

On some arthropods associated with *Ficus* species (Moraceae) in the Maltese Islands

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ABSTRACT. An account is given on the 39 arthropod species which were found on different *Ficus* trees in the Maltese Islands. Seventeen species represent new records for Malta including *Anothopoda fici*, *Asetadiptacus emiliae*, *Astichus bachmaieri*, *Ecpnylus caudatus*, *Empoasca alsiosa*, *Eupristina verticillata*, *Ficocyba ficaria*, *Gynaikothrips ficorum*, *Josephiella microcarpae*, *Philotrypesis caricae*, *Pleistodontes* sp., *Rhaphitelus maculatus*, *Rhyncaphytoptus ficifoliae*, *Scobicia chevrieri*, *Silba adipata*, *Singhiella citrifolii* and *Zanchius breviceps*. *Anothopoda fici* and *Zanchius breviceps*, also represent new records for the entire European territory. Of the 39 arthropods, 33 feed on *Ficus* trees, whereas the rest are either parasitoids or predators of some of these plant feeders. The 33 species which use *Ficus* as their host-plant spend most of their development on and utilise the aforementioned trees as their main source of food, at least during their larval development. The 33 species were grouped as follows:

- (i) Seven species were associated with wood including *Scobicia chevrieri*, *Metholcus cylindricus*, *Deroplia troberti*, *Niphona picticornis*, *Hypoborus ficus*, *Hypocryphalus scabricollis* and *Hypothenemus leprieurii*;
- (ii) Seventeen species were plant sap feeders including *Zanchius breviceps*, *Empoasca alsiosa*, *Ficocyba ficaria*, *Homotoma ficus*, *Bemisia tabaci*, *Singhiella citrifolii*, *Toxoptera aurantii*, *Greenidea ficicola*, *Planococcus ficus*, *Pseudococcus longispinus*, *Ceroplastes rusci*, *Coccus hesperidum*, *Saissetia oleae*, *Lepidosaphes conchiformis*, *Anothopoda fici*, *Asetadiptacus emiliae* and *Rhyncaphytoptus ficifoliae*;
- (iii) Six species induce galls either inside the florets of syconia, such as *Blastophaga psenes*, *Odontofroggattia galili*, *Eupristina verticillata* and *Pleistodontes* sp., or in the leaves, such as *Josephiella microcarpae* and *Gynaikothrips ficorum*;
- (iv) Two species feed on the tissue of syconia, namely *Ceratitidis capitata* and *Silba adipata*;
- (v) One species has larvae that specialise in eating the leaf tissue, namely *Choreutis nemorana*.

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Of these 33 arthropods, fifteen species are polyphagous. Two additional species namely *Hypoborus ficus* and *Greenidea ficicola* even though generally associated with *Ficus carica* or *Ficus* spp. respectively, have been associated with few other unrelated host-plants and as such should be considered polyphagous. *Ficocyba ficaria* is a dioecious species, host alternating between *Ficus carica* in summer and *Lonicera* in winter. The rest of the species are generally either associated with different *Ficus* (oligophagous) or with just one species (monophagous) as for most gall inhabiting species. New host-plant records include: *Ficus carica* for *Metholcus cylindricus*, *Zanchius breviceps* and *Anothopoda fici*; *Ficus elastica* for *Toxoptera aurantii*, and *Ficus microcarpa* for *Anothopoda fici* and *Asetadiptacus emiliae*. Additionally, the predatory bug, *Montandoniola moraguesi* feeding on *Gynaikothrips ficorum* was also found. Three parasitoids were found associated with the larvae of *Hypoborus ficus*. These include the ectoparasitic brachonid, *Ecphylus caudatus* and the chalcid parasitoids, *Rhaphitelus maculatus* and *Astichus bachmaieri*. A third species of chalcid parasitoid, *Encyrtus aurantii* was found associated with *Coccus hesperidum* and the kleptoparasite, *Philotrypesis caricae* was found in association with *Blastophaga psenes*.

KEY WORDS. Malta, galls, Hymenoptera, Hemiptera, Coleoptera, Diptera, Thysanoptera, Lepidoptera, Eriophyoidea.

INTRODUCTION

The Maltese vascular flora is composed of about 1,100 different species of which around 800 are presumed to be indigenous, the rest being naturalised aliens. In the Maltese Islands the genus *Ficus* is represented by 10 species, of which none is a true native. *Ficus carica* Linnaeus is the only economically important *Ficus* in Malta, commonly known as the fig tree. It can grow up to 8 m in height (Fig. 1). *Ficus carica* produce edible fruits which represent a popular agricultural commodity in Malta with average wholesale quantities sold through organised markets between 1995 and 2000 of: 140,279 kilograms for early figs, 13,544 kilograms for late figs and 19,154 kilograms for dry figs (ANONYMOUS, 2002). *Ficus carica* is an archeophyte to Mediterranean-type countries. BORG (1922) described 32 different varieties of fig trees which were grown in Malta at that time. Apart from cultivation, this tree can be found growing in a wide range of habitats including maquis, rocky places, and valleys, between crevices and on disturbed grounds such as cliffs.

During British rule, new *Ficus* species and other decorative species started appearing in the Maltese Islands. In the early 1800s and especially after World War II, *Ficus microcarpa* Linnaeus (Fig. 2) and *F. benjamina* Linnaeus (Fig. 3) were imported, mostly from Sicily, by the government for street and square planting (J. Borg, *pers. comm.*, 2012). *Ficus microcarpa*, also commonly found in scientific literature under the names of *F. nitida* (Thunberg) Miquel and *F. retusa* Linnaeus (the latter often considered as a distinct species), is a popular ornamental plant in many countries. *Ficus microcarpa* and *F. benjamina* are both native to Southeast Asia and Australia. In Malta, *F. benjamina* is much less common in the open than *F. microcarpa*. Other *Ficus* species introduced in Malta include *Ficus rubiginosa* Desfontaines ex Ventenat (Fig. 4) and *Ficus elastica* Roxburgh (Fig. 5). *Ficus rubiginosa* (sometimes referred to as *Ficus australis* Willdenow) is native to Australia and the tree is quite common in Malta. This species of *Ficus* has never been known to fruit in Malta, and large individuals of this tree have been mostly planted over the past 10-20 years. Other species of *Ficus* found in the Maltese Islands in small numbers in public places or private gardens include *F. vasculosa* Wallich ex Miquel, *F. hookeri*



Figure 1: *Ficus carica*; **Figure 2:** *Ficus microcarpa* with detail of leaves and syconia; **Figure 3:** *Ficus benjamina* with detail of leaves and syconia; **Figure 4:** *Ficus rubiginosa* with detail of leaves and syconia; **Figure 5:** *Ficus elastica*; **Figure 6:** *Ficus lyrata*.

Miquel, *F. macrophylla* Desfontaines ex Persoon, *F. altissima* Blume, and *F. lyrata* Warburg (Fig. 6).

Few works have been found which document the entomofauna associated with *Ficus* in the Mediterranean. LONGO *et al.* (1998) lists several species of aphids, scale insects and the thrips, *Gynaikothrips ficorum* which are all associated with *Ficus* spp. in Italy. LO VERDE *et al.* (2007) dealt with the Agaonidae which occur in Europe and their role in the naturalisation of *Ficus* spp. in Italy. The work lists six species of fig wasps associated with the syconia of different *Ficus* spp.

Studies and information on the occurrence of arthropods associated with *Ficus* spp. in Malta are mostly lacking. BORG (1922) described pests and diseases associated with the common fig, *Ficus carica* in his book entitled “*Cultivation and diseases of fruit trees in the Maltese Islands*”. One major disadvantage of this book is that it does not always specify whether the species mentioned therein were actually observed in Malta. He mentioned four insects which are associated with *Ficus carica* namely, the pollinating fig wasp, *Blastophaga psenes* (under the name *Blastophaga grossorum*) where he stated that it is common on the fig tree and it is its exclusive pollinator. He also mentioned the scale insect, *Ceroplastes rusci*, which causes the tree to shed its foliage prematurely and the fruits fail to ripen; the fruit fly, *Ceratitis capitata* and the fig fly *Lonchaea aristella*. For the latter, he mentioned that it is a common species in Malta. These two flies cause considerable damage by laying their eggs in the syconia, cause the fruit to rot and make them unsellable (BORG, 1922). SALIBA (1963) in his work on the insect pests of crop plants, lists six species of insects which can be found on the fig tree in Malta namely *Ceratitis capitata*, *Ceroplastes rusci*, *Chrysomphalus aonidum*, *Diaspidiotus ostreaeformis* (under the name *Quadraspidiotus ostreaeformis*), *Lepidosaphes conchyiformis*, and *Lonchaea aristella*. Most other publications dealing with insects found in Malta, provide annotated faunistic lists, in which mention of single records were found in association with *Ficus* spp. Thus, BORG (1919) among other scales, mentioned two associated with *Ficus carica*; the fig scale (*Ceroplastes rusci*) and the oystershell scale (*Lepidosaphes ulmi*). In the early 1930's, a follow-up work was published by BORG (1932) with a more complete list of scale insects found in Malta. In this work he included six species that were found in association with *Ficus* namely *Abgrallaspis cyanophylli* (under the name *Aspidiotus cyanophylli*) on *Ficus altissima* and *F. rubiginosa*, *Diaspidiotus ostreaeformis* on *F. carica*, *Lepidosaphes conchyiformis* (under the name *Lepidosaphes ficifoliae*) on *F. carica*, *Ceroplastes rusci* as very common on *F. carica*, *Ceroplastes sinensis* on *F. carica* and *Planococcus ficus* (under the name *Pseudococcus ficus*) as frequent on the fruit and foliage of the common fig. CARUANA GATTO (1926) in his work entitled “*Primo contributo alla conoscenza dei zoocidii delle Isole Maltesi*” mentioned *Blastophaga psenes* (under the name *Blastophaga grossorum*) as a common wasp that causes and develops in galls of the caprifig (*Ficus carica*). Information on the occurrence of this pollinating wasp in Malta was also provided in a semi-popular article written by VOVLAS & VOVLAS (2010). In a revisionary work on the bark beetles of Malta (MIFSUD & KNIŽEK, 2009), three species were found in association with *Ficus* spp. *Hypoborus ficus* associated with *Ficus carica*; *Hypocryphalus scabricollis* on *Ficus microcarpa* and other *Ficus* spp. and *Hypothenemus lepriurii* on *F. carica*. In the original description of *Alaocyba melitensis* (MAGNANO & MIFSUD, 1998) material of this species was found while sifting through 20-40 cm soil under *Ficus carica* and *Quercus ilex* and the species may be associated with roots of these trees. MIFSUD (2008) mentioned the aphid *Greenidea ficicola* as a species feeding on *Ficus microcarpa*. LO VERDE & PORCELLI (2010) report for the first time the presence of the non-pollinating fig wasp *Odontofroggata galili*, as strictly associated with *Ficus microcarpa*. The same authors predicted the presence of the true pollinator of *F. microcarpa*, *Eupristina verticillata*, in the Maltese Islands due to the self-regeneration of young fig trees in remote areas. DE LUCCA (1953), VALLETTA (1973) and SAMMUT (2000) recorded the moth *Choreutis nemorana* as occurring on *Ficus carica* in Malta.

MATERIAL AND METHODS

The present work was mainly undertaken between June 2011 and May 2012 and different localities in both Malta and Gozo (open fields, alongside roads and public places) were visited aimed at looking for *Ficus* trees. Only those arthropods (and their associated parasitoids/predators) that are strictly associated with *Ficus* were included in the study. These included all species which directly feed on *Ficus* (at least in their larval stages) and as a consequence of this spend most of their life cycle on the mentioned hosts. Visual inspection of the entire tree, including syconia, leaves, branches and trunk was done. Collection from the canopy of the tree was done via sweeping and insects were then collected with an aspirator. Dried twigs and branches, leaves and syconia were collected from all *Ficus* spp. for rearing larvae of beetles, flies, wasps and moths waiting for their complete development into adults. This material was placed separately in plastic jars covered by fine mesh, but in the case of leaf galls, twigs with such infested leaves were placed in water. A similar procedure was adopted for rearing parasitoids of scale insects and other insects found on *Ficus*. Sampled insects were either stored in 70% alcohol or dry mounted. For extraction of eriophyoids, the method developed by MONFREDA *et al.* (2008) was used and material obtained was conserved in 75% ethanol and then, mounted and studied following DE LILLO *et al.* (2010). For histopathological observations, *Ficus microcarpa* foliar galls were retained in FAA (Formaldehyde-Acetic acid solution) for 4-5 days, dehydrated in a tetryary butyl alcohol series, and embedded in paraffin (58°C melting point). Embedded material was sectioned at 10-15 micrometer-thick sections, stained with safranin and fast green and mounted permanently for microscopic examination (JOHANSEN, 1940). The material was mainly collected by Annushka Falzon (AF) and David Mifsud (DM), complimented with other material collected by Francesco Porcelli (FP) and Chris Halumphy (CM) and is conserved in the private collection of DM.

Macro-photography used in this work was done using a Canon EOS 7D digital camera equipped with a Canon MP-E 56mm macro lens and very often with the use of a tripod. For species smaller than 2 mm, a Canon Powershot A80 digital camera mounted on a Zeiss Axioscope was used for slide mounted specimens, and a Zeiss 200-C dissecting microscope was used from insects in alcohol or dry mounted (with the same Canon camera mounted). Photographs were later edited using Photoshop.

RESULTS

For the purpose of the present work, the different species found on *Ficus* were not treated in a phylogenetic or systematic approach but were grouped according to different ecological regimes with respect to their host-plants, *Ficus* spp.: Group 1 includes species associated with wood; Group 2 includes plant sap feeders; Group 3 includes gall-associated species; Group 4 includes species which feed within syconia tissue and Group 5 is represented by a single species, which specialises in feeding on leaf tissue.

ANNOTATED SPECIES LISTS

GROUP 1 - WOOD ASSOCIATED SPECIES

Scobicia chevrieri (A. Villa & J.B. Villa, 1835)
(Coleoptera: Bostrichidae)

Material examined. MALTA: Buskett, 56 adults emerged between 5-25.x.2011 from dead twigs of *Ficus carica* collected on 8.vii.2011, AF & DM.

Notes. *Scobicia chevrieri* (Fig. 7) represents a new record for the Maltese Islands. It is widely distributed in the Mediterranean Region and to some extent in the Near East. It was intercepted in USA and Canada but there are no confirmed records of its establishment in the wild (BAHILLO DE LA PUEBLA *et al.*, 2007). It is a polyphagous species being reported on a wide range of host-plants, where it generally develops in dead or weakened branches of *Castanea* sp., *Ceratonia siliqua*, *Citrus* sp., *Eucalyptus* sp., *Ficus carica*, *Laurus* sp., *Morus alba*, *Olea* sp., *Pinus halepensis*, *P. brutia*, *Pistacia vera*, *Prunus avium*, *Punica* sp., *Quercus calliprinos*, and *Retama monosperma* (NARDI & RATTI, 1995; AKŞIT & ÇAKMAK, 2005; BAHILLO DE LA PUEBLA *et al.*, 2007).

***Metholcus cylindricus* (Germar, 1817)**

(Coleoptera: Anobiidae)

Material examined. MALTA: Buskett, 25.vi.2012, 4 adults emerged from dead branches of *Ficus carica* which were collected on 8.vii.2011, AF & DM.

Notes. *Metholcus cylindricus* (Fig. 8) is widely distributed in southern Europe, Greece, Israel and North Africa. It was reported from Malta by CAMERON & CARUANA GATTO (1907). This anobiid is known to develop in different wood such as that of *Amygdalus*, *Eriogaster*, *Euphorbia*, *Juniperus*, *Macadamia*, *Phoenix*, *Pinus*, *Pistacia*, *Prunus*, *Quercus*, and *Ulmus* (NARDI & RATTI, 1995). The present record of *M. cylindricus* from *Ficus carica* represent a new host-plant record.

***Deroplia torberti* (Mulsant, 1843)**

(Coleoptera: Cerambycidae)

Material examined. MALTA: Buskett, 4 adults emerged between 1-7.x.2011 from dead twigs of *Ficus carica* collected on 8.viii.2011, AF & DM.

Notes. *Deroplia torberti* (Fig. 9) is a typical Mediterranean species. Larval development takes place in dead or dying twigs of mainly broadleaf trees (LA MANTIA *et al.*, 2010). The species was previously reported from the Maltese Islands from Buskett (SCHEMBRI & SAMA, 1986; MIFSUD & BOOTH, 1997) and Wied Qannotta (MIFSUD, 2002).

***Niphona picticornis* Mulsant, 1839**

(Coleoptera: Cerambycidae)

Material examined. MALTA: Dingli, 5.i.1998, 1 adult reared from dead branches of *Ficus carica*, DM; Fomm ir-Rih, 31.iii.1989, 1 adult reared from dead branches of *F. carica*, DM.

Notes. *Niphona picticornis* (Fig. 10) is distributed throughout the Mediterranean Region. Larval development takes place in dead branches and stems of several broadleaf trees and occasionally also in conifers. The species is common in the Maltese Islands and was reported by CAMERON & CARUANA GATTO (1907), SCHEMBRI & SAMA (1986) and MIFSUD (2002).

***Hypoborus ficus* Erichson, 1836**

(Coleoptera: Scolytidae)

Material examined. MALTA: Buskett, more than 110 adults emerged between 5-26.x.2011 from dead twigs of *Ficus carica* which were collected on 8.vii.2011, AF & DM; Paola (Addolorata cemetery), 21 adults emerged on 12.x.2011 from dead twigs of *Ficus carica* collected on 18.viii.2011, AF.

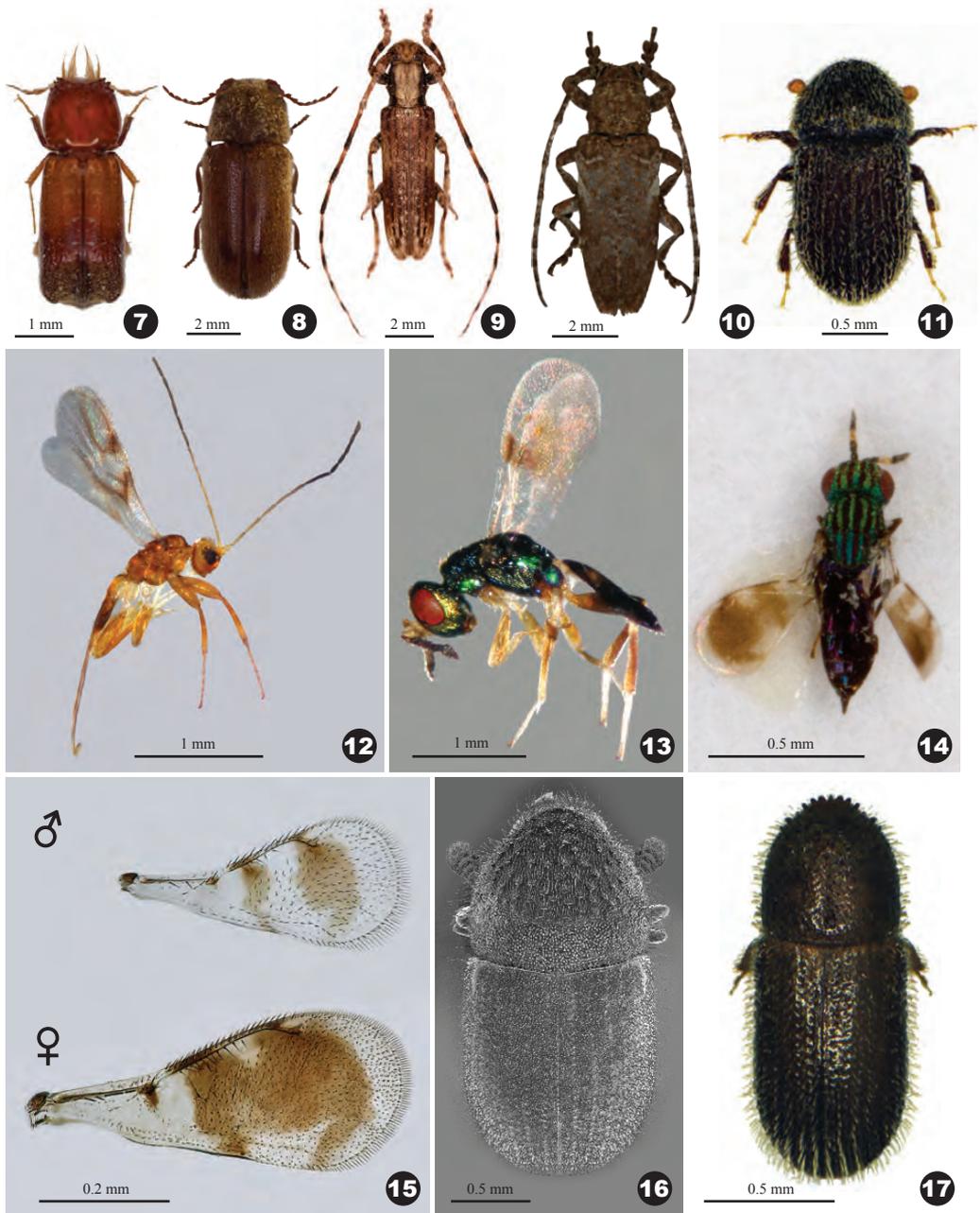


Figure 7: *Scobicia chevrieri*; **Figure 8:** *Metholcus cylindricus*; **Figure 9:** *Deroplia torberti*; **Figure 10:** *Niphona picticornis*; **Figure 11:** *Hypoborus ficus* (after MIFSUD & KNÍŽEK, 2009); **Figure 12:** *Ecpnylus caudatus*; **Figure 13:** *Rhabphitelus maculatus*; **Figure 14:** *Astichus bachmaieri*; **Figure 15:** Male and female forewings of *A. bachmaieri*; **Figure 16:** *Hypocryphalus scabricollis*; **Figure 17:** *Hypothenemus leprieurii* (after MIFSUD & KNÍŽEK, 2009).

Notes. *Hypoborus ficus* (Fig. 11) is widely distributed in Europe, North Africa and the Near East and is mainly found in dead branches of *Ficus carica* but has also been recorded on *Ailanthus altissima*, *Styrax officinalis* and *Vitis vinifera* (MIFSUD & KNIŽEK, 2009). The species is very common in the Maltese Islands and was previously reported by CAMERON & CARUANA GATTO (1907), CILIA (1974) and MIFSUD & KNIŽEK (2009).

Thirty-five specimens of *Ecphylyus (Sactopus) caudatus* Ruschka, 1916 (Fig. 12) (Hymenoptera: Braconidae: Doryctinae) were reared from dead branches of *Ficus carica* infested with the bark beetle, *Hypoborus ficus*. The material was collected from Buskett (Malta) on 8.vii.2011 and the parasitic hymenopteran emerged between the 8-27.ix.2011. The genus *Ecphylyus* currently accommodates more than 55 described species worldwide with a predominantly New World distribution. All species of the genus *Ecphylyus* with known host-parasitoid relationships are larval ectoparasitoids of Scolytidae and rarely Anobiidae, Bostrichidae, Lyctidae and Cerambycidae (BELOKOBYSKIJ & MAETO, 2009). *Ecphylyus* Förster is the type genus of the tribe Ecphylini and easily distinguished from other doryctines by absence of nervellus and submedial cell in hind wing and second radiomedial vein and nervulus in forewing, the closed apically brachial cell of fore wing, the short first flagellar segment of antenna (shorter than second segment), the reduced numbers of segments in maxillary and labial palpi, and the metasoma behind first tergite always smooth. *E. caudatus* was recorded from Algeria, Austria, Croatia, France, Israel, Italy, Morocco, Romania, Russia (European part), Tunisia (Belokobylskij, S., *pers. comm.*, 2012) and now also from Malta. *E. caudatus* is an ectoparasitoid of larval stages of *Hypoborus ficus*, but is also parasitic on other bark beetles, namely *Chaetoptelius vestitus* [on *Pistacia atlantica*] and *Liparthrum colchicum* [on *Laurus nobilis*]; its parasitism on *Pityokteines vorontzovi* and *Sinoxylon sexdentatum* are doubtful and quite possibly due to incorrect determination of parasitoids (Belokobylskij, S., *pers. comm.*).

Another parasitic hymenopteran reared from branches of *Ficus carica* infested with *Hypoborus ficus* was *Rhaphitelus maculatus* Walker, 1834 (Fig. 13) (Hymenoptera: Chalcidoidea: Pteromalidae). The material was collected from Buskett (Malta) on 8.vii.2011 and six specimens of *R. maculatus* emerged between 5-6.x.2011. *Rhaphitelus maculatus* is cosmopolitan in distribution but was not previously recorded from Malta. It is a parasitoid on the larva and pupa of Scolytidae and Curculionidae developing in twigs of various forest trees (XIAO & HUANG, 2001). The genus *Rhaphitelus* currently accommodates three described species having mainly a Palearctic distribution (XIAO & HUANG, 2001).

Thirty-one specimens of a species of chalcid parasitoid, *Astichus bachmaieri* Doğanlar, 1992 (Fig. 14) (Hymenoptera: Chalcidoidea: Eulophidae) were also reared from branches of *Ficus carica* infested with *Hypoborus ficus* collected on 8.vii.2011 from Buskett (Malta). Adults emerged between 5-26.x.2011. The genus *Astichus* currently accommodates 26 described species worldwide (NOYES, 2012). *Astichus* spp. are characterised by bright metallic colours on the head and thorax (often striped), dark patterns on the wings (mottled or banded) and dark funicle with at least one pale segment. Most species are found in association with bracket fungi, where they are parasitic on beetles of the family Ciidae (NESER, 2012). However, *A. bachmaieri* previously known only from Corsica, seems to be parasitic on larvae of *Hypoborus ficus* as also indicated in DOĞANLAR (1992). In the original description of *A. bachmaieri* there is no mention with respect to sexual dimorphism in forewing pattern but our material clearly indicated that this is particularly so (Fig. 15).

***Hypocryphalus scabricollis* (Eichhoff, 1878)**

(Coleoptera: Scolytidae)

Material examined. MALTA: Paradise Bay, 23.xi.2003, 12 adults on *Ficus carica*, DM; Hal Far, 29.ii.2012, 35 adults on dead *F. microcarpa*, DM; Dingli, 100s of adults and larvae collected on 8.vii.2011, from under bark of *F. carica*, AF & DM; Fawwara, 19.vii.2011, 43 adults, on *F. carica*, DM (material was collected from under bark, usually on the main trunk of live *Ficus carica* trees).

Notes. *Hypocryphalus scabricollis* (Fig. 16) was described from the ‘Republic of the Union of Myanmar’ (Burma), in the Indian sub-continent, where the species is native. The species was recorded for the first time from Europe in Malta (MIFSUD & KNIŽEK, 2009) where it is common and widely distributed. This species was probably introduced in Malta via commerce of cultivated *Ficus microcarpa* and is now being more commonly found on *Ficus carica* where considerable economic damage is reported on apparently healthy trees.

***Hypothenemus leprieurii* (Perris, 1866)**

(Coleoptera: Scolytidae)

Material examined. MALTA: Buskett, two adults emerged between 5-26.x.2011 from dead twigs of *Ficus carica* which were collected on 8.vii.2011, AF & DM.

Notes. *Hypothenemus leprieurii* (Fig. 17) is reported from several Mediterranean countries. It was previously reported from the Maltese Islands by MIFSUD & KNIŽEK (2009) and *Ficus carica* is the only known host-plant for this bark beetle.

GROUP 2 - PLANT SAP FEEDERS***Zanchius breviceps* Wagner, 1951**

(Hemiptera: Miridae)

Material examined. MALTA: Paola (Addolorata), 18/21.viii.2011, 4 nymphs and 23 adults, AF; M’Xlokk, 5.viii.2011, 1 adult, AF; Fgura, 10.viii.2011, 1 adult, AF; Msida, 10 adults, 20.viii.2011, DM (all material was collected from the lower surface of leaves of *Ficus carica*).

Notes. *Zanchius breviceps* (Fig. 18) was described from Egypt and is also known to occur in Israel, Syria, Iraq, Saudi Arabia, Sudan, Nigeria, Burkina Faso, Niger, Chad, Eritrea, Yemen and Iran (LINNAVUORI, 2009; A. Carpezza, *pers. comm.*, 2012). The present records for Malta are new for this territory, and for Europe. Malta now represents the northernmost distribution for this species. *Zanchius breviceps* is a polyphagous species known to have various hosts, including *Calotropica procera*, species from the family Malvaceae such as *Abutilon* spp., and *Tamarix* spp. (LINNAVUORI, 2009). *Ficus carica* represents a new host-plant record for this mirid bug.

***Empoasca alsiosa* Ribaut, 1933**

(Hemiptera: Cicadellidae)

Material examined. MALTA: Buskett, 8.vii.2011, 3 ♂♂, 2 ♀♀ and 2 nymphs, on underside of leaves of *Ficus carica*, AF & DM.

Notes. *Empoasca alsiosa* is a north Mediterranean species and represents a new record for Malta. It is a polyphagous species which lives on both monocotyledons and dicotyledons (V. D'Urso, *personal communication*, 2012).

***Ficocyba ficaria* (Horvath, 1897)**

(Hemiptera: Cicadellidae)

Material examined. MALTA: Buskett, 8.vii.2011, 4 ♂♂, 5 ♀♀ and 3 nymphs, AF & DM; Paola (Addolorata), 21.viii.2011, 4 ♀♀ & 1 ♂, AF. GOZO: Fontana, 20.viii, 2011, 5 ♂♂, 13 ♀♀ and 4 nymphs, AF & DM (all material was collected under leaves of *Ficus carica*).

Notes. *Ficocyba ficaria* (Fig. 19) is a typical Mediterranean species and represents a new record for the Maltese Islands. It is a dioecious species, which is found on *Lonicera* spp. in winter, and on *Ficus carica* in summer (VIDANO, 1960).

***Homotoma ficus* (Linnaeus, 1758)**

(Hemiptera: Homotomidae)

Material examined. MALTA: Buskett, 21.vii.2011, 2 ♂♂ & 3 ♀♀, AF & DM, same locality, 8.vii.2011, 12 empty 5th instar nymph casts, 20 ♂♂ & 13 ♀♀, AF & DM; Paola (Addolorata cemetery), 18.viii.2011, 26 ♀♀ & 29 ♂♂, AF (all collected from leaves of *Ficus carica*).

Notes. *Homotoma ficus* (Fig. 20) occurs in Central and Southern Europe, and is widely distributed in the Mediterranean basin. It has been introduced in England and North America (MIFSUD *et al.*, 2010). It was previously reported from Malta by MIFSUD (1997). The species is exclusively found on *Ficus carica*. In Malta, this species was abundant on the aforementioned host-plant on foliage close to the ground.

***Bemisia tabaci* (Gennadius, 1889)**

(Hemiptera: Aleyrodidae)

Material examined. MALTA: Żejtun, 20.vi.2011, on the underside of leaves of young *Ficus carica*, growing along road side, AF & DM. GOZO: Mgarr, 20.viii.2011, on the underside of leaves of young *Ficus carica*, AF & DM (material represented by numerous puparia and immature stages).

Notes. *Bemisia tabaci* (Fig. 21) is cosmopolitan in distribution. It is a polyphagous species that is known from over 500 host-plant species assigned to over sixty different families (MARTIN *et al.*, 2000). Adults cause direct and indirect damage to the host plant by feeding and via transmission of over 100 plant viruses. It was recorded for the first time from the Maltese Islands by MIFSUD (1995).

***Singhiella citrifolii* (Morgan, 1893)**

(Hemiptera: Aleyrodidae)

Material examined. GOZO: Victoria, 17.ii.2012, 1 puparium on *Ficus microcarpa*, CM.

Notes. *Singhiella citrifolii* is native to Asia but is now widely distributed throughout the warmer parts of the world including the Eastern Mediterranean (Lebanon, Morocco) and the Middle East (Iran) (MARTIN, 2000). The species represents a new record for Malta. It is a polyphagous species with a preference for *Citrus*.

***Toxoptera aurantii* (Boyer de Fonscolombe, 1841)**

(Hemiptera: Aphididae)

Material examined. MALTA: Żejtun, 15.vii.2011, 14 apterae and several nymphal stages on new shoots of *Ficus elastica*, AF & DM.

Notes. *Toxoptera aurantii* (Fig. 22) is distributed in warm temperate regions of the World and has been recorded from more than 120 plant species, most belonging to 10 different plant families (BLACKMAN & EASTOP, 2000). It has been recorded on the following species of *Ficus*: *F. akesotsang*; *F. ampelos*; *F. aurantiaca*; *F. carica*; *F. hispada*; *F. ingens*; *F. obscura*; *F. religiosa*; *F. foveolata*; *F. heterophylla*; *F. microcarpa*; *F. pumila*; and *F. tomentosa* (HOLMAN, 2009), and thus, *F. elastica* represents a new host plant record for *T. aurantii*. *T. aurantii* is a very important agricultural pest because it is known to transmit at least nine plant viruses (BLACKMAN & EASTOP, 2000). It was previously recorded from Malta by CARUANA GATTO (1926) and MIFSUD *et al.* (2011).

***Greenidea ficicola* Fakahashi, 1921**

(Hemiptera: Aphididae)

Material examined. MALTA: Zejtun, 24.vi.2011, on *Ficus rubiginosa*, DM; Zejtun, 22.vi.2011, on *F. microcarpa*, AF & DM; Marsaskala, 16.vii.2011, on *F. carica*, DM; Luqa (around airport), 29.vi.2011, on *F. rubiginosa*, DM. GOZO: Muxar, 20.viii.2011, on *F. microcarpa*, AF & DM (material represented by numerous apterae and nymphal stages).

Notes. *Greenidea ficicola* (Fig. 23) is native to Southeast Asia but was accidentally introduced to Italy, Spain, Malta, Africa and the New World (COEUR D'ACIER *et al.*, 2010). It is most commonly found on *Ficus* spp., but it has also been recorded on *Psidium guajava* (BLACKMAN & EASTOP, 2010) and *Artocarpus integrifolia* (SOUSA-SILVA *et al.*, 2005). *Ficus carica* has been mentioned in the



Figure 18: *Zanchius breviceps*; **Figure 19:** *Ficocymba ficaria*; **Figure 20:** *Homotoma ficus*; **Figure 21:** *Bemisia tabaci*; **Figure 22:** *Toxoptera aurantii*; **Figure 23:** *Greenidea ficicola*.

literature as a host-plant of *G. ficicola* both in natural and under laboratory conditions (BELLA *et al.*, 2009), however, the presence of this aphid on the aforementioned host-plant has been rarely observed in Sicily (BELLA & MAZZEO, 2009). During the present study, the species was encountered only once on *Ficus carica* (in Marsaskala) where small colonies were observed mainly on teneral leaves and young syconia. It was previously reported from Malta by MIFSUD (2008).

***Planococcus ficus* (Signoret, 1875)**

(Hemiptera: Pseudococcidae)

Material examined. MALTA: Marsaxlokk/Delimara (Tas-Silg), 5.vii.2011, on *Ficus carica*, AF, DM & FP (material represented by numerous adult and immature stages).

Notes. *Planococcus ficus* (Fig. 24) is widely distributed in the Mediterranean basin, the Near East, South Africa and Argentina (COX, 1989; WALTON & PRINGLE, 2004). It is a polyphagous species that is particularly damaging to *Vitis vinifera* (COX, 1989). *Planococcus ficus* was recorded for the first time in Malta by BORG (1919) under the name *Dactylopius vitis*, and was reported again by MIFSUD & WATSON (1999).

***Pseudococcus longispinus* (Targioni Tozzetti, 1867)**

(Hemiptera: Pseudococcidae)

Material examined. MALTA: Valletta, 4.vi.2012, on *Ficus rubiginosa*, DM; Żejtun, 29.iii.1994, on *Ficus microcarpa*, DM (material represented by numerous adult and immature stages).

Notes. *Pseudococcus longispinus*, commonly known as long-tailed mealybug, is a cosmopolitan and polyphagous species previously recorded from the Maltese Islands by BORG (1932) and MIFSUD & WATSON (1999).

***Ceroplastes rusci* (Linnaeus, 1758)**

(Hemiptera: Coccidae)

Material examined. MALTA: Żejtun, 26.x.2011, on *Ficus microcarpa*, AF; Msida, 14.x.2011, on *F. carica*, DM; Paola (Addolorata) 18.viii.2011, on *F. carica*, AF, same locality, 13.vii.2011, on *F. carica*, AF. **GOZO:** Munxar, 20.viii.2011, on *F. carica*, AF & DM; Xlendi, 20.viii.2011, on *F. rubiginosa*, AF & DM (material represented by numerous adult females and different larval instars).

Notes. *Ceroplastes rusci* (Figs. 25, 26) is almost cosmopolitan in distribution and probably native to the Afro-tropical Region (VU *et al.*, 2006). Commonly known as the fig wax-scale, it is a polyphagous species living on various host plants from numerous families. In the present study, *C. rusci* was often found in large numbers covering entire leaves and branches of *Ficus carica* and was previously recorded from Malta by BORG (1919; 1932) and SALIBA (1963).

***Coccus hesperidum* Linnaeus, 1758**

(Hemiptera: Coccidae)

Material examined. MALTA: Żejtun, 5.vii.2011, on *Ficus microcarpa*, AF, DM & FP (material represented by numerous adult females and immature stages, attended by the ant *Crematogaster scutellaris*).

Notes. *Coccus hesperidum* (Fig. 27) is a cosmopolitan species which is polyphagous having been found on almost every kind of plant except grasses (GILL, 1988). Commonly known as the brown soft scale, this species was reported from Malta by BORG (1919; 1932) under the name *Lecanium hesperidum* and SALIBA (1963).

From *Coccus hesperidum* collected from Żejtun, 1 ♂ & 18 ♀♀ of a parasitoid belonging to the Family Encyrtidae (Hymenoptera: Chalcidoidea) emerged between 8-12.vii.2011. This parasitoid was identified as *Encyrtus aurantii* (Geoffroy, 1785) (Fig. 28), a cosmopolitan species in distribution. *Encyrtus aurantii* was previously recorded from Malta by FARRUGIA (1998) under its synonym, *E. lecaniorum* Mayr, 1876. He reared the species from the same scale host, *Coccus hesperidum*, which was collected on citrus trees and *Morus alba*. Species of the genus *Encyrtus* are readily recognised by the tuft of setae at the apex of the scutellum and infused forewing with a short marginal vein and long postmarginal and stigmatic veins (NOYES, 1988). Host scale insects for *E. aurantii*, include *Ceroplastes rusci*, *C. sinensis*, *Coccus hesperidum*, *C. pseudomagnoliarum*, *C. viridis*, *Eulecanium tiliae*, *Parthenolecanium corni*, *P. fletcheri*, *Pulvinaria psidii*, *P. floccifera*, *Saissetia coffeae*, *S. oleae*, *S. privigna*, *Parasaissetia nigra*, *Sphaerolecanium prunastri* and *Eucalymnatus tessellatus* (JAPOSHVILI & KARACA, 2007).

***Saissetia oleae* (Olivier, 1791)**

(Hemiptera: Coccidae)

Material examined. MALTA: Żejtun, 10.vii.2011, on *Ficus carica*, DM. GOZO: Fontana, 20.viii.2011, on *F. carica*, AF & DM (material represented by numerous immature and adult scales).

Notes. *Saissetia oleae* (Fig. 29), an Afrotropical species in origin, is now considered as cosmopolitan in distribution. Commonly known as the black olive scale, this species is polyphagous and is recorded from over 60 plant families (PELLIZZARI & GERMAIN, 2010). BORG (1919) reported the species for the first time from Malta under the name *Lecanium oleae*, and it was subsequently reported by BORG (1932), SALIBA (1963) and HABER & MIFSUD (2007).

***Lepidosaphes conchiformis* (Gmelin, 1790)**

(Hemiptera: Diaspididae)

Material examined. MALTA: Marsaxlokk (Tas-Silg), 5.vii.2011, on *Ficus carica*, AF, FP & DM. GOZO: Munxar, 20.viii.2011, on *F. carica*, AF & DM (material represented by numerous adult female scales).

Notes. *Lepidosaphes conchiformis* (Fig. 30) is probably Asian in origin (TAKAGI, 1970). The species is recorded from North Africa, throughout Europe, South America (Argentina and Chile), the Near and Middle East, and Australia (MILLER & DAVIDSON, 2005). It is a polyphagous species that has been reported on over sixty plant species from eighteen different families. However, in the Mediterranean Region, this species is generally found on *Ficus carica* (BALACHOWSKY, 1954). *Lepidosaphes conchiformis* was previously recorded from Malta by BORG (1932) under the name *Lepidosaphes ficifoliae*, where he stated that it is “very common on the lower surface of the leaves of the common fig (*Ficus carica*) and also of *Ficus Pseudo-carica* and *Ficus Parcelli*.” It was also reported by SALIBA (1963) as uncommon, mostly on figs.

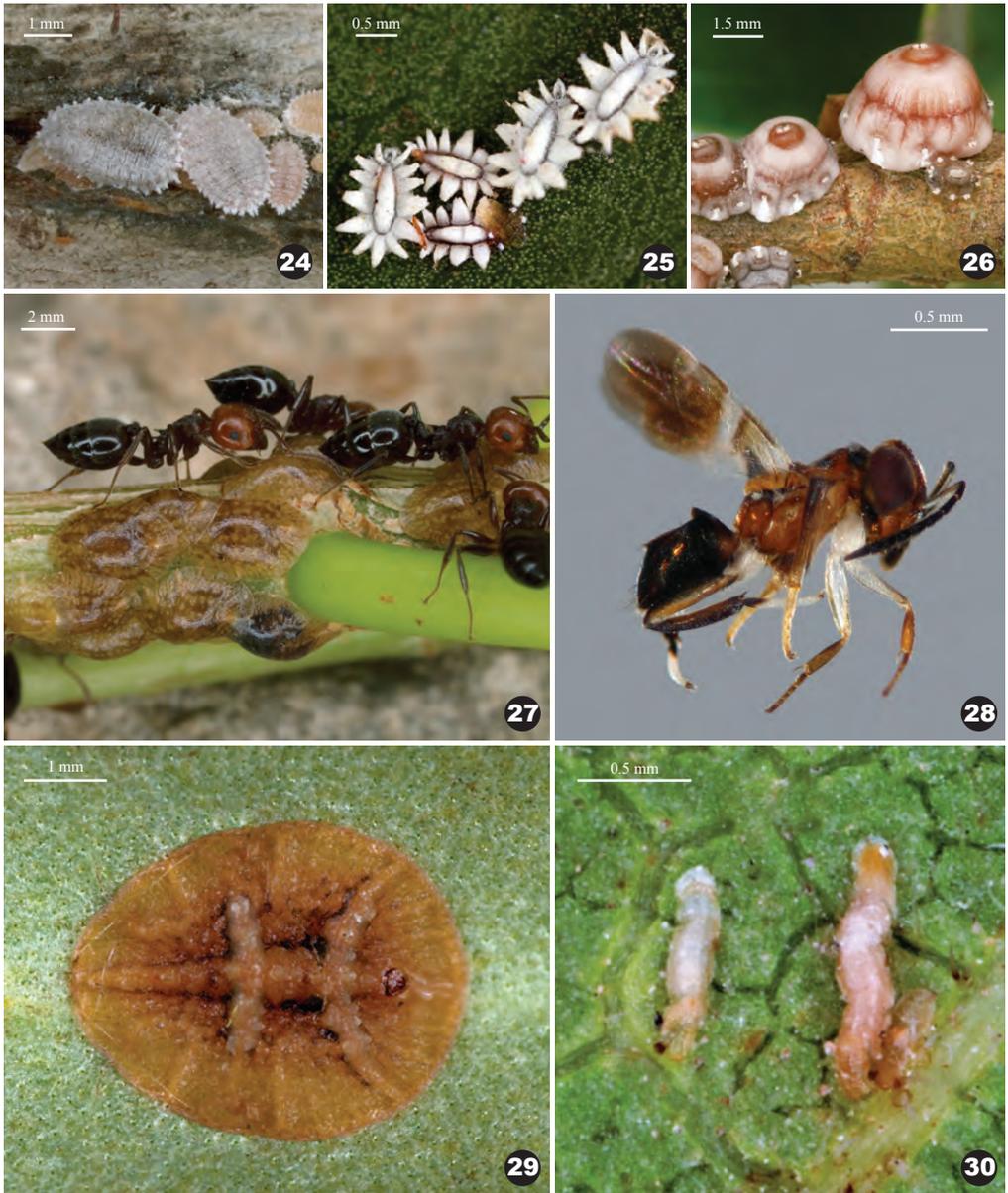


Figure 24: *Planococcus ficus*; **Figure 25 - 26:** *Ceroplastes rusci*; **25:** nymphs; **26:** adult females; **Figure 27:** *Coccus hesperidum* attended by the ant *Crematogaster scutellaris*; **Figure 28:** *Encyrtus aurantii* (female); **Figure 29:** *Saissetia oleae*; **Figure 30:** *Lepidosaphes conchiformis*.

***Anothopoda fici* Mohanasundaram, 1982**

(Acari: Eriophyidae)

Material examined. MALTA: Marsaskala, 13.x.2011, on *Ficus carica*, AF; Msida, 3.x.2011, on *F. carica*, AF, same locality, 7.x.2011, on *F. carica*, AF, same locality, 13.x.2011 on *F. microcarpa*, AF, same locality, 13.x.2011 on *F. carica*, AF (material represented by numerous adults and larvae).

Notes. *Anothopoda fici* was known only from India and the present record is new for Malta and the Palaearctic Region. This eriophyoid was originally described on *Ficus* sp. (MOHANASUNDARAM, 1982), therefore both *Ficus carica* and *F. microcarpa* represent new host-plant records for this mite.

***Asetadiptacus emiliae* Carmona, 1971**

(Acari: Diptilomiopidae)

Material examined. MALTA: Marsaskala, 13.x.2011, on *Ficus carica*, AF; Msida, 3.x.2011, on *F. carica*, AF, same locality, 7.x.2011, on *F. carica*, AF, same locality, 13.x.2011 on *F. microcarpa*, AF, same locality, 13.x.2011 on *F. carica*, AF (material represented by numerous adults and larvae).

Notes. *Asetadiptacus emiliae* was known from Croatia, Portugal, Italy and Mexico and it represents a new record for Malta. This eriophyoid has been previously reported only on *Ficus carica* and on a *Ficus* sp. (CARMONA, 1971; PETANOVIĆ, 1988; VILLALOBOS SANTANA & ESPINOZA CARILLO, 1990; DE LILLO, 1997); subsequently, *F. microcarpa* is a new host-plant record for this species.

***Rhyncaphytoptus ficifoliae* Keifer, 1939**

(Acari: Diptilomiopidae)

Material examined. MALTA: Marsaskala, 13.x.2011, on *Ficus carica*, AF; Msida, 3.x.2011, on *F. carica*, AF, same locality, 7.x.2011, on *F. carica*, AF, same locality, 13.x.2011 on *F. microcarpa*, AF, same locality, 13.x.2011 on *F. carica*, AF (material represented by numerous adults and larvae).

Notes. *Rhyncaphytoptus ficifoliae* is widely distributed, mainly where *Ficus carica* and other *Ficus* spp. are native, or have become established. It is known from Armenia, Australia, Bosnia Herzegovina, Bulgaria, Chile, Croatia, Egypt, England, Greece, India, Iraq, Iran, Italy, Macedonia, Portugal, Madeira, Montenegro, Saudi Arabia, Serbia and USA (California) (KEIFER, 1939; CHANNABASAVANNA, 1966; SEPASGOSARIAN, 1975; ZAHER *et al.*, 1978; PERALTA, 1993; DE LILLO, 2004; AL-ATAWI & HALAWA, 2011). It represents a new record for the Maltese Islands and it lives exclusively on *Ficus* spp. (DE LILLO, 1988).

GROUP 3 - GALL INDUCERS***Blastophaga psenes* (Linnaeus, 1758)**

(Hymenoptera: Agaonidae)

Material examined. MALTA: Haġar Qim, 6-10.x.2011, more than 100 females and numerous males emerged from caprifig (*Ficus carica*) fruit collected on 1.x.2011, AF & DM.

Notes. *Blastophaga psenes* (Figs. 31, 32) is native to India but it is now cosmopolitan in distribution since it has been introduced and established in numerous countries where *Ficus carica* is cultivated. It is the pollinator for *Ficus carica* but in India and Africa it also pollinates *Ficus palmata* (WIEBES, 1994). It lives inside the Caprifig syconium and fertilises them in a process called caprifigation. At first an adult female wasp enters a flowering receptacle through a small bracteate opening known as the ostiole (found opposite the petiole) and during this process the female is dusted with pollen from the syconium. The wasp wanders inside the syconium cavity to lay eggs into the pistillate florets, and thus pollinates the non-pistillate florets of the fig. Subsequently, infested florets develop into galls while others form dry, seed-like bodies called achenia (VOVLAS & LARIZZA, 1996; VOVLAS & VOVLAS, 2010). In Malta, *B. psenes* was originally recorded by CARUANA GATTO (1926) under the name *Blastophaga grossorum*.

More than 70 specimens of a kleptoparasite were collected from *Ficus carica* fruit collected from Haġar Qim (Malta) on 1.x.2011. The species was identified as *Philotrypesis caricae* (Linnaeus, 1762) (Chalcidoidea: Pteromalidae). This species is a parasite of the pistillate florets of caprifig syconia. The female wasp (Fig. 33) oviposits in the outside of the syconium of florets that already have developing galls and host a *Blastophaga psenes* larva. The larvae of *P. caricae* emerge from the egg and feed on the tissues of the gall. *Blastophaga psenes* larvae are unable to compete for food and consequently die (VOVLAS & LARIZZA, 1996). Parasitic fig wasps like *P. caricae* have evolved adaptations for syconium life. Such adaptations include long ovipositors to penetrate the syconium from the outside, and most males are apterous enabling them to move easily within the syconium (COOK & RASPLUS, 2003). *Philotrypesis caricae* is known from the Caucasus, France, Israel, Italy, Ukraine, Central Asia and Canada (NOYES, 2012), and represents a new record for the Maltese Islands.

Pleistodontes sp.

(Hymenoptera: Agaonidae)

Material examined. MALTA: Bir id-deheb, 24.vi.2011, more than 120 females and numerous males emerged from syconia of *Ficus rubiginosa*, AF & DM. GOZO: Xlendi, 55 females and numerous males, 20.viii.2011, AF & DM.

Notes. This species represents a new record for Malta. In Europe, the first record of *Pleistodontes* sp. was in 2002 from Sicily (LO VERDE *et al.*, 2007). Two species of *Pleistodontes* were collected, one from *Ficus rubiginosa* and one from *Ficus watkinsiana*. These two species were attributed to the group "*Pleistodontes imperialis*". These species could not be identified to species level as a systematic revision of this group is required (LO VERDE *et al.*, 2007). It is most likely that the *Pleistodontes* sp. (Fig. 34) collected in this study is the same species as the one collected from Sicily on the fruits of the same host-plant. The genus *Pleistodontes* is native to Australia and South East Asia (PEMBERTON, 1923; NOYES, 2012). In Malta, this species was collected from syconia of *Ficus rubiginosa* where it oviposits in the florets, inducing gall formation (Fig. 35).

Eupristina verticillata Waterstone, 1921

(Hymenoptera: Agaonidae)

Material examined. MALTA: Żejtun, 17.vi.2011, 36 adults emerged from mature syconia of *Ficus microcarpa*, AF & DM. GOZO: Xlendi, 20.viii.2011, 3 adults emerged from syconia of *F. microcarpa*, AF & DM.

Notes. *Eupristina verticillata* (Fig. 36) is native to Asia (FARACHE *et al.*, 2009) but it has become established in a number of countries with the introduction of the ornamental tree, *Ficus microcarpa*. *Eupristina verticillata* is the pollinator of *Ficus microcarpa*, the tree on which it is most commonly found; however there are some records of this pollinator on *Ficus benjamina*, which is another possible host (WIEBES, 1992). The data presented here for *E. verticillata* from the Maltese Islands represents a new geographical record; however this species must have been present in Malta for several years due to the self-regeneration of the aforementioned tree in remote areas, as was already hypothesised by LO VERDE & PORCELLI (2010).

***Odontofroggatia galili* Wiebes, 1980**

(Hymenoptera: Agaonidae)

Material examined. MALTA: Msida, 7 ♂♂ & 10 ♀♀, 20.x.2011, AF; Valletta, 32 ♂♂ & 31 ♀♀, 20.ii.2012, AF & DM; Żejtun, 51 ♂♂ & 40 ♀♀, 24.ii.2012, AF & DM. GOZO: Xlendi, 20.viii.2011, 30 ♂♂ & 26 ♀♀, AF & DM (all from syconia of *Ficus microcarpa*).

Notes. *Odontofroggatia galili* (Figs. 36, 37) is native to Asia with records from China, Malaysia, Papua New Guinea, and Taiwan, but is also recorded from Australia, USA, Hawaii, Israel, Greece, Italy and Malta (BOUČEK, 1988; BEARDSLEY, 1998; LO VERDE & PORCELLI, 2010). It is exclusively associated with syconia of *Ficus microcarpa*. The female oviposits through the outside of the syconium by means of an elongated ovipositor that is coiled within the gaster when not in use. The eggs are laid in young ovaries of the syconia which are then transformed into galls when the larvae start feeding (BEARDSLEY, 1998). *Odontofroggatia galili* is considered to be a non-pollinating fig wasp since its presence does not guarantee the production of fertile seeds (LO VERDE & PORCELLI, 2010).

***Josephiella microcarpae* Beardsley & Rasplus, 2001**

(Hymenoptera: Agaonidae)

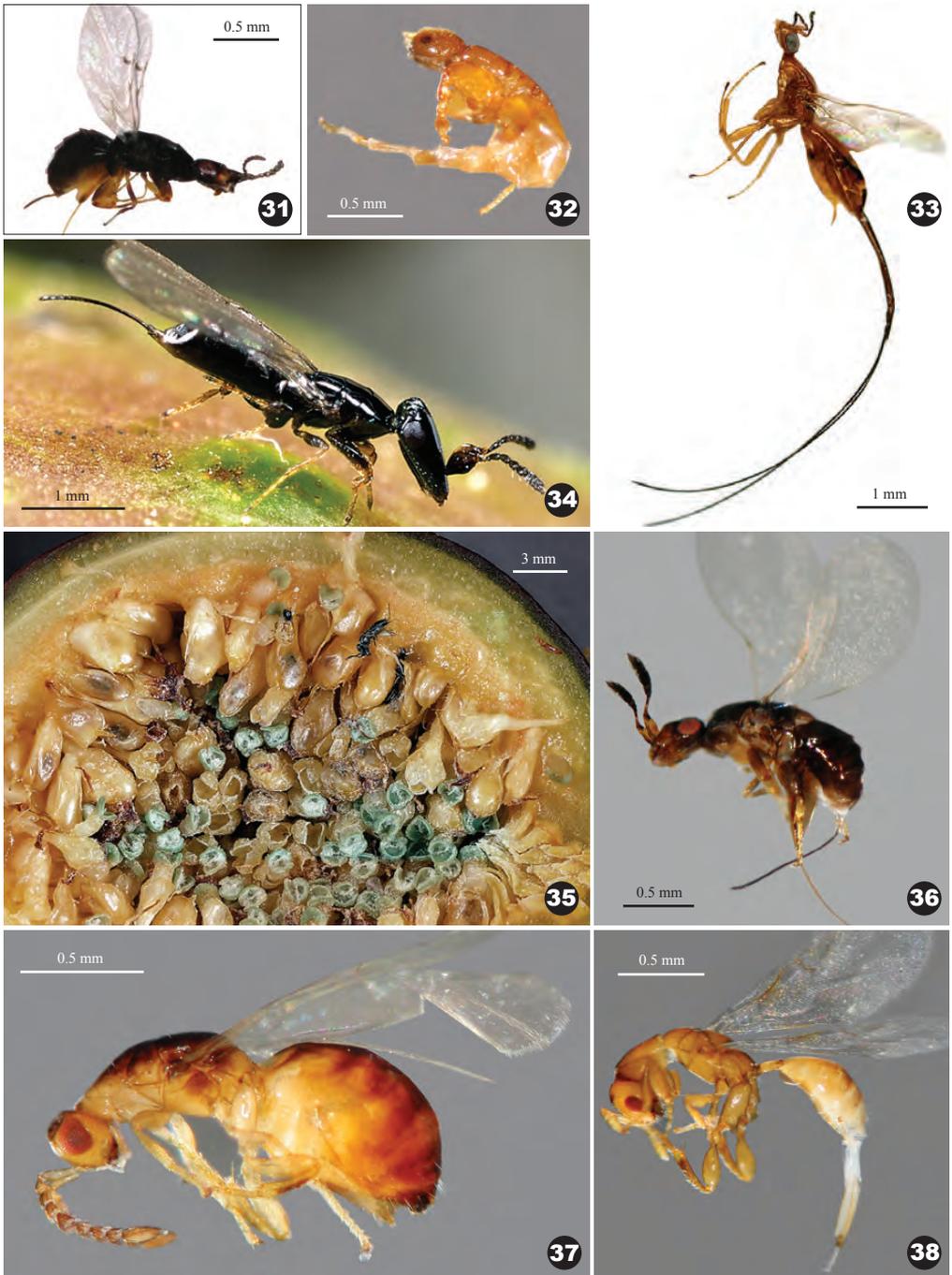
Material examined. MALTA: Msida, 2.vii.2011, 24 adults, DM; Msida, 15.vi.2011, 11 adults, DM; Żejtun, numerous adults emerged on 26.xi.2011 from leaf galls of leaves of *Ficus microcarpa* collected on 19.xi.2011, AF.

Notes. *Josephiella microcarpae* (Fig. 39) is native to Southeast Asia and it has been introduced and established in Hawaii, California, Canary Islands and Italy (including Sicily) (BEARDSLEY & RASPLUS, 2001; RASPLUS *et al.*, 2010). It produces characteristic galls (Fig. 40) in the leaves of *Ficus microcarpa*. The larva inside the leaf of *F. microcarpa* induces the formation of hyperplastic tissue (Figs. 41, 42, 43) around it and this continues to grow until the gall attains its characteristic size. Once the adult insect develops inside the gall, it will leave the gall via an exit hole (Fig. 44) which the insect normally bores on the lower surface of the leaf. This species has two generation per year and emergence of *J. microcarpae* was observed twice during the present study, in May/June and in October. This species represents a new record for the Maltese Islands, however, galls of this species have been observed in Malta since at least 2006 (DM, *personal observation*).

***Gynaikothrips ficorum* (Marchal, 1908)**

(Thysanoptera: Phlaeothripidae)

Material examined. MALTA: Mgarr, 1.ix.2011, AF; Żejtun, 22.vi.2011, AF & DM; Floriana (Argotti), 8.vii.2011, AF & DM; Msida, 13.x.2011, AF; Ta Qali, 28.viii.2011, DM. GOZO: Xlendi, 20.vii.2011, AF & DM (material was all collected from leaves of *Ficus microcarpa* and is represented by numerous adults, immature stage and eggs).



Figures 31 - 32: *Blastophaga psenes*; **31:** female; **32:** male; **Figure 33:** *Philotrypes caricae* (female); **Figure 34:** *Pleistodontes* sp.; **Figure 35:** galls in the florets of syconia of *Ficus rubiginosa* induced by *Pleistodontes*; **Figure 36:** *Eupristina verticillata*; **Figure 37 - 38:** *Odontofroggattia galili*; **37:** female; **38:** male.

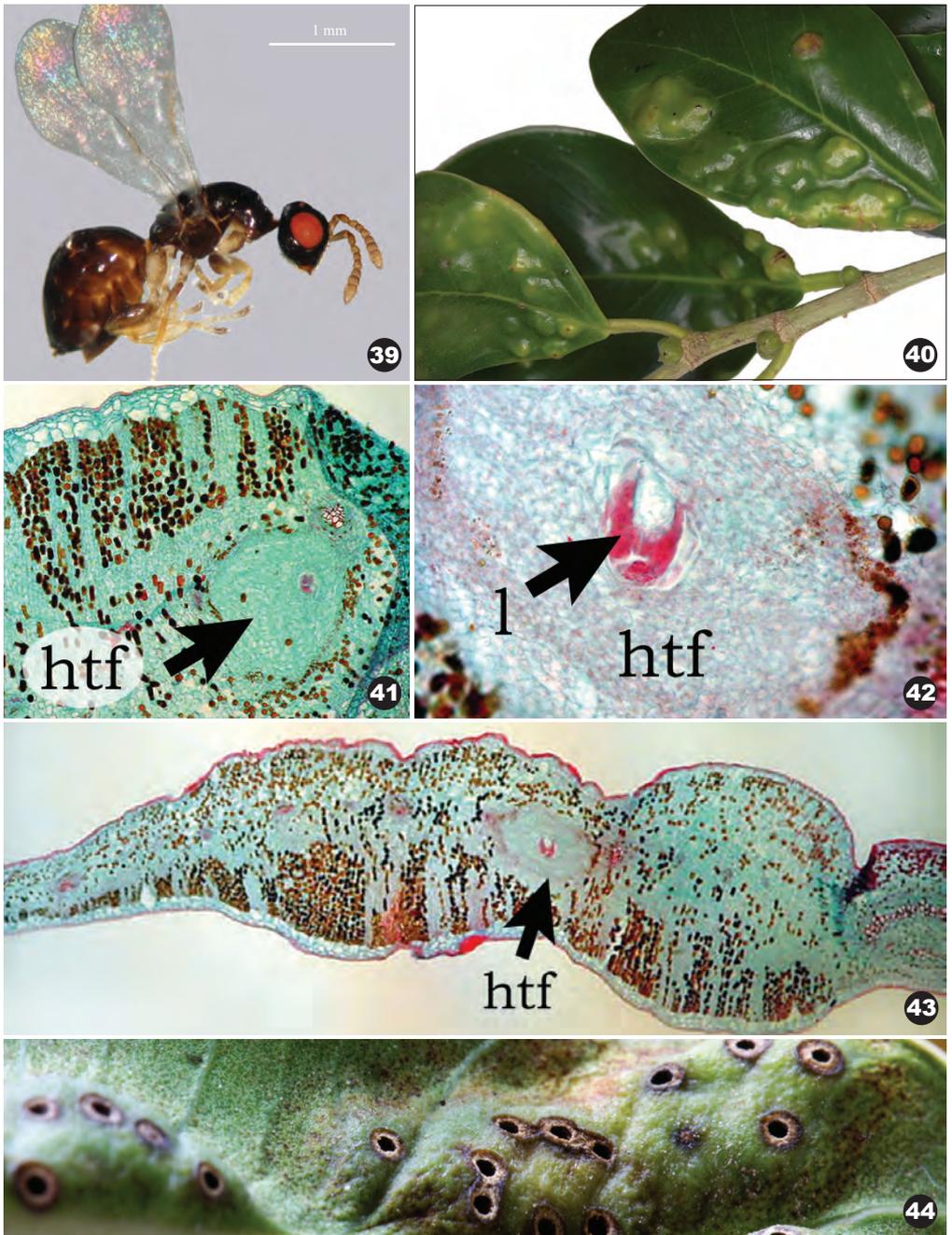


Figure 39: *Josephiella microcarpae*; **Figure 40:** galls on leaves of *Ficus microcarpa* induced by *Josephiella microcarpae*; **Figure 41 - 43:** Transverse histological sections of symptomatic leaf portions showing hyperplastic tissue formation (htf) around each larva (l) at its grown phase; **Figure 44:** Exit holes caused by the emerging adults of *Josephiella microcarpae* on the lower leaf surface of *Ficus macrocarpa* at the end of the disease cycle.

Notes. *Gynaikothrips ficorum* (Fig. 45) is native to Southeast Asia but was intercepted for the first time in the Palaearctic Region from Algeria, and since then it has established in several countries the Euro-Mediterranean Region. It was recorded in Europe for the first time in 1983 from Corsica (REYNAUD, 2010), and represents a new record for Malta, even though the species have been observed in Malta for many years (DM, *personal observation*). Species from the genus *Ficus* are the preferred hosts for *G. ficorum*, especially *Ficus microcarpa*. Larval and adult stages (Figs. 46) of *G. ficorum* cause the infested leaves of the host-plant to become curled (Fig. 47), hard and tough, and gradually turn yellowish-brown until they fall off.

From the various samples of thrips collected during the present study, several specimens of a heteropteran bug belonging to the family Anthocoridae were often collected from within the curled leaves. The species was identified as *Montandoniola moraguesi* (Puton, 1896) (Fig. 48) which is a natural predator of *Gynaikothrips ficorum*. Other thrips which serve as prey includes *Arrhenot ramakrishnae*, *Frankliniella occidentalis*, *Gynaikothrips flaviantennatus*, *Liothrips africanus*, *Liothrips jluggae*, *Liothrips oleae*, *Liothrips urichi* and *Thrips tabaci* (SABELIS & VAN RIJN, 1997). *Montandoniola moraguesi* is native to Southeast Asia, and it has become established in a number of countries, including the USA, either accidentally with the international trade of *Ficus microcarpa* or deliberately for the biological control of thrips. This species has been previously recorded from Malta by PÉRICART (1972) and SCHEMBRI (1993).

GROUP 4 - SYCONIA TISSUE FEEDERS

Ceratitis capitata (Wiedemann, 1824)

(Diptera: Tephritidae)

Material examined. **GOZO:** Munxar, 7 adults emerged on 3.ix.2011 from fruit of *Ficus carica* collected on 20.viii.2011, AF & DM.

Notes. *Ceratitis capitata* (Fig. 49) is native to tropical eastern Africa, but has been introduced in infested fruits by the global fruit trade to many parts of the world. It is a polyphagous species known to attack more than 260 different fruits. The larvae cause damage to the syconia by feeding on the pulp and spreading rotting bacteria. The species was previously reported from Malta by TAGLIAFERRO (1893), BORG (1922), SALIBA (1963) and SCHEMBRI *et al.* (1991).

Silba adipata Mc Alpine, 1956

(Diptera: Lonchaeidae)

Material examined. **MALTA:** Zejtun, 7 adults emerged between 8-12.vii.2011 from fruit of *Ficus carica* collected on 28.vi.2011, DM; Paola (Addolorata Cemetery), 6 adults emerged between 2-8.ix.2011 from fruit of *F. carica* collected on 21.viii.2011, AF. **GOZO:** Munxar, 37 adults emerged on 3-10.ix.2011 from fruit of *Ficus carica* collected on 20.viii.2011, AF & DM; Buskett, 12 adults emerged between 1-6.vii.2011 from fruit of *F. carica* collected on 8.vii.2011, DM.

Notes. *Silba adipata* (Fig. 50) is known from Spain (Mallorca), Italy, Montenegro, Greece, Cyprus, Canary Islands, Syria, Israel, Jordan, Iraq, Egypt and South Africa (MACGOWAN & FREIDBERG, 2008). It is exclusively found on *Ficus carica* where its larvae feed on the tissue of the syconia just under the peel, destroying the fruit and causing unripe fruit to fall prematurely. As such the present mention of this species from Malta represents a new record for this country. However, BORG (1992) states that the “fig fly (*Lonchaea aristella* Beck) is frequently met with on our fig trees, particularly

on trees growing near heaps of manure, close to the farmstead, ...". *Lonchaea aristella* is a synonym of *Silba virescens* Macquart, 1851 although the fact that this was recorded from figs may be a good indication of a misidentification of *S. adipata* (MACGOWAN & FREIDBERG, 2008). SALIBA (1963), following BORG's (1922) record, again mentioned *Lonchaea aristella* as occasionally found on figs.

GROUP 5 - LEAF TISSUE FEEDER

Choreutis nemorana Hübner, 1799

(Lepidoptera: Choreutidae)

Material examined. MALTA: Zejtun, one adult emerged on 24.viii.2011 from infested leaves of *Ficus carica* collected on 3.viii.2011, AF & DM; Valletta, one adult emerged on 30.viii.2011 from leaves of *F. carica* collected on 20.viii.2011, DM.

Notes. *Choreutis nemorana* (Fig. 51) is distributed in the Mediterranean area, parts of Asia, the Canary Islands and Madeira. The larvae (Fig. 52) cause damage by chewing leaves (Fig. 53) of *Ficus carica*. This species has been previously recorded from the Maltese Islands by DE LUCCA (1953) from Gharghur, by VALLETTA (1973) from Birkirkara, as an uncommon species whose larva feeds on *Celosia plumosa*, and by SAMMUT (2000), as a species found in many places whose larvae eat the leaves of *Ficus carica*. The record of *Celosia plumosa* as a host-plant for this moth is incorrect.

DISCUSSION

In the present study, 39 arthropod species were found in association with *Ficus* spp. and seventeen of these represent new records for Malta. Not all arthropod-*Ficus* associations were taken into consideration in this study but only those that utilise various parts of these trees as their main source of food (at least during larval development), were included. Thirty-three species were included in this category. Parasitoids and predators of some of these arthropods were also studied and six species were found.

It is worth mentioning that more than half (17 species which include: *Scobicia chevrieri*, *Metholcus cylindricus*, *Deroplia troberti*, *Niphona picticornis*, *Hypoborus ficus*, *Hypothenemus leprieurii*, *Zanchius breviceps*, *Empoasca alsiosa*, *Ficocyba ficaria*, *Homotoma ficus*, *Bemisia tabaci*, *Planococcus ficus*, *Saissetia oleae*, *Lepidosaphes conchiformis*, *Blastophaga psenes*, *Silba adipata* and *Choreutis nemorana*) of the 33 arthropods found feeding on *Ficus* spp. in Malta were exclusively found on *Ficus carica* and not on any other *Ficus* spp. This may be due to the fact that this tree is the most widely established one in the Mediterranean Region, and is actually considered as an archeophyte. Six further species (*Hypocryphalus scabricollis*, *Greenidea ficicola*, *Ceroplastes rusci*, *Anothopoda fici*, *Asetadiptacus emiliae* and *Rhyncaphytoptus ficifoliae*) were also found feeding on *Ficus carica*, as well as on other *Ficus* spp. The second most preferred *Ficus* was *F. microcarpa* with a total of 13 arthropods able to feed on it and of these, six species were exclusively found on this host-plant. *Ficus rugubinos*a was found to host only four species, and of these only *Pleistodontes* sp. was exclusive to it, whereas *Toxoptera aurantii* was the only arthropod found feeding on *Ficus elastica*. Despite repeated searches for arthropods in the wood, syconia and leaves of the other *Ficus* species occurring in Malta, no feeding arthropods were found on them.

Most of the gall inducing species are generally monophagous to their particular *Ficus* host. Thus, *Blastophaga psenes* is the pollinator for *Ficus carica* even though in India and Africa it also pollinates *Ficus palmata* (WIEBES, 1994). *Eupristina verticillata* is the pollinator for

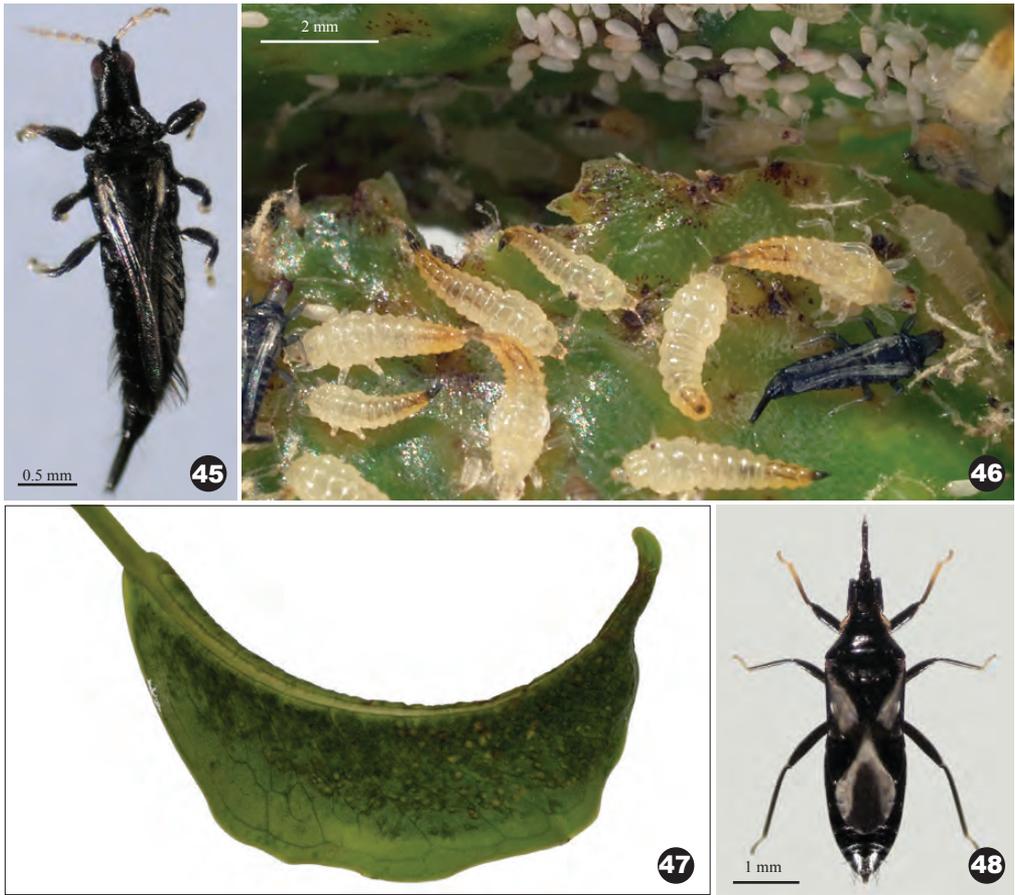


Figure 45: *Gynaikothrips ficorum*; **Figure 46:** Eggs, larval stages and adults of *G. ficorum* inside the leaf curl; **Fig. 47:** Leaf curl of *Ficus microcarpa* induced by *G. ficorum*; **Fig. 48:** *Montandoniella moraguesi*.

Ficus microcarpa, but there are records of this pollinator on *Ficus benjamina* (WIEBES, 1992). *Odontofroggata galili* is exclusively associated with scyonia of *Ficus microcarpa* whereas the *Pleistodontes* sp. is most likely to be also exclusively associated with *Ficus rubiginosa*. *Josephiella microcarpa* and *Gynaikothrips ficorum* are leaf gall inducers; the former utilise the sole host-plant, *Ficus microcarpa*, whereas *G. ficorum* is oligophagous on *Ficus* spp. with a marked preference for *Ficus microcarpa*. Other monophagous species include *Choreutis nemorana* which feeds exclusively on leaf tissue of *Ficus carica*; *Homotoma ficus*, a phloem feeder of *Ficus carica*; and *Silba adipata* with larval stages exclusively found feeding on the tissue of syconia of *Ficus carica*. The three bark beetles (*Hypoborus ficus*, *Hypocryphalus scabricollis* and *Hypothenemus leprieurii*) and the three eriophyoid mites (*Anothopoda fici*, *Asetadiptacus emiliae* and *Rhyncaphytoptus ficifoliae*) can also be regarded as either monophagous or oligophagous on *Ficus* spp, with the exception of *Hypoborus ficus* which even though it is mostly associated with *Ficus carica*, was also recorded on the unrelated hosts *Ailanthus altissima*, *Styrax officinalis* and *Vitis vinifera*. It is important to mention in this context how *Hypocryphalus scabricollis*, a species which until recently was only

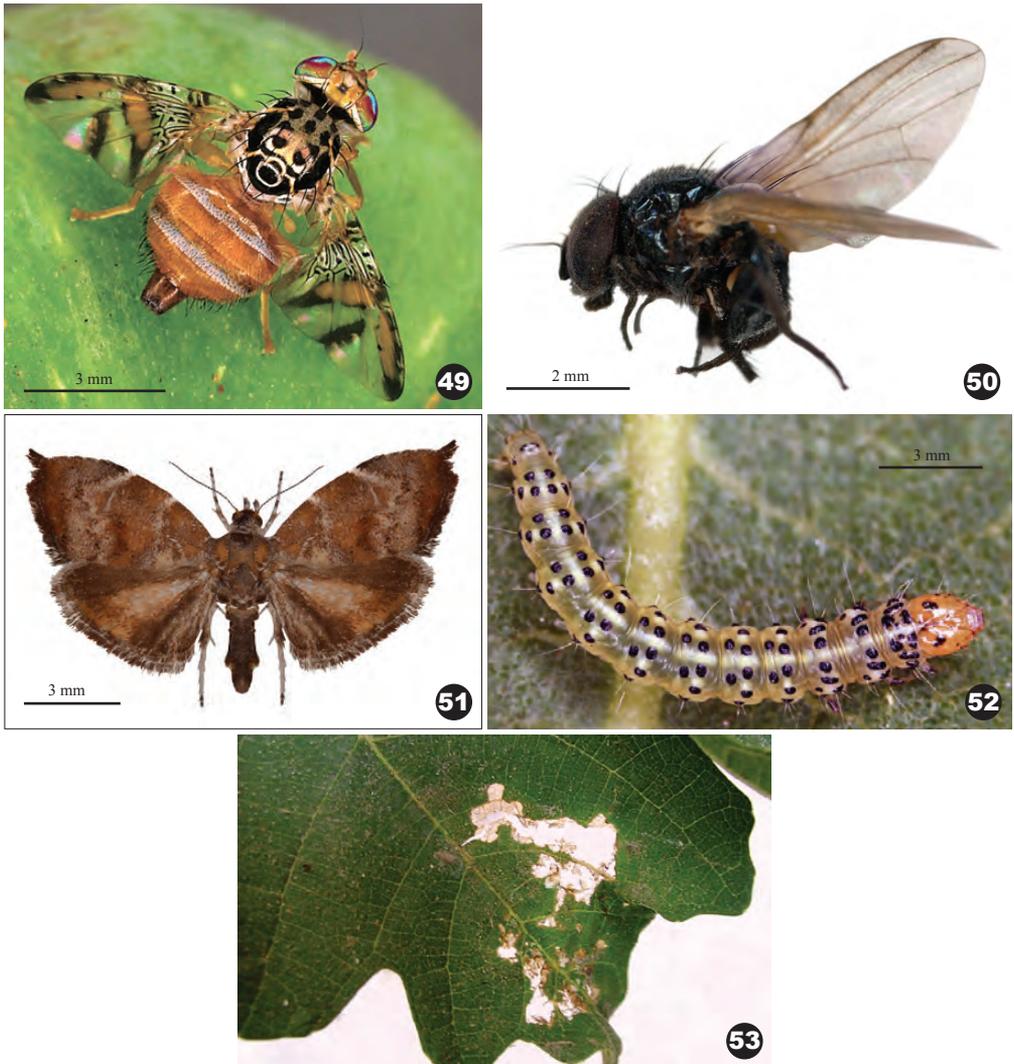


Figure 49: *Ceratitidis capitata*; **Figure 50:** *Silba adipata*; **Figure 51 - 52:** *Choreutis nemorana*; **51:** Adult; **52:** caterpillar; **Figure 53:** Damage caused by *Choreutis nemorana* on leaves of *Ficus carica*.

found associated with dead branches of *Ficus microcarpa* has shifted its apparent preference from this tree to *Ficus carica*. In fact it is causing considerable economic damage to these trees in Malta, as the species is attacking the main trunks of apparently healthy trees. Such damage is caused by both adults and larvae which kill the tissue just under the bark and within weeks the tree dies. In this respect other fig growing countries should be alerted of this possibly emerging pest. The aphid, *Greenidea ficicola* is also mostly found in association with *Ficus* spp. but is also recorded on *Psidium guajava* (BLACKMAN & EASTOP, 2010), and *Artocarpus integrifolia* (SOUSA-SILVA *et al.*, 2005). A unique species is represented by *Ficocyba ficaria* which is dioecious, and found on *Lonicera* spp. in winter and on *Ficus carica* in summer (VIDANO, 1960). The rest of the species,

namely *Scobicia chevrieri*, *Metholcus cylindricus*, *Deroplia troberti*, *Niphona picticornis*, *Zanchius breviceps*, *Empoasca alsiosa*, *Bemisia tabaci*, *Singhiella citrifolii*, *Toxoptera aurantii*, *Planococcus ficus*, *Ceroplastes rusci*, *Coccus hesperidum*, *Saissetia oleae*, *Lepidosaphes conchiformis* and *Ceratitidis capitata* are polyphagous.

Another aspect worth discussing is the presence of true native species associated with *Ficus* trees in Malta *versus* the established alien ones. Out of the 33 *Ficus* feeding arthropods, all the gall inducing species are established aliens of relatively recent introduction into the Mediterranean area. The only notable exception to this is *Blastophaga psenes* which probably was introduced in the Mediterranean area with its host-plant in antiquity. All these gall inducing species are Asian in origin in conformity with the origin of their host-plants. Both *Greenidea ficicola* and *Singhiella citrifolii* are native to Asia but are expanding their distribution ranges rapidly in many parts of the World. *Hypocryphalus scabricollis* is another Asian species in origin. Its presence in Malta is probably due to its accidental introduction with *Ficus microcarpa* several years ago. Several other arthropod-associated species are now cosmopolitan or sub-cosmopolitan in distribution and it is often difficult to predict with certainty their origins in terms of distribution patterns. Typical examples include *Bemisia tabaci*, *Ceratitidis capitata*, *Ceroplastes rusci*, *Coccus hesperidum*, *Lepidosaphes conchiformis*, *Pseudococcus longispinus*, *Saissetia oleae* and *Toxoptera aurantii* which are widely distributed agricultural pests. *Ceratitidis capitata* is native to tropical eastern Africa; *Ceroplastes rusci* and *Saissetia oleae* are possibly Afrotropical in origin whereas *Lepidosaphes conchiformis* is most likely Asian in origin. *Toxoptera aurantii* was only recently indicated as having a possibly Mediterranean origin (PÉREZ HIDALGO & MIFSUD, 2011). *Rhyncaphytoptus ficifoliae* and *Asetadiptacus emiliae* are vagrants and, as usual, small populations of these mites are not normally looked for, since damage caused by their presence on *Ficus* host-plants is often indistinguishable. Therefore, an extended distribution range for these species is strongly foreseen. In addition, the geographical position of the Maltese Islands, close to the areas in which these mites were previously reported, and their ability to be easily dispersed by wind, can also explain their presence in Malta. *Anothopoda fici* could have reached the Maltese Islands via passive dispersal as a consequence of trade of goods and agricultural commodities. The presence of *Zanchius breviceps* in Malta is more difficult to interpret. It represents a Near Eastern element (present also in Eastern Africa) and its native origins in Malta are plausible. However, *Choreutis nemorana*, *Deroplia torberti*, *Empoasca alsiosa*, *Ficocyba ficaria*, *Homotoma ficus*, *Hypoborus ficus*, *Hypothenemus leprieurii*, *Metholcus cylindricus*, *Niphona picticornis*, *Planococcus ficus*, *Scobicia chevrieri* and *Silba adipata* are all of Mediterranean origin, some of which however have also invaded other territories via accidental introductions due to anthropogenic activities.

Relatively few results were obtained for parasitoids and predators of the *Ficus* feeding arthropods found in Malta, and this was possibly due to limited sampling. The most interesting results were the species which naturally control the bark beetle, *Hypoborus ficus*. In fact three different parasitoids were collected, all from Buskett (Malta), the only locality characterised by extensive semi-natural woodland. These include the ectoparasitic brachonid, *Ecphylyus caudatus* and the chalcid parasitoids, *Rhaphitelus maculatus* and *Astichus bachmaieri*, all of which are new records for Malta. Another chalcid parasitoid, *Encyrtus aurantii*, was also found developing in *Coccus hesperidum* collected on *Ficus microcarpa*. Another very interesting association was that between the pteromalid wasp, *Philotrypesis caricae*, and *Blastophaga psenes*. Larvae of this species feed on the gall tissue produced by *Blastophaga psenes* in the florets of syconia of *Ficus carica*. In so doing, it competes with the developing *Blastophaga* larvae in the florets, a typical kleptoparasitic association. The only predatory species found during this study was *Montandoniola moraguesi* feeding on *Gynaikothrips ficorum* in leaf galls of *Ficus microcarpa* induced by this thrips.

Other *Ficus* feeding arthropods are expected to either occur in Malta, or may eventually arrive and establish themselves through international trade of these trees. For example, *Aceria ficus* (Cotte, 1920) is highly expected to be present in Malta. This eriophyoid is commonly found wherever fig trees are cultivated and represent an important agricultural pest because it is a vector of Fig Mosaic Disease agents, whose symptoms were previously observed in Malta (DM, *personal observations*). Its intra-plant distribution (mainly found on the youngest leaves) during spring and early summer (de Lillo, *personal observations*) might have influenced the results of wrong sampling. There are also several polyphagous aphids and scale insects already recorded from Malta which are known to feed also on *Ficus* spp. in other Mediterranean countries, and thus it is only a matter of time to also find them on *Ficus* hosts in Malta. A whitefly species, *Aleyrodes elevatus*, a typical Mediterranean species associated with *Ficus carica* (MARTIN *et al.*, 2000), was never found in Malta despite repeated investigations, and it may well be absent from this territory. There are also many chalcid wasps associated with syconia of different *Ficus* spp. and very often the ecological relationships between them are poorly understood. Of these, some species have already been introduced and established in some Euro-Mediterranean countries, such as *Platyscapa quadriceps* (Mayr, 1885), *Walkerella microcarpa* Bouček, 1993 and *Philotrypesis emeryi* Grandi, 1926 (e.g. LONGO *et al.*, 1998; KOPONEN & ASKEW, 2002). Recently, MIFSUD & PORCELLI (2012) reported the occurrence of *Macrohomotoma gladiata* Kuwayama, 1908 (Hemiptera: Homotomidae) on *Ficus microcarpa* in Spain. If this species establishes itself, it can easily spread throughout the Mediterranean basin where this tree is present.

Despite this extensive account of the *Ficus* feeding arthropods found in Malta, it is expected that further investigations will yield even more species and possibly more parasitoids and predators of these organisms.

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