STUDIES ON THE BIONOMICS OF OLIVE PSYLLID, *EUPHYLLURA STRAMINEA* LOGINOVA (HOMOPTERA: APHALARIDAE) WITH SPECIAL REFERENCE TO OLIVE CULTIVAR EFFECTS

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INTRODUCTION

The olive psyllid *Euphyllura straminea* Loginova (Homoptera: Aphalaridae) was recorded in Egypt as a new pest on olive trees in 1994 (Nada, 1994). Ecological studies on this species were undertaken by Sharaf El-Din and Hashem (1999). Superfamily Psylloidea has a world wide distribution and comprises about 1300 species in 150 genera. The most common species is the olive psyllid, *Euphyllura olivana* Costa which is a polyphagous species having wide host plant range particularly olive trees (*Olea eurapaea* L.). The biology and field observation on *E.olivana* were tackled by several investigators in different parts of the world (Starvaki, 1980, Mustafa and Najjar; 1985, Fimiani, 1985; Bene *et al.,* 1997). However, information about the development, mortality and adult behavior of *E.straminea* are lacking, particularly under environmental conditions of Egypt.

Euphyllura straminea has 1-2 generations annually, (Sharaf El-Din & Hashem, 1999; Elwan, 2001). Adult and nymph stages suck the sap from the leaves causing fall of the fruit ferans, racemes and cause reduction in the fertility rate of flowers, in addition to the secretion of honey dew. The literature on the biology of this pest is lacking allover the world and there were scattered researches in Iraq (Ali and Ahamed, 1985). In an attempt to contribute and cover such a gap in the knowledge, the present comparator biological studies are aimed with special reference to the effect of olive cultivars on insect development, sexual reproduction and survivorship.

MATERIAL AND METHODS

Source of olive seedlings

Seedlings of olive cultivars: Eugazy, Bequal, Meshen and Tuffahy were supplied by the Spanish olive project, Fac. Agriculture, Cairo University for carrying out the biological studies.

Sources of insects

Adults (females and males) of the olive psyllid, *Euphyllura straminea* Loginova (Homoptera: Aphalaridae) were collected from infested olive orchard 20 km far from Giza city, Egypt at the beginning of spring generation (March).

Insect rearing

To rear the various stages of *E. straminea* on olive seedling and to carry out further biological studies, plastic pots (20 cm diameter) with two years old olive seedling, were prepared. An olive shoot/pot was chosen and inserted inside a glass tube with opened ends. The bottom end was plugged with a piece of cotton around the olive shoot while the other end was covered with tull and fasted with rubber band. Insects were introduced to olive shoot by the aid of a fine brush. Olive seedlings were watered every three days.

Duration assessment of sexual reproduction

To estimate the duration of pre-oviposition, oviposition, post- oviposition and the total number of eggs laid by a single female, 10 newly emerged adults (5 females and 5 males) were derived from stock culture of the insect and kept on an olive shoot inside the previous described glass tube (16 replicates were used). Sexual reproduction periods as well as the number of eggs/female were counted and recorded. For cases where the swollen buds on shoot are filled with eggs, insects may be transported to a new virgin shoot and caged again to complete egg laying. Observations were regularly done until insect death.

Egg hatchability percent and duration assessment of immature stages

To estimate the incubation period and egg hatchability percentage, swollen buds with known number of eggs were separated by the aid of small knife and stucked on the apex of olive shoots caged with glass tubes. Shoot cages were carefully examined daily and the number of newly hatched 1st instar nymphs were counted and hatchability percent was recorded. The development of various

nymphal instars (5 instars) was followed up and observed daily until the appearance of newly emerged adults.

After adult emergence, newly emerged psyllids, a pair of adults (♀&♂) was caged on an olive shoot by the same previous descried manner (16 replicates). The sexual reproductive periods (pre-oviposition, oviposition and postovipositions) were determined as well as the number of eggs oviposited by a single female.

Effect of olive cultivars

The effect of olive cultivars: Bequal, Eugazy, Meshen and Tuffahy on the developmental rate and fecundity of *E.straminea* was investigated under laboratory conditions (21.3 ± 2°C & 44.13% rel. humidity). Seedlings of the different olive cultivars (two years old) cultivated in 20cm plastic pots were prepared (4 seedlings/cultivar). Ten newly hatched 1st instar nymphs derived from the mass rearing stock culture were released in a glass tube cage fixed on one cultivar shoot/seedling (4 cages with 40 1st instar nymphs/cultivar; 4 replicates). Cages with nymphs on various cultivars were inspected daily and pots with seedlings were watered every three days. Insect inspection and observations were continued until emergence of psyllid adults. Records on the duration of nymph instars and number of dead nymphs were carried out. Newly emerged psyllids were sexed and 10 adults (5 females & 5 males) were caged on a new olive shoot of the same cultivar (4 replicates/cultivar). Data on sexual reproductive periods, number of deposited eggs, adult longevity and egg hatchability were recorded. Results were accomplished by SAS (1994) and variance analysis to clarify the differences among treatments.

RESULTS AND DISCUSSION

The mean developmental time to adult eclusion for *E.straminea*. feeding on Tuffahy olive shoots (*Olea europaea* L.) is given in Table (1). Development of embryo within the egg required 7-8 days with an average of 7.8 ± 0.64 days at 21.3°C and 44.13 % rel. humidity conditions.

Duration of nymphal instars

The psyllid *E.straminea* has five nymphal instars; the last acdysis is followed by the adult stage. The 1st nymphal instar lasted 5.3 ± 1.3 days while the duration of the rest nymphal instars ranged between 3.8± 1.3 and 6.3 ± 0.3 days being the longest for the 2nd instar and the shortest for the 5th nymphal instar. The total developmental time ranged between 23 and 35 days with an average of 25.7 ±

2.18 days. Similar results were reported by Ali and Ahmed (1985) in Iraq. Awadallah and Swailem (1971) recorded 12-16 days for the total nymphal duration of the psyllid *Pauropsylla trichaeta* Petty which is approximately the half period of the present studied species and that may be ascribed to the variations of the psyllid species, environmental conditions and host plant.

TABLE (I)

Mean durations (± S.E.) and other biological parameters of the olive psyllid, *E.straminea* fed on Tuffahy olive shoots under laboratory conditions. (21.3°C ± 2 °C & 44.1 ± 5 % rel. humidity.

Biological parameters	Duration in days	
	Range	Mean + S.E
Incubation period (days)	(7-8)	7.8 + 0.64
1st nymph instar period (days)	(4-7)	5.3 + 1. 3
2nd nymph instar period (days)	(5-8)	6.3 + 0.32
3rd nymph instar period (days)	(5-7)	6.0 +0.42
4th nymph instar period (days)	(5-7)	4.3+1.42
5th nymph instar period (days)	(4-6)	3.8 +1.31
Total developmental time (days)	(23-35)	25.7 + 2.18
Pre-oviposition period (days)	(9-12)	10.3 + 0.7
Oviposition period (days)	(17-22)	19.0 + 1.5
Post-oviposition period (days	(8-16)	13.3 + 1.4
No. of eggs/female	(90-133)	106.6 + 19.7
Egg hatchability (%)	(52.8-95.8)	70.6+ 4.3
Adult longevity	(40-45)	24.5 +1.02
Sex ratio (♂:♀)	(1:1.6 - 1:1.7)	1 :1.4
Total life cycle (days)	(30-43)	36.8 + 3.91

Nymphal mortality

During the development of *E.straniunea,* nymphal instars may suffer mortality which differs among instars. As shown in Table (4), 1st and 2nd instars suffered the highest rates of mortality (2.5 and 2.5%, respectively) and those greatly diminished throughout the development of the 4th nymphal instar (1.2%) and become completely negligible or absent among nymphs of the 5th instar. Mortality occurred among individuals of the various nymphal instars was caused by failure in ecdysis, natural mortality and parasitism. The parasite *Psyllaephagus euphyllure*

was isolated from the 5th instar nymphs. Ali and Ahmed (1985) reffered to four parasitoid species parasitizing on the 5th nymphal instar of *E.straminea* in Iraq and the parasitism rate ranged between 1 to 29% but *E. straminea* was not included within those species.

Sexual reproductive periods and egg laying

The newly emerged adults are yellowish green in colour. Mating usually occurred at day light and took place soon after adult emergence. Mated females commenced egg-laying 9-12 days post emergence, and eggs are deposited singly or in small groups of 5-35 eggs/bud. Females laid eggs in the swollen buds and recent formed green leaves and never on old leaves or shoot stems. Oviposition lasted 17-22 days with an average of 19.0 $\pm$ 1.5 days under 21.3°C and 44.13% rel. humidity conditions. Female deposited 90-133 eggs (106.6 $\pm$ 19.7 in average eggs/female) through this period. Post-oviposition period averaged 13.3 $\pm$1.4 days Table (1). Ali and Ahmed (1985) recorded 24.7, 29.76 and 40.7 days for pre-oviposition, oviposition and post-oviposition periods of *E.straminea* under field conditions and the total number of eggs/female average 150 $\pm$ 15.76 eggs. These obvious differences could be attributed to the variation of temperature and rel. humidity in laboratory and filed circumstances.

Adult longevity and sex ratio

In the present study, adults of the olive psyllid, *E.straminea* survived 40-45 days with an average of 42.5$\pm$ 1.02 days at 21.3°C & 44.13 % rel. humidity, where females lived longer than males. Similar results were achieved by Ali and Ahmed in Iraq (1985). Sex ratio between females and males of *E.straminea* under laboratory conditions was 1:1.4(♂ :♀) with slight predominance of females Table (1).

Effect f olive cultivars

The experimented olive cultivars: Bequal, Meshen Eugazy and Tuffahy showed pronounced effects on duration of immatures development, mortality, fecundity and adult longevity of the olive psyllid *E. straminea* under uncontrolled laboratory conditions.

a. Incubation period

Incubation time of eggs laid by *E.straminea* females previously fed on different olive cultivars showed insignificant variations. Eggs hatched after 8.4, 8.2 and 7.8 day for Bequal , Eugazy and Tuffahy cultivars, respectively (Table 2).

TABLE (II)

Duration of *E.straminea* life cycle reared on different olive cultivars under laboratory conditions av. = (21.3°C ± 2 °C & 44.1 ± 5 % rel. humidity.

Olive cultivar	Mean duration (in days)		
	Incubation period	Immature stages	Life cycle
Bequal	8.4 a (7-12)	31.3 ab (26-40)	39.7 ab (33-52)
Eugazy	8.2 a (7-9)	37.3 a (30-44)	45.5 a (37-53)
Tuffahy	7.8 a (7-8)	25.7 b (23-35)	33.5 b (30-43)

Values followed by the same letter are not significantly different [P=0.05 ; Duncan's multiple range test (Duncan, 1955)].

b. Developmental time of nymphal stage

Development of nymphal stage of *E.straminea* passes through five instars. Duration of these instars was influenced by rearing on olive cultivars. As shown in Table (3), the total developmental period was the longest for nymphs developed on Meshen cultivar (39.5 ± 9.9 days) while the shortest (25.7 ± 4.5 days) was recorded for Tuffahy cultivar. Nymphs reared on Eugazy and Bequal cultivars required 37.3 ± 6.3 and 31.3 ± 6.3 days for completion of development, respectively. Accordingly, results indicated that nymphal instars preferred Tuffahy since its development was faster and thus duration was the shortest. On the other hand, Meshen cultivar was the least preferred cultivar as development was slow and developmental period was the longest. Life cycle of *E.straminea* lasted 39.7, 45.5 and 33.5 days on Bequal, Eugazy and Tuffahy cultivars, respectively.

c. Mortality rate of immatures

Table (4) clarifies that the experimented olive cultivars influenced the survival rates of the various nymphal instars. Generally, 1st instar suffered the greatest mortality and this rate decreased in the following instars being zero for the 5th instar for all olive cultivars. Regarding olive cultivars effects, feeding of nymphal instars on Tuffahy induced the least percentage of mortality (8.75%), while the highest rate (21.75%) was resulted due to feeding on Meshen cultivar. Mortality percentages of 17.5% and 10.62% were attained when nymphal instars were fed on Bequal and Eugazy cultivars, respectively. These results prove the suitability of Tuffahy cultivar as food substrate which promoted insect development and induced the least rate of mortality.

TABLE (III)

Average developmental time (mean ± SE) of *E.straminea* immatures reared on different olive cultivars under controlled conditions (21.3°C ± 2 °C & 44.1 ± 5 % rel. humidity.

Cultivar		Durations (in days)					
		1st instar	2nd Instar	3rd instar	4th instar	5th instar	Total
Bequal	Aver.	6.3±0.5	6.0±0.2	6.5±0.4	6.0±0.4	6.5±0.4	31.3±1.63 b
	Range	5-9	5-7	5-8	5-7	6-9	26-40
Eugazy	Aver.	8.4±0.1	7.1±0.2	6.3±1.7	7.0±1.7	85±1.9	37.3±6.3 a
	Range	7-11	6.8	6-8	5-8	6-9	30-44
Meshen	Aver.	8.5±2.6	6.5±1.6	7.5±1.8	8.0±1.6	9.0±2.3	39.5±9.9 a
	Range	7-10	6-7	7-8	7-9	8-10	35-45
Tuffahy	Aver.	5.3±1.3	6.3±0.3	6.0±0.2	4.3±1.4	3.8±1.3	25.7±2.18 c
	Range	4-7	5-8	5-7	5-7	4-6	23-35

Values followed by the same letter are not significantly different [P=0.05; Duncan's multiple range test (Duncan, 1955)].

TABLE (IV)

Mortality percentages of nymphal instars of *E.straminea* reared on buds of olive cultivars under uncontrolled temperature & rel. humidity av. =Temp. (21.3°C ± 2 °C & 44.1 ± 5 % rel. humidity.

Cultivars		% Mortality					
		1st instar	2nd instar	3rd instar	4th instar	5th instar	Total
Bequal	Aver.	3.8±0.3	1.8±0.3	1.5±0.1	1.0±0.2	0.0±0.0	17.50±2.11 ab
	Range	2-7	1-5	2-3	2-3	0-0	--
Eugazy	Aver.	5.0±0.4	1.1±0.6	1.5±0.2	0.5±1.7	0.0±0.0	10.62±1.30 bc
	Range	1-9	1.2	1-4	2-3	0.0-0.0	--
Meshen	Aver.	6.8±1.8	3.3±1.1	3.0±0.8	2.8±0.6	0.0±0.0	21.75±5.10 a
	Range	5-8	4-6	4-5	3-4	0-0	--
Tuffahy	Aver.	2.5±0.6	2.5±0.5	1.2±0.2	1.2±0.3	0±0	8.75±2.0 c
	Range	1-4	1-7	1-3	1-3	0.0-0.0	---

Values followed by the same letter are not significantly different [P=0.05; Duncan's multiple range test (Duncan, 1955)].

d. Sex ratio

Number of female and male adults developed on olive cultivars *i.e.* Bequal, Eugazy and Tuffahy showed more females than males and sex ratio was 1:1.7, 1:1.6

and 1:1.4 male: female adults with insignificant difference (Table 5). So, it could be stated that olive cultivars tested in the present study had no conspicuous effect on the sex ratio of developed *E. straminea* adults with slight predominance of females.

e. Sexual reproductive periods

Pre-oviposition period ranged between 9 and 12 days with an average of 10.3±0.7 days on the experimented cultivars. On the other hand, oviposition and post-oviposition durations were pronouncedly influenced by olive cultivars. The shortest ovipostion and post-oviposition periods occurred for female adults fed on Tuffahy; it averaged 19 and 13.3 days while the longest periods (24.5 and 17.0 days) were recorded for Bequal-fed females. Ovi-and post-oviposition periods averaged 20.5 and 15.3 days for Eugazy fed-females (Table 5).

f. Fecundity

The total number of eggs produced by *E.straminea* female was also affected by its host plant (food substrate). Results presented in Table (5) show great variation in the number of deposited eggs/female due to olive cultivar. Tuffahy-fed female produced 106.6 eggs while those fed on Bequal and Eugazy-laid averages of 68.6 and 52.4 eggs/female, respectively. These results again prove the great suitability of Tuffahy cultivar as food and susceptibility to be infested by *E. straminea* than other tested cultivars.

g. Adult longevity

Tested olive cultivars had slight effect on the longevity of produced adults. Eugazy-fed adults survived 84-51 days (mean. 49.8 days), while those fed on Bequal and Tuffahy survived 47.8 and 42.5 days, respectively (Table 5). The difference among these periods was statistically insignificant.

Olive cultivars may affect the biological processes of many insects attacking olive trees (Sobreiro *et al.* 1993). In the present study, the tested cultivars had pronounce effects on the development, fecundity, survival of different stages and proved that Tuffahy cultivar was the most suitable for this species while Meshen cultivar was the least preferred. Similarly Ali and Ahmed (1985) found that Bashiki variety was suitable for *E.straminea* development, while feeding on Dekel variety retarded development and induced high mortality. They ascribed preference of Bashiki due to the size of olive shoot buds where female preferred it for egg-laying and also to the chemical composition of bud leaves. We reached similar results concerning Tuffahy cultivar as it has bigger bud, succulent leaves and higher content

of nitrogen (Table 6). Similar effects of host plant on sexual reproduction of *E.philneae* was achieved by Prophetou (1997) as oviposition and postoviposition durations were three months longer on the host plant *Philyrea* 1, two months shorter on *philyrea* 2 and one and half months shorter on olive trees. On the other hand, Zouiten *et al.* (2000) attributed the preference of olive cultivar to be attached by *E.olivina* to quantitative differences in phenolic compounds as young shoots and flower buds from 7 cultivars differing in resistance to the pest.

TABLE (V)

Mean number of eggs/female, hatchability, percentages, adult longevity and sex ratio of *E.straminea* reared on different olive cultivars under laboratory conditions (21.3°C ± 2 °C & 44.1 ± 5 % rel. humidity).

Cultivars	No. of eggs/female	% Hatchability	Pre-oviposition period (days)	Oviposition period (days)	Post-oviposition period (days)	Adult Longevity (days)	Sex ratio ♂:♀
Bequal	68.6 b (40-82)	82.9 a (68-95)	10.3 a (9-12)	24.5 a (19-24)	17.0 a (10-22)	47.8 a (43-53)	1:1.7 a
Euguzy	52.4 bc (22-86)	61.3 b (54-72)	10.0 a (9-11)	20.5 ab (23-28)	15.3 ab (13-17)	49.8 a (18-51)	1.0:1.6 a
Tuffahy	106.6 a (90-133)	75.3 ab (53-96)	10.3 a (9-12)	19.0 b (17-22)	13.3 b (40-16)	42.5 a (40-45)	1:1.4 a

Values followed by the same letter are not significantly different [P=0.05 ; Duncan's multiple range test (Duncan, 1955)].

TABLE (VI)

Chemical composition of buds and terminal shoot leaves of olive cultivars.

Cultivars	Nitrogen (%)	Phosphorus p.p.m	Potassium p.p.m
Bequal	0.170	1.62	38.22
Eugazy	0.220	1.95	37.21
Meshen	0.190	1.97	35.31
Tuffahy	0.250	1.71	35.32

SUMMARY

The present study is the first on the biology of *E. straminea* in Egypt. The insect passes five nymphal instars under laboratory conditions. Immature stages required 25.7 ± 4.5_days for complete development. Mortality averaged 8.75%. Female laid eggs singly and produced 106.6 eggs/female on shoos, leaves and flower buds. Sex ratio averaged 1:1.4 male: female with dominance of females and adult survived 40-45 days with a mean of 42 days.

Olive cultivars: Bequal, Eugazy, Meshen and Tuffahy had significant effects on development, mortality, fecundity and adult longevity. Tuffahy cultivar was the most suitable for the insect development and egg production, while Meshen was the least preferred. Variation in the suitability of tested cultivars was discussed.

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