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LIFE TABLES OF *LEPIDOSAPHES ULMI* (L.) AND *PALAEOLECANIUM BITUBERCULATUM* (TARGIONI TOZZETTI) (HEMIPTERA: COCCOIDEA) ON APPLE TREES IN VAN PROVINCE, TURKEY.

ABSTRACT

LIFE TABLES OF *LEPIDOSAPHES ULMI* (L.) AND *PALAEOLECANIUM BITUBERCULATUM* (TARGIONI TOZZETTI) (HEMIPTERA: COCCOIDEA) ON APPLE TREES IN VAN PROVINCE, TURKEY.

Apples are the most important cultivated crop in Van Province in Eastern Anatolia Region, Turkey, where *Lepidosaphes ulmi* (L.) and *Palaeolecanium bituberculatum* (Targioni Tozzetti) (Hemiptera: Coccoidea) are amongst the most economically important pest species. Life-table data were collected in the field for these two species in two different apple orchards. The development time for each stage was recorded once a month in the Winter and every fortnight during the Spring, Summer and Autumn. In each orchard, both shoots and leaves of five randomly selected trees were sampled and each stage of the two scale species was counted. The life-table data were analyzed with regard to the age of the insects and the season, and it was found that *L. ulmi* and *P. bituberculatum* had one generation a year. Of several mortality factors, parasitisation was the most important (25.8% for *L. ulmi* and 23.8% for *P. bituberculatum*).

Key words: *Aphytis mytilaspidis*, aphelinid, *Coccophagus palaeolecanii*.

INTRODUCTION

Horticulture is very important in the Van Province of Turkey, where apple production is the most important fruit crop. This is due to the special microclimate in the area around Van Lake, which is surrounded by mountains. Of the pests which attack apple in this area, two coccid species are economically important, namely *Lepidosaphes ulmi* (L.) and *Palaeolecanium bituberculatum* (Targioni Tozzetti) (Erol & Yasar, 1994). There has been no detailed study of these species in the Van Region and this paper presents the life tables of these two species in order to provide basic background knowledge for further research.

MATERIALS AND METHODS

The studies were carried out between 1994 and 1995 in two unsprayed apple orchards in Van Province, one which had an infestation of *L. ulmi* and the other *P. bituberculatum*. Samples were collected monthly during the winter and every fortnight during the rest of the year (April to October

inclusive). For samples of both species, five trees approximately 1.5-2.0m tall in each orchard were randomly chosen, from each of which five 20cm shoots (one from the four sides of the tree and another from the centre) and 25 leaves were collected. The number of scales on 10 cm of each shoot and on the lower surface of each leaf were counted and placed in the following categories: egg, 1st-instar nymph, 2nd-instar nymph, young female, mature female and parasitized individuals. No male stages were found. When each scale was counted, they were dissected so that the presence of parasitoids could be detected.

The following life table data were calculated (Morris, 1963; Morris & Miller, 1954; Harcourt, 1969; Krebs, 1972):

x	age interval at which the sample was taken.
lx	the number of scales alive at the start of each stage noted in the x column.
dx	the mortality within the age interval stated in the x column.
dxF	the mortality factor responsible for dx.
100qx	percentage mortality.
Sx	survival rate within x.

RESULTS AND DISCUSSION

Lepidosaphes ulmi

L. ulmi had one generation a year in Van Province, overwintering in the egg stage beneath the scale cover. One generation a year is normal for Europe (Bodenheimer, 1949; Çanakçioglu (1977), but two generations have been recorded on apple and pear in the Aegean and Mediterranean regions of Turkey (Nizamlioglu, 1957; Okul *et al.,* 1978).

Although some biological races are known to have males (Ferris, 1937; Kosztarab & Kozár, 1988; Gerson, 1990; Kozár, 1990), no males were found during this study and so it is likely that this species is parthenogenetic in Van Province. The overwintering eggs hatch in May and the crawlers settle on 1st- and 2nd-year old shoots, although, when particularly abundant, they can settle elsewhere (Samarasinghe & LeRoux, 1966).

The life cycle of the scale and the number of scales parasitised by its parasitoid are shown in Fig. 1. The 1st-instar nymphs completed their development by mid-July and the next generation of adult females

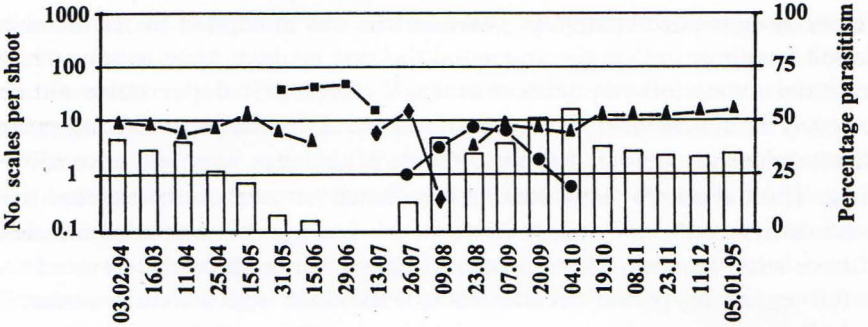

Fig. 1. Number of each stage of *Lepidosaphes ulmi* per 10cm length of shoot (——) and percentage parasitism (bars) by *Aphytis mytilaspidis* in Van province in 1994-1995 (left y-axis = log scale). Where -▲- = egg data; -•- = nymphal data; -♦- = data for immature adult females and -●- = data for mature adult females.

commenced egg laying towards the end of July. One of the main mortality factors was parasitisation by the aphelinid *Aphytis mytilaspidis* (Le Baron) which attacks mainly the egg stage but can also be found in the adult females. Thus, the percentage mortality became much reduced on hatching. However, when the new generation of eggs was laid in August, the mortality rate rose again sharply. During the egg stage, the percentage parasitism ranged between 22 and 36%. Parasitisation of the new generation was seen at the end of July. The life table data (which refer to field conditions) are given in Table 1. Here, the initial population was calculated theoretically, based on

Table 1. Life table for *Lepidosaphes ulmi*.

x	lx	dxF	dx	$100qx_1$	$100qx^1$	Sx
Eggs (N)	11,650.6	Parasites "Others" Total	4305.56 7111.07 11,416.63	36.96 61.04	36.96 61.04	0.020
Larvae	233.98	Parasites "Others" Total	0.00 151.20 151.20	0.00 64.62	0.00 1.30	0.354
Young adult females	82.78	Parasites "Others" Total	4.90 22.04 26.94	5.92 26.62	0.04 0.19	0.675
Mature adult females	55.84	Parasites "Others" Total	35.19 20.65 55.84	63.02 36.98	0.30 0.18	

the number of females in the previous years population, as follows: the mean number of eggs per female was 39.8 and this was multiplied by the number of adult female scales on the shoots on the first counting date in May. Thus, the initial estimated population of eggs was 11,650.6 per 10cm shoot. However, as almost 37% were parasitised by *A. mytilaspidis* and a further 61% died due to unknown factors, only 2% of the eggs were still alive in the Spring. Thus, about 234 eggs were able to hatch but of these 64.6% died due to unknown factors, so that only 35.4% of the 234 eggs became adult females. Of these adult females, 55.8% produced eggs but not all adults survived for the full egg-laying period because 63% of the adult scales were parasitised. Thus, the next generation eggs were laid by the 37% surviving adult females. It is clear from Table 1 that mortality was high in the egg and nymphal stages. It can be shown that natural mortality factors were the cause of this high mortality. The high rate of parasitism is thought to be because the orchards had been unsprayed in the two years prior to the study.

Palaeolecanium bituberculatum

P. bituberculatum also has only one generation a year in Van Province and overwinters as an egg beneath the female scale cover. Hatching occurs at the beginning of May and the crawlers settle on the leaves (Özgökçe, 1995) where they remain until adult. Once mated at the end of June, the adult

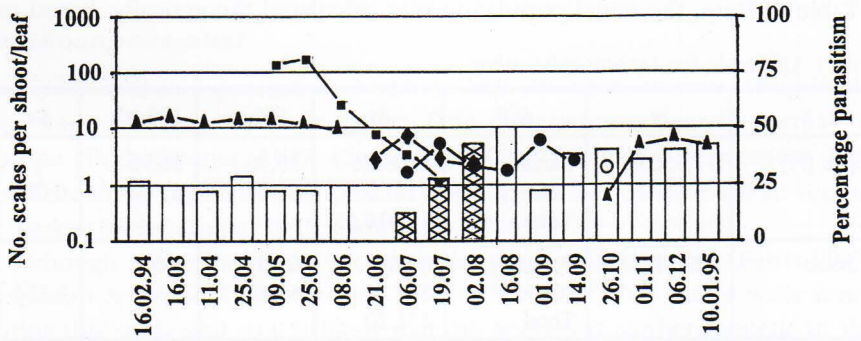

Fig. 2. Number of each stage of *Palaeolecanium bituberculatum* per 10cm length of shoot or per leaf (——) and percentage parasitism (bars) by *Coccophagus palaeolecanii* in Van province in 1994-1995 (left y-axis = log scale). Where white bars = parasitism on shoots and hatched bars = parasitism on leaves; and -▲- = egg data (on twigs); -▪- = nymphal data (on leaves); -◆- = data for immature adult females on leaves; -●- = data for immature adult females on twigs, and -○- = data for mature adult females on twigs.

females move (preferably) onto the young shoots and shoot tips but they can also settle on the branches of the tree. They do no move again. The survivorship curve and life cycle of the scale and the number of scales parasitised are shown in Fig. 2. The mature adult females commence laying the eggs of the next generation towards the end of October.

The main parasite attacking *P. bituberculatum* is the aphelinid parasitoid *Coccophagus palaeolecanii* Jasnosh, which mainly attacks the adult stage but can also parasitise the egg and the nymphal stages. Parasitisation was lowest at the end of June, when the larval population was highest but, by the end of October, when the eggs of the next generation had been laid, the percentage parasitism rose again.

The percentage parasitism was calculated in the same manner as for *L. ulmi*, and ranged between 17 and 41%. This high percentage parasitism may have been indirectly due to *Hyponomeuta malinellus* Zell (Lepidoptera: Hyponomeutidae) which caused much damage to the leaves and thus a reduction in the number of scales for the available parasitoids. The initial estimated population (see under *L. ulmi*) started with 18,783.5 eggs per 10cm shoot or one leaf, but there was very high mortality, with 25% being lost through parasitism and 73.2% due to unknown factors (Table 2), so that only 1.8% hatched to become crawlers. Thus, a mean of 332.9 individuals hatched, of which 1.5% were lost through parasitism and a further 84.2% through other factors. Thus, only 14.3% of the eggs that hatched actually became adult

Table 2. Life table for *Palaeolecanium bituberculatum*.

x	lx	dxF	dx	$100qx_1$	$100qx^1$	Sx
Eggs (N)	18,783.5	Parasites "Others" Total	4700.23 13,750.37 18,450.60	25.02 73.20	25.02 73.20	0.018
Larvae	332.85	Parasites "Others" Total	5.00 280.20 285.20	1.50 84.18	0.03 1.49	0.143
Young adult females	47.65	Parasites "Others" Total	5.35 38.20 43.55	11.23 80.172	0.03 0.20	0.086
Mature adult females	4.10	Parasites "Others" Total	1.90 2.20 4.10	46.34 53.66	0.01 0.01	

females; of these, 11.2% were parasitised and a further 80.2% were killed by other factors, leaving only 8.6% of the original adults to lay eggs for the next generation. Of these next generation eggs, it was found that 46.3% were parasitised, leaving 53.7% to found the next generation.

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