlined above. Nevertheless, the galls induced by these species are markedly different, as are their host plants; *Atriplex halimus* is a widespread desert and salt-marsh shrub with C_4 photosynthesis, whereas *Atriplex lanfrancoi* is endemic to seaside cliffs in the Maltese islands, and represents an ancient clade within *Atriplex* of species with C_3 photosynthesis (Kadereit *et al*. 2010). It is noteworthy that *A. halimus* is common in the Maltese islands but no galls were observed on it, including in localities where *A. lanfrancoi* galls were found (DM, personal observation). Our data leave us in no doubt that *A. scopuli* and *A. punica* are distinct species.

Chalcidoid parasitoids associated with *Asphondylia scopuli* on *Atriplex lanfrancoi*

Eurytoma sp. nr *dentata* Mayr, 1878

(Chalcidoidea: Eurytomidae)

Eurytoma dentata is known as a parasitoid of *Asphondylia* spp., nine of which (plus one *Contarinia* species) are listed as hosts by Noyes (2012). Mayr (1878) had specimens reared from galls of *Asphondylia sarothamni* Loew and *A. verbasci* Vallot on *Cytisus* and *Verbascum* respectively, and from seed-pods of *Lotus*, *Medicago*, *Genista* and *Coronilla.* Material of *E. dentata*, available for comparison with the Maltese specimens, was reared from galls of *A. verbasci* on *Verbascum sinuatum* from Crete, Cyprus and Turkey (leg. M. Boness), *A. punica* Marchal on *Atriplex halimus* from Cyprus (M. Boness) and *A. sarothamni* on *Cytisus scoparius* from Germany (M. Boness). *Eurytoma dentata* has a broad distribution covering most of Europe and is known from the Caucasus, Central Asia and India east to the Phillipines. An account of the biology of *E. dentata* (under its synonym *E. nesiotes* Crawford), as an ectoparasitoid of *Asphondylia sesami* Felt on *Sesamum indicum*, is given by Tiwari (1974).

Material examined. 4♂ 4♀, Malta, Migra Ferħa, 5–25.v.2012, D. Mifsud, emerged 10–16.vi.2012 from galls of *Asphondylia scopuli* on *Atriplex lanfrancoi*; 2♂ 6♀, same data, emerged 20–30.vi.2012, deposited in the private collections of DM & RA.

Compared with *E. dentata* associated with *Asphondylia* galls on *Cytisus* and *Verbascum,* the specimens reared from *Atriplex lanfrancoi* are small, the mesepisternal tooth is relatively low and less sharply pointed, and the male antennal funicle segments have rather long apical petioles. In addition, the antennal scape is entirely pale in females and very broadly pale basally in males, whereas in specimens of *E. dentata* from *Cytisus*, *Viburnum* and *Atriplex halimus* the scape has very little, if any, pale coloration. These differences prevent a positive identification of the Maltese material as *E. dentata.* The generic placement of *E. dentata* and allied species, currently considered to belong to *Eurytoma*, is unresolved (Lotfalizadeh *et al.* 2007).

Mesopolobus melitensis Askew, n. sp.

(Chalcidoidea: Pteromalidae)

Female (Fig. 19). Length 1.7–2.3 mm. Head and thorax purplish black; propodeum dark blue-green, shiny; gaster dark brown dorsally, the first tergite bluish-green and the sixth with weak greenish reflections, laterally with mainly coppery tints. Antenna with scape and pedicel light brown, funicle segments except the fifth darker brown, clava pale yellow. Legs with coxae dark brown, weakly metallic, colored as thoracic pleura; legs otherwise light brown, the pro- and mesofemora often, and tibiae sometimes, slightly darker; apical tarsal segments and pretarsi dark brown. Wings clear, venation pale testaceous.

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FIGURES 19–22. *Mesopolobus melitensis*. 19. Female, lateral. 20. Male, lateral. 21. Female, head, frontal. 22. Male, head, frontal.

Head (Fig. 21): 1.3 times breadth of thorax, in dorsal view 2.3 times as broad as long, frons slightly protuberant with scrobal depression hardly developed, occiput strongly emarginate, temples about one-seventh of eye length; head in facial view 1.3 times as broad as high. Ocelli small, in a triangle of about 120°, POL twice OOL, OOL rather more than 3 times ocellar diameter. Antennal toruli with upper margins at about lower orbital level. Clypeus with anterior margin very weakly emarginate, striate, striae not extending onto face; face and gena finely and uniformly reticulate. Oral fossa 1.6 times malar space. Left mandible with 3 teeth, right with 4. Antennal scape about equal in length to height of eye, reaching only to about one diameter below anterior ocellus; pedicel plus flagellum 0.8 times as long as breadth of head; pedicel in dorsal view almost 3 times as long as broad, almost as long as the first four flagellar segments; 3 anelli, first two transverse, third subquadrate; first four funicle segments subquadrate, fifth weakly transverse, first funicle segment broader than pedicel; clava a little shorter than three preceding funicle segments, not quite 3 times as long as broad, apex bluntly rounded; sensillae on funicle and claval segments rather sparse, in single transverse row on each segment.

Mesosoma 1.2 times as long as broad; pronotum with collar almost one-quarter length of mesoscutum (holotype) but sometimes shorter, not carinate anteriorly but abruptly angled into anterior face of pronotum which is vertical to dorsal plane of mesonotum, pronotal neck concealed in dorsal view; mesoscutum 2.3 times as long as broad; scutellum almost circular and almost as long as combined length of mesoscutum and pronotum; sculpture of thoracic dorsum finely reticulate, dull, areoles on scutellum only about half diameter of those on mesoscutum, pronotal collar without posterior shiny strip; mesepisternum with ventral half weakly reticulately sculptured. Propodeum medially about 0.4 times as long as scutellum; median area between lateral plicae rather more than twice as broad as long, median carina extending over about anterior two-thirds, divided posteriorly into two carinae which run into the curved, converging lateral plicae behind well-developed apical foveae; nucha short; median area and nucha smooth, shiny; spiracles about one-third of median length of propodeum, almost touching metanotum. Legs rather stout, pro- and metafemora about 3.3 times as long as broad.

Forewing: costal cell bare on upper surface, a few setae on apical one-third of under surface; basal cell and basal vein bare; speculum large, open below, extending to stigmal vein on upper surface as a strip behind marginal vein; disc of forewing quite densely setose, but setae short and pale; apical fringe developed. Lengths of costal cell: marginal vein: stigmal vein: postmarginal vein as 325:152:134:148 in holotype, somewhat variable, but marginal vein always slightly longer than postmarginal vein and postmarginal vein 1.1 to 1.3 times as long as stigmal vein.

Gaster: ovate, 1.1 (holotype)—1.3 times as long as rest of body and twice as long as broad, slightly narrower than thorax; basal tergite occupying about one-fifth of total length, its posterior margin evenly curved; last tergite slightly broader than long; ovipositor sheath somewhat projecting; apex of hypopygium about 0.4 times gaster length.

Male (Fig. 20). Length 1.0–1.3mm. Head and mesosoma purplish black, only face and propodeum with greenish tints; gaster (including aedeagus) entirely bright testaceous, almost orange. Antenna except clava pale testaceous; clava with two basal segments dark brown, third segment mostly pale yellowish. Legs with coxae mostly concolorous with thorax, otherwise bright yellowish testaceous excepting brown tarsal claws.Wings faintly brownish.

Head (Fig. 22): with reticulate sculpture, that on gena just behind malar sulcus rather finer than elsewhere but shining, without patch of very fine, dull sculpture. Antenna with scape about 10 times as long as broad, not reaching level of anterior ocellus; pedicel plus flagellum 0.8 times as long as breadth of head; pedicel almost as long as anelli plus first funicle segment; flagellum thin basally, first funicle segment scarcely broader than third anellus and only half as broad as pedicel, funicle segments 1–4 slightly longer than broad, fifth funicle segment quadrate, about 0.7 times as long as pedicel and slightly narrower than clava; clava ovate, about 2.5 times as long as broad.

Gaster: oval, about as long as mesosoma.

Material examined. Holotype: ♀, Malta, Migra Ferħa, 3.vi.2012, D. Mifsud, ex galls of *Asphondylia scopuli* (Diptera, Cecidomyiidae) on *Atriplex lanfrancoi*, emerged between 23–30.vi.2012, deposited in the National Museums of Scotland, Edinburgh (NMS). Allotype: ♂, same data as holotype, emerged between 5 and 20.vi.2012, deposited in NMS. Paratypes: 7♀, same data as holotype, emerged 23–30.vi 2012; 14♂, same data as holotype, emerged 5–20.vi.2012; other material examined: 2♀, 5♂, same data as holotype, emerged as holotype and allotype respectively; 1♀, same data as holotype, emerged 30.vi.2012; 1♂, same data as holotype, emerged 23.vi.2012. paratype depositories: 2♀, 2♂ NMS; 2♀, 3♂ TAUI; 2♀, 3♂ in private collection of DM; 1♀, 6♂ in private collection of RA.

Etymology. *Mesopolobus melitensis* is named after Melita, an ancient name for the island of Malta.

Comments. *Mesopolobus melitensis* belongs to a small group of species which are parasitoids in galls of Cecidomyiidae and characterized by a short, squat mesosoma with the mesoscutum about twice as broad as long. Females have blackish bodies with purplish tints but males are more greenish, with pale legs, and gasters more or less yellowish. Antennae in both sexes have three anelli and five funicle segments. In females of this group, the antennal clava is usually paler than the remainder of the antenna, but in males (where known) it is mostly darker.

The group has a Mediterranean distribution and comprises *Mesopolobus maculipennis* (Mercet 1923) (reared from galls of *Stefaniola* on *Salsola*), *M. flaviclavatus* (Ferrière 1952), *M. meridionalis* Garrido & Nieves-Aldrey (1996) and *M. melitensis*, together with an undescribed species from Spain and Portugal (reared from galls of *Stephaniella atriplicis* (Kieffer) on *Atriplex halimus*, an unidentified cecidomyiid in flowers of *Halimione portulacoides*, and *Rhopalomyia* on *Artemisia*) mentioned by Askew *et al.* (2001) as *M. ? flaviclavatus*. The hosts of *M. flaviclavatus* and *M. meridionalis* are unknown.

Females of *M. melitensis* may be distinguished from those of *M. flaviclavatus* and *M. meridionalis* by the relative length of the gaster, which in *M. flaviclavatus* is nearly 1.6 times as long as the rest of the body (and described as fiery red laterally and ventrally) (Ferrière 1952, von Rosen 1960), and in *M. meridionalis* only 0.7 times as long. In both *M. melitensis* and *M. maculipennis* the female gaster is 1.1–1.3 times as long as the combined lengths of head and mesosoma. The forewing of *M. melitensis* has a complete apical fringe, but in *M. maculipennis* this is absent between the end of the postmarginal vein and the wing apex. Also, the postmarginal vein in *M. melitensis* is nearly as long as the marginal vein, whereas in *M. maculipennis* it is only about 0.7 times as long. In females of *M. melitensis* the whitish clava contrasts conspicuously with the dark funicle segments, but in females of *M. maculipennis* the color difference between clava and funicle segments is much less evident. The head of *M. melitensis* in profile is narrower than that of *M. maculipennis*, and the tegula in *M. melitensis* is dark, whereas in *M. maculipennis* it is pale. The male of *M. melitensis* has an entirely bright yellowish-orange gaster and differs strikingly from that of *M. maculipennis* in which the gaster is dark with pale coloration restricted to part of the ventral surface and a broad sub-basal band on the dorsal surface. Males of *M. flaviclavatus* and *M. meridionalis* are unknown.

***Eupelmus* (*Macroneura*) *muellneri* Ruschka, 1921**
(Chalcidoidea: Eupelmidae)

Eupelmus muellneri is a brachypterous Palaearctic species known from the Canary Islands, southern Europe (north of the Czech Republic), North Africa and the former USSR. It is polyphagous but strongly associated with gall-forming hosts on herbaceous plants and shrubs. Hosts in Lepidoptera (Pyralidae), Diptera (Cecidomyiidae, Tephritidae), Hymenoptera (Cynipidae, Eurytomidae) and, improbably, Hemiptera (Aphidoidea) are cited in Noyes (2012). Specimens of *E. muellneri* reared from the following hosts have been examined:

Lepidoptera, Gelechiidae, *Oecocecis guyonella* (Guenee) on *Limoniastrum* (Tunisia, Djerba Island, leg. M. Boness) (new host record); Diptera, Cecidomyiidae, *Stefaniella atriplicis* (Kieffer) on *Atriplex halimus* (Portugal, Spain, Tunisia); *Asphondylia punica* Marchal on *Atriplex halimus* (Cyprus) (new host record), unidentified cecidomyiid galls on *Artemisia* (Spain) and *Capparis spinosa* (Cyprus); Diptera, Tephritidae, *Myopites* sp(p). on *Inula* (mainland Spain and Majorca); Hymenoptera, Cynipidae, *Isocolus lichtensteini* (Mayr) on *Centaurea nicaensis* (Formentera), *Phanacis helminthiae* (De Stefani) on *Picris aculeata* (Sicily, leg.V. Rocco Lo Duca, R.R. Askew) (listed under *Phanacis ?caulicola* in Askew *et al.* 2006), *Timaspis cichorii* Kieffer on *Cichorium intybus* (Spain, leg. A. Ribes) (new host record), *Diplolepis eglanteriae* (Hartig) on *Rosa sempervirens* (Malta, Wied Incita, D. Mifsud) and *Diplolepis* sp. on *Rosa* (Spain).

Material examined. 13♀, Malta, Migra Ferħa, 5–25.v.2012, D. Mifsud, emerged 13–20.vi.2012 from galls of *Asphondylia scopuli*; 6♀, same data, emerged 26–30.vi.2012, all deposited in the private collections of DM & RA.

It is noteworthy that only females of *E. muellneri* were reared in Malta from both *Asphondylia scopuli* (19 individuals) and *Diplolepis eglanteriae* (3 individuals). In comparison, the ratio of males to females reared from cecidomyiid galls elsewhere approximates 1:2.

***Neochrysocharis violaceus* Askew, 1999 (Eulophidae)**

Neochrysocharis violaceus was described from specimens reared from galls of *Asphondylia conglomerata* De Stefani (Cecidomyiidae) on *Atriplex halimus* collected in the Canary Islands by U. Sellenschlo (Báez & Askew 1999). Subseqently, several specimens were captured in Los Monegros, Spain, one of which was reared from a gall of *Stefaniola salsolae* (Tavares) (Cecidomyiidae) on *Salsola vermiculata* (Askew *et al.* 2001), and M. Boness reared *N. violaceus* from galls of the following Cecidomyiidae:

29♂ 81♀ ex unidentified species in flowers of *Halimione portulacoides* (Portugal);

2♀ ex *Asphondylia verbasci* on *Verbascum sinuatum* (Portugal) (new host record);

2♀ ex *Lasioptera eryngii* (Vallot) on *Eryngium maritimum* (Menorca) (new host record).

Material examined. 2♂ 5♀, Malta, Migra Ferħa, 5–25.v.2012, D. Mifsud, emerged 5–20.6.2012 from galls of *Asphondylia scopuli*; 5♀, same data, emerged 24–30.vi.2012.

The finding of *N. violaceus* in Malta represents a considerable eastwards extension of its hitherto known range.

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