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The oak gall wasps of Israel (Hymenoptera, Cynipidae, Cynipini)—diversity, distribution and life history

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Abstract

Oak-galling wasps (Hymenoptera: Cynipidae, Cynipini) have been studied in Israel only superficially so far, despite interest in the Israeli fauna given its location at the southern edge of distribution range of the wasps and their oak hosts. We provide the first comprehensive review of the Israeli fauna of oak cynipids based on an extensive survey of the five naturally occurring oak species in Israel. We report 53 cynipid species, 37 of which are reported from Israel for the first time, 10 are currently known only from this country, and 9 are undescribed. With 27 species, *Andricus* is by far the biggest genus in Israel, followed by *Cerroneuroterus*, *Neuroterus Plagiotrochus*, and *Pseudoneuroterus* with 4 species each. *Andricus megalucidus* is synonymized under *A. cecconii* and *Cerroneuroterus cerrifloralis* is synonymized under *C. lanuginosus*. The sexual generations of *Andricus cecconii, A. coriariformis, A. coriarius, A. miriami, Cerroneuroterus lanuginosus* and *Pseudoneuroterus macropterus* are reported here for the first time. We recorded 65 gall types, with bud galls being the most common and conspicuous, followed by leaf and catkin galls. We provide illustrated keys for all Israeli species based on their galls, as well as information on host associations, life history, phenology and distribution patterns where available. 21 cynipid species are associated with *Quercus ithaburensis* and 27 species are associated with *Q. boissieri*, whereas *Q. libani*, *Q. calliprinos* and *Q. cerris* host much fewer species. Most species are currently known from either their sexual or asexual generation while only 24% of them are known from both. Mount Hermon was found to be an important hotspot, hosting about half of the Israeli cynipid fauna, and species richness generally declines from the Golan Heights southwards to the Judean Mountains. Cynipid species that are associated with oaks of sections *Cerris* and *Quercus* in Europe are mostly associated with the same sections in Israel.

Key words: Distribution, Host alternation, Levant, Phenology, *Quercus*

Introduction

Gall wasps (Hymenoptera: Cynipidae) are a major lineage of herbivorous insects within the predominantly parasitoid Cynipoidea (Ronquist 1999; Ronquist *et al*. 2015). The most species-rich tribe within the family is the Cynipini (oak gall wasps), with more than 1000 described species in approximately 40 genera worldwide (Melika & Abrahamson 2002; Abe *et al*. 2007; Liljeblad *et al*. 2008; Melika *et al*. 2010; Pénzes *et al*. 2018). The Cynipini are restricted to plants of the family Fagaceae, predominantly oaks (*Quercus* spp.), on which they induce galls of diverse structures in leaves, buds, stems, flowers, fruits and roots (Stone *et al*. 2002; Melika 2006b). Most Cynipini show cyclical alternation between sexual (spring) and asexual (fall) generations, which differ markedly in both wasp and gall morphology, and may develop on different host-plant organs or sometimes on different host-plant species (Folliot 1964; Melika & Abrahamson 2002; Pujade-Villar *et al*. 2001; Stone *et al*. 2002; Harper *et al*. 2004). Consequently, the association between the sexual and asexual generations of the same species is problematic and is usually resolved with molecular markers (e.g., Stone *et al*. 2008). Adding to this difficulty is the fact that the sexual-generation galls of many species are very inconspicuous and similar among different species. For example, aggregated catkin galls on European oaks that had originally been attributed to *Andricus burgundus* Giraud, have been shown to represent the sexual generations of several different species (Stone *et al*. 2008).

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Geographic variation and species diversity among the Cynipini generally matches those of their oak hosts (Cornell & Washburn 1979). The genus *Quercus* comprises almost 600 species belonging to six intrageneric groups of two clades: 'Old World Oaks' and 'New World Oaks' (Hubert *et al*. 2014), and the oak gall-wasps are associated with all groups (Stone *et al*. 2002; Abe *et al*. 2007). Stone *et al*. (2009) found a deep split between cynipid taxa that develop on each oak section in Asia, followed by an independent spread to the Western Palaearctics. Within the Western Palearctics, the Levant constitutes the edge of distribution range for several oak species and their associated cynipid taxa, and is of particular interest given its location between three phyto- and zoogeographical regions. Nevertheless, the cynipid fauna of this region received limited attention so far, with data available mainly from Iran and Turkey (e.g., Azizkhani *et al*. 2006; Melika 2006a; Tavakoli *et al*. 2008; Kiyak *et al*. 2008; Melika *et al*. 2010; Azmas & Katilmış 2017), and fragmentary data from Jordan, Syria and Lebanon (e.g., Nieves Aldrey & Massa 2006; Rizzo & Askew 2009).

The five oak species that are native to Israel reach their southernmost distribution range in the Middle East (Zohary 1961; Dufor-Dror & Ertas 2004) and include *Q. ithaburensis*, *Q. libani* and *Q. cerris* from section *Cerris, Q. calliprinos* from section *Ilex*, and *Q. boissieri* from section *Quercus*. Of these, *Q. libani* and *Q. cerris* are restricted to the northernmost part of Israel on Mt. Hermon, with the latter represented by a few trees only, whereas *Q. ithaburensis* and *Q. calliprinos* have a wider, albeit fragmented, distribution in northern and central Israel (Figs 1–4). Eight additional European species were introduced into the country as ornamentals and are widely planted in gardens and public areas (most notably *Q. robur* and *Q. pedunculiflora*), where they often bear large numbers of galls, in particular those of *Andricus sternlichti* Bellido, Pujade-Villar & Melika.

Although some of the Israeli oaks are dominant forest trees and host dozens of cynipid species, this rich fauna has been only superficially studied so far. Bodenheimer (1930) was the first to mention oak galls from Israel, followed by Bytinski-Salz & Sternlicht (1967), who recorded 30 types of galls, and Sternlicht (1968a, b), who keyed and illustrated 40 gall types from *Q. calliprinos* and *Q. ithaburensis* alone. However, only a few of the gallers mentioned by these authors were identified to species, and the validity of some of the identifications is uncertain. The Israeli fauna associated with *Q. boissieri, Q. cerris,* and *Q. libani* has never been studied. In the present study we provide the first comprehensive review of the 53 species of oak cynipids currently known to occur on all native oaks in Israel, including illustrated keys for their galls and notes on their life history and distribution.

Materials and methods

Collecting and rearing of insects. Galls on the five native oak species in Israel were surveyed during 2012–2016 at least twice for each of the spring and fall generations (February-June and September-December, respectively) along the distribution ranges of the oaks in 19 sites (Table 1, Figs 1–4). Less attention has been dedicated to *Q. calliprinos*, which supports a relatively small number of cynipid species. Further sporadic observations in additional sites are also reported in the relevant sections of the species synopsis. Exotic, ornamental oaks were not included in this survey.

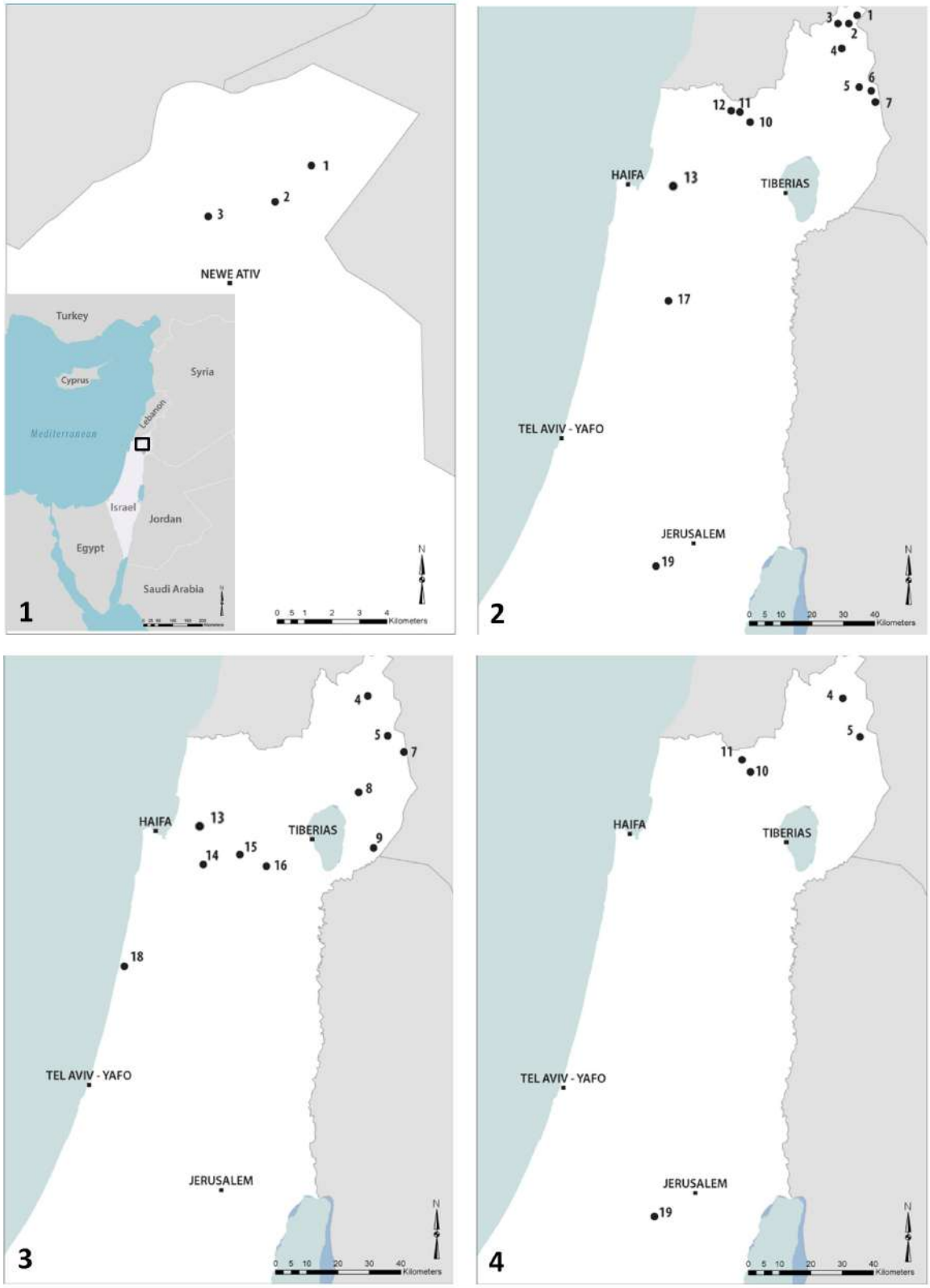
Galls on all plant parts except roots were surveyed and collected in the field and brought to the laboratory, where they were kept at room temperature in ventilated rearing cages until adult emergence. Information on species that are known to induce root galls in Israel is based on Sternlicht (1968a, b). A sample of each gall type was dissected in order to examine the gall structure and record its phenology. Some galls of asexual generations that required an overwintering period were kept in plastic bags at 4°C from November to March, after which they were transferred to rearing cages at room temperature until adult emergence. Reared adults were either mounted on pinned cardboards for morphological study and/or preserved in 96% ethanol for molecular study. All studied wasp and gall material are deposited in the Steinhardt Museum of Natural History at Tel Aviv University (SMNHTAU), except for some paratypes that are deposited in the Plant Health and Molecular Biology Laboratory, National Food Chain Safety Office, Budapest, Hungary (PHMB) as detailed below.

Taxonomy. Species identity was determined by one or more of the following methods: A) Comparison of adult wasp morphology to material in the Melika collection in PHMB and to the relevant literature. B) Comparison of galls to material in the Sternlicht collection in SMNHTAU, to the Melika collection in PHMB, or to the literature when no other material was available. C) Comparison of mitochondrial COI sequences to sequences available in GenBank or to those of specimens from the PHMB as part of an ongoing molecular work on the Israeli cynipids (Shachar, unpublished data). Information in the following keys and synopsis is based on our own surveys and on

the relevant published literature. Literature sources are given where appropriate, but we have not attempted to provide an exhaustive literature review of the distribution and phenology of species that are known from Europe and Asia. Information on the distribution of Israeli species from Sternlicht (1968b) is incorporated into our own records. Similarly, only new synonyms are mentioned here, and we do not provide a list of synonyms for the currently recognized species names, as such lists are available in the literature (e.g., Nieves-Aldrey 2001; Melika 2006b; Melika *et al*. 2010).

TABLE 1. Cynipid collection sites along the distribution range of the five native oaks in Israel.

Region	Site	Oak species
Golan Heights	Mt. Hermon, 1780 m.a.s.l. N'33°18'1.32, E'35°45'15.78	*Q. boissieri* *Q. libani*
	Mt. Hermon, 1500 m.a.s.l. N'33°18'15.27, E'35°46'5.93	*Q. boissieri* *Q. libani*
	Mt. Kahal N'33°17'13.51, E'35°44'10.79	*Q. cerris* *Q. boissieri* *Q. libani*
	Odem Forest N'33°12'23.76, E'35°44'2.04	*Q. boissieri* *Q. calliprinos* *Q. ithaburensis*
	En Zivan N'33°5'38.58, E'35°47'53.37	*Q. boissieri* *Q. ithaburensis*
	Allone HaBashan N'33°5'6.21, E'35°49'57.59	*Q. boissieri*
	Tel Hazeqa N'33°3'18.54, E'35°50'59.40	*Q. boissieri* *Q. ithaburensis*
	Yehudiyya N'32°56'1.15, E'35°41'38.68	*Q. ithaburensis*
	Mezar N'32°45'27.17, E'35°44'46.93	*Q. ithaburensis*
Upper Galilee	Mt. Meron N'32°59'35.86, E'35°24'52.27	*Q. boissieri* *Q. calliprinos*
	Pa'ar cave N'32°1'52.35, E'35°23'8.73	*Q. boissieri* *Q. calliprinos*
	Mt. Addir N'33°1'59.94, E'35°21'4°.76	*Q. boissieri* *Q. calliprinos*
Lower Galilee and Mt. Carmel	Nahal Rakefet N'32°67.39, E'35°08.75	*Q. boissieri* *Q. ithaburensis* *Q. calliprinos*
	Bet Keshet Forest N'32°43'14.87, E'35°22'29.42	*Q. ithaburensis*
	Hosha'aya N'32°46'17.43, E'35°17'18.94	*Q. ithaburensis*
	Alonim N'32°43'11.64, E'35°8'47.07	*Q. ithaburensis*
Coastal Plain	HaSharon Forest N'32°25'58.42, E'34°53'52.07	*Q. ithaburensis*
Judean Mountains	Zur Hadassa N'31°42'43.71, E'35°5'30.24	*Q. boissieri* *Q. calliprinos*
West Bank	Rehan Forest N'32°28'43.73, E'35°84'17	*Q. boissieri* *Q. calliprinos*



FIGURES 1–4. Cynipid collection sites on oaks in Israel. 1. *Q. libani* and *Q. cerris*. 2. *Q. boissieri*. 3. *Q. ithaburensis*. 4. *Q. calliprinos*. Numbers correspond to the following collection sites: 1. Mt. Hermon, 1780m; 2. Mt. Hermon, 1500m; 3. Mt. Kahal; 4. Odem Forest; 5. En Zivan; 6. Allone HaBashan; 7. Tel Hazeqa; 8. Yehudiyya; 9. Mezar; 10. Mt. Meron; 11. Pa'ar cave; 12. Mt. Addir; 13. Nahal Rakefet; 14. Alonim; 15. Hosha'aya; 16. Bet Keshet Forest; 17. Rehan Forest; 18. HaSharon Forest; 19. Zur Hadassa.

Results

Taxonomy and life history of the Israeli Cynipini

The Israeli fauna of oak cynipids currently includes 53 species in 10 genera of gall inducers (Table 2). About half of the species in Israel belong to the polyphyletic genus *Andricus* Hartig, the largest cynipid genus worldwide, which is considered a "trashcan" for oak Cynipidae and in need of revision (Melika 2006b). Also included in the synopsis are two species of *Synophrus* Hartig, belonging to the cynipid inquiline tribe Synergini.

More than 60% of the Israeli species have a broader Western Palearctic distribution, and 20% are found only in the Levant. We found six undescribed species, all are currently known only from Israel, with no similar galls from Europe or the Levant. Three of these belong to *Andricus*: one is represented by a single female of the asexual generation and the other two are known only from their sexual generation galls, from which no adults were reared. The latter two species are ascribed here to *Andricus* based on the resemblance of their galls to those of *Andricus* species in Europe. The three remaining undescribed species belong to an undescribed genus close to *Cerroneuroterus* Melika & Pudje-Villar, and are currently known only from adults of the sexual generation. We therefore postpone their official description until more material becomes available.

Some species for which galls were rarely found or from which adults were not reared are included here only tentatively, and more study is needed in order to verify their identities. These include one species from *Q. ithaburensis* that closely resembles *Andricus istvani* Melika in gall and adult morphology but its identity was not established with confidence due to several differences in adult morphology. The identity of one species from *Q. ithaburensis* and one species from *Q. libani* and *Q. cerris* whose galls resemble those of European species is not established with confidence here because no adults were reared form the galls.

Overall, we recorded 65 types of galls, most of which develop in buds (53%) or leaves (35%), and some in catkins, acorns and branches (Table 2). Gall density varied dramatically among years, sites and individual trees within a site. Some galls were very rare whereas others were consistently abundant. Gall structures were likewise diverse with regard to rigidity, number of larval chambers, and the presence of spines or hairs. Some galls are usually found in aggregations whereas others are found individually; some were typical of young vigorous trees or branches, while others were found on older, slow-growing trees.

Identification keys based on gall morphology

Identification of species based on gall morphology can be challenging because gall morphology may change throughout its development. Colors change from bright green or pink to brown, texture changes from soft and fleshy to hard and woody, and galls may look differently when aggregated than when solitary. Inqulines and parasitoids can also alter the morphology of the galls they invade. Some galls remain on the tree for a year or more and may be mistaken for other galls, in which case emergence holes may be indicative.

To facilitate its use, the key provided here is divided into three parts by oak species, such that separate keys are given for galls on *Q. boissieri*, for galls on *Q. ithaburensis*, and for galls on the remaining three oaks. This is because *Q. boissieri* and *Q. ithaburensis* support a large number of gall types whereas the remaining three oaks support much fewer types. To use the keys, it is important to determine first whether a gall develops in a bud, leaf, catkin or branch. Bud and catkin galls, particularly on *Q. ithaburensis*, are sometimes difficult to distinguish because many of the catkin galls are big, take over the entire catkin and may stay on the tree until the next fall, similar to bud galls. The attachment of the gall to the plant may provide a clue as to the nature of the galled organ because many catkin galls are carried on a delicate stalk (e.g., Figs 47–48), whereas bud galls are attached directly to the branch (e.g., Figs 18, 20) and some may incorporate the basal part of leaves (e.g., Fig. 67). Leaf galls may be apparent on both sides of the leaf but are usually attached to it only on one side (Figs 30–34, 59–62). This is in contrast to several species of gall midges (Diptera: Cecidomyiidae), which also develop in leaf galls on Israeli oaks but whose galls are visible on both sides of the leaf and cannot be detached from it.

The following keys do not include root galls or galls recorded by Sternlicht (1968b) but not found by us, as well as very rare galls, the identity of which was not verified here. Similarly, galls of arthropods other than cynipids are not keyed here, including the several types of cecidomyiid leaf galls on *Q. ithaburensis* and *Q. libani*, the

common and conspicuous petiole gall induced by the lepidopteran *Heliozela sericiella* Haworth (Heliozelidae) on *Q. ithaburensis* (Sternlicht 1968b), and common leaf galls induced by mites of the family Eriosomatidae, which appear as dark, shallow depressions on the underside of *Q. ithaburensis* and *Q. calliprinos* leaves (Sternlicht 1968b).

Key to galls of Israeli oak Cynipidae on *Quercus boissieri*

1. Bud galls . . . 2
- Leaf, acorn, or catkin gall . . . 18
2. Spherical gall with or without spines or protuberances . . . 9
- Gall not spherical . . . 3
3. Gall composed of several distinct, elongate or tapered lobes (Figs 15–17) . . . 4
- Gall not composed of distinct, elongate lobes (Figs 21, 23–26) . . . 5
4. Irregularly shaped gall up to 65 mm in diameter, composed of long, tapered, delicate lobes of varying length, pale green when young, brown and woody when mature . . . *Andricus coriarius* (Hartig), asexual (fall) generation (Figs 15–16)
- Gall usually composed of 3 thick, widely splayed lobes . . . *Andricus coriariformis* Melika, Challis & Stone, asexual (fall) generation (Fig. 17)
5. Scaly, artichoke-like brown gall, up to 13 mm wide and 20 mm long, in apical buds. Tip of gall tightly closed when young, open when mature . . . *Andricus foecundatrix* (Hartig), asexual (fall) generation (Figs 23–24)
- Gall different from above . . . 6
6. Cylindrical, velvety, light brown gall in apical bud, narrowest at mid part . . . *Andricus tomentosus* (Trotter), asexual (fall) generation (Fig. 25)
- Gall different from above . . . 7
7. Gall with very long and pointed, sometimes curved apex, widest basally. Brown and woody. Very rare . . . *Andricus solitarius* (Fonscolombe), asexual (fall) generation
- Gall different from above . . . 8
8. Rigid, pentagon-shaped gall, 5–15 mm in diameter, composed of 5 velvety units. Green when young, brown when mature. Rare . . . *Andricus megatruncicolus* Melika, asexual (fall) generation (Fig. 21)
- Carambola-shaped gall, with 3–4 distinct longitudinal ridges, 5–7 mm long, 3–5 mm wide. Green when young, pale brown when mature. . . . *Andricus* sp. 3, sexual (spring) generation (Fig. 26)
9. Gall entirely composed of distinct lobes forming spherical structure (Figs 9–11) . . . 10
- Gall is spiny or smooth sphere, not composed of discrete lobes (Figs 5–6, 13–14, 18–20, 22) . . . 12
10. Gall composed of short and thick, pyramidal lobes, 20–40 mm in diameter, pinkish and spongy . . . *Andricus curtisii* (Müller), asexual (fall) generation (Fig. 11)
- Gall composed of long tapered extensions . . . 11
11. Gall up to 6 mm in diameter, green to purple, sticky and flexible when young, light brown and woody when mature. On lower branches close to the ground. . . . *Andricus hystrix* Kieffer, asexual (fall) generation (Fig. 10)
- Gall up to 20 mm in diameter, with longitudinal ridges between lobes. Bright green and sticky when young, light brown and woody when mature . . . *Andricus grossulariae* Giraud, asexual (fall) generation (Fig. 9)
12. Irregularly spherical gall, up to 20 mm in diameter, smooth, wrinkly, without spines or projections, pale brown. . . . *Biorhiza pallida* Olivier, sexual (spring) generation (Fig. 22)
- Gall completely or partially covered by spines or projections . . . 13
13. Projections or spines distributed uniformly on entire gall surface . . . 14
- Projections or spines usually confined to specific part of gall, not covering entire surface . . . 15
14. Gall more than 25 mm in diameter, densely covered by brittle, slightly curved, thin and blunt spines up to 10 mm in length. Shiny green and sticky when young, pale brown and woody when mature . . . *Andricus cecconii* Kieffer, asexual (fall) generation (Fig. 6)
- Gall usually much smaller, covered by straight, blunt, short spines, up to 6 mm in length. Light green or red and sticky when young, brown and woody when mature . . . *Andricus lucidus* (Hartig), asexual (fall) generation (Fig. 5)
15. Big gall, more than 18 mm in diameter. . . . 16
- Smaller gall, up to 15 mm in diameter . . . 17
16. Gall up to 30 mm in diameter, bearing 2–3 mm long projections, often joined by shallow ridges. Pale green when young, very pale brown and extremely hard when mature. Very common. . . . *Andricus sternlichti* Bellido, Pujade-Villar & Melika, asexual (fall) generation (Fig. 20)
- Gall of up to 40 mm in diameter, with circle of tiny spines around widest part. Green, soft, fleshy and sticky when young, deep plum-like purple and rigid when mature . . . *Andricus quercustozae* (Bosc), asexual (fall) generation (Figs 13–14)
17. Gall without stalk, with apical 'crown', resembling blueberry. On branch tips, mostly in clusters. Green when young, brown and very hard when mature . . . *Andricus moreae* (Graeffe), asexual (fall) generation (Fig. 18)
- Gall carried on long stalk, with very short apical projections up to 1.2 mm long, pale brown. Only on Mt. Hermon. . . . *Andricus* sp. 1, asexual (fall) generation (Fig. 19)
18. Acorn gall . . . 19

- Leaf or catkin gall 20
19. Gall densely covered by long, curved, tapered and branching spines up to 30 mm long. Pink and sticky when young, pale brown and woody when old. Only on Mt. Hermon . . . . . *Andricus caputmedusae* (Hartig), asexual (fall) generation (Figs 7–8)
- Gall evenly covered by short spines up to 3 mm long, green when young, very pale brown to white with purple spines when mature. Very rare. . . . . *Andricus chodjaii* Melika, asexual (fall) generation (Fig. 12)
20. Catkin gall 21
- Leaf gall. 22
21. Spherical gall, up to 8 mm in diameter, fleshy, shiny, light green with purple 'veins' . . . . . *Neuroterus quercusbaccarum* (Linnaeus), sexual (spring) generation (Fig. 27)
- Clustered galls, each 2 mm in diameter, light brown to yellow, densely covered by whitish, short, hairs . . . . . *Andricus* sp. 2, sexual (spring) generation (Fig. 28)
22. Elongate gall, 5–15 mm long, usually with acute tip, soft and green when young, hard and reddish-brown when mature. Very rare; only on Mt. Hermon . . . . . *Cynips cornifex* Hartig, asexual (fall) generation (Fig. 29)
- Circular, spherical or ovoid galls. 23
23. Flat, blister-like gall between upper and lower epidermis of leaf, 3 mm in diameter, paler green than leaf . . . . . *Neuroterus numismalis* (Geoffroy), sexual (spring) generation (Fig. 30)
- Gall on underside surface of leaf. Different from above. 24
24. Small, ovoid gall attached to main leaf vein, 1.5–3 mm long, up to 2 mm wide, accompanied by two thin, leafy 'wings'. Yellowish-green and shiny when young, with purple or red dots when mature. . . . . *Neuroterus anthracinus* (Curtis), asexual (fall) generation (Fig. 31)
- Circular or spherical gall, different from above 25
25. Gall is entire sphere, clustered or solitary (Figs 32–33) 26
- Gall is half sphere, ring-shaped or flat, usually in clusters (Figs 34–36) 27
26. Gall is fleshy, firm sphere, 15–25 mm in diameter, light green with white dots when young, yellowish with white dots when old, usually in clusters. . . . . *Cynips quercus* (Fourcroy), asexual (fall) generation (Fig. 32)
- Gall is crinkled sphere, 4–6 mm in diameter, green when young, light brown when old, not in clusters . . . . . *Cynips divisa* Hartig, asexual (fall) generation (Fig. 33)
27. Fleshy dome or doughnut-shaped gall 28
- Flat, thin gall, sometimes with raised margins, up to 7 mm in diameter, usually in clusters. Pale green to dark pink or purple . . . . . *Neuroterus albipes* (Schenck), asexual (fall) generation (Fig. 34)
28. Dome-shaped gall, 3 mm high above leaf surface, up to 6 mm in diameter, pale green when young, with dark pink rim or completely pink when mature . . . . . *Neuroterus quercusbaccarum*, asexual (fall) generation (Figs 35–36A)
- Doughnut-shaped gall, up to 2 mm above leaf surface and 3 mm in diameter, with central pit, silky brown . . . . . *Neuroterus numismalis*, asexual (fall) generation (Fig. 36B)

Key to galls of Israeli oak Cynipidae on *Quercus ithaburensis*

1. Acorn or catkin galls, found in spring. 2
- Leaf, bud, or twig galls, found in spring or fall 8
2. Scaly gall in young acorn, up to 12 mm long, not sticky, light green. . . . . *Pseudoneuroterus saliens* (Kollar), sexual generation (Fig. 57)
- Catkin gall, different from above 3
3. Common spherical gall, 25–30 mm in diameter, composed of thin-walled, flat subunits, light green to reddish, sometimes with velvety cover when young, light brown when mature; occupies entire catkin . . . . . *Andricus cecconii*, sexual generation (Figs 47–48)
- Smaller gall, tapered or ovoid, usually in clusters 4
4. Conical, tapered galls 5
- Velvety, ovoid galls 6
5. Clustered galls up to 2.5 mm long each, cryptic, light brown. . . . . *Andricus coriarius*, sexual generation (Fig. 52)
- Clustered, galls up to 7 mm long each, light green and soft when young, bright red to deep purple and rigid when mature. . . . . *Andricus grossulariae*, sexual generation (Figs 49–50)
6. Cryptic, ovoid galls, 1.5–2 mm in diameter, green when young, light brown when mature, covered by white, velvety hair . . . . . *Cerroneuroterus lanuginosus* (Giraud), sexual generation (Fig. 54)
- More conspicuous galls, spherical or kidney-shaped 7
7. Kidney-shaped, velvey galls, up to 4 mm long, green when young, purple-green when mature, usually in panicle clusters . . . . . *Andricus vindobonensis* Müllner, sexual generation (Fig. 51)
- Spherical galls, 4–7 mm in diameter, light green with velvety white hair, usually not clustered. . . . . *Pseudoneuroterus* sp. 2, sexual generation (Fig. 53)
8. Leaf galls. 9
- Bud or twig galls 16
9. Gall constitutes integral part of leaf 10
- Gall attached to one side of leaf, detachable. 12

10. Rigid gall on the main leaf vein, up to 3 mm wide, same color as leaf . . . . . *Andricus* sp. nr. *quercusradicis* (Fabricius), sexual (spring) generation (Fig. 65)
- Gall not on the main leaf vein 11
11. Big, amorphous gall, occupying entire or most of leaf, hard and inflated on underside, soft and covered by dense hair on upper side, green with white hair when young, dark brown with golden hair when mature. . . . . *Andricus* sp. nr. *istvani*, sexual (spring) generation (Fig. 63)
- Smaller, spherical gall, up to 12 mm in diameter, with tapered apical extension up to 4 mm long, hard and green when young, dark brown when old. . . . . *Dryocosmus mikoi* Melika, Tavakoli, Stone & Azizkhani, sexual (spring) generation (Fig. 64).
12. Flattened gall with central pit, very hairy, usually in clusters 13
- Spherical or elliptical gall, smooth, often in clusters 14
13. Gall up to 7 mm in diameter, 5 mm high, completely covered by white to golden, silky, long hairs, black at center. . . . . *Cerroneuroterus lanuginosus*, asexual (fall) generation (Figs 60–61)
- Gall up to 6 mm in diameter, 2 mm high, somewhat flower-shaped with irregular rims, completely covered by white to pinkish hairs, white at center . . . . . *Cerroneuroterus gyulaigaraiae* (Melika), asexual (fall) generation (Fig. 62)
14. Succulent, spherical gall, up to 10 mm in diameter when mature, usually next to leaf vein. Tiny, soft and green, covered by short black hairs when young, green to velvety brown when mature . . . . . *Chilaspis israeli* (Sternlicht), asexual (fall) generation (Fig. 59)
- Gall up to 5 mm in diameter, elliptical or ovoid 15
15. Rigid, elliptical gall on main leaf vein, up to 5 mm long, 3 mm high, usually on underside but sometimes on upperside of leaf or on petiole, light brown to brown. . . . . *Pseudoneuroterus saliens*, asexual (fall) generation (Fig. 58)
- Ovoid gall, 1.5–3 mm long, sometimes on main leaf vein, up to 2 mm wide, accompanied by a thin, leafy 'wing', on underside of leaf. Yellow-green and shiny. . . . . *Neuroterus anthracinus*, asexual (fall) generation (Fig. 66)
16. Conspicuous, spherical to ovoid twig gall, same color and structure of twig. . . . . *Pseudoneuroterus macropterus* Hartig, asexual (fall) generation
- Bud gall 17
17. Cryptic spring gall 18
- Conspicuous fall or spring gall 19
18. Smooth, conical, single-unit gall, 1.5–2 mm long, sheathed by bud scales, thin walled, same color as scales . . . . . *Pseudoneuroterus macropterus*, sexual (spring) generation (Fig. 55)
- Velvety, spherical, gall, 4.5–5 mm in diameter, composed of several fused units, each 1.3–2 mm in diameter . . . . . *Pseudoneuroterus* sp. 1, sexual (spring) generation (Fig. 56).
19. Spherical, smooth, single-unit gall 20
- Partly or completely hairy gall, composed of several units 23
20. Gall up to 15 mm in diameter 21
- Gall more than 15 mm in diameter, multi-chambered 22
21. Gall light green when young, light brown to brown when mature, sometimes slightly wrinkled, with free internal, ovoid larval chamber . . . . . *Aphelonyx persica* Melika, Stone, Sadeghi & Pujade-Villar, asexual (fall) generation (Figs 37–38)
- Gall same color as branch, extremely hard and thick-walled, without free internal larval chamber . . . . . *Andricus coriarius* gall invaded by *Synophrus politus,* sexual generation (Fig. 41)
22. Spherical gall, sometimes wrinkly, up to 30 mm in diameter, light green and fleshy when young, light brown to brown and rigid when mature . . . . . *Aphelonyx persica* gall invaded by *Synergus variabilis*, asexual (fall) generation (Figs 39–40).
- Spherical to amorphic gall, up to 30 mm in diameter, extremely hard, same color and texture as branch. . . . . *Synophrus olivieri* Kieffer, sexual (spring) generation, original gall inducer unknown (Fig. 42)
23. Very sticky, deeply grooved, velvety gall, up to 20 mm in diameter, at tips of young branches, bright green to deep purple. . . . . *Dryocosmus mayri* Müllner, sexual (fall) generation (Fig. 46)
- Gall not sticky, different from above. 24
24. Spherical gall composed of rigid mushroom-shaped subunits; green, soft and completely covered by short, white fuzz when young, woody and fuzzy only on tip of subunits when mature. . . . . *Andricus miriami* Shachar, asexual (fall) generation (Figs 43–44)
- Amorphous, very hairy gall, composed of small triangular subunits, densely covered by long hair, whitish-pinkish when young, golden-brown when mature. . . . . *Chilaspis israeli*, sexual (spring) generation (Fig. 45)

Key to galls of Israeli oak Cynipidae on *Quercus calliprinos, Q. libani* and *Q. cerris*

1. Galls on *Q. calliprinos* 2
- Galls on *Q. libani* or *Q. cerris*. 4
2. Leaf galls. 3
- Branch galls. Spherical or elongate woody swelling, 10–35 mm long . . . . . *Plagiotrochus razeti* Barbotin, asexual (fall) generation (Fig. 73)
3. Gall is conspicuous swelling on both sides of leaf, 8–14 mm in diameter, light green when young, red when mature, often in clusters, multi-chambered . . . . . *Plagiotrochus quercusilicis* (Fabricius), sexual (spring) generation (Fig. 74)

- Gall is slender swelling on both sides of leaf, 2 mm in diameter, sometimes in clusters, single-chambered . . . . . *Plagiotrochus coriaceus* (Mayr), asexual (fall) generation

4. Leaf galls 5
- Bud, acorn or catkin galls 8

5. Gall is large swelling of leaf midrib on *Q. libani*, same color of leaf when young, light brown when mature. . . . . *Andricus melikai* Pujade-Villar, sexual (spring) generation (Fig. 68)
- Gall attached to leaf; different from above 6

6. Gall constitutes tapered, dark-purple chamber carried on thin, delicate stalk, on *Q. libani* . . . . . *Andricus* sp. nr. *amenti*, sexual (spring) generation (Fig. 69)
- Spherical or elliptical gall, different from above 7

7. Spherical gall, up to 7 mm in diameter, completely covered by pinkish, silky long hairs, with black center. Usually in clusters. On *Q. libani* and *Q. cerris* . . . . . *Cerroneuroterus* sp. nr. *lanuginosus*, asexual (fall) generation (Fig. 70)
- Elliptical gall, up to 2 mm in diameter, covered by small projections, pale when young, green to dark red and purple when mature. On *Q. libani* . . . . . *Cerroneuroterus minutulus* (Giraud), asexual (fall) generation

8. Acorn or catkin gall 9
- Bud gall 11

9. Soft, scaly gall in young acorn, up to 12 mm long, light green. On *Q. libani* . . . . . *Pseudoneuroterus saliens*, sexual (spring) generation (Fig. 57)
- Catkin gall, clustered, cone shaped with tapered apex, on *Q. libani* 10

10. Gall light green when young, bright red when mature not densely clustered. . . . . *Andricus coriariformis* sexual (spring) generation
- Gall light brown throughout development; always densely clustered . . . . . *Andricus coriarius*, sexual (spring) generation (Fig. 52)

11. Gall composed of one spherical unit 12
- Gall composed of several units 13

12. Gall up to 15 mm in diameter, light green when young, light brown to brown when mature, sometimes slightly wrinkled, with internal ovoid larval chamber moving freely within gall. On *Q. libani* . . . . . *Aphelonyx persica*, asexual (fall) generation (Figs. 37–38)
- Slightly irregularly-shaped gall, sometimes wrinkled, up to 30 mm in diameter, light green when young, light brown to brown when mature, multi-chambered. On *Q. libani* . . . . . *Aphelonyx persica* gall invaded by *Synergus variabilis*, asexual (fall) generation (Figs 39–40)

13. Mulberry-shaped gall, composed of 17–40 small units, up to 6 mm long, green with light brown tips, velvety, sometimes sticky when young; hard and brown when mature. On *Q. libani* and *Q. cerris* . . . . . *Andricus miriami* Shachar, sexual (spring) generation (Figs 71–72)
- Big, leafy rosette bud gall, 25–40 mm in diameter, multi-chambered. On *Q. libani* . . . . . *Andricus multiplicatus* Giraud, sexual (spring) generation (Fig. 67)

Synopsis of the fauna

Following is an annotated list of the Cynipini of Israel in alphabetical order. The details for each species include information on host plants in Israel and elsewhere, life history, phenology, distribution and specific comments where relevant. Life history and phenological data pertain to the Israeli fauna and may differ from those of the same species in other parts of its distribution range.

Andricus Hartig, 1840

A large Holarctic genus of approximately 300 described species (Melika & Abrahamson 2002), inducing a great diversity of galls on all tree organs and on numerous oak species from sections *Cerris, Quercus, Lobatae* and *Protobalanus.* The genus is represented by 81 species in the Western Palearctic fauna, 28 of which are known from both generations, (Stone *et al.* 2008). Some species exhibit obligate host alternations between a sexual generation on oaks from section *Cerris* and an asexual generation on oaks from section *Quercus.* Curently, 28 species are known from Israel from *Q. ithaburensis, Q. boissieri, Q. libani* and *Q. cerris*.

Andricus caputmedusae (Hartig, 1843)

Host plants. Israel: *Q. boissieri*. Europe: common on *Q. petraea* and *Q. pubescens*, occasionally on *Q. robur* and *Q. frainetto*, *Q. dalechampii* and *Q. hartwissiana*. Greece, Turkey and Iran: *Q. infectoria*.

Life history. Known only from the bud galls of the asexual generation. Molecular data suggest that the sexual generation of this species develops in cryptic bud galls currently attributed to the *A. burgundus* complex or to *A. atkinsonae* Melika, Stone, Sadeghi & Zargaran, 2008 (as in Fig. 52) (Stone *et al*. 2008; Tavakoli *et al*. 2008). The gall of the asexual generation occupies the acorn and acorn cup, covering the entire surface of the acorn. Young galls consist of a circle of petal-like spines radiating from a young acorn cup. The fully developed spines in a mature gall originate as small bumps within this circle, gradually developing into long, twisted spines that are often branched, and reach 30 mm in length. Individual galls may reach 6 cm in diameter and are single-chambered, but aggregations of several galls may form a multi-chambered mass reaching 10 cm in diameter. Young galls are bright pink and coated by sticky resin (Fig. 7), whereas mature galls are light brown and not sticky (Fig. 8). Some of the galls drop from the tree in fall and mature on the ground, whereas others remain on the tree after adult emergence and become black.

Phenology. Galls become apparent in July and mature in the fall. Some adults emerge in late September-early October, while others emerge in February and March. A few enter diapause and emerge in the following year.

Distribution. Israel: Mt. Hermon, 1500 and 1780 m.a.s.l., Mt. Kahal. Elsewhere: Widespread from Northern Europe to Iran.

Comments. The galls of this species resemble galls of the asexual generation of *A. cecconii* on the same oak host (Fig. 6) (previously known as *A. megalucidus* Melika, Stone, Sadeghi & Pujade-Villar, synonymized in the present paper) but differ from them in the branching, irregular, harder and more pointed spines, and in containing a single larval chamber, whereas galls of *A. cecconii* are multi-chambered.

Andricus cecconii Kieffer, 1901

Andricus megalucidus Melika, Stone, Sadeghi & Pujade-Villar**, new synonym.**

Host plants. Israel: *Q. ithaburensis* (sexual generation) and *Q. boissieri* (asexual generation). Galls of the asexual generation can also be found on the introduced *Q. pedunculiflora*, which is widely planted in Israel as an ornamental. Elsewhere: *Q. coccifera*, *Q. brantii,* and *Q. libani* (sexual generation) (Maisuradze 1968; Katilmiş & Kiyak 2008), *Q. infectoria* in Turkey and Iran, and possibly *Q. pubescens* in Greece (asexual generation) (Pujade-Villar *et al.* 2002).

Life history. The association of the sexual and asexual generations of this species was established for the first time in the present study. The sexual generation develops on oaks from section *Cerris*, on which it induces spherical multi-chambered catkin galls, composed of 10–18 delicate, conical, thin-walled units that are joined at their bases, 25–30 mm in diameter when mature (Fig. 47). The units are round, with undulating rims, and contain 1–2 chambers each. They are smooth-surfaced and green when young, becoming reddish where exposed to the sun, and turning brown when mature (Fig. 48). Some of the galls are green to light purple and covered by velvety hair. Old galls remain on the tree until the next year. The asexual generation develops on oaks from section *Quercus*, inducing large, conspicuous, globular, multi-chambered bud galls of up to 50 mm in diameter (Fig. 6). These galls are densely covered by slightly curved, long and thin spines, up to 10 mm long, which are blunt-tipped and easily broken. The gall is light green when young, turning grayish when old.

Phenology. Galls of the sexual generation usually begin to develop in late February and adults emerge from them in April, but at higher elevations (e.g., in En Zivan) they develop later and adults emerged in July. Galls of the asexual generation mature in fall, and while most adults emerge from them in January, some emerge in early spring and some remain in diapause for at least 2 years.

Distribution. Israel: Galls of the sexual generation are common throughout the distribution range of *Q. ithaburensis*, whereas galls of the asexual generation are common in the northern part of Israel but rare in Zur Hadassa (the Judean Mountains). Elsewhere: known from Greece, Transcaucasia, Turkey, Jordan, and Iran.

Comments. Galls of the sexual generation are very distinct and do not resemble any other oak catkin galls in Israel. They resemble galls of the sexual generation of *A. lucidus* (= *A. aestivalis*) in Europe. When young, *A. lucidus* galls have a shiny, waxy surface, whereas the galls of *A. cecconii* are covered by fine pubescence. In Israel galls of the asexual generation resemble those of *A. caputmedusae* (Figs 7–8) but differ from them in having straight and more delicate spines compared to the irregularly branched and pointier spines of *A. caputmedusae* and

in being multi-chambered as opposed to single-chambered. *Andricus megalucidus* is synonymized here under *A. cecconii* based on molecular evidence (Shachar, unpublished).

Andricus chodjaii Melika, 2008

Host plants. Israel: Q. *boissieri*; Turkey and Iran: *Q. infectoria.*

Life history. Known only from the bud galls of the asexual generation. The gall develops on the acorn-cup, is ellipsoid, multi-chambered, up to 20 mm in diameter, and covered by short spines of up to 3 mm in length (Fig. 12). The gall turns from green to white as it matures, at which point the spines are easily detached from it, leaving purple dots behind.

Phenology. Galls become visible from mid-August and adults emerge in November-December (Tavakoli *et al*. 2008). Some galls drop from the tree and the wasps complete their development in them on the ground.

Distribution. Israel: Rare, found only in Allone HaBashan. Elsewhere: Iran and Turkey.

Comments. Galls of this species are somewhat similar to galls of the asexual generation of *A. lucidus* (Fig. 5), but *A. lucidus* galls have numerous longer spines, are green and covered by sticky resin, whereas galls of *A. chodjaii* are not sticky. This gall is hardly distinguishable from that of *A. seckendorffi* (Wachtl), which is known from Europe and Turkey, and where these species occur together they can be distinguished from each other only on the basis of adult morphology (Tavakoli *et al*. 2008).

Andricus coriariformis Melika, Challis & Stone, 2008

Host plants. Israel: *Q. libani* (sexual generation) and *Q. boissieri* (asexual generation). Iran: *Q. infectoria.*

Life history. Prior to the present study, only the asexual generation of this species was known and the association between it and the sexual generations is established here for the first time. Galls of the sexual generation develop in catkin galls of oaks from section *Cerris*, are up to 6 mm long, conical, pointy and single-chambered, usually in clusters (as in Fig. 49). They are light green and soft when very young, turning bright red when mature. Galls of the asexual generation develop on oaks from section *Quercus*, are up to 20 mm in diameter, usually composed of three splayed, thick and smooth lobes, each ending in a few elongate projections pointing in the same direction and only slightly curved (Fig. 17). The gall is green when young, turning pale straw-yellow, hard and woody when mature.

Phenology. Galls of the sexual generation begin to develop in March-April and adults emerge from them in May. Galls of the asexual generation begin to develop in August and adults emerge from them in January-February, after which the galls may remain on the tree for several years

Distribution. Israel: Mt. Hermon 1500 and 1780 m.a.s.l. Elsewhere: galls of the asexual generation are known from Iran and Turkey (Tavakoli *et al*. 2008; Mutun & Dinç 2015).

Comments. Galls of the asexual generation of this species may be confused with those of *A. coriarius* (Figs 15–16), but *A. coriarius* galls have more numerous spine-like projections that vary in length unlike the three thick lobes of *A. coriaformis* galls. Galls of the sexual generation are very similar to those of *A. grossulariae* on *Q. ithaburensis* (Figs 49–50) but are found on *Q. libani*. Molecular data suggest that adults reared from these galls are genetically identical to those of *A. coriariformis* (Shachar, unpublished data) and thus represent the sexual generation of *A. coriariformis*, hence the species is now known from galls and adults of both generations.

Andricus coriarius (Hartig, 1843)

Host plants. Israel: *Q. ithaburensis*, *Q. libani*, *Q. cerris* (sexual generation), *Q. boissieri* (asexual generation). Elsewhere: numerous oak species from sections *Cerris* (sexual generation) and *Quercus* (asexual generation).

Life history. Both the sexual and asexual generations were previously recorded (Stone *et al*. 2008), but a detailed description of the sexual-generation galls was not given and is provided here for the first time. Galls of the sexual generation develop on oaks from section *Cerris*. They usually form a cluster of 15 or more conical, single-

chambered, 2.0–2.5 mm long and 1.5 mm wide units that are tapered apically, smooth, greenish-brown and thin-walled (Fig. 52). Galls of the asexual generation are found on oaks from section *Quercus*, and are morphologically diverse. The typical galls are composed of several tapering, curved lobes up to 30 mm long, which form a big, irregular sphere and are multi-chambered (Fig. 15). Other galls in the population have shorter, thicker lobes (Fig. 16). Young galls are pale green with flexible spiny lobes, sometimes with soft brown hair at their center. Mature galls are brown and woody.

Phenology. Adults of the sexual generation emerge in May in most locations in Israel, but at higher elevations and cooler habitats (e.g. Mt. Hermon) galls become apparent only in April and adults emerge in June. Galls of the asexual generation begin to develop in August and adults emerge from them in late December to January, after which galls may remain on the tree for several years.

Distribution. Israel: Mt. Hermon, 1500 and 1780 m.a.s.l., Mt. Kahal, En Zivan, Allone HaBashan, Tel Hazeqa. Elsewhere: common and widespread in Europe, from Great Britain to the Iberian Peninsula and Greece, Morocco, Turkey, Transcaucasia and Iran (Melika 2006b).

Comments. Galls of the sexual generation (Fig. 52) are very similar to galls of the *A. burgundus* species complex. Stone *et al*. (2008) showed that the sexual generation of several *Andricus* species, including *A. caputmedusae, A. coriarius* and *A. hystrix*, develops in small, aggregated bud galls similar to those of the *A. burgundus* species complex or *A. atkinsonae*. Our unpublished molecular results corroborate that observation, hence the galls and adults of both generations of *A. coriarius* are now known. Adults of the sexual generation will be described elsewhere.

The typical galls of the asexual generation are superficially similar to those of *A. grossulariae* (Fig. 9) but differ in the more delicate and pointed lobes. The less common morphologies of this gall (Fig. 16) resemble the galls of *A. coriariformis* (Fig. 17) but lobes of the latter are shorter and widely splayed.

Andricus curtisii (Müller, 1870)

Host plants. Israel: *Q. boissieri.* Elsewhere: *Q. infectoria.*

Life history. Known only from the bud galls of the asexual generation, which develop from lenticel (accessory) buds on the trunk and well-established branches. These are big, striking galls, 20–40 mm in diameter, composed of pyramidal units that form a spherical structure, pinkish, with a velvety cover (Fig. 11), and contain a single central chamber embedded in spongy tissue. Old galls remain on the tree for several years. Molecular data suggest that the sexual generation of this species develops in cryptic bud galls currently attributed to the *Andricus burgundus* complex (Stone *et al*. 2008).

Phenology. The galls develop through the summer and mature by late September-early October. In Israel, adults emerge from January to early February, whereas in Europe they usually emerge in spring.

Distribution. Israel: Odem Forest, En Zivan, Allone HaBashan, Tel Hazeqa, Rehan Forest. Elsewhere: a locally common eastern-mediterranean species known from Croatia, Greece, Southern Italy, Turkey, Iran, West Azarbaijan, Kurdistan and Algeria.

Comments. The galls of this species cannot be mistaken for any other gall in Israel. They resemble the galls of *A. hartigi* Hartig on *Q. petraea, Q. pubescens* and *Q. robur* in Europe and Asia Minor but *A. hartigi* galls are covered by detachable spines whereas *A. curtisii* galls are velvety.

Andricus curvator Hartig, 1840

Host plants. Israel: *Q. ithaburensis*. Elsewhere: common on *Quercus petraea, Q. pubescens, Q. robur*, and a few other species.

Life history. Both the sexual and asexual generations are known, but only the sexual generation was found in Israel, in either leaves or branch tips. Leaf galls constitute inconspicuous, spherical, 2 mm swellings of the leaf margin or along leaf veins, yellowish-green when young, turning pale brown when mature (Sternlicht 1968b, Fig. 46). Branch-tip galls (Sternlicht 1968b, Fig. 58) constitute swellings of the shoot, 4–8 mm long and 3–6 mm wide, and are the same color of the branch. The asexual generation develops in smooth, ovoid, thin-walled, single-

chambered bud galls within the bud scales, 3–4 mm in length and 2 mm in diameter. The base of the mature gall remains concealed within the bud scales. The gall is initially greenish-red, turning brown when mature. Usually found singly, rarely in pairs. The larval chamber is surrounded by spongy tissue.

Phenology. Galls of the sexual generation appear in April and adults emerge from them in May-June. Sternlicht (1968b) recorded the branch galls in January-February and the leaf galls in March, and adults emerged from them in June-July. The galls of the asexual generation begin to develop in June and mature by October. Adults usually emerge from them in February-March, although some remain in diapause inside the gall for another year.

Distribution. Israel: Rare in Tivo'n. Elsewhere: a very common and widespread species throughout the distribution range of European white oaks, Morocco, east to Transcaucasia and Iran.

Comments. Sternlicht (1968b) attributed the branch galls to *Andricus* nr. *curvator* and the leaf galls to *Andricus* sp., but both of types of galls indeed belong to *A. curvator*.

Andricus foecundatrix (Hartig, 1840)

Host plants. Israel: *Q. boissieri*. Elsewhere: several species from section *Quercus*.

Life history. Both the sexual and asexual generations are known, but in Israel only the galls of the asexual generation were found. These are brown, scaly, artichoke-like bud galls at the tips of branches, up to 13 mm in diameter and 20 mm long, (Fig. 23) and are single chambered. Young galls are closed tightly but open as they mature to release a small, internal spherical chamber (Fig. 24), which drops to the ground, where the insect completes its development. Old galls remain on the tree for several years and become brown (Fig. 24). The sexual generation develops in small catkin galls, thin walled, up to 2 mm long, with a pointed tip, covered by dense, pale pubescence and surrounded by the anthers. The galls are initially green, turning pale brown when mature (Adler 1881).

Phenology. Galls of the sexual generation begin to develop in April, mature in May, and adults emerge from them immediately. Adults of the asexual generation emerge in April of the following spring, but some remain in diapause in the leaf litter inside the expelled, spherical chamber of the gall for another year.

Distribution. Israel: Mt. Hermon 1500 and 1780 m.a.s.l., Mt. Kahal, Odem Forest, En Zivan, Allone HaBashan, Tel Hazeqa, Mt. Meron, Pa'ar cave, Mt. Addir, Nahal Rakefet. Elsewhere: a widespread species in the Western Palaearctic, from Morocco and Iberia to Great Britain and southern Scandinavia and eastwards to Iran.

Andricus grossulariae Giraud, 1859

Host plants. Israel: *Q. boissieri* (asexual generation) and *Q. ithaburensis* (sexual generation). Elsewhere: several species from section *Quercus* (asexual generation) and section *Cerris* (sexual generation).

Life history. Until recently, *A. grossulariae* was known only from its sexual generation, but rearing experiments (Walker 2002) and molecular data (Stone *et al*. 2008) associated it with galls that had been traditionally attributed to the asexual generation of *A.mayri*/*A.panteli*, hence these two species were synonymized under *A. grossulariae*. The sexual generation induces conical, pointy catkin galls, up to 7 mm long, single-chambered, and usually in clusters. They are light green and soft when very young (Fig. 49), turning bright red to deep purple and woody when mature (Fig. 50). Old galls remain on the tree until the next year. The asexual generation develops in bud galls that are up to 50 mm in diameter, composed of thick, tapering projections that form a sphere (Fig. 9), and are multi-chambered. They are bright green and sticky when young, turning light brown, woody, and not sticky when mature. Old galls may remain on the tree for a year.

Phenology. In Israel, galls of the sexual generation begin to develop in late February to early March and adults emerge from them in late March, but in higher, colder localities (e.g., Odem Forest and En Zivan) they develop later in the season and adults emerge in May. Galls of the asexual generation develop during the fall and adults emerge in January.

Distribution. Israel: Galls of the sexual generation are common and widespread throughout the distribution range of *Q. ithaburensis* in the country. Galls of the asexual generation are common in the northern part of Israel but are rare in Zur Hadassa (Judean Mountains). Elsewhere: A widespread and locally common species from Northern Africa through the Iberian Peninsula across Europe and the Balkans to Asia Minor, Iran and Caucasia.

Comments. Galls of the sexual generation are very similar to those of *A. coriariformis* on *Q. libani*, but develop on *Q. ithaburensis*. They are also somewhat similar to galls of *A. vindobonensis* (Fig. 51) but differ from them in having pointed apices and in their bright red color when mature, whereas the galls of *A. vindobonensis* are kidney- or bean-shaped, and dull purple-green when mature. Galls of the asexual generation are somewhat similar to the less common morphologies of *A. coriarius* galls (Fig. 16) but are more robust, and their lobes are shorter, more numerous and less tapered.

Andricus hystrix Kieffer, 1897

Host plants. Israel: *Q. boissieri* (asexual generation). Elsewhere: *Q. petraea, Q. pubescens, Q. robur* and *Q. infectoria* (asexual generation); *Q. cerris* (sexual generation).

Life history. The sexual generation of this species has been described recently (Folliot & Pujade-Villar 2006) from adult males, but in Israel the species is known only from the bud galls of its asexual generation. These are composed of multiple elongate, flexible projections that form a sphere of up to 6 mm in diameter (Fig. 10). They are green to purple and sticky when young, turning light brown, woody, and not sticky when mature. The sexual generation develops in single-chambered, solitary bud galls, 8 mm long and 1.3 mm in diameter, with longitudinal ribs and blunt tip. The gall is almost entirely concealed within the bud scales, smooth, medium to light brown or orange-brown (Folliot & Pujade-Villar 2006).

Phenology. In Israel, galls of the asexual generation begin to develop in June on branches close to the ground on young trees, and adults emerge from them in October. In Europe and Asia Minor adults emerge in September. Galls of the sexual generation develop in early spring and adults emerge from them in April-May.

Distribution. Israel: Rare, found only on Mt. Meron and Pa'ar cave. Elsewhere: Southern and Central Europe and Turkey.

Comments. Galls of the asexual generation are somewhat similar to those of *A. grossulariae* (Fig. 9) but differ from them in their smaller size, more delicate lobes, and the lack of longitudinal ridges along the lobes. Furthermore, in Israel *A. grossulariae* galls develop on high branches whereas *A. hystrix* galls are usually found on lower branches of young trees. The rare, single-chambered, spiny gall of *Andricus serotinus* (Giraud) (unknown from Israel) develops in similar regions on similar hosts, but can be distinguished form galls of *A. hystrix* by the fact that it is covered in many fine, almost feathery spines.

Andricus lucidus (Hartig, 1843)

Host plants. Israel: *Q. boissieri*. Elsewhere: several species from section *Quercus.*

Life history. Recent rearing experiments (Walker 2002) and unpublished molecular data showed that the sexual generation of this species is the taxon previously known as *Andricus aestivalis*. The asexual generation induces small to medium, spherical bud galls, up to 25 mm in diameter (Fig. 5). The gall is composed of short, straight and blunt lobes of up to 6 mm in length and is multi-chambered. Young galls are light green or reddish-purple and sticky, turning brown, woody and not sticky when mature. Old galls remain on the trees for several years and often lose the lobes. The sexual generation is known from Europe, where it induces big, rosette-like catkin galls, up to 25 mm in diameter on *Q. cerris*.

Phenology. Galls of the asexual generation begin to develop in August and adults emerge from them in January-February.

Distribution. Israel: Mt. Hermon 1780 m a.s.l. and 1500 m a.s.l., Odem Forest, En Zivan, Allone HaBashan, Tel Hazeqa, Mt. Meron, Mt. Adir. Elsewhere: widespread from Southern France to Iran.

Andricus megatruncicolus Melika, 2008

Host plants. Israel: *Q. boissieri*. Iran and Turkey: *Q. infectoria*.

Life history. Known only from the bud galls of the asexual generation, which are pentagon-shaped, 5–15 mm in diameter and single-chambered (Fig. 21). The galls are broadly attached to the branch and are composed of five flattened units that sheath a spherical mass. Old galls remain on the tree for several years.

Phenology. Galls develop over the summer and mature in September, adults emerge in the following spring (Tavakoli *et al*. 2008).

Distribution. Israel**:** Very rare, found only twice in one location on Mt. Hermon at 1780 m.a.s.l. Elsewhere: Iran and Turkey.

Comments. The species epithet reflects the close similarity of the adults and galls of the asexual generation to those of *Andricus truncicolus* (Giraud), and the larger size of the gall. The extreme rarity of purely asexual lifecycles in oak gallwasps (Stone *et al*. 2002) suggests that *A. megatruncicolus* has a sexual generation which probably develops on oaks from section *Cerris*.

Andricus melikai Pujade-Villar, 2002

Host plants. Israel: *Q. libani*. Greece: *Q. ithaburensis* ssp. *macrolepis* (= *aegilops*).

Life history. Known only from the the leaf galls of the sexual generation, which constitute substantial swellings of the leaf midrib and are multi-chambered (Fig. 68). Viable galls were found in June and July but no adults were reared from them.

Phenology. Galls begin to develop in April-May and adults emerged from them in June (in Greece) (Pujade-Villar *et al*. 2002).

Distribution. Israel: Very rare, found only twice on Mt. Hermon at 1780 m.a.s.l. Otherwise known only from Greece (Pujade-Villar *et al.* 2002).

Comments. Galls of this species superficially resemble those of *A. istvani* from Iran as both species cause multi-chambered leaf swellings on oaks from section *Cerris*. However, based on a comparison of the galls collected in Israel to those deposited in the PHMB, we concluded that the Israeli species is *A. melikai*.

Andricus miriami Shachar, 2015

Andricus morula (Shachar, Inbar & Dorchin), **new synonym.**

Host plants. *Q. ithaburensis* (asexual generation) and *Q. libani* and *Q. cerris* (sexual generation).

Life history. Prior to the present study, only the asexual generation of this species was known but recent molecular data suggest that *Andricus morula* (Shachar et al. 2017) is actually the sexual generation of *Andricus miriami* (Shachar, unpublished data), therefore the association of the two generations is established here for the first time (but see discussion of previous suggestions under the comments section). Galls of the sexual generation develop in mulberry-like catkin galls, composed of 17–40 small units attached to the branch at their bases (Figs 71–72). Young galls are soft and green to light brown at their tips, and completely covered by white velvety hairs and coated by nectar that attracts other insects. Mature galls are 12–17 mm long, 10–14 mm wide, and their apical part turns darker. The asexual generation develops in large and conspicuous bud galls, 20–40 mm in diameter, composed of 10–40 mushroom-shaped units that are joined at their bases to form a sphere (Fig. 43). Each subunit contains several larval chambers. Young galls are green, soft, and completely covered by short, white fuzz, whereas mature galls are woody, with the white fuzz limited to the tips of units. Old galls may remain on the tree for several years (Fig. 44).

Phenology. Galls of the sexual generation begin to develop in April and mature in June through July, when they reach their final size. Adults emerge in July and early August, after which the galls dry up, become woody and may remain on the tree for another year. Galls of the asexual generation begin to develop towards the end of March and mature in September. Adults emerge in January.

Distribution. Israel: The sexual generation is currently known only from Israel: Mt. Hermon 1500 and 1780 m.a.s.l., Mt. Kahal. The asexual generation is common and widespread throughout the distribution range of the host plant and is has also been recorded from Jordan (Nieves Aldrey & Massa 2006).

Comments. The name *A. miriami* has recently been validated in a formal description (Shachar *et al*. 2015). Sternlicht (1968b, Fig. 29) mentioned both the sexual and asexual generations of *A. miriami* and described their galls, but did not provide evidence for the association between them. More recently, Nieves Aldrey & Massa

(2006) and Rizzo & Askew (2009) recorded *A. miriami* from Jordan, where they reported to have found galls of both generations, but again, did not say what this decision was based on and did not describe the actual wasps. Our unpublished molecular data indicate that the taxon attributed by Sternlicht (1968b) to the sexual generation of *Andricus miriami* is a distinct species, close to *A. istvani*, and that *A. morula* is genetically identical to *A. miriami*. Therefore, we synonymize here *A. morula* under *A. miriami*, and this species is now known from galls and adults of both generations.

Galls of the sexual generation of *A. miriami* resemble somewhat galls of the sexual generation of *A. cecconii* (Figs 47–48) but are much smaller, woodier, elongate rather than spherical, and always sticky with a velvety cover, whereas *A. cecconii* galls are never sticky and may or may not have a velvety cover. The asexual generation of *Andricus turcicus* Melika, Mutun & Dinç induces similar galls on *Q. infectoria* and *Q. petraea* in Turkey, but these are small and single-chambered compared to the big, multi-chambered galls of *A. miriami*.

Andricus moreae (Graeffe, 1905)

Host plants. Israel: *Q. boissieri*. Elsewhere: *Q. pubescens* and *Q. infectoria.*

Life history. Known only from the bud galls of the asexual generation. These are spherical, single-chambered galls, 10 mm in diameter, resembling a blueberry, with a small apical 'crown'. They are found on the terminal parts of branches, usually in small clusters, dark green, turning brown and very hard when mature (Fig. 18). Old galls remain on the tree for several years and turn darker. The similarity of this species to host-alternating *Andricus* species suggests that if a sexual generation exists, it induces galls on oaks from section *Cerris* (e.g. *Q. cerris*, *Q. brantii*, *Q. libani*).

Phenology. Galls develop quickly from early to late August and the adults emerge from them in Israel in September-October (elsewhere also in November). In other countries where this species is known, some of the adults overwinter inside the galls and emerge in March of the following year.

Distribution. Israel: Mt. Hermon 1500 and 1780 m.a.s.l., Odem Forest, Allone HaBashan, Mt. Addir. Elsewhere: Geece, Turkey, Syria, Lebanon, Iran.

Comments. This species has not been collected for many years following its original description and its status was uncertain (Bellido *et al.* 2003). However, recently, many galls were found and adults were reared from Greece, Syria and Iran (Kwast 2005; Azizkhani *et al.* 2006), as well as during the present study.

The general shape and phenology of these galls resemble those of *A. sternlichti* (Fig. 20) but *A. sternlichti* galls are much bigger, pale brown when mature, and have typical pointy protuberances connected by ridges, which are absent in the much smaller and darker brown galls of *A. moreae*.

Andricus multiplicatus Giraud, 1859

Host plants. Israel: *Q. libani*. Elsewhere: *Q. brantii*, *Q. cerris*, *Q. trojana*.

Life history. Known only from the bud galls of the sexual generation, which are multi-chambered, often aggregated leafy rosettes, 25–40 mm in diameter, with numerous larval chambers at the bases of the rosette leaves (Fig. 67). Old galls remain on the tree for a year.

Phenology. Galls begin to develop in May, at which time the rosette is bright green. Adults emerge from them in June, after which the gall turns brown and dries out.

Distribution. Israel: Mt. Hermon, 1780 m.a.s.l. Eleswhere: common from South-central Europe to Turkey.

Comments. This gall resembles that of *A. cydoniae* Giraud, which is unknown from Israel and develops on the same oak hosts. However, the galls of *A. cydoniae* are genuinely multi-chambered, with many larval chambers inside a single solid mass of tissue, rather than an aggregation of distinct galls. In Europe, *A. multiplicatus* is known from *Q. cerris* but we did not find it on this host plant in Israel. The morphology of the galls on the different host plants in Iran and Europe is similar to that of the Israeli galls on *Q. libani*.

Andricus quercustozae (Bosc, 1792)

Host plants. Israel**:** *Q. boissieri*. Elsewhere: several oak species from section *Quercus*.

Life history. Known only from the bud galls of the asexual generation, although population genetic evidence strongly supports the existence of an unknown sexual generation (Rokas *et al.* 2003). The galls constitute some of the most conspicuous cynipid galls in Israel. They are big and spherical (up to 40 mm in diameter), with a whorl of small, tapered spines around their widest circumference (Figs 13–14). Young developing galls are green, soft, fleshy and very sticky (Fig. 13), and turn purple and woody as they mature. Mature galls are deep purple, resembling the color of a plum, sticky, woody on the outside but spongy on the inside, with a single central larval chamber. Old galls may remain on the tree for several years.

Phenology. Galls begin to develop in July and adults emerge the following spring. Adults may diapause for up to 3 years.

Distribution. Israel: Mt. Hermon 1500 and 1780 m.a.s.l., Odem Forest, En Zivan, Allone HaBashan, Tel Hazeqa, Mt. Meron (very rare). Certain trees in Odem Forest and Allone HaBashan regularly bear hundreds of galls. Elsewhere: a widespread and common Western Palaearctic species, from North Africa across Southern Europe to Asia Minor.

Comments. Galls of this species are somewhat similar to those of *A. hungaricus* Hartig from Hungary, Austria and the Balkan, but *A. hungaricus* galls do not have the typical whorl of small spines and are not sticky.

Andricus solitarius (Fonscolombe, 1832)

Host plants. Israel: *Q. boissieri.* Elsewhere: Several oak species from section *Quercus*.

Life history. Both the sexual and asexual generations are known, but in Israel only old bud galls of the asexual generation were found and no adults were reared. These galls are conical, single-chambered swellings at the tips of branches, widest basally, with very long and pointed, sometimes curved apex, brown and woody when mature. The sexual generation is known from Europe to induce single-chambered catkin galls, which develop from the flower buds on a stunted inflorescence petiole (Docters van Leeuwen 1934). The base of the gall is surrounded by stunted anthers, filaments and a small circle of hairs.

Phenology. Old galls of the asexual generation were found in Israel in July. In Europe, galls of the sexual generation develop before the catkin elongates, mature in May, and adults emerge from them soon afterwards. Galls of the asexual generation become visible in June, mature at the end of summer, and adults emerge from them in October.

Distribution. Israel: Very rare, observed only twice on Mt. Hermon at 1500 m.a.s.l. and on Mt. Meron. Elsewhere: A widespread but usually uncommon species all over Europe, northwest Africa, Transcaucasia and Iran.

Andricus sternlichti Bellido, Pujade-Villar & Melika, 2003

Host plants. Israel: *Q. boissieri*, *Q. pedunculiflora*. Elsewhere: *Q. pubescens, Q. infectoria* and a few other species of section *Quercus*.

Life history. Known only from the bud galls of the asexual generation ,which are spherical, single-chambered, 20–22 mm in diameter, attached to the branch by a very short stalk and bear several pointed projections often joined by ridges (Fig. 20). Young galls are green and fleshy, turning pale brown and extremely hard when mature. Molecular phylogenetic work (Stone *et al.* 2008) suggests that if a sexual generation exists, it probably induces galls on oaks of section *Cerris*.

Phenology. Galls begin to develop in May and adults emerge from them in early October, after which the galls may remain on the tree for several years.

Distribution. Israel**:** Common throughout the distribution range of *Q. boissieri*. Elsewhere: widespread from France to Turkey, Syria and Iran.

Comments. Galls of this species are of the most common cynipid galls on *Q. boissieri* in Israel and are also frequently observed on the introduced *Q. pedunculiflora* that is commonly planted in gardens and public areas.

The species is named after Sternlicht, who recognized that it was undescribed and intended to describe it as "*Andricus carmelis*". However, the species was described only in 2003 by Bellido *et al.*, who eliminated the confusion between it and *A. gallaetinctoriae* and *A. tinctoriusnostrus*.

Andricus tomentosus (Trotter, 1901)

Host plants. Israel: *Q. boissieri*. Elsewhere: several oak species from section *Quercus*.

Life history. Known only from the bud galls of the asexual generation, which develop on lateral or terminal buds. They are conical, 14–18 mm long, brown with a velvety cover and single-chambered, widest at base, thinner at mid-part, and widen again apically (Fig. 25).

Phenology. In Israel, young galls were found in November but no adults were reared. In Europe the larvae overwinter for 1–2 years inside the galls and adults emerge in March-April.

Distribution. Israel: Rare on Mt. Hermon at 1780 m.a.s.l., Allone HaBashan, Tel Hazeqa (only on one tree but in large numbers), Mt. Meron, Pa'ar cave. Elsewhere: Locally common in Southern and Eastern Europe, Turkey and Iran.

Andricus vindobonensis Müllner, 1901

Host plants. Israel: *Q. ithaburnsis*. Elsewhere: *Q. cerris*.

Life history. Known only from the catkin galls of the sexual generation, which are kidney-shaped, up to 4 mm long, single-chambered, often in aggregations (Fig. 51). They are green when young, sometimes turning purple when mature, and covered by velvety fuzz. Old galls drop to the ground with the dry catkin.

Phenology. Galls begin to develop in March and adults emerge from them in late April through June-July.

Distribution. Israel**:** Rare in En Zivan and Tel Hazeqa. Elsewhere: Patchy distribution but sometimes common in the Balkans and Turkey.

Comments. The galls of this species are somewhat similar to those of *A. grossulariae* (Figs 49–50) but are kidney- or bean-shaped and purple or green when mature, whereas *A. grossulariae* galls have pointed apices and are bright red when mature.

Andricus sp. nr. *amenti*

Host plants. Israel: *Q. libani* and *Q. cerris.*

Life history. Known only from the delicate, single-chambered leaf galls of the sexual generation, which are composed of an oval purple chamber that is carried on a long stalk for a total length of 8–11 mm (Fig. 69).

Phenology. Young galls were observed in April and a single female of the sexual generation emerged in May.

Distribution. Known only from Israel: common on some trees on Mt. Hermon at 1780 m.a.s.l. and more rare at 1500 m.a.s.l. and on Mt. Kahal.

Comments. Similar galls in Europe that develop in catkins of oaks from section *Quercus* belong to *A. alniensis* Folliot, *A. amenti* Giraud, *A. callidoma* Hartig, *A. malpighii* (Adler) and *A. seminationis* (Giraud) (Melika 2006b). However, the single adult we reared in Israel differs morphologically from those of the European species and is found on leaves of an oak from section *Cerris*. Together with preliminary molecular data (Shachar, unpublished) this suggests that the Israeli population represents a distinct species despite the similar gall morphology. A formal description of this species will be published elsewhere once more adults are reared.

Andricus sp. nr. *istvani*

Host plants. Israel: *Q. ithaburensis*.

Life history. Known only from the leaf galls of the sexual generation. These are large, conspicuous galls, 10–

45 mm long, amorphous, and multi-chambered (Fig. 63). The underside of the galled leaf is rigid and swollen, and its upper side is soft and densely covered by short hairs. Young galls are green with white hairs, turning dark brown with golden hairs as they mature.

Phenology. Galls begin to develop in February and adults emerge in March.

Distribution. Known only from Israel: En Zivan, Yehudiyya, Hosha'aya, Alonim, Tiv'on.

Comments. The galls of this species are similar to those of *A. istvani* from Iran (Tavakoli *et al.* 2008) but the adults reared from them are morphologically different. Sternlicht (1968b) attributed these galls to the sexual generation of *Andricus miriami* but preliminary molecular data (Shachar, unpublished) indicate that this is a distinct species, the formal description of which will be given elsewhere.

Andricus sp. nr. *quercusradicis* (Fabricius, 1798)

Host plants. Israel: *Q. ithaburensis*; Elsewhere: Mainly oaks from section *Cerris* (sexual generation) and from both *Cerris* and *Quercus* sections (asexual generation).

Life history. Both the sexual and asexual generations are known. The sexual generation induces single-chambered, usually aggregated leaf galls on *Q. ithaburensis*, which are cryptic swellings of the main leaf vein, up to 3 mm in width (Fig. 65). The asexual generation develops in woody, thick-walled multi-chambered root galls on *Q. ithaburensis* that are 3–10 cm in diameter when mature (Sternlicht 1968b, Fig.1).

Phenology. This species has a two-year lifecycle. Galls of the sexual generation develop in spring and adults emerge from them in September-October (Sternlicht 1968b). In Europe adults emerge in August-September and some may emerge the following year (Melika 2006b). The root galls of the asexual generation develop in the second year of the lifecycle. They mature in September and adults overwinter in them and emerge the following spring.

Distribution. Israel: En Zivan, Mezar, Tiv'on, Hadera. Elsewhere: widespread in Europe and Northwest Africa to Transcaucasia and Asia Minor.

Comments. The identity of this species could not be established with confidence because no adults were reared from the galls. Based on the morphology of the galls and the available data on its life history, we assume that it is related to *A. quercusradicis*, although that species is known from oaks in section *Quercus* whereas the galls in Israel are found on oaks from section *Cerris*.

Andricus sp. 1

Host plant in Israel: *Q. boissieri.*

Life history. Known only from the bud galls of the asexual generation, which are spherical, 10–12 mm in diameter, with tiny protuberances on distal half, carried on a distinct stalk and are light brown (Fig. 19). The walls of the gall are thick and encircle a single, thin-walled larval chamber.

Phenology. Galls attained their final size and shape in August, when they contained big larvae, and a single adult emerged in November.

Distribution. Israel: rare, found only on Mt. Hermon at 1500 and 1780 m.a.s.l.

Comments. The galls of this species are somewhat similar to those of *A. sternlichti* (Fig. 20) but are much smaller, carried on a longer stalk, and their protuberances are limited to the apical half of the gall whereas those on galls of *A. sternlichti* are found all over the gall. They are also somewhat similar to galls of *Dryocosmus tavakolii* Melika, Stone & Azizkhani, but adult morphology and preliminary molecular data (Shachar, unpublished) suggest that they represent a distinct species, the formal description of which will be published elsewhere.

The following two species are considered to be undescribed because of their unique gall morphologies, which do not resemble those of any known species. Although no adults were reared from the galls, they are tentatively ascribed here to *Andricus* based on the general resemblance of some gall attributes to those of *Andricus* species in Israel and Europe.

Andricus sp. 2

Host plant in Israel. *Q. boissieri.*

Life history. Known only from the catkin galls of the sexual generation. These are small, spherical galls, 2 mm in diameter, light brown to yellow, densely covered by short whitish hairs, single-chambered, and are found in clusters (Fig. 28).

Phenology. Galls were found in May but no adults were reared from them.

Distribution. Israel: Observed only once on a single tree in Mt. Kahal.

Andricus sp. 3

Host plant in Israel. *Q. boissieri.*

Life history. Known only from the bud galls of the sexual generation, which resemble a small carambola fruit, with 3–4 distinct longitudinal ridges, 5–7 mm long and 3–5 mm wide and single-chambered (Fig. 26). Young galls are green and fleshy, turnning pale brown when mature.

Phenology. Young galls were found in April and matured in June but no adults were reared from them. They were found only on low branches of young trees, close to the ground.

Distribution. Israel**:** rare species, found only on a few trees on Mt. Meron and Pa'ar cave.

Aphelonyx Mayr, 1881

A Western Palearctic genus with three species, *A. cerricola* (Giraud), *A. persica* Melika, Stone, Sadeghi & Pujade-Villar, and *A. kordestanica* Melika, all of which are known only from the asexual generation and induce bud galls on oaks of section *Cerris*.

Aphelonyx persica Melika, Stone, Sadeghi & Pujade-Villar, 2004

Host plants. Israel: *Q. ithaburensis* and *Q. libani.* Elsewhere: *Q. libani, Q. brantii, Q. castaneifolia.*

Life history. Known only from the bud galls of the asexual generation, which are spherical, single-chambered, 10–14 mm in diameter, with velvety, sometimes slightly wrinkled surface, broadly attached to the branch or sometimes to the trunk (Fig. 37), often in clusters of 5–8. The gall contains an internal ovoid chamber that is attached to the inside wall in young galls but detaches from it and rolls freely inside the mature gall (Fig. 38). Young galls are light green, turning brown when mature. Old galls remain on the trees for several years.

Phenology. Galls appear in August and adults emerge from them in October-November. In the present study one adult emerged from a gall on *Q. libani* in January.

Distribution. Israel: Common on *Q. ithaburensis* throughout its distribution range; on *Q. libani* found only on Mt. Hermon at 1780 m.a.s.l. Elsewhere: Turkey, Syria, Lebanon, Iran.

Comments. Galls of *A. persica* are very similar to those of *A. cerricola* and *A. kordestanica* but these species have not been found in Israel. The galls are often invaded by the inquiline *Synergus variabilis* Mayr, especially on *Q. ithaburensis*. An invaded gall is bigger, irregularly shaped and multichambered (Figs 39–40), whereas an uninvaded gall is spherical and single-chambered (Figs 37–38). Sternlicht (1968b) listed the axesual generation of *Andricus kollari* Hartig as occurring in Israel (his Figs 18–20) but we never found this species in Israel and conclude that Sternlicht mistook its galls for those of *Aphelonyx persica*. Galls of the two species are somewhat similar in shape and colour but those of *A. kollari* develop only on oaks from section *Quercus*.

Biorhiza Westwood, 1840

A Holarctic genus with six species, four of which in the Nearctic Region (Melika & Abrahamson 2002), one - *B. nawai* (Ashmead) in the Eastern Palaearctic, and another - *B. pallida* in the Western Palaearctic. All species are

associated with oaks of section *Quercus*, on which the asexual generation develops in root galls and the sexual generation in bud galls (Melika 2006b).

Biorhiza pallida (Olivier, 1791)

Host plants. Israel: *Q. boissieri.* Elsewhere: several oak species from section *Quercus*.

Life history. The sexual generation induces multi-chambered, irregularly spherical, soft and spongy galls, 15–30 mm in diameter, light brown when mature (Fig. 22). The asexual generation develops in multi-chambered galls in the roots.

Phenology. Galls of the sexual generation appear shortly after bud burst and mature through May and June. In Israel adults emerge in May, whereas in Southern Northern Europe they emerge at the end of May or in late June, respectively. Galls of the asexual generation take two years to mature, and complete their developement in the winter of their second year. The wingless females of the asexual generation emerge in the winter or very early spring, climb up the tree, and lay their eggs on shoots (Melika 2006b).

Distribution. Israel: Rare; known only from Mt. Kahal. Only the sexual generation was found in the present study, as root galls were not surveyed. Elsewhere: A widespread and often common species known from Europe, Northwestern Africa, east to Transcaucasia, Turkey and Iran. Data on the distribution in the Far East of Russia appears to be erroneous due to misidentification with another species - *B. nawai* (Ashmead) (Melika 2012).

Cerroneuroterus Melika & Pujade-Villar, 2010

A Palearctic genus with nine species, inducing bud and leaf galls on oaks from section *Cerris*. Adults most closely resemble those of *Neuroterus* (Melika *et al*. 2010).Three valid species are currently known from the Eastern Palaearctic and six species are known from the Western Palaearctic (Melika *et al*. 2010). Three of the latter occur in Israel, where they develop on *Q. ithaburensis, Q. libani* and *Q. cerris*. An additional species in Israel appears to be undescribed.

Cerroneuroterus gyulaigaraiae (Melika, 2006)

Host plants. Israel: *Q. ithaburensis.* Elsewhere (Syria and Iran): *Q. ithaburensis*, *Q. brantii*.

Life history. Known only from the leaf galls of the asexual generation, which are circular, flat, rigid structures, up to 2 mm thick and 6 mm in diameter, white at center, orange along undulating rims, and covered by sparse white hairs (Fig. 62). They are usually found in clusters and then their rims can be slightly irregular as they are squeezed together.

Phenology. Galls appear in August, drop to the ground in late October to November, and the pupae or adults overwinter in them on the ground. Adults emerge in January. Parasitism rates in Israel can exceed 80%.

Distribution. Israel: Mezar, Bet Keshet Forest, Hosha'aya, Alonim, Tiv'on, HaSharon Forest. Elsewhere: Syria, Iran.

Comments. The galls of this species are superficially similar to those of *Cerroneuroterus lanuginosus* on the same host plant (Figs 60–61) but differ from them in being orange with a white center rather than white with a black center, and in being less hairy. Sternlicht (1968b) referred to this species as *Neuroterus* sp. (his Fig. 44).

Cerroneuroterus lanuginosus (Giraud, 1859)

Cerroneuroterus cerrifloralis (Müllner), **new synonym**.

Host plants. Israel: *Q. ithaburensis*. Elsewhere: several oak species from section *Cerris*.

Life history. The sexual and asexual generations of this species are associated with each other for the first time in the present study. The sexual generation induces inconspicuous, spherical catkin galls, 1.5–2 mm in diameter,

green when young, turning brown when mature, covered by white hairs (Fig. 54). The galls are single-chambered and the chamber fills the entire volume of the gall. The asexual generation induces flat, circular leaf galls, up to 7 mm in diameter and 5 mm thick, densely covered by long, white to golden hairs with a black center of shorter hairs (Figs 60–61). These are probably the most abundant cynipid galls in Israel, which often cover the entire leaf surface; a single tree can bear tens of thousands of galls, although gall density may vary dramatically between years and trees.

Phenology. Galls of the sexual generation appear in early February and adults emerge from them in late February. Galls of the asexual generation begin to develop in August, drop from the leaf or together with the leaves in fall, and the wasps overwinter in them as pupae or adults. Adults emerge in January.

Distribution. Israel: Very common and widespread throughout the distribution range of *Q. ithaburensis*. Elsewhere: A common species from South-central Europe to Transcaucasia and Iran.

Comments. The sexual generation is known from Austria and Hungary, and although adults in Europe and in Israel are slightly different morphologically, we consider them to belong to the same species. Sternlicht (1968b) attributed the galls of this species to the sexual generation of *Neuroterus aprilinus* Giraud (currently a synonym of *Neuroterus politus* Hartig (Pujade-Villar & Ros-Farré 2001)). However, the galls of *C. lanuginosus* are covered by white hairs and are thin walled, whereas those of *N. politus* are smooth with a fleshy wall when young, turning thick when mature.

Galls of the asexual generation are similar to galls induced by an unidentified cecidomyiid species on the same host plant but the cecidomyiid galls are brownish-white and are evident as rigid tubercles on the upper side of the leaf, whereas the galls of *C. lanuginosus* are usually white and are evident only on the underside of the leaf.

Galls of the sexual generation of this species have been attributed so far to *C. cerrifloralis* but molecular work shows that they actually belong to *C. lanuginosus* (Shachar, unpublished data), therefore we synonymize *C. cerrifloralis* under *C. lanuginosus* and the species is now known from both generations.

Cerroneuroterus minutulus (Giraud, 1859)

Host plants. Israel: *Q. libani.* Europe: *Q. cerris*.

Life history. Known only from the leaf galls of the asexual generation, which are found on veins, predominantly on the lower side of the lamina, elliptical, up to 2 mm in diameter, covered by small projections, usually solitary but sometimes in aggregations. Young galls are pale, turning green to dark red and purple when mature.

Phenology. Galls are first observed in August and mature in November. Larvae overwinter inside the galls in the leaf litter and adults emerge early the following spring.

Distribution. Israel: Mt. Hermon, 1780 m.a.s.l. Elsewhere: Central Europe, Turkey Balkan, Northern Africa.

Cerroneuroterus sp. nr. *lanuginosus* (Giraud, 1859)

Host plants. *Q. libani*, *Q. cerris*.

Life history. Known only from the leaf galls of the asexual generation, which are flat, spherical, up to 5 mm thick and 7 mm in diameter, covered by long, whitish or pinkish to golden hairs with a black center of shorter hairs, usually in clusters (Fig. 70).

Phenology. Galls begin to develop in August, drop to the ground in the fall, and the larvae overwinter in them on the ground. No adults were reared.

Distribution. Israel: Mt. Hermon 1500 and 1780 m.a.s.l., Mt. Kahal.

Comments. The galls of this species are very similar to those of *C. lanuginosus* on *Q. ithaburensis* (Figs 60–61) but their hairs are pinkish to golden as opposed to the white hairs on *C. lanuginosus* galls. As no adulsts were reared it was impossible to determine whether the galls on *Q. libani* belong to *C. lanuginosus* or belong to a different species. Somewhat similar galls are induced by an unidentified cecidomyiid species on the same host plant but these have brownish hairs and are evident as rigid tubercles on the upperside of the leaf, whereas galls of *Cerroneuroterus* nr. *lanuginosus* are evident only on the underside of the leaf.

Chilaspis Linnaeus, 1758

A Western Palearctic genus with two species, *C. israeli* Sternlicht and *C. nitida* (Giraud), inducing catkin and leaf galls on oaks from section *Cerris.* The asexual and sexual generations are known for both species, developing in detachable leaf galls and catkin galls, respectively. Morphologically, the genus closely resembles *Dryocosmus* and *Plagiotrochus* (Pujade-Villar *et al*. 2003b; Melika *et al*. 2010), but its synonymization with *Dryocosmus* by Ács *et al*. (2007) was premature and did not incorporate adequately molecular or morphological characters found in other cynipid genera (e.g., *Aphelonyx*, and *Neuroterus*). In a more recent phylogenetic reconstruction, *C. nitida* and *C. israeli* formed a strongly-supported monophyletic clade together with *Plagiotrochus*, and were clearly separated from *Dryocosmus* (Stone *et al*. 2009).

Chilaspis israeli Sternlicht, 1968

Host plants. Israel: *Q. ithaburensis.* Elsewhere: *Q. brantii*, *Q. castaneifolia*, *Q. libani.*

Life history. The sexual generation induces big and hairy, multi-chambered catkin galls, 20–40 mm in diameter (Fig. 45), composed of small triangular subunits that are densely covered by long hairs. Each unit contains one very rigid larval chamber that is attached to the catkin petiole. When young, the hairs are whitish to pinkish, turning golden-brown when mature. The asexual generation induces detachable, spherical leaf galls, up to 10 mm in diameter, which are often alined on the underside of the leaf and are single chambered (Fig. 59). Young galls are tiny and covered by black fuzz, turning green and hard when mature. They then drop from the leaves, turning brown with a velvety cover after a few days on the ground, and the larvae diapause in them for 4–10 months.

Phenology. Galls of the sexual generation begin to develop in February and adults emerge from them in late February to early March or in April in the Golan Heights. Galls of the asexual generation begin to develop in September and mature in December. Some of the larvae pupate and emerge as adults in February-March of the following year, whereas others remain in diapause and emerge only in October.

Distribution. Israel: Throughout the distribution range of *Q. ithaburensis*. Elsewhere: Lebanon, Jordan, Iran.

Comments. Sternlicht (1968b) described *Chilaspis israeli* (his Figs 49, 57) as a subspecies of *Chilaspis nitida* Giraud, which was later recognized as a distinct species by Pujade-Villar *et al*. (2003b). Galls of both generations are very similar to those of *C. nitida* in Europe but are bigger (up to 10 mm in diameter compared to 5 mm in *C. nitida*), and the two species are geographically separated, with *C. israeli* restricted to several oak species in the Levant and Iran and *C. nitida* to *Q. cerris* in Europe.

Cynips Linnaeus, 1758

The genus is represented by nine species in the Western Palaearctic and one species, *C. staminobia* Kovalev, in the Eastern Palaearctic (Melika 2012) as well as many species from The Nearctic Region (Kinsey 1930, 1936; Melika & Abrahamson 2002). Three species are known from Israel on *Q. boissieri*.

Cynips cornifex Hartig, 1843

Host plants. Israel: *Q. boissieri.* Elsewhere: *Q. pubescens, Q. petraea, Q. infectoria.*

Life history. Known only from the leaf galls of the asexual generation, which are bilaterally flat projections, 5–15 mm long, usually with a blunt tip, on the underside of the leaf (Fig. 29). They are soft and green when young, turning hard and reddish-brown when mature.

Phenology. In Israel, viable galls were found in November but no adults were reared. In Europe, galls of this species begin to develop in June, drop to the ground with the leaves when mature, and the adults emerge in April of the following year.

Distribution. Israel: Very rare, observed only once on a single tree on Mt. Hermon at 1780 m.a.s.l. Elsewhere: Widespread and locally abundant from southern France to Iran.

Cynips divisa Hartig, 1840

Host plants. Israel: *Q. boissieri*. Elsewhere: several oak species from section *Quercus*.

Life history. Both the sexual and asexual generations are known but in Israel only the leaf galls of the asexual generation were found. These are spherical, detachable galls on the underside of the leaves, 4–6 mm in diameter and single-chambered (Fig. 33). Young galls are green and fleshy, turning golden-brown and thick-walled when mature. Galls of the sexual generation are small, conical, single-chambered leaf-margin galls with a small apical tip.

Phenology. In Europe, galls of the asexual generation begin to develop in June and adults emerge from them in October-November or in February-March of the following year. In Israel they were found in July but no adults were reared from them. Galls of the sexual generation develop rapidly after leaf burst in spring and adults emerge in May.

Distribution. Israel: Throughout the distribution range of *Q. boissieri*. Elsewhere: A common species from the Iberian Peninsula to Transcaucasia and Iran.

Comments. Galls of the asexual generation of this species are somewhat similar to those of *Cynips quercus* on the same host plant (Fig. 32) but are smaller and golden-brown rather than green.

Cynips quercus Fourcroy, 1758

Host plants. Israel: *Q. boissieri*. Elsewhewe: several oak species from section *Quercus*.

Life history. Known in Israel only from the leaf galls of the asexual generation, which are spherical, single-chambered galls, 15–25 mm in diameter, resembling small grapes (Fig. 32). The galls are fleshy, firm, light green with white dots when young, yellowish with white dots when mature. The larval chamber is located in the center of the gall, surrounded by a thin wall. The sexual generation is known from Europe to develop in single-chambered galls in dormant lenticel buds, often on the trunk or on larger branches, and rarely on shoots of the previous year (Melika 2006b).

Phenology. Galls of the asexual generation appear in July and drop to the ground in November-December while still attached to the leaves. Adults emerge from them in January-February. Galls of the sexual generation appear in Europe in May and adults emerge from them in June (Melika 2006b).

Distribution. Israel: Mt. Hermon at 1500 and 1780 m.a.s.l., Odem Forest, En Zivan, Allone HaBashan, Tel Hazeqa, Mt. Meron, Mt. Addir. Elsewhere: A common species throughout Europe and Asia Minor, to Turkey and Lebanon, but restricted only to the extreme northeast of the Iberian Peninsula and absent from Portugal.

Comments. Galls of the asexual generation are similar to those of *Cynips quercusfolli* Linnaeus in Europe (Melika 2006b).

Dryocosmus Giraud, 1859

A Holarctic genus of 29 species, inducing leaf, twig, shoot and bud galls on oaks from sections *Cerris*; *Castanea,* and *Chrysolepis*. Most species are known from both generations. Adults resemble those of *Chilaspis* but differ from them in certain morphological characters. This is a paraphyletic genus, with seven species in the Western Palaearctic (Cerasa *et al*. 2018) and many species in the Eastern Palaearctic (Tang *et al*. 2016a) and the Nearctic Regions (Melika & Abrahamson 2002). Two species are known from Israel on *Q. ithaburensis*.

Dryocosmus mayri Müllner, 1901

Host plants. Israel: *Q. ithaburensis.* Elsewhere: *Q. ithaburensis, Q. cerris* and *Q. macrolepis.*

Life history. Known only from the bud galls of the sexual generation, which are irregularly spherical masses, up to 20 mm in diameter, composed of 6–20 units, each with a single larval chamber (Fig. 46). They are light green to deep purple, sometimes with white hairs apically, and are very sticky.

Phenology. Galls begin to develop in February and adults emerge from them in late February-March.

Distribution. Israel: Mezar, Bet Keshet Forest, Hosha'aya, Alonim, Tiv'on, HaSharon Forest. Elsewhre: Austria, Hungary, Ukraine, Greece, Turkey and Jordan.

Dryocosmus mikoi Melika, Tavakoli, Stone & Azizkhani, 2006

Host plants. Israel: *Q. ithaburensis.* Elsewhere: *Q. libani, Q. brantii* and *Q. castaneifolia.*

Life history. Known only from the leaf galls of the sexual generation, which constitute spherical swellings at the base of leaves, up to 12 mm in diameter, with an apical 'crest' up to 4 mm long (Fig. 64). They are single-chambered, fleshy and bright green when young, turning hard as they mature, and dark brown when old.

Phenology. Galls begin to develop in March (June in higher elevations - e.g., En Zivan) and adults emerge in May-June.

Distribution. Israel: Rare in En Zivan, Mezar, Yehudiyya, Dan and Hagoshrim. Elsewhere: Iran.

Neuroterus Hartig, 1840

A large Holarctic genus of 92 species, which induce leaf, catkin and bud galls on oaks from sections *Cerris* and *Quercus* (Melika & Abrahamson 2002). Alternation of generations is known. Six species are known from the Western Palaearctic and seven are known from the Eastern Palaearctic. Four species occur in Israel on *Q. boissieri* and *Q. ithaburensis*.

Neuroterus albipes (Schenck, 1863)

Host plants. Israel: *Q. boissieri.* Elsewhere: several oak species from sections *Quercus* and *Cerris*.

Life history. Galls of the sexual generation are elliptical leaf-margin galls, up to 4 mm in length, causing deformation of the leaf, light brown, covered by short white hairs, rigid and single-chambered. Galls of the asexual generation are flat, irregularly spherical leaf galls, up to 7 mm in diameter, usually in clusters (Fig. 34). They have a central pit and resemble a small flower with undulating margins, varying in color from pale green to pink and purple.

Phenology. Galls of the sexual generation were observed in May and July but no adults were reared from them. Galls of the asexual generation appear in August, mature and drop from the leaves in late November-December, and the larvae overwinter in them on the ground until adult emergence in January-February. In Europe, adults emerge in spring.

Distribution. Israel: Galls of the sexual generation are rare and were observed on only a few occasions in Tel Hazeqa, Mt. Meron, Pa'ar cave and Rehan Forest. Galls of the asexual generation were found on Mt. Hermon at 1500 and 1780 m.a.s.l., Odem Forest, En Zivan, Allone HaBashan, Tel Hazeqa, Pa'ar cave and Mt. Addir. Elsewhere: Widespread and occasionally common from the Iberian Peninsula north to Great Britain Isles and east to Turkey and Transcaucasia. Also known from Northern Africa.

Comments. The galls of the asexual generation are somewhat similar to those of *Neuroterus quercusbaccarum* on *Q. boissieri* (Figs 35–36A) but are flatter and thinner, with no hairs.

Neuroterus anthracinus Curtis, 1838

Host plants. Israel: *Q. boissieri*, *Q. ithaburensis.* Elsewere: mostly on oaks from section *Quercus* but also on species from section *Cerris*.

Life history. Both generations are known but in Israel only the asexual generation was found so far. It induces single-chambered leaf galls which constitute small, ovoid sturctures, 1.5–3 mm long and up to 2 mm wide, wrapped between two thin, wing-like extensions (Figs 31, 66). They are yellow to green and shiny when young,

and develop purple or red dots as they mature and then drop from the leaf, leaving the 'wings' behind. The sexual generation develops in single-chambered, lateral or terminal bud galls, usually gregarious (2–6 galls in one group), rounded or slightly ovate, 2 mm long and 1.5 mm in diameter when mature, green or yellowish, smooth, often with distorted leaves attached to the side or tip of the gall.

Phenology. Galls of the asexual generation appear in late August, mature by September, drop to the ground, and adults emerge from them the following spring. Galls of the sexual generation develop rapidly in Europe and adults emerge from them in May-June.

Distribution. Israel: Widespread and common throughout the distribution range of *Q. boissieri*. Elsewhere: Common and locally abundant throughout most of Europe to Crimea, Turkey and Iran.

Comments. Sternlicht (1968b) referred to this species as *Andricus ostreus*, a name that was later synonymized under *Neuroterus anthracinus* (Pujade-Villar *et al.* 1998).

Neuroterus numismalis (Geoffroy in Fourcroy, 1785)

Host plants. Israel: *Q. boissieri.* Elsewhere: several oak species from section *Quercus*.

Life history. The sexual generation develops in circular, single-chambered leaf blisters, 3 mm in diameter, with a small central bump on both sides of the leaf (Fig. 30). When young, the galls are the same color of the leaves and therefore difficult to notice. When mature, they turn paler green. The asexual generation induces button-shaped, single-chambered leaf galls, up to 3 mm in diameter, with a pitted center surrounded by silky golden-brown hairs (Fig. 36B).

Phenology. The phenology of this species in Israel is unclear because in June galls of the sexual generation contained small larvae, whereas in Europe adults already emerge from these galls at that time of year. Galls of the asexual generation begin to develop in August and drop from the leaf in November. Larval development continues on the ground and adults emerge in March.

Distribution. Israel: Galls of the sexual generation were found on Mt. Hermon at 1780 m.a.s.l., Mt. Meron, Pa'ar cave, Mt. Addir, and Zur Hadassa. Galls of the asexual generation were also found on Mt. Hermon at 1500 m.a.s.l. and in Allone HaBashan. Elsewhere: A pan-European species extending eastwards as far as Iran.

Comments. Galls of the sexual generation cannot be mistaken for any other leaf galls in Israel. They are similar to those of *Andricus gallaeurnaeformis* Fonscolombe in Iberia and Turkey but the latter do not have the central bump.

Neuroterus quercusbaccarum Linnaeus, 1758

Host plant. Israel: *Q. boissieri*. Elsewhere: several species from section *Quercus*.

Life history. The sexual generation induces the largest catkin galls on oaks in Israel. These are fleshy, spherical galls, up to 8 mm in diameter, smooth, shiny, light green with purple 'veins' and single-chambered (Fig. 27). The asexual generation induces dome-shaped leaf galls, up to 6 mm in diameter, with a pointed central projection, single-chambered, usually in clusters (Fig. 35, 36A). When young, the galls are pale green, sometimes covered by very short, reddish hairs, turning pink as they mature.

Phenology. Galls of the asexual generation appear in August, drop from the leaves in November-December and adults emerge from them in March. Galls of the sexual generation appear in March and adults emerge from them in April-May.

Distribution. Israel: Known from galls of both generations throughout the distribution range of *Q. boissieri*. Elsewhere: Common and widespread from Northwestern Africa to Norway, Russia and Iran.

Comments. Galls of the asexual generation are similar to those of *Neuroterus tricolor* Hartig in Europe but the latter are spherical rather than dome-shaped and do not have a central pointed projection.

Plagiotrochus Mayr, 1881

The genus is represented by 14 species in the Western Palearctic, of mostly Mediterranean distribution, which

induce galls on all parts of oaks from section *Ilex* and less commonly *Cerris* (Nieves-Aldrey 2001; Melika & Abrahamson 2002). Seven species are known in the Eastern Palaearctic (Tang *et al*. 2016b). Both generations are known for most species, the majority of which are associated only with evergreen oaks. Adults resemble those of *Chilaspis*. Three species are known from Israel on *Q. calliprinos*, one of which has been found only once.

Plagiotrochus coriaceus (Mayr, 1882)

Host plants. Israel: *Q. calliprinos.* Elsewhere: *Q. ilex* and *Q. coccifera.*

Life history. Known only from the leaf galls of the asexual generation, which are slender, single-chambered swellings protruding on both sides of the leaf, 2 mm in diameter, sometimes in aggregations.

Phenology. The galls develop in spring and summer and adults emerge the following spring. In Israel old galls were observed in May.

Distribution. Israel: Found once in Nahal Sfunim at the foothills of Mt. Carmel. Elsewhere: Western Mediterranean.

Plagiotrochus quercusilicis (Fabricius, 1798)

Host plants. Israel: *Q. calliprinos.* Elsewhere: *Q. ilex* and *Q. coccifera*.

Life history. Known only from the leaf galls of the sexual generation, which are multi-chambered, fleshy, rigid, ovoid, up to 8 mm in diameter, occupying most of the leaf (Fig. 74). The galls are green when young, red when mature, with smooth and shiny surface.

Phenology. Galls begin to develop in March and adults emerge from them in April-May.

Distribution. Israel: Odem Forest, Mt. Meron, Pa'ar cave, Kfar Hahoresh, Tiv'on, Mt. Carmel, Zur Hadassa. Elsewhere: This is the most common and widespread species in the genus *Plagiotrochus,* with a circum-mediterranean distribution.

Comments. When young, the galls resemble those of *Plagiotrochus australis* Mayr on Q. *ilex* in the Western Mediterranean Region but *P. australis* galls are single-chambered whereas those of *P. quercusilicis* are multi-chambered. Sternlicht (1968b) referred to galls of this species as belonging to the sexual generation of *Plagiotrichus kiefferianus* Tavares, a species that has been synonymized under *P. gallaeramulorum* Boyer de Fonscolombe (Pujade-Villar 2005). The possibility that *P. quercusilicis* and *P. gallaeramulorum* are synonymous was first suggested by Tavares (1926) and later by Nieves-Aldrey (2001) but without clear evidence.

Plagiotrochus razeti Barbotin, 1985

Host plants. Israel: *Q. calliprinos.* Elsewhere: *Q. ilex.*

Life history. Both the sexual and asexual generations are known but in Israel only the branch galls of the asexual generation were found. These constitute 10–35 mm long globular to elongate, multi-chambered swellings of the branch (Fig. 73). The larval chambers are arranged in a circle around at the gall circumference. The sexual generation induces single-chambered galls in lateral and terminal buds and in catkins, sometimes in aggregations.

Phenology. In Iberia, galls of the asexual generation develop in summer and adults emerge from them in December-January. Galls of the sexual generation develop in May and adults emerge at the end of that month (Nieves-Aldrey 2001).

Distribution. Israel: Pa'ar cave, Tivo'n, Mt. Carmel. Elsewhere: Iberian Peninsula, France.

Comments. The three females we reared from galls of the asexual generation run to *P. razeti* in available keys (Nieves-Aldrey 2001) and their comparison to voucher specimens of *P. razeti* from Iberia, deposited in the PHMB, suggested that they belong to that species. Galls of the asexual generation resemble those of *Plagiotrochus gallaeramulorum* from Europe but the larval chambers in the latter are arranged along the longitudinal axis of the gall rather than radially. Sternlicht attributed these galls to the asexual generation of *Plagiotrichus kiefferianus*, a species that was since synonymized with *Plagiotrochus gallaeramulorum* (Pujade-Villar 2005). We consider this species to be distinct from *Plagiotrichus gallaeramulorum* due to the different structure of the galls.

Pseudoneuroterus Kinsey, 1923

A Western Palearctic genus of four species, which is closely related to *Neuroterus* (Melika *et al*. 2010). Species in this genus induce leaf, acorn or branch galls on oaks from section *Cerris*, and both generations are known for some of them. Two described and two undescribed species are known from Israel on *Q. ithaburensis*.

Pseudoneuroterus macropterus (Hartig, 1843)

Host plants. Israel: *Q. ithaburensis.* Elsewhere: Several species from section *Cerris*.

Life history. Prior to the present study, only the asexual generation of this species was known (Sternlicht 1968b) and the association between it and its sexual generation is established here for the first time. Galls of the asexual generation are multi-chambered stem swellings, 5–60 mm in length, of the same color of the branch (Fig. 12 in Sternlicht 1968b). The sexual generation develops in small, conical bud galls, up to 2 mm in length, inside the basal part of a bud scale (Fig. 55). The single-chambered gall is green when young, light brown when mature, with thin and delicate walls but harder than the scale itself. The larva occupies the entire volume of the gall.

Phenology. Galls of the sexual generation were found in early February and adults emerged from them later that month. Galls of the asexual generation become evident in summer but no adults were reared from them in the present study. Sternlicht (1968b) reported to have reared adults in February-March or in September-October of the following year.

Distribution. Israel: Sexual generation: Hosha'aya, Alonim, Tiv'on, Hasharon Forest. Asexual generation: Rare, observed only once in the present study in Yehudiyya. Also recorded from Tiv'on (as *Neuroterus macropterus*) (Sternlicht 1968b). Elsewhere: Widespread and locally common from Central Europe to Iran.

Comments. Sternlicht (1968b) attributed the galls of this species to the sexual generation of *Neuroterus aprilinus* Mayr (his Figs 21–22), a species that was later synonymized under *Neuroterus politus* (Pujade-Villar & Ros-Farré 2001). However, the galls we found are ovoid and thin-walled whereas those of *N. politus* are thick-walled and pointed apically, and our molecular data suggest that this species does not belong in *Neuroterus*. Instead, these data suggest that adults reared from the sexual generation galls are genetically identical to those of *Pseudoneuroterus macropterus* (based on sequences in Genbank), and thus represent the sexual generation of that species. Therefore, *P. macropterus* is now known from galls and adults of both generations.

Pseudoneuroterus saliens Kollar, 1857

Host plants. Israel: *Q. ithaburensis*, *Q. libani* and *Q. cerris*. Elsewhere: several species from section *Cerris*.

Life history. The sexual generation forms multi-chambered galls in the first-year acorns of *Q. ithaburensis*, *Q. libani* and *Q. cerris* (Fig. 57). Infected acorns stop developing, do not fall from the tree, and appear fresh and light green, with no other external evidence of the gall. Galls on all three oak species in Israel look the same. The asexual generation induces elliptical leaf galls, up to 5 mm long and 3 mm wide on *Q. ithaburensis* (Fig. 58). These are single-chambered, rigid, light to dark brown, and are usually aggregated on the underside of the leaf but sometimes also on its upper side or on the leaf petiole.

Phenology. Galls of the sexual generation begin to develop in February and adults emerge from them in March. In higher elevations (e.g., En Zivan, Mt. Hermon), the galls appear in April and adults emerge in May, whereas in Europe they emerge in June-August. Galls of the asexual generation appear in Israel in August but no adults were reared from them in the present study due to extremely high parasitism rates. In Europe, adults emerge from these galls in April.

Distribution. Israel: Galls of both generations are widespread on Mt. Hermon at 1500 and 1780 m.a.s.l., Mt. Kahal, En Zivan, Yehudiyya, Mezar, Dan Valley, Hagoshrim, Hosha'aya, Alonim, Tiv'on and HaSharon Forest. Galls of the asexual generation were also found in Nahal Rakefet, Bet Keshet Forest, Pardes Hanna and Zikhron Ya'akov. Elsewhere: Widespread from the Iberian Peninsula to Iran.

Comments. No other species in Israel develops in first-year acorns and no species induces similar leaf galls on *Q. ithaburensis*, hence this species can be recognized with confidence. Sternlicht (1968b) attributed the galls of the

sexual generation to *Neuroterus* sp. (his Fig. 56), and those of the asexual generation to *Neuroterus saltans* Giraud (his Fig. 43), a name that was later synonymized under *Pseudoneuroterus saliens* (Melika *et al*. 2010). In the same work he mentioned another thin-walled, yellow to brown ovoid gall that is attached to the leaf midrib or petiole (his Fig. 41) and referred to it as *Neutoterus* sp., but we ascribe this gall as well to *P. saliens*.

Pseudoneuroterus sp. 1

Host plant in Israel: *Q. ithaburensis*.

Life history. This species develops in cryptic, spherical bud galls, 4.5–5 mm in diameter, which are composed of several fused units and covered by white velvety fuzz (Fig. 56).

Phenology. Galls were first observed in early February and adults emerged from them in early March.

Distribution. Israel: Hasharon Forest.

Comments. The galls of this species are somewhat similar to those of *Dryocosmus tavakolii* Melika, Stone & Azizkhani, but adult morphology and molecular data (Shachar, unpulished) show that they belong in Pseudoneuroterus. The species will be formally described once more material becomes available.

Pseudoneuroterus sp. 2

Host plant in Israel. *Q. ithaburensis*.

Life history. This species is currently known only from its sexual generation, which develops in cryptic, ovoid galls, 4–7 mm in diameter, in apical buds (Fig. 53). The galls are soft, light green, with velvety white cover.

Phenology. Galls were found in early February and adults emerged from them in early March.

Distribution. Israel: Mezar, Hosha'aya, Alonim, Hasharon Forest.

Comments. Mrphological and molecular data (Shachar, unpulished) place this specis in *Pseudoneuroterus* but due to the small number of adults we obtained, the species is not described here formally and will be dealt with once more material become available.

Synophrus Hartig, 1843

A West Palearctic genus of 7 species, which was originally described as a gall inducer on oaks from section *Cerris* but later transferred to the inquilinous tribe *Synergini* on the basis of adult morphology (Ronquist 1994). Species in this genus invade various galls on oaks from section *Cerris.* Invasion of a gall by *Synophrus* is always lethal to the gall inducer (Pujade-Villar *et al*. 2003a; Pénzes *et al*. 2009) and is associated with extensive modification of the gall tissues, almost similar to the effect of the gall-inducer itself (Pénzes *et al*. 2009). Two species are currently known from Israel on *Q. ithaburensis*.Two additional species, S. *libani* Melika & Pujade-Villar and S. *syriacus* Melika, which are known from Lebanon and Syria, respectively (Pénzes *et al.* 2009), may also occur in Israel but have not been found yet.

Synophrus olivieri Kieffer, 1898

Host plants. Israel: *Q. ithaburensis*. Elsewhere: *Q. suber* and *Q. ithaburensis*.

Host gall-wasp: Unknown.

Life history. Known only from the sexual generation, which develops in extremely hard, multi-chambered galls of irregular shape, up to 30 mm in diameter, of the same color of the branch (Fig. 42; Sternlicht 1968b, Figs 10–11).

Phenology. Galls develop in spring and adults emerge from them in March of the following year.

Distribution. Israel: Mezar, Bet Keshet Forest, Hosha'aya, Alonim, Tiv'on, HaSharon Forest. Elsewhere: North Africa, Asia Minor.

Synophrus politus Hartig, 1843

Host plants. Israel: *Q. ithaburensis*. Elsewhere: several species from section *Cerris.*

Host gall-wasp. The sexual generation invades galls of species in the *Andricus burgundus* complex (Pénzes *et al*. 2009).

Life history. Known only from the sexual generation, which develops in galls induced by the *Andricus burgundus* complex (e.g., *A. caputmedusae*, *A. coriarius*, *A. curtisii*) (Pujade-Villar *et al*. 2003a; Pénzes *et al*. 2009). In Israel, this species has been reared from the clustered, conical bud galls of *A. coriarius* (Fig. 52), causing them to develop into a single spherical unilocular gall, up to 15 mm in diameter, of the same color of the branch, with very hard walls encircling a single larval chamber (Fig. 41; Sternlicht 1968b, Figs 13, 15–17). Invaded galls were found in February and adult inquilines emerged in December-January.

Distribution. Israel: Mezar, Hosha'aya, Alonim, Tiv'on, Hasharon Forest. Elsewhere: Northwest Africa to Iran.

Comments. The galls of this species resemble somewhat those of *Aphelonys persica* but *A. persica* galls are light brown, with more delicate and sometimes wrinkled surface (Fig. 37), whereas *S. politus* galls are of the same color of the branches, rougher and more rigid. Moreover, *A. persica* galls are hollow and thin-walled (Fig. 38) relative to the very thick-walled galls of *S. politus*.

Synergus Hartig, 1840

This is the biggest genus of cynipid inquilines, with 117 described species throughout the Holarctic and Neotropical Regions. The genus is found in galls of species associated mostly with deciduous oaks of sections *Cerris*, *Ilex*, *Lobatae* and *Quercus*. One species is known from Israel on *Q. ithaburensis*.

Synergus variabilis Mayr, 1872

Host plant: Israel: *Q. ithaburensis*. Elsewhere: *Q. cerris*.

Host gall wasp: Israel: *Aphelonyx persica*. Elsewhere: several species in the genera *Andricus*, *Aphelonyx*, *Dryocosmus* and *Pseudoneuroterus* (Melika 2006b).

(Invaded) gall and biology: Known only from the sexual generation, which develops in Israel in bud galls of *Aphelonyx persica* (Fig. 37) and causes substantial enlargement of the gall up to 30 mm in diameter. Invaded galls are light green and fleshy when young (Fig. 39), turning pale brown and woody when mature (Fig. 40). They appear in August and adults emerge in January-February. No adults of the original gall inducer emerged from invaded galls.

Distribution: Israel: Nahal Rakefet, Bet Keshet Forest, Hosha'aya, Alonim, Tiv'on, HaSharon Forest. Elsewhere: From Great Britain to Russia.

Concluding remarks

This work provides the first thorough review of the cynipid fauna of Israel. We revised and updated initial surveys of this group (Bytinski-Zals & Sternlicht 1967; Sternlicht 1968a, b), added many collection sites and surveyed the three remaining native Israeli oaks (*Q. boissieri, Q. libani, Q. cerris*) which were not studied before. In his pioneering work on the oak cynipids of Israel, Sternlicht (1968b) recorded 43 gall types and attributed 28 of them to species. In the present work we recorded 65 gall types and 53 cynipid species, 37 of which are recorded from Israel for the first time. Some of the species are recorded here only tentatively based on their galls alone or on morphologically unique adults which require further study. Two species are recorded as undescribed and apparently belong to *Pseudoneuroterus* based on morphological attributes and preliminary molecular data (Shachar, unpublished) but their official description requires further study.

TABLE 2. The oak Cynipidae in Israel, their host plants and distribution. Comments refer to the Israeli fauna. Numbers in comments column refer to identification method: 1. Gall morphology; 2. Adult morphology; 3. Molecular data.

Species	Host plants	Sexual generation gall	Asexual generation gall	Known distribution	Comments
Andricus caputmedusae	*Q. boissieri*	Unknown	Acorn cup (Figs 7–8)	Palearctic	Only on Mt. Hermon. 1
Andricus cecconii	*Q. ithaburensis*, *Q. boissieri*	Catkin (Figs 47–48)	Bud (Fig. 6)	Western Palearctic	Common. 1,2,3
Andricus chodjaii	*Q. boissieri*	Unknown	Acorn cup (Fig. 12)	Levant	Very rare. 1
Andricus coriariformis	*Q. libani*, *Q. boissieri*	Catkin	Bud (Fig. 17)	Levant	Only on Mt. Hermon. 1,2
Andricus coriarius	*Q. boissieri*	Bud (Fig. 52)	Bud (Figs 15–16)	Palearctic	1,2,3
Andricus curtisii	*Q. boissieri*	Unknown	Bud (Fig. 11)	Palearctic	Uncommon. 1,2
Andricus curvator	*Q. ithaburensis*	Leaf (Sternlicht 1968b, Fig. 46)	Branch (Sternlicht 1968b, Fig. 58).	Palearctic	No adults reared from Israel. 1
Andricus foecundatrix	*Q. boissieri*	Not known from Israel	Bud (Figs 23–24)	Palearctic	No adults reared from Israel. 1
Andricus grossulariae	*Q. ithaburensis*, *Q. boissieri*	Catkin (Figs 49–50)	Bud (Fig. 9)	Palearctic	1,2,3
Andricus hystrix	*Q. boissieri*	Not known from Israel	Bud (Fig. 10)	Western Palearctic	Rare. 1
Andricus lucidus	*Q. boissieri*	Not known from Israel	Bud (Fig. 5)	Palearctic	1,2
Andricus megatruncicolus	*Q. boissieri*	Unknown	Bud (Fig. 21)	Levant	Rare, only on Mt. Hermon. 1
Andricus melikai	*Q. libani*	Leaf (Fig. 68)	Unknown	Levant	Very rare, no adults reared from Israel. 1
Andricus miriami	*Q. ithaburensis*, *Q. libani*, *Q. cerris*	Bud (Figs 71–72)	Bud (Figs 43–44)	Israel	Asexual generation very common, sexual generation only on Mt. Hermon. 1,2,3
Andricus moreae	*Q. boissieri*	Unknown	Bud (Fig. 18)	Levant	1,2
Andricus multiplicatus	*Q. libani*	Bud (Fig. 67)	Unknown	Palearctic	1,2,3
Andricus quercustozae	*Q. boissieri*	Unknown	Bud (Figs 13–14)	Western Palearctic	1
Andricus solitarius	*Q. boissieri*	Not known from Israel	Bud	Palearctic	Very rare, only on Mt. Meron. 1
Andricus sternlichti	*Q. boissieri*	Unknown	Bud (Fig. 20)	Palearctic	Very common, also on introduced oak spp. 1,2
Andricus tomentosus	*Q. boissieri*	Unknown	Bud (Fig. 25)	Palearctic	Rare. No adults reared from Israel. 1
Andricus vindobonensis	*Q. ithaburensis*	Catkin (Fig. 51)	Unknown	Western Palearctic	1
Andricus sp. nr. *amenti*	*Q. libani*, *Q. cerris*	Leaf (Fig. 69)	Unknown	Israel	One adult reared from Israel. 1
Andricus sp. nr. *istvani*	*Q. ithaburensis*	Leaf (Fig. 63)	Unknown	Israel	1
Andricus sp. nr. *quercusradicis*	*Q. ithaburensis*	Leaf (Fig. 65)	Root	Palearctic	No adults reared from Israel. 1
Andricus sp. 1	*Q. boissieri*	Unknown	Bud (Fig. 19)	Israel	Single female reared from Israel. 1
Andricus sp. 2	*Q. boissieri*	Bud (Fig. 28)	Unknown	Israel	Rare. No adults reared from Israel. 1

……continued on the next page

TABLE 2. (Continued)

Species	Host plants	Sexual generation gall	Asexual generation gall	Known distribution	Comments
Andricus sp. 3	*Q. boissieri*	Bud (Fig. 26)	Unknown	Israel	Rare. No adults reared from Israel. 1
Aphelonyx persica	*Q. ithaburensis*, *Q. libani*	Unknown	Bud (Figs 37–38)	Levant	Very common. 1,2,3
Biorhiza pallida	*Q. boissieri*	Bud (Fig. 22)	Not known from Israel	Palearctic	Rare. 1,2,3
Cerroneuroterus gyulaigaraiae	*Q. ithaburensis*	Unknown	Leaf (Fig. 62)	Levant	1
Cerroneuroterus lanuginosus	*Q. ithaburensis*	Catkin (Fig. 54)	Leaf (Figs 60–61)	Palearctic	Very common. 1,2,3
Cerroneuroterus sp. nr. *lanuginosus*	*Q. libani*, *Q. cerris*	Unknown	Leaf (Fig. 70)	Israel	No adults reared . 1
Cerroneuroterus minutulus	*Q. libani*	Unknown	Leaf	Western Palearctic	Very rare. No adults reared from Israel. 1
Chilaspis israeli	*Q. ithaburensis*	Catkin (Fig. 45)	Leaf (Fig. 59)	Levant	1,2,3
Cynips cornifex	*Q. boissieri*	Not known from Israel	Leaf (Fig. 29)	Palearctic	Very rare. No adults reared from Israel. 1
Cynips divisa	*Q. boissieri*	Not known from Israel	Leaf (Fig. 33)	Palearctic	1
Cynips quercus	*Q. boissieri*	Not known from Israel	Leaf (Fig. 32)	Palearctic	Only in the Golan Heights. 1.2.3
Dryocosmus mayri	*Q. ithaburensis*	Bud (Fig. 46)	Unknown	Western Palearctic	1,2,3
Dryocosmus mikoi	*Q. ithaburensis*	Leaf (Fig. 64)	Unknown	Levant	No adults reared from Israel. 1
Neuroterus albipes	*Q. boissieri*	Leaf	Leaf (Fig. 34)	Palearctic	1,2,3
Neuroterus anthracinus	*Q. boissieri*, *Q. ithaburensis*	Not known from Israel	Leaf (Figs 31, 66)	Palearctic	No adults reared from Israel. 1
Neuroterus numismalis	*Q. boissieri*	Leaf (Fig. 30)	Leaf (Fig. 36B)	Palearctic	Adults of sexual generation not reared from Israel. 1,2,3
Neuroterus quercusbaccarum	*Q. boissieri*	Catkin (Fig. 27)	Leaf (Figs 35– 36A)	Palearctic	Very common. 1,3
Plagiotrochus coriaceus	*Q. calliprinos*	Unknown	Leaf	Western Palearctic	Very rare. No adults reared from Israel. 1
Plagiotrochus quercusilicis	*Q. calliprinos*	Leaf (Fig. 74)	Unknown	Western Palearctic	1,2,3
Plagiotrochus razeti	*Q. calliprinos*	Not known from Israel	Branch (Fig. 73)	Western Palearctic	1,2
Pseudoneuroterus macropterus	*Q. ithaburensis*	Bud (Fig. 55)	Branch	Western Palearctic	Asexual generation rare. No adults reared from Israel. 1,3
Pseudoneuroterus saliens	*Q. ithaburensis*, *Q. libani*, *Q. cerris*	Acorn (Fig. 57)	Leaf (Fig. 58)	Palearctic	Only sexual generation reared from Israel. 1,2,3
Pseudoneuroterus sp. 1	*Q. ithaburensis*	Bud (Fig. 56)	Unknown	Israel	Undescribed. 1,2,3
Pseudoneuroterus sp. 2	*Q. ithaburensis*	Bud (Fig. 53)	Unknown	Israel	Undescribed . 1,2,3
Synergus variabilis (in *Aphelonyx persica* galls)	*Q. ithaburensis*	Bud (Figs 39–40)	Unknown	Israel	1
Synophrus olivieri (in *Andricus coriarius* galls)	*Q. ithaburensis*	Bud (Fig. 42)	Unknown	Western Palearctic	1,3
Synophrus politus	*Q. ithaburensis*	Bud (Fig. 41)	Unknown	Palearctic	1

FIGURES 5–10. Galls on *Quercus boissieri.* 5. *Andricus lucidus*, asexual generation (arrow) and *Andricus moreae*, asexual generation (bottom); 6. *Andricus cecconii*, asexual generation; 7. *Andricus caputmedusae*, asexual generation, young gall; 8. *Andricus caputmedusae*, asexual generation, mature gall; 9. *Andricus grossulariae*, asexual generation; 10. *Andricus hystrix*, asexual generation.

FIGURES 11–16. Asexual generation galls on *Quercus boissieri.* 11. *Andricus curtisii*; 12. *Andricus chodjaii*; 13. *Andricus quercustozae*, young gall; 14. *Andricus quercustozae*, mature gall; 15. *Andricus coriarius*, mature gall; 16. *Andricus coriarius*, old gall.

FIGURES 17–22. Galls on *Quercus boissieri.* 17. *Andricus coriariformis*, asexual generation; 18. *Andricus moreae*, asexual generation; 19. *Andricus* sp. 1, asexual generation; 20. *Andricus sternlichti*, asexual generation; 21. *Andricus megatruncicolus*, asexual generation; 22. *Biorhiza pallida*, sexual generation.

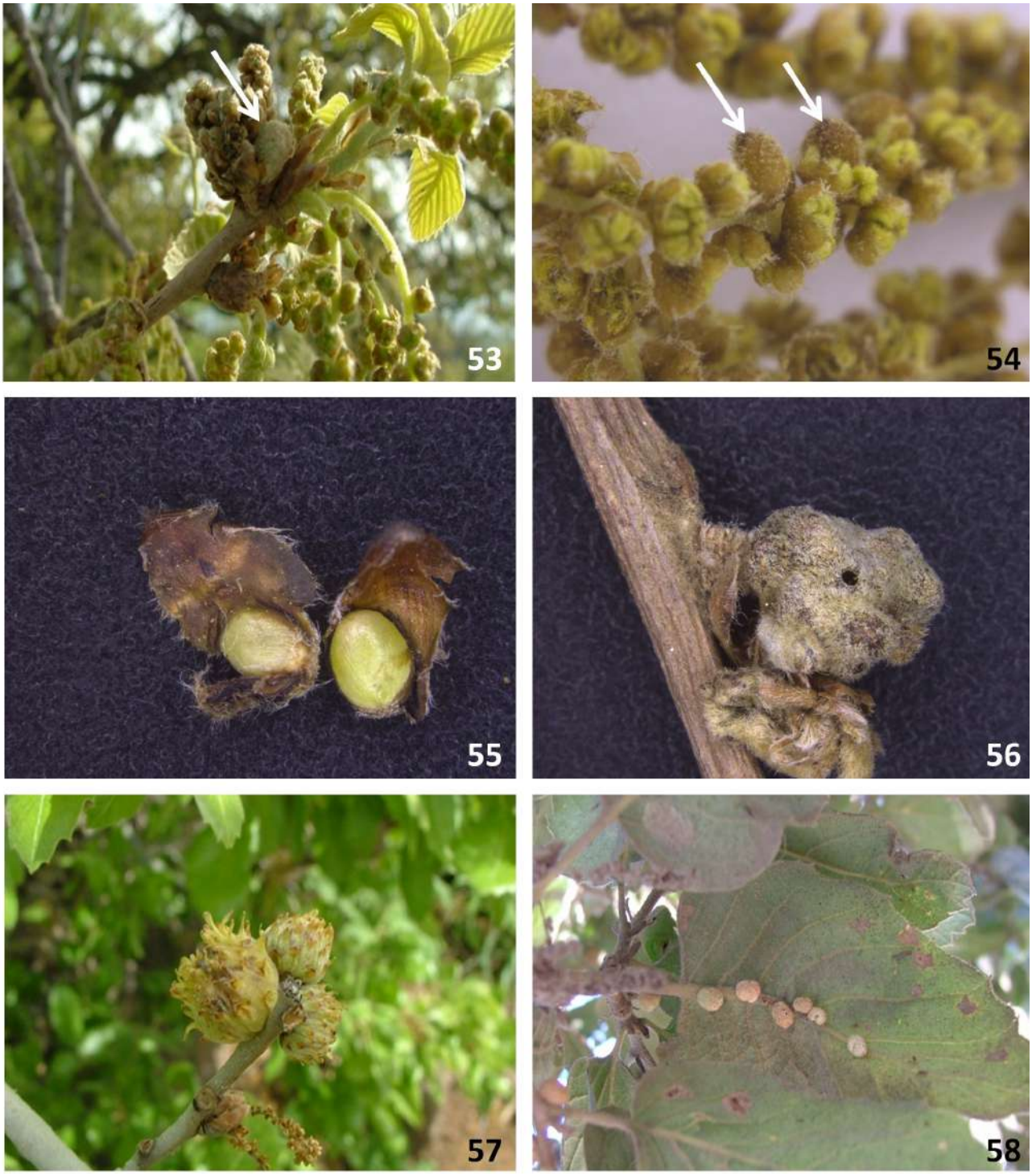
FIGURES 23–28. Galls on *Quercus boissieri.* 23. *Andricus foecundatrix*, asexual generation, young galls; 24. *Andricus foecundatrix*, asexual generation, mature galls showing spherical inner chamber about to be ejected; 25. *Andricus tomentosus* asexual generation; 26. *Andricus* sp. 3, sexual generation; 27. *Neuroterus quercsbaccarum*, sexual generation (arrow); 28. *Andricus* sp. 2, sexual generation (arrows point to emergence holes).

FIGURES 29–34. Galls on *Quercus boissieri.* 29. *Cynips cornifex*, asexual generation; 30. *Neuroterus numismalis*, sexual generation; 31. *Neuroterus anthracinus*, asexual generation; 32. *Cynips quercus*, asexual generation; 33. *Cynips divisa*, asexual generation; 34. *Neuroterus albipes*, asexual generation.

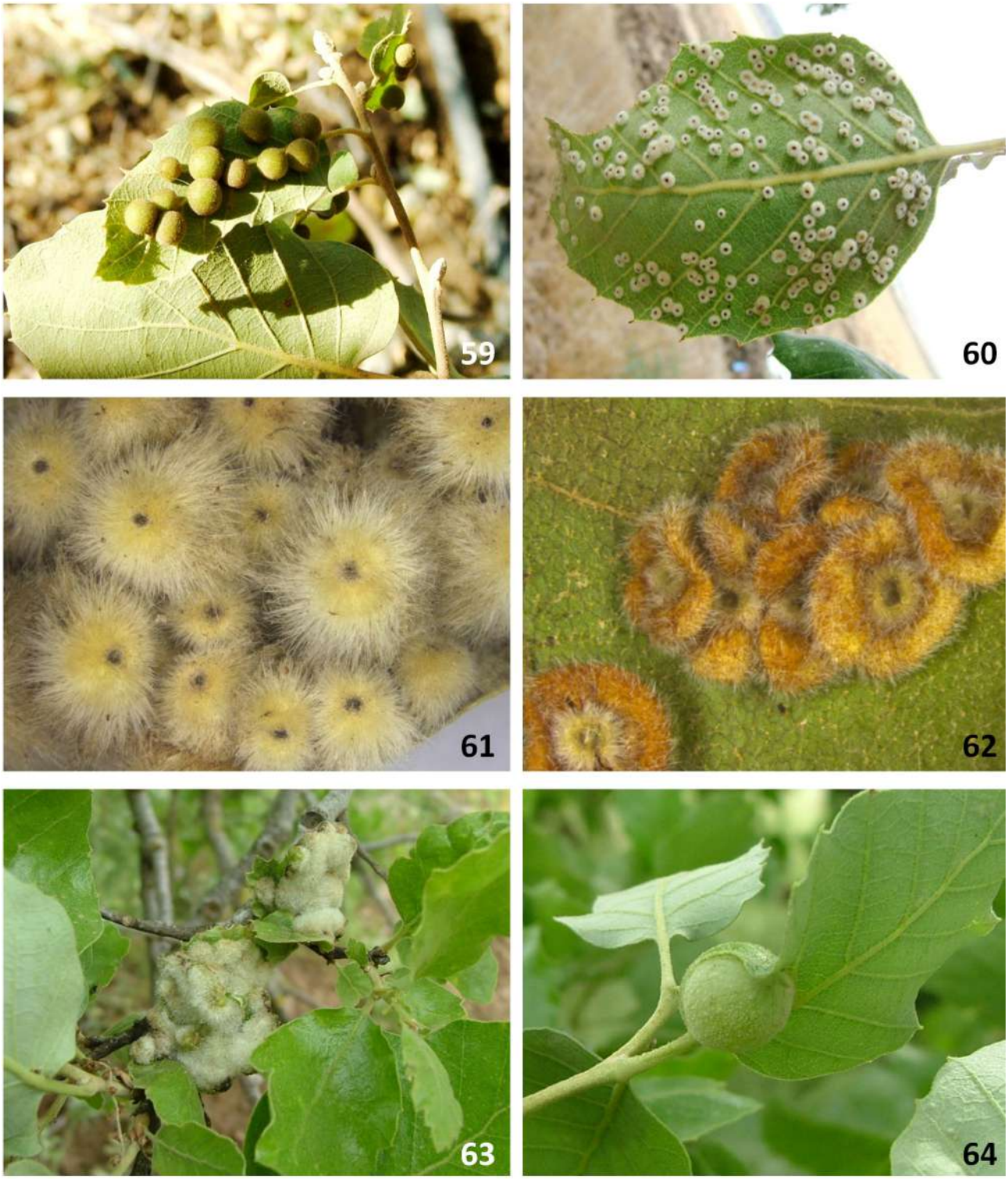
FIGURES 35–40. Galls on *Quercus boissieri* and *Q. ithaburensis*. 35. *Neuroterus quercsbaccarum*, asexual generation on *Quercus boissieri*; 36. *Neuroterus quercsbaccarum* (A) and *Neuroterus numismalis* (B), asexual generations on *Q. boissieri*; 37. *Aphelonyx persica*, asexual generation on *Quercus ithaburensis*; 38. *Aphelonyx persica*, asexual generation on *Quercus ithaburensis*, gall dissected to show inner chamber; 39. *Aphelonyx persica* gall ivaded by the inquiline *Synergus variabilis* on *Quercus ithaburensis*; 40. Same, old gall with emergence holes of inquilines.

FIGURES 41–46. Galls on *Quercus ithaburensis*. 41. *Synophrus politus*, sexual generation; 42. *Synophrus olivieri* sexual generation; 43. *Andricus miriami*, asexual generation; 44. Same, old gall; 45. *Chilaspis israeli*, sexual generation; 46. *Dryocosmus mayri*, sexual generation.

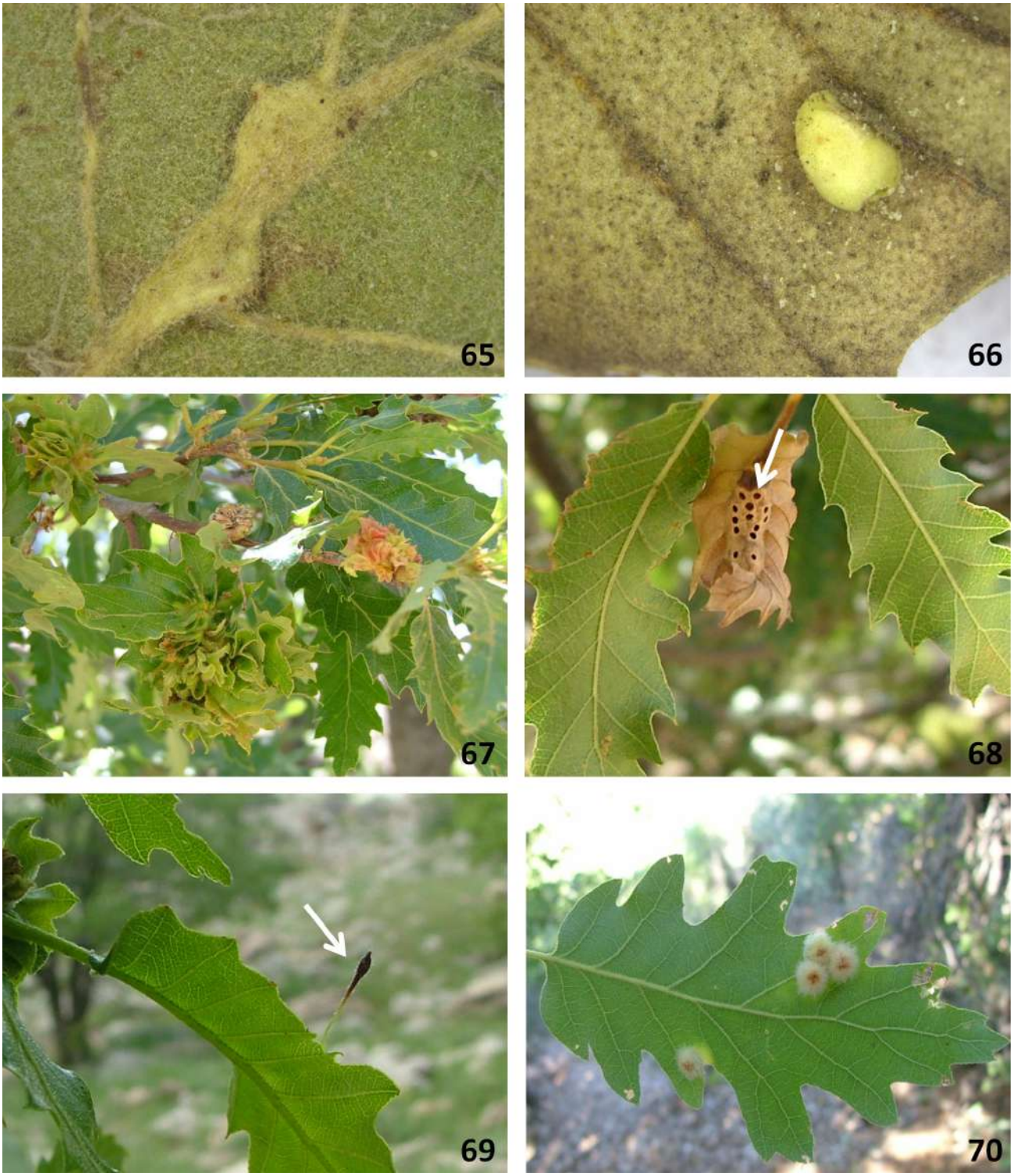
FIGURES 47–52. Sexual generation galls on *Quercus ithaburensis*. 47. *Andricus cecconii*; 48. Same, old gall; 49. *Andricus grossulariae*, young galls; 50. *Andricus grossulariae*, old galls (arrow); 51. *Andricus vindobonensis*; 52. *Andricus coriarius*.



FIGURES 53–58. Galls on *Quercus ithaburensis.* 53. *Pseudoneuroterus* sp. 2, sexual generation; 54. *Cerroneuroterus lanuginosus*, sexual generation; 55. *Pseudoneuroterus macropterus*, sexual generation; 56. *Pseudoneuroterus* sp. 1, sexual generation; 57. *Pseudoneuroterus saliens*, sexual generation; 58. *Pseudoneuroterus saliens*, asexual generation.



FIGURES 59–64. Galls on *Quercus ithaburensis.* 59. *Chilaspis israeli*, asexual generation; 60–61. *Cerroneuroterus lanuginosus*, asexual generation; 62. *Cerroneuroterus gyulaigaraiae*, asexual generation; 63. *Andricus* sp. nr. *istvani*, sexual generation; 64. *Dryocosmus mikoi*, sexual generation.



FIGURES 65–70. Galls on various *Quercus* species. 65. *Andricus* sp. nr. *quercusradicis*, sexual generation on leaf of *Quercus ithaburensis*; 66. *Neuroterus anthracinus*, asexual generation on *Quercus ithaburensis*; 67. *Andricus multiplicatus*, sexual generation on *Quercus libani*; 68. *Andricus melikai*, sexual generation on *Quercus libani*; 69. *Andricus* sp. nr. *amenti*, sexual generation on *Quercus libani*; 70. *Cerroneuroterus* sp. nr. *lanuginosus*, asexual generation on *Quercus libani*.

FIGURES 71–74. Galls on various *Quercus* species. 71. *Andricus miriami*, sexual generation on *Quercus libani*; 72. Same, old gall; 73. *Plagiotrochus razeti*, asexual generation on *Quercus calliprinos*; 74. *Plagiotrochus quercusilicis*, sexual generation on *Quercus calliprinos*.

For some of the studied oak species, Israel constitutes the southern edge of their distribution range, and 20% of the Western Palearctic cynipid species are represented in the country. Some of these species, e.g. *A. caputmedusae* and *A. quercustozae*, are common in Europe but restricted in Israel to cooler habitats in higher elevations in the Golan Heights and Mt. Hermon. Twenty of the species recorded here from Israel are known only from the Levant (e.g., *Aphelonyx persica*, *A. moreae, Chilaspis israeli*) and several were known so far only from Iran (e.g., *A. coriariformis, A. chodjai*) (Tavakoli *et al*. 2008). Ten additional species are currently known only from Israel, although they are likely to be found in neighboring countries if similar surveys are conducted there. It is noteworthy that half of the cynipid fauna of Israel (25 species) is found on Mount Hermon, and 18 of those species are associated with *Q. boissieri*. Species richness on this host plant is highest in the northern part of the country, and declines towards the Judean Mountains – the southernmost site where this oak species is found naturally. By contrast, no similar north-south trend is evident for *Q. ithaburensis*, which hosts 21 cynipid species in Israel, suggesting that geographic factors have a different effect on cynipid communities on these two oak species.

Most galling insects are host- and organ-specific, inducing galls on only one plant species and on a specific plant organ (Dreger-Jauffret & Shorthouse 1992), but in cynipids this extreme specificity is somewhat more flexible as many species use several oak hosts in the same section or in different sections, and sometimes alternate among host organs (Abrahamson *et al*. 1998; Ronquist & Liljeblad 2001; Melika 2006b). Western Palearctic species that are associated with a certain oak section in Europe are associated with different oak species of the same section in Israel. This ability to use different host species from the same section is a known phenomenon, and may promote cynipid expansion between Europe and Israel and within Israel itself. This is attested by the fact that many cynipid species that use *Q. cerris* and *Q. libani* on Mt. Hermon are also found on *Q. ithaburensis* which does not

occur on Mt. Hermon but is common further south. Another example is the abundance of galls of local cynipd species on introduced European oaks that are planted as ornamentals in Israel (e.g., *A. sternlichti* and *A. grossulariae* on *Q. robur*).

Andricus species that alternate between section *Cerris* for their sexual generation and section *Quercus* for their asexual generation are known in Europe (Cook *et al*. 2002; Stone *et al*. 2002; Liljeblad *et al*. 2008), and four such examples are now recorded also from Israel. The sexual generations of *A. cecconii*, *A. coriarius*, *A. coriariformis* and *A. grossulariae* develop in Israel on *Q. ithaburensis* or *Q. libani* (section *Cerris*), whereas their asexual generations develop on *Q. boissieri* (section *Quercus*).

The majority of cynipid species in Israel (as elsewhere) are known only from one of their generations whereas only 24% are known from both (Table 2). Additional collecting efforts may reveal more galls and associations, and efforts should be focused on inconspicuous galls of sexual generations, which may be morphologically indistinguishable among different cynipid species (Stone *et al*. 2008). It is also possible that some of the galls recorded here constitute the sexual and asexual generations of the same species and that these will be associated with each other once more molecular data become available. Lastly, it is possible that some species for which only the asexual generation is known do not have a sexual generation at all (Csóka *et al*. 2005; Abe 2007).

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