A study of natural enemies of olive leaf gall midge (*Dasineura oleae* Angelini, Diptera, Cecidomyiidae) as an emerging pest on olive trees in Palestine

دراسة الاعداء الحيوية لذبابة تدرن اوراق الزيتون (*Dasineura oleae*) كآفة ناشئة على اشجار الزيتون في فلسطين

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Abstract

The olive leaf gall midge (*Dasineura oleae*) is an emerging pest on olive trees in Palestine since the year 2015. This pest infests the leaves, young shoots, inflorescence and fruit stalks of olive trees causing a reduction in the yield. The infestations with *D. oleae* could be observed on the above-mentioned organs as elongate, indefinite galls. No previous studies were conducted on natural enemies of this pest in Palestine so that the present research aimed at studying the native parasitoids of *D. oleae* in Palestine in terms of identifying the species of these parasitoids and determining the average percent of parasitism caused by them on *D. oleae*. Results indicated that there were two species of native hymenopterous parasitoids reared from galls of *D. oleae* on leaves of olive trees: *Platygaster oleae* Szelenyi (Platygastridae) and *Zeytinus hatayensis* Doğanlar (Eulophidae). Certain keys were used for identification of the parasitoids' species in addition to specific illustrations that were provided in the present study. Results also indicated that the average percent of parasitism caused by these parasitoids were found to be related to the altitudes of the studied olive orchards since the average percent of

parasitism was the highest: 69.54-82.36% for *P. oleae* and 17.64-30.46% for *Z. hatayensis* at lower altitudes (82-229m above sea level) but it was up to 100% for *P. oleae* and up to 0% for *Z. hatayensis* at higher altitudes (492-635m above sea level), respectively. The overall average percent of parasitism was 87.97% for *P. oleae* whereas, it was 12.03% for *Z. hatayensis*. These results are promising and might help in developing an effective biocontrol program using these parasitoids as natural enemies of the insect. Such effective use of these natural enemies has been discussed in the paper.

Keywords: Altitudes; Biocontrol; Native parasitoids; *Olea europaea*; *Platygaster oleae*; *Zeytinus hatayensis*.

ملخص

ذبابة تدرن اوراق الزيتون هي آفة ناشئة على اشجار الزيتون في فلسطين منذ العام 2015. تصيب هذه الآفة الاوراق والنموات الحديثة في اشجار الزيتون بالاضافة الى الازهار واعناق الثمار مسببة نقصا في الانتاج. يمكن مشاهدة الاصابة على الاشجار على شكل درنات متطاولة بحدود غير واضحة. لا يوجد دراسات سابقة على الاعداء الحيوية لهذه الآفة في فلسطين، لذا فان هذا البحث يهدف الى دراسة الاعداء الحيوية المحلية (المتطفلات الحشرية) للآفة فيما يتعلق بتعريف ووصف هذه الانواع من المتطفلات ومعرفة نسبة التطفل الذي يسببه كل نوع منها على يرقات ذبابة تدرن اوراق الزيتون. بينت النتائج التي تم الحصول عليها ان هناك نوعين من المتطفلات الحشرية من رتبة الحشرات غشائية الاجنحة كانت قد انبثقت من درنات الذبابة على اوراق زيتون مصابة تم جمعها من مناطق مختلفة مزروعة باشجار الزيتون في الضفة الغربية. وهذه الانواع قد تم تعريفها كما يلي:

Platygaster oleae Szelenyi (Platygastridae) and *Zeytinus hatayensis* Doğanlar (Eulophidae)

وتم كذلك تعريف ووصف هذه الانواع بناءا على صور واضحة كانت قد التقطت لهذه المتطفلات ولاجزاءها المختلفة وتم مقارنتها بالمعلومات الموجودة في مفاتيح التصنيف المعروفة عالميا لهذه المتطفلات. كما بينت النتائج ان معدلات التطفل المتسببة عن هذه المتطفلات على يرقات الذبابة كانت متفاوتة حسب ارتفاعات المناطق المزروعة باشجار الزيتون والمشمولة في هذه الدراسة حيث كانت المعدلات اعلى ما يمكن (69.54 الى 82.36%) للمتطفل الاول (بلاتيجاستر اوليه) بينما كانت اقل (17.64 الى 30.46%) للمتطفل الثاني (زيتينيص هاتاينسس) على ارتفاعات منخفضة (82 الى 229م فوق مستوى سطح البحر) ولكنها كانت 100% للمتطفل الاول و0% للمتطفل الثاني عند الارتفات العالية (492 الى 635م فوق مستوى سطح البحر) على التوالي. وكان المعدل الكلي لنسبة التطفل في جميع المعاملات 87.97% للمتطفل الاول بينما كان

12.03% للمتطفل الثاني. كانت النتائج في مجملها جيدة وواعدة ويمكن ان تساعد في تطوير برامج مكافحة حيوية فعالة للآفة باستخدام المتطفلات الحشرية التي تم تعريفها ووصفها في هذه الدراسة. كما تم في هذه الدراسة مناقشة كيفية استعمال هذه المتطفلات بشكل فعال لمكافحة الآفة.

الكلمات المفتاحية: الارتفاع، المكافحة المتكاملة، المتطفلات الحشرية المحلية،
Olea europaea, Zeytinus hatayensis, Platygaster oleae

Introduction

The olive leaf gall midge (*Dasineura oleae*) has been reported as an insect pest of olive trees in many countries of Mediterranean region such as Jordan, Montenegro, Syria, Turkey, Greece and Italy (Al-Tamimi, 1997; Hrncic, 1998; Darvas *et al*., 2000; Doğanlar *et al*., 2011; Simoglou *et al*., 2012; Boselli & Bariselli, 2015). The insect has been also reported as an emerging pest on olive trees cultivated in several Palestinian governorates since 2015 but the intensity of infestation with insect has increased in the last two years (Batta, 2019).

In Palestine and elsewhere in other countries, *D. oleae* infests the different organs of olive trees including leaves, young shoots, flower stalks (inflorescence) and fruit stalks by inducing elongate indefinite galls on these organs (Fig. 1, a-d). Only one larva develops inside the gall induced and the whole development from the egg, across the larva, pupa up to adult phase runs inside the gall. Yield loss may occur due to the infestation of *D. oleae* on the flower and fruit stalks so that the galls of insect induced in these tissues interrupt the nutrient flow to the developing fruits thus aborted or small sized fruits are produced (Batta, 2019). One generation per year usually develops in many areas of olive production in several countries of Mediterranean region (Al-Tamimi 1997; Darvas *et al*., 2000; Doğanlar *et al*., 2011), but at favorable conditions and in certain geographic areas, a second generation may develop in the subcoastal regions of olive production in eastern Mediterranean countries such as Syria and Palestine (Baidaq *et al*., 2015; Batta, 2019). The adult flies of *D. oleae* are usually present in nature from March to the beginning of May for the first generation and from October to the beginning November for the second generation (Batta, 2019).

Figure (1): Infestation of *Dasineura oleae* on olive trees and parasitism by the native parasitoids, **a:** Damage caused by *D. oleae* on leaves and shoots of olive trees, **b**: Infestation with *D. oleae* on olive leaves appeared as indefinite and elongate galls on the lower leaf surface, **c**: Galls of *D. oleae* on the upper surface of infested leaf, **d**: Galls of *D. oleae* on the inflorescence and fruit stalks, **e:** Healthy, unparasitized pupa of D. oleae (yellow appearance), **f-g:** Parasitized pupoae of *D. oleae* with the parasitoid inside (black color refers to parasitism), **h:** Regular circular exit hole used for emergence of the adult parasitoids from *D. oleae* galls, **i**: Emergence of *D. oleae* adult after completing the life cycle in form of irregular exit hole (rupture) with puparium left near the hole after emergence. **Scale bars = 100 µm** (in the above illustrations).

For the current status of *D. oleae* control in Palestine and elsewhere in the Mediterranean countries, very little information has been reported in this respect especially on using chemical insecticides for the control of this insect. Some specific insecticides such as fenthion, methidathion and diazinon, and to a lesser extent dimethoate, were used for the insect control (Iordanou, 1982). These insecticides could be applied, at a rate of 0.06% a.i (active ingredient), in March to protect the new shoots and flowers from infestation by the adults of the first generation that emerge on March. They could be also applied in October to protect the leaves from infestation by the adults of the second generation that emerge on October. However, application of these insecticides may cause the extermination of the natural enemies of the insect in the treated areas. Therefore, control of *D. oleae* mainly relies on the use of natural enemies especially the indigenous parasitoids that suppress the population of the insect and reduce its damage. For example, Doğanlar *et al*. (2009) reared and described an indigenous parasitoid (*Quadrastichus dasineurae* Doğanlar, Hymenoptera, Eulophidae) from the larvae of *D. oleae* in Hatay province, Turkey. Several species of native parasitoids were also reared from galls of *D. oleae* (as larval and pupal parasitoids) on leaves and shoots of olive in the above-mentioned province (Doğanlar, 2011).

In Palestine, the natural enemies (e.g. native parasitoids) on larvae and pupae of *D. oleae* infesting olive orchards have not yet been investigated. Therefore, the present research aimed to study the native parasitoids of *D. oleae* in the olive orchards in the northern part of the West Bank in terms of the following elements: i) to identify the species of native parasitoids on the larvae and pupae of *D. oleae* in the sampled areas, ii) to describe the species of native parasitoids by providing with the required illustrations and in consulting with specific keys, iii) to determine the rates of parasitism on *D. oleae* by the identified parasitoids in the sampled areas distributed over variable altitudes.

Materials and Methods

Collection of samples and rearing of the native parasitoids

Samples of leaves and branches of infested olive trees with *D. oleae* were collected from different Palestinian localities cultivated with olive orchards as follows:

1. Kadouril: Tulkarm governorate, altitude: 82m above sea level, coordinates: 32°18'48.3"N 35°01'19.9"E;
2. Wadi Kana: Sulfeet governorate, altitude: 229m above sea level, coordinates: 32°09'28.7"N 35°06'38.5"E;
3. Seilet El-Dahr: Jenin governorate, altitude: 492m above sea level, coordinates: 32°18'52.8"N 35°11'21.4"E;
4. Assira El- Shamalieh: Nablus governorate, altitude: 635m above sea level, coordinates: 32°14'59.9"N 35°16'05.6"E.

Four samples per locality were randomly collected from infested trees during the period extending from October 15, 2018 to January 15, 2019. The choice of this time period of the year is attributed to the presence of mature larvae of *D. oleae* that may be parasitized by the native parasitoids since the mature larvae are the most susceptible stage of the insect to parasitism. The purpose of collecting the samples was to identify the species of indigenous parasitoids and to determine the parasitism percent caused by these parasitoids on *D. oleae* galls in the sampled areas. The collected samples were incubated in closed transparent plastic bags (dimensions: 35 x 25 cm) under the following conditions: temperature of 25 ± 2°C and 16 hours of light per day. Emerged adult parasitoids for each locality were collected using an aspirator then mounted and preserved in 70% ethanol for being identified then described. The incubation period was extended until the emergence of all adult parasitoids from infested galls in the samples (October 15, 2018 to January 15, 2019).

Description and identification of the native parasitoids on galls of D. oleae

Specimens of adult parasitoids preserved in 70% ethanol were used for identification and description of the parasitoid species reared from *D. oleae* galls on the infested leaves. Adults of each parasitoid species were morphologically examined under dissecting and compound microscopes then microscopic slide preparations for the different body parts of these adults were prepared and examined during the identification. Representative pictures for the male and female adults of each species of parasitoids and their body parts were taken during the microscopic examination for illustrating and describing them. Body colour, characteristics of female and male genitalia, characteristics of mesosoma and scutellum, characteristics of the gaster, antennae and legs, in addition to the venation of the fore wings are used in the description of each parasitoid species. Illustrations for the above-mentioned characters are also provided.

Determination of parasitism percent on D. oleae by the native parasitoids

After the identification and description of each parasitoid species reared from galls of *D. oleae* in the different localities of olive production areas, samples of collected and preserved specimens of parasitoid adults in 70% ethanol representing the different localities were used for determination of the average percent of parasitism for each parasitoid species in the samples per locality and governorate according to the following method:

1. taking four samples of preserved parasitoid specimens per locality. Each sample usually contain all species reared from *D. oleae* galls specific to the locality,
2. counting the total number of preserved specimens of all species of parasitoid adults in the sample,
3. counting the number of preserved specimens for each parasitoid species in the sample,

4. calculating the percentage of each parasitoid species in the sample in relation to the total number,
5. calculating the average percentage of each parasitoid species in the samples per locality and governorate.

Collecting and preserving of parasitoid specimens elapsed from October 15, 2018 to January 15, 2019. All of the counts that have been carried out during the determination of average percent of parasitism were repeated three times at different periods of time during October 15, 2018 to January 15, 2019. The average number of these counts for each parasitoid species was indicated in Table 1.

Data analysis

Statistical analysis was performed on the data regarding the average percent of parasitism by each species of parasitoids on *D. oleae* per locality and governorate. Analysis performed includes the Analysis of Variance (ANOVA) and means' separation by Tukey HSD test to check the presence of significant differences between the means.

Results

Identification and description of the native parasitoids reared from D. oleae galls

Two species of native hymenopterous parasitoids on *D. oleae* were identified in the present research: *Platygaster oleae* Szelenyi (Platygastridae), *Zeytinus hatayensis* Doganlar (Eulophidae). This identification is considered a new record for Palestine. Males and females of these parasitoids were reared from *D. oleae* galls of the collected samples. The species were identified by consulting the key given by Doğanlar (2011). The required illustrations for this identification are provided in Fig. 2-5.

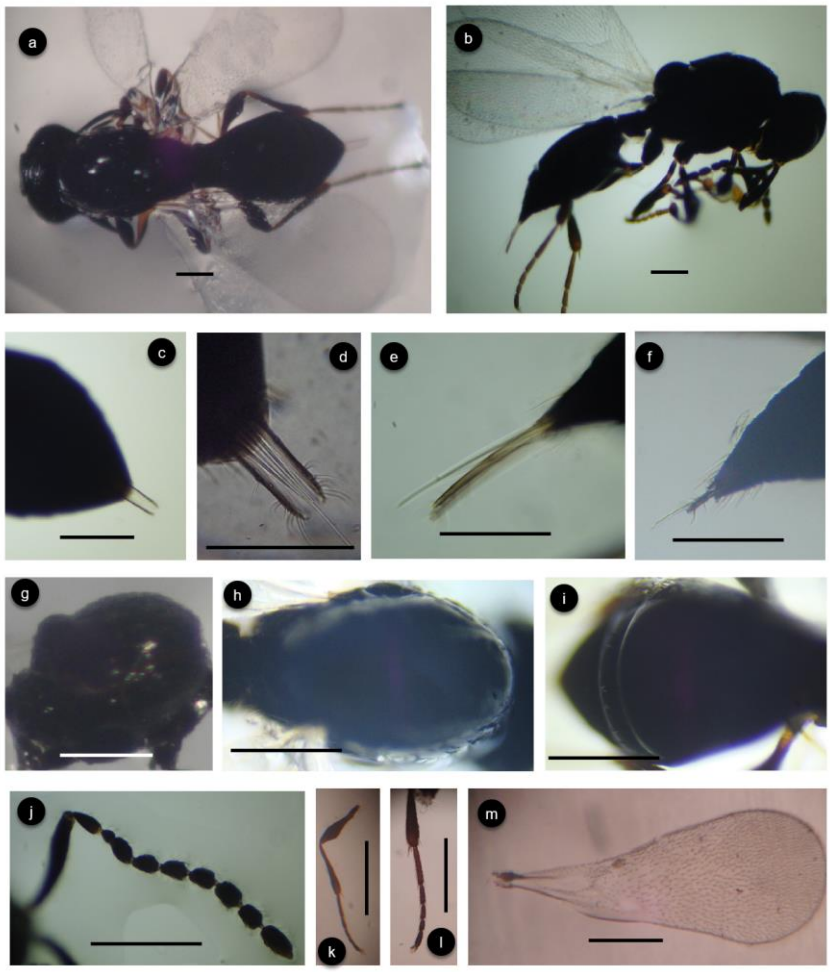
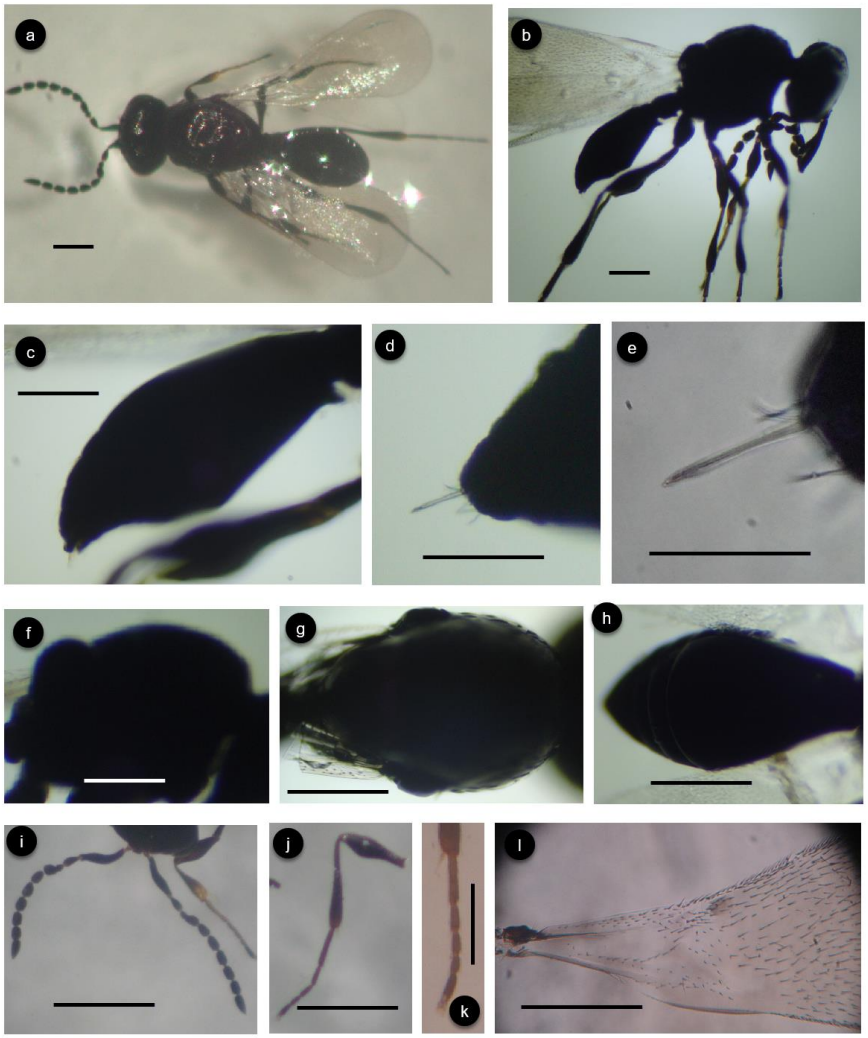


Figure (2): *Platygaster oleae* female reared from *D. oleae* galls, **a-b:** dorsal and lateral views of the female adult, **c**: tip of abdomen of the female adult showing the ovipositor (dorsal view), **d-f**: enlarged view of the female ovipositor (dorsal and lateral views), **g-h.** lateral and dorsal views of mesonotum and scutellum, **i**: dorsal view of the gaster with characvteristic reticulations, **j:** characteristic antenna, **k-l**: characteristic legs, **m**- characteristic forewing. **Scale bars = 100 µm** (in the above illustrations).

***Platygaster oleae* Szelenyi:** It is an endoparasitoid in the larvae and pupae of *D. oleae* living inside the galls. It develops inside the host until the adult emergence. The diagnostic characters of male and female adults *P. oleae* were given in Fig. 2&3. Males and females of *P. oleae* are characterized by dark brown or black body regions (head, thorax and abdomen) (a-b in Fig. 2&3). Pronotum more or less triangular, and extending to tegulae. Mesonotum and scutellum (mesosoma) elongate with black color (g-h in Fig. 2, f-g in Fig.3). Antennae are black in color and arising near margin of clypeus, 10 segmented (j in Fig. 2, I in Fig. 3). Front wings without marginal and stigmal veins (m in Fig. 2, i in Fig. 3). Legs are black in color, long with enlarged coxae, femura and tibae (a-b and k-i in Fig. 2, a-b and j-k in Fig. 3). The gaster is black in color but with few whitish rings on tip of abdomen dorsally (i in Fig. 2, h in Fig. 3). The females have long appendicular ovipositor for thrusting in the galls of *D. oleae* during egg laying (c-f in Fig. 2). The males have an aedeagus (c-e in Fig. 3). The mean body length for the females = 1.12± 0.13 mm (n=50 adults) and for males = 0.90± 0.15 mm (n=50 adults). Total number collected specimens was 500 (males and females) and all of the specimens were reared by Y. A. Batta as endoparasitoid of *D. oleae*.



Figur (3): *Platygaster oleae* male reared from *D. oleae* galls, **a-b:** dorsal and lateral views of body, **c**: lateral view of abdomen, **d-e**: tip of the aedagus (lateral view), **f-g.** lateral and dorsal views of mesonotum and scutellum, **h.** dorsal view of the gaster, **i:** characteristic antennae, **j**: hind leg **k**: hind tarsus with one tibial spur, **l**- enlarged base of the forewing. **Scale bars = 100 µm** (in the above illustrations).

***Hosts*:** *Dasineura oleae* (Szelenyi, 1940; Al-Tamimi, 1997).

***Distribution*:** Croatia (Szelenyi, 1940), Israel (Avidov & Harpaz, 1969), Jordan (Al-Tammi, 1997), Greece, (Fauna europea, 2010). New record on the presence of *P. oleae* in Palestine is reported in the present research

***Zeytinus hatayensis* Doğanlar:** It is an endoparasitoid in the larvae and pupae of *D. oleae*, in addition to *Lasioptera oleicola* Skuhravá (Diptera: Cecidomyiidae). It develops inside the host until the adult emergence. The diagnostic characters of male and female adults *Z. hatayensis* were given in Fig. 4&5. Males and females of *Z. hatayensis* are characterized by having pale-yellow mesosoma (mesonotum and scutellum) distinctly convex (a & e in Fig. 4, a & f in Fig. 5). Wings of both sexes are transparent with distinct yellow marginal vein, in addition to small stigmal vein in the fore wings (c in Fig. 4, e in Fig. 5). Antennae of both sexes are pale-brown in color but male antennae bear long hair-like processes projecting between the antennal segments (a-d in Fig. 5) whereas, female antennae don't bear hair-like processes between the antennal segments (a & b in Fig. 4). Legs of both sexes are brown moderately long with yellow trochanter, tibia and tarsus (a & d in Fig. 4, a, i and j in Fig. 5). The gaster of males and females is pale-yellow with brownish bands dorsally (a & f in Fig. 4, a & g in Fig. 5). The female is characterized by brownish to reddish eyes (a in Fig. 4) with a prominent ovipositor (g in Fig. 4). The male is characterized by the presence of black and yellow spots distributed on various body parts (a & g in Fig. 5) with a prominent aedeagus (h in Fig. 5). The mean body length for the females = 1.33± 0.15 mm (n=50 adults) but for males = 1.03± 0.17 mm (n=50 adults). Total number of collected specimens was 500 (males and females) and all of the specimens were reared by Y. A. Batta as endoparasitoid of *D. oleae*.

Figure (4): *Zeytinus hatayensis* female reared from *D. oleae* galls, **a**: lateral views of the female adult, **b:** antenna with characteristic pedicel and basal segments,**c:** characteristic vein of the forewing, **d:** characteristic hind leg, **e:** dorsal view of the characteristic mesosoma, **f:** dorsal view of the gaster, **g:** ventral view of gaster showing the ovipositor. **Scale bars = 100 µm** (in the above illustrations).

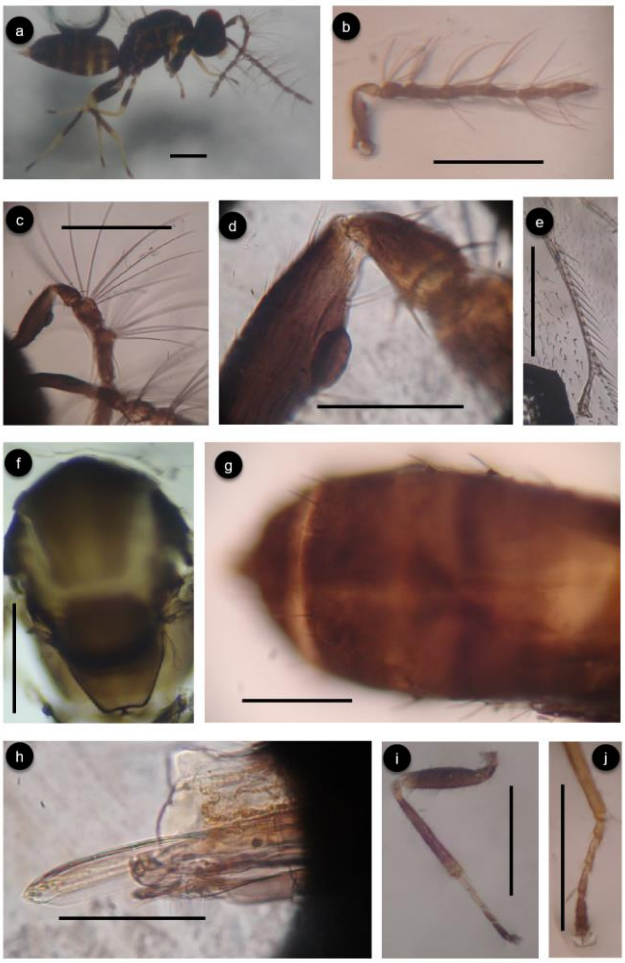


Figure (5): *Zeytinus hatayensis* male reared from *D. oleae* galls, **a**: lateral view of the male adult, **b:** antenna with characteristic pedicel and scape, **c:** enlarged base of antenna**, d:** enlarged pedicel and scape, **e:** characteristic vein of the forewing, **f:** dorsal view of the characteristic mesosoma, **g:** dorsal view of the gaster, **h:** lateral view of abdominal tip showing the characteristic male genitalia (aedagus), **i:** hind leg, **j:** characteristic tarsus and pretarsus of the hind leg. **Scale bars = 100 µm** (in the above illustrations).

***Hosts*:** *Dasineura oleae* (Doganlar, 2011; Ramadhane *et al*., 2017).

***Distribution*:** Hatay province (Turkey) (Doganlar, 2011), Syria (Ramadhane *et al*., 2017). New record on the presence of *P. oleae* in Palestine is reported in the present research.

Mode of parasitism on D. oleae by the native parasitoids and its evaluation

Females of the parasitoids of *P. oleae* and *Z. hatayensis* have long, appendicular ovipositor for depositing eggs deeply inside the galls where the larvae of *D. oleae* are present. The hatched larvae of the parasitoid parasitize on the larvae of *D. oleae* and destroy them. Parasitized larvae of *D. oleae* are characterized by having partially or completely dark color (Fig. 1, f-g) compared to yellow-colored, unparasitized larvae (Fig. 1, e). After completing the development, the parasitoid larvae pupate inside the gall then the adult parasitoids emerge from the hosting galls after a period of pupation by chewing small circular exit holes in the wall of these hosting galls (Fig. 1, h). If the galls of *D. oleae* were not parasitized by either *P. oleae* or *Z. hatayensis*, the adult flies of *D. oleae* emerged from the hosting gall by making firstly a rupture (irregular exit hole; Fig. 1, i) in the wall of these galls as a result of exiting of mature pupae from the gall then the adult flies emerge from exited pupae leaving the pupal skins (puparia) attaching to the leaves near the exit hole (Fig. 1, i).

Parasitism of D. oleae by the native parasitoids

After the identification and description of each parasitoid species reared from *D. oleae* galls as indicated in the above section, the average percent of parasitism by *P. oleae* and *Z. hatayensis* was determined as indicated in Table 1. The average % of parasitism by *P. oleae* varied from 69.54% in Wadi Kana (229m above sea level) to 100 % in Seilet El-Dahr (492 m above sea level) and Assira El-Shamalieh (635m above sea level) (Table 1) whereas, the average % of parasitism by *Z. hatayensis* varied from 0% in Seilet El-Dahr (492 m above sea level) and Assira El-Shamalieh (635m above sea level) to 30.46% in Kadouri/ (82m above sea level) (Table 1). Therefore, the average percent of parasitism caused by each species on *D. oleae* depends upon the altitude of the area in which

olive trees are cultivated. Significant differences (at $p \leq 0.05$) were obtained between the values of average % of parasitism in the different localities. In briefly, *P. oleae* constituted the largest portion in the samples taken at all altitudes (overall average % of parasitism was 87.97% for *P. oleae* versus 12.03% for *Z. hatayensis*, respectively) (Table 1).

Table (1): Average percent of parasitism caused by the native parasitoids on *Dasineura oleae* on olive trees in different localities in the northern West Bank during the period from October 15, 2018 to January 15, 2019**.**

Locality /governorate of olive orchards and cultivar	Samples taken from reared parasitoids on *D. oleae* galls	Total number of parasitoids counted / locality	Number of *P. oleae* counted / locality	Number of *Z. hatayensis* counted / locality	% of *P. oleae* / locality	% of *Z. hatayensis* / locality
Kadouri/Tulkarm governorate (32°18'48.3"N 35°01'19.9"E) **82** m (269.0 feet) above sea level; cultivar: Nabali	1	128	110	18	85.94	14.06
	2	184	138	46	75.00	25.00
	3	150	109	41	72.67	27.34
	4	144	138	6	95.83	4.17
Average					82.36 **b**	17.64 **B**
Wadi Kana/Sulfeet governorate (32°09'28.7"N 35°06'38.5"E) **229** m (751.3 feet); cultivar: Nabali-Mohassan	1	105	75	30	71.43	28.57
	2	115	65	50	56.52	43.48
	3	120	80	40	66.67	33.33
	4	85	71	14	83.53	16.47
Average					69.54 **a**	30.46 **C**
Seilet El-Dahr/Jenin governorate (32°18'52.8"N 35°11'21.4"E) **492** m (1614.2 feet) above sea level; olive cultivar Nabali	1	125	125	0	100	0
	2	115	115	0	100	0
	3	78	78	0	100	0
	4	46	46	0	100	0
Average					100 **c**	0 **A**
Assira El-Shamalieh /Nablus governorate (32°14'59.9"N 35°16'05.6"E) **635**m (2083.3 feet) above sea level; olive cultivar Nabali	1	69	69	0	100	0
	2	38	38	0	100	0
	3	52	52	0	100	0
	4	27	27	0	100	0
Average					100 **c**	0 **A**
Overall average					**87.97**	**12.03**

* Means in each column followed by the same letter are not significantly different at $P \leq 0.05$ using ANOVA and Tukey HSD test for means separation.

Discussion

The importance of the present research could be attributed to the following reasons: i) it is the first report on the natural enemies of the olive leaf gall midge (*Dasineura oleae*) in Palestine, ii) the chemical control of *D. oleae* in the Palestinian olive orchards is irrational and unprogrammed so that random insecticidal sprays of olive trees against this pest lead to kill the parasitoids that may naturally reduce the population of *D. oleae* in the various Palestinian areas of olive production. Moreover, it is important to study the population dynamics of the native parasitoids of *D. oleae* throughout the year. The data obtained in this respect are necessary for timing the insecticidal sprays that may be applied against the insect in case of its outbreak so that killing of native parasitoids can be avoided. Furthermore, chemical sprays should be avoided at the time of emergence of these adult parasitoids from parasitized galls of *D. oleae*. Tondini and Petacchi (2019) detected the presence of four species of parasitoids in what is called "parasitoid complex" on *D. oleae* in Tuscany province (Italy). Of these species, *P. oleae* was one of them. These parasitoids usually appear during October to November so olive farmers usually stop application of insecticides during that period of time to avoid killing of the parasitoids. Also, in Hatay Province (Turkey), no chemical treatment of olive trees against *D. oleae* were practiced due to presence of active parasitoids performing a natural balance between the insect and its parasitoid complex so that the pest population remained low with no significant economic damage (Doganlar, 2011).

The average percent of parasitism on *D.oleae* caused by the identified parasitoids was higher in *P. oleae* compared with *Z. hatayensis* (87.97% vs. 12.03% , respectively, as an overall average). These results are in agreeing with that of Doganlar *et al*. (2011) who stated that the frequency of *P. oleae* presence in Hatay province (Turkey) was more than that of *Z. hatayensis* in the same province (177 vs. 27 as sampled specimens of the parasitoids, respectively). Also, the description of our identified indigenous parasitoids (*P. oleae* and *Z. hatayensis*) is almost similar to that of Doganlar (2011) for the same species.

The use of native parasitoids in the future for biocontrol of *D. oleae* could be enhanced by the following methods: i) multiplication and reproduction of these parasitoids could be encouraged in the targeted area of olive orchards by avoiding the frequent application of insecticidal sprays that kill the parasitoids especially during the period of adult parasitoids' emergence , ii) the number and efficacy of these parasitoids in the targeted area could be increased by doing inoculative releases of these parasitoids after rearing them in the insectary. The released parasitoids can establish themselves in the area alongside with the native parasitoids of the same species.

Conclusions

The natural enemies of *D. oleae* were studied in the present research by, first, identifying and describing the species of native parasitoids of *D. oleae* in the Palestinian olive orchards then by determining the average percent of parasitism caused by the identified species of native parasitoids on *D. oleae* in the sampled areas. The diagnostic characters of these species including the necessary illustrations were provided in the present research. The average percent of parasitism caused by the identified species of native parasitoids was found to be closely related to the altitude of the sampled areas giving that *P. oleae* was present in all ranges of altitudes (82 to 635m above sea level) whereas, *Z. hatayensis* was present only in low altitudes (82 to 229m above sea level). Moreover, *P. oleae* was the dominant species of parasitoids with the largest portion of parasitism percent (69.54-82.36% as an average percent of parasitism) whereas, *Z. hatayensis* constituted the smallest portion of the parasitism rate (17.64-30.46% an average percent of parasitism). The overall average % of parasitism was 87.97% for *P. oleae* whereas, it was 12.03% for *Z. hatayensis*. The results of this study clearly indicate the significant role of native parasitoids in the regulation of *D. oleae* outbreaks and in the use of these parasitoids as biocontrol agents against the insect in the Palestine.

References

– Al-Tamimi, M.M.A. (1997). *Population Trends of Olive Leaf Midge Dasineura oleae Loew (Diptera: Cecidomyiidae) and the Effect of*

Some Insecticides on the Midge and its Parasites in Amman District. MSc. thesis, NCARE, Jordan, p 77.

- Avidov, Z. & Harpaz, I. (1969). *Plant Pests of Israel.* Israel Universities Press, Jerusalem, p 549.
- Baidaq, Z.M., Ramadhane, A.M. & Tara, R.A. (2015). Biological synchronization of the Endoparasitoid *Platygaster demades* Walker (Hymenoptera: Platygasteridae) with its host the olive leaf midge *Dasineura oleae* F. Loew (Diptera: Cecidomyiidae). *International Journal of Agricultural and Environmental Sciences, 2*(3), 1– 8.
- Batta, Y. (2019). New Findings on Infestation and Phenology of *Dasineura oleae* Angelini (Diptera, Cecidomyiidae): An Emerging Pest on Olive Trees in the Palestinian Territories. *Journal of Plant Diseases and Protection, 126*, 55-66
- Boselli, M. & Bariselli, M. (2015). Il pericolo corre sulle foglie degli olivi. *Agricoltura Settembre Ottobre, 2015*, 60-62.
- Darvas, B., Skuhravá, M. & Andersen, P. (2000). *Agricultural Dipteran Pests of the Palaearctic Region*. In Contributions to a Manual of Palaearctic Diptera: General and Applied Dipterology; Papp, L. & Darvas, B., Eds.; Science Herald, Budapest, Vol. 1, pp. 565-650.
- Doğanlar, M. (2011). Parasitoids complex of the olive leaf gall midges, *Dasineura oleae* (Angelini 1831) and *Lasioptera oleicola* Skuhravá (Diptera: Cecidomyiidae) in Hatay Turkey, with descriptions of new genus and species from Tetrastichinae (Hymenoptera: Eulophidae). *Turkish Journal of Entomology, 35* (2), 245-264.
- Doğanlar, M., LaSalle, J., Sertkaya, E. & Doğanlar, O. (2009). A new species of *Quadrastichus* Girault, 1913 (Hymenoptera: Eulophidae: Tetrastichinae) from Hatay, *Turkey. Turkish Journal of Zoology, 33*, 309-314.

- Doğanlar, M., Sertkaya, E. & Skuhravá, M. (2011). Pest status of olive leaf gall midge *Dasineura oleae* (Angelini, 1831), description of *Lasioptera oleicola* Skuhravá sp. new (Diptera: Cecidomyiidae) and effectiveness of parasitoids on their populations in Hatay. *Turkish Journal of Entomology, 35* (2), 265-284.
- Fauna Europaea. (2010). Fauna Europaea. Retrieved January 1, 2010, from http://www.faunaeur.org; Version 2.4.
- Hrncic, S. (1998). A survey of olive pests in Montenegro. IV International Symposium on Olive Growing. *ISHS Acta Horticulturae, 586*, 23-28.
- Iordanou, N. (1982). *Chemical control of the olive midge, Dasineura oleae, in Cyprus.* Miscellaneous Reports 6. Agricultural Research Institute, Ministry of Agriculture and natural resources. 4 p.
- Ramadhane, A.M., Tara, R.A. & Baidaq, Z.M. (2017). Identification of parasitoids accompanying olive leaf midge, *Dasineura oleae* F. Löew (Diptera, Cecidomyiidae) in some areas of the Syrian coastal region. *Tishreen Univer J Res Sci Studies – Biol Sci Series, 93* (9), 121-132.
- Simoglou, K.B., Karataraki, A., Roditakis, N.E. & Roditakis, E. (2012). *Euzophera bigella* (Zeller) (Lepidoptera: Pyralidae) and *Dasineura oleae* (F. Low) (Diptera: Cecidomyiidae) emerging olive crop pests in the Mediterranean? *Journal of Pest Science, 85*(2),169–177.
- Szelenyi, G. (1940). Ein Beitrag zur Kenntnis parasitischer Hymenopteren an Hand einiger Zuchtergebnisse (Hymenoptera: Proctotrupoidea). *Arbeitsgemeinschafts für Morphologie, taxonomie und Entomologie der Berlin-Dahem, 7*, 226-236.
- Tondini, E. & Petacchi, R. (2019). First observations on the parasitoid complex and on the biology of *Dasineura oleae* during an outbreak in Tuscany, Italy. *Bulletin of Insectology, 72*(1), 93-102.