Bulletin of Entomological Research (2008) **98**, 53–56
doi:10.1017/S0007485307005378

Printed in the United Kingdom

The parasitoid complex of *Parthenolecanium corni* Bouché in the city of Tbilisi and its surroundings and comparison with some other European countries

G. Japoshvili[1]*, N. Gabroshvili[2] and B. Japoshvili[3]

[1]Plant Protection Department, Faculty of Agriculture, Suleyman Demirel University, Isparta, Turkey: [2]Institute of Zoology, Georgian Academy of Sciences, Chavchavadze ave. 31, 0179, Tbilisi, Georgia: [3]Ilia Chavchavadze State University, Chavchavadze ave. 32, 0179, Tbilisi, Georgia

Abstract

The European fruit lecanium (EFL), *Parthenolecanium corni* Bouché (Hemiptera: Coccoidea), is a common and harmful soft scale, which attacks *Fraxinus oxycarpa* Willd. and other ornamental and orchard plants in Tbilisi, Georgia. This study investigates the phenology, degree of plant damage and effect of parasitoids on this scale in Tbilisi, a densely populated area. We present data on the 32 species of chalcidoid parasitoids recorded from EFL in Georgia and south-eastern Europe. The scale is heavily parasitized in Tbilisi, but we did not find any variation in seasonal abundance. The most common parasitoid of EFL was *Blastothrix longipennis* (Hymenoptera: Encyrtidae).

Keywords: Coccidae, Chalcidoidea, Encyrtidae, Georgia, Transcaucasus

(Accepted 10 April 2007)

Introduction

The European fruit lecanium (EFL), *Parthenolecanium corni* Bouché (Hemiptera: Coccoidea) (Kawecki, 1958; Kosztarab & Kozar, 1988), is a common and harmful soft scale, infesting the branches and trunks of its host plants, particularly *Fraxinus* spp. and some other ornamental and fruit plants. In a heavy infestation, the plant may even die. Plants often become defoliated due to the accumulation of sooty moulds growing on the honeydew (Borchsenius, 1957; Khadzhibeili, 1983; Kosztarab & Kozar, 1988).

Integrated pest management (IPM) is now recognized as the preferred strategy to achieve sustainable agricultural production (Yasnosh *et al*., 1996) because alternatives, such as the use of pesticides, have various side-effects on both the environment and human health.

*Author for correspondence
Fax: +90 246 237 16 93
E-mail: giorgij70@yahoo.com

EFL is regulated by a large number of species of parasitoids and predators in Georgia and some Eastern European countries (Thompson, 1954). We are currently investigating the phenology of EFL in Tbilisi. The aim of our investigation is to clarify the role of the parasitoid complex in the population dynamics of the EFL. These investigations consider only the parasitoids and do not include other natural enemies of the EFL, such as predators, nematodes and viruses.

Material and methods

The investigations and collection of material was conducted in four different localities, between April–October 1995–2000, 2002 and 2006 on *Fraxinus* and stone fruit trees in Tbilisi. In addition to the data collected in the four study sites, published information was included in our investigation (Sugonjaev, 1976, 1984; Trjapitzin, 1989; Guerrieri & Noyes, 2000; Rzaeva, 2002; Sentenac & Kuntzmann, 2003; Japoshvili & Noyes, 2005; Noyes, 2006).

Table 1. Mean population density of *Parthenolecanium corni* per ten centimetre of branch, % damage and % parasitism at four sites in Tbilisi, April–August, 1998–1999.

Site	Mean EFL per 10-cm-long branches		Damage %		Parasitism %	
	1998	1999	1998	1999	1998	1999
Botanical garden	22 ± 3.776	2.07 ± 1.55	80	21	64	25
Turtle Lake, Ethnographical Museum	30 ± 3.642	0.46 ± 0.924	98	1	88	14
Lake Lisi, Nutsubidze Plateau	20 ± 3.07	3.8 ± 1.43	74	15	42	4
Tbilisi Sea neighborhood	33.143 ± 3.377	0.43 ± 0.85	48	12	30	7

Table 2. Percentage parasitism for each of the seven parasitoids recorded from *Parthenolecanium corni* at four sites in Tbilisi, June–October, 1998–1999.

Parasitoid species	Botanical garden		Turtle Lake, Ethnographical Museum		Lake Lisi, Nutsubidze Plateau		Tbilisi Sea neighbourhood	
	1998	1999	1998	1999	1998	1999	1998	1999
Blastothrix longipennis Howard	65.6	23	84	–	100	100	95.6	56.4
Metaphycus insidiosus (Mercet)	2	0.1	1	14	–	–	–	–
Microterys duplicatus (Nees)	0.1	–	–	–	–	–	–	–
Cheiloneurus claviger Thomson	–	–	–	–	–	–	4.4	43.6
Trichomasthus albimanus Thomson	2	–	–	–	–	–	–	–
Coccophagus lycimnia (Walker)	27.3	68.9	12	47	–	–	–	–
*Pachineuron muscarum*_L.	3	8	1	39	–	–	–	–

Our estimate of the scale of density was based on the mean number of adult coccids per ten centimeter branch and their developmental rate from studying 200 insects on a plant. At each site, we sampled ten randomly chosen 12–13-year-old scale-infested Caucasian ash trees (*Fraxinus oxycarpa*). Samples were also collected regularly from other host plants, including the following: *Cercis siliquastrum, Prunus divaricata, Celtis caucasica, Acer* sp., *Acacia* sp., *Ulmus foliacea, Rosa* spp., *Malus domestica* and *Cornus mas*. Parasitoids were reared in glass bottles covered with a fine mesh. To prevent desiccation, the humidity was maintained by placing a wet filter paper inside each bottle and changing it daily (see Nikolskaya & Yasnosh, 1966). The emerging parasitoids were identified and counted. The number of parasitized scales was determined by the presence of exit holes in the adult scales. Second instar nymphs also were parasitized and the parasitism was considered together with adult females. From this, we estimated the percentage parasitism.

The population fluctuations of EFL and its natural enemies were determined in the four main sites and also generally in the streets of Tbilisi (including 5–25-year-old trees). The sites represented two groups: two undisturbed areas in the surroundings of Tbilisi, and two areas inside the city of Tbilisi polluted by car exhausts. In each site, EFL-infested trees were selected randomly and the scale insects were collected from the trunk, branches and twigs. The percentage of plants damaged by EFL was calculated using the formula $P = B \times 100a^{-1}$, where P is the percentage damage, B are the harmed plants (infested plants) and a is the number of studied samples (Khadzhibeili, 1983). This formula was also used to establish the role of parasitoids in the suppression of the EFL. Standard error was also calculated.

We also compared the EFL parasitoid fauna of Georgia with that of some East European countries using the Jaccard formula where the coefficient of similarity equals $c \times (a + b - c)^{-1}$ (Magurran, 1988), where a is the number of

https://doi.org/10.1017/S0007485307005378 Published online by Cambridge University Press

Table 3. Parasitoid records from *Parthenolecanium corni* from five regions in Eastern Europe and Transcaucasus.

Parasitoid species 1	Fam 2	Gr 3	Ru 4	Ukr 5	Mold 6	Tr 7	Arm 8	Geo 9	Az 10
Coccophagus lycimnia (Walker)	Aphel	+	+	+	+	+	+	+	+
C. scutellaris (Dalman)	Aphel	+	−	+	−	+	−	+	−
C. semicircularis (Förster)	Aphel	+	−	−	−	−	−	+	−
Marietta picta (Andre)	Aphel	+	+	−	+	+	+	+	−
Blastothrix longipennis Howard	Enc	−	+	−	+	−	+	+	+
Cerapterocerus mirabilis Westwood	Enc	+	+	+	+	+	+	+	+
Cheiloneurus claviger Thomson	Enc	+	+	+	+	+	+	+	+
Ch. paralia (Walker)	Enc	−	+	+	−	+	+	+	+
Eusemion cornigerum (Walker)	Enc	−	+	−	+	−	−	+	−
Metaphycus chermis (Fonscolombe)	Enc	+	+	−	+	−	−	−	−
M. dispar (Mercet)	Enc	+	+	−	−	+	+	+	+
M. flavus (Howard)	Enc	+	+	−	−	+	−	+	−
M. helvolus (Compere)	Enc	+	−	−	−	+	−	−	−
M. insidiosus (Mercet)	Enc	+	+	−	+	+	+	+	+
M. luteolus (Timberlake)	Enc	−	+	+	−	−	−	+	+
M. maculipennis (Timberlake)	Enc	+	−	−	−	−	−	−	−
M. punctipes (Dalman)	Enc	−	+	+	+	−	−	−	−
M. silvestrii Sugonjaev	Enc	−	+	+	+	+	+	+	+
M. stagnarum Hoffer	Enc	−	+	−	−	+	−	−	−
M. zebratus (Mercet)	Enc	+	+	+	+	−	−	+	−
Microterys duplicatus (Nees)	Enc	+	+	−	+	−	+	+	+
M. lunatus (Dalman)	Enc	+	+	+	−	+	−	+	+
M. nietneri (Motschulsky)	Enc	−	−	−	−	+	−	+	+
M. notus Sugonjaev	Enc	−	+	−	−	−	−	−	−
M. sylvius (Dalman)	Enc	−	+	+	+	+	+	+	+
Trichomasthus albimanus Thomson	Enc	−	+	+	+	+	+	+	+
Aprostocetus trjapitzini (Kostjukov)	Eul	−	+	−	+	+	−	−	−
Baryscapus sugonjaevi (Kostjukov)	Eul	−	+	−	+	−	+	+	−
Eupelmus urozonus Dalman	Eupel	+	−	+	−	+	+	−	−
Pachineuron coccorum (Linnaeus)	Pterom	+	+	+	−	−	−	−	−
P. muscarum (Linnaeus)	Pterom	+	+	+	+	+	+	+	−
P. solitarium (Hartig)	Pterom	−	+	−	+	−	−	+	−

Fam, family; Aphel, Aphelinidae; Enc, Encyrtidae; Eul, Eulophidae; Eupel, Eupelmidae; Pterom, Pteromalidae; Gr, Greece; Ru, Russia; Ukr, Ukraine; Mold, Moldova; Geo, Georgia; Arm, Armenia; Tr, Turkey; Az, Azerbaijan.

species in one plot, b is the number of species in the second plot and c is the number of species which were recorded at both sites.

Results and discussion

EFL was found in most areas of Tbilisi; it has one generation per year and overwinters as second-stage nymphs on the branches and trunks of the host tree. Observations showed that, after overwintering, the second-stage nymph begins to develop, then molts into the third-stage nymph, which finally molts into the adult stage between the end of April and mid-May. In mid-May, the insects mate and the females lay 220–1200 eggs during 25–30 days. First-stage nymphs crawl over plants, settling on the young branches. The adult females produce abundant sweet 'honeydew', which pollutes the leaves. Saprophytic sooty-mould fungi develop on the honeydew, causing blackening of the leaves, thus, greatly diminishing the quality of the host.

Table 1 gives the scale population, the % damage and the % parasitism for four sites. In 1998, the average number of ovipositing females on 10-cm-long trunks from all sites was less than that found in 1999. The degree of parasitism also decreased from 1998 to 1999. The population decreased due to the effect of high parasitism and, consequently, in the following years decreased parasitoid number. In 2000 and 2002, we could not locate any samples of EFL, probably as a result of a cold winter and hot summer in 2000. In 2006, we found very few scales, only one tree that was infested at a low density, with not more than one female per ten centimeters sampled. Table 2 shows the % parasitism of EFL by each of the parasitoids recorded in this study at each of the four sites in Tbilisi. The most abundant parasitoid at all the sites was *Blastothrix longipennis* Howard, with a parasitism rate of 65.6% and 1 : 1 (female : male) sex ratio. The next most abundant parasitoid was *Coccophagus lycimnia* Walker, which was found at two of the sample sites, had 38.8% parasitism and a male:female sex ratio of 3 : 1. *Pachyneuron muscarum* L. and *Metaphycus insidiosus* (Mercet) were also recorded at two of the sites and their parasitism rates were 12.75% and 4.3%, respectively, with a similar male to female sex ratio of 2 : 1. *Cheiloneurus claviger* Thomson, *Trichomasthus albimanus* Thomson and *Microterys duplicatus* (Nees) were recorded only at one site, and their parasitism rates were 24%, 1% and 0.05%, respectively.

A list of parasitoids recorded from EFL in central western and southeastern Europe is presented in table 3. The EFL parasitoid fauna of Georgia is most similar to that of Russia, with a coefficient of similarity of 0.69. A high coefficient of similarity is also seen for Georgia-Azerbaijan (0.61), Georgia-Moldova and Georgia-Armenia (0.58 each) and Georgia-Turkey (0.56). The lowest coefficient of similarity was between Georgia-Ukraine and Georgia-Greece with

https://doi.org/10.1017/S0007485307005378 Published online by Cambridge University Press

0.46 each. We also compared the fauna of Transcaucasus with Greece, Russia, Ukraine, Moldova and Turkey. The results were 0.5, 0.67, 0.5, 0.56 and 0.59, respectively.

Thirty-two species of chalcidoid parasitoids have been recorded from EFL in southeastern parts of Europe (table 3). Seven species were not included in table 3 since we considered these records to be based on erroneous identification: *Coccophagus pulchellus* (Boucek, 1977), *Pteroptrix dimidiata* (Yasnosh *et al*., 1996), *Blastothrix britannica* (Sentenac & Kuntzmann, 2003), *B. sericea* (Thompson, 1954; Mitic-Muzina, 1964, 1967; Herting, 1972; Boucek, 1977; Sikharulidze & Tavamaishvili, 1977; Tudor, 1982; Noyes & Hayat, 1994), *Discodes aeneus* (Boucek, 1961, 1965; Herting, 1972), *Metaphycus pappus* (Trjapitzin, 1978) and *Thysanus ater* (Trjapitzin, 1975, 1978; Boucek, 1977). It appears that EFL populations are significantly under control by their natural enemies. We suggest that a long-term investigation be undertaken to determine the EFL-parasitoid relations in the urban areas in order to determine the influence of pollution on their population dynamics. The results of this investigation indicate that one of the significant factors in maintaining *P. corni* below its economic threshold is the complex of natural enemies, the most important of which is the parasitoid *Blastothrix longipennis*.

Although the above findings are based on an extensive amount of material, the study is still far from complete and is being continued both in Tbilisi and neighbouring sites.

References

Borchsenius, N.S. (1957) Fauna of USSR, (Homoptera: Coccidae). *Zoologicleskij Institut Akademii Nauk* **66** (9), 1–494 (in Russian).

Boucek, Z. (1961) Notes on the chalcid fauna (Chalcidoidea) of Moldavian SSR. Trudy Moldavskogo Nauchno-Issledovatel'skogo Instituta Sadovodstva, *Vinogradarstva i Vinodeliya, Kishinev* **7**, 5–30.

Boucek, Z. (1965) A review of the Chalcidoid fauna of the Moldavian SSR, with descriptions of new species (Hymenoptera). *Sborník Faunistickych Prací Entomologického Oddeleni Národního Musea v Praze* **11**, 5–37.

Boucek, Z. (1977) A Faunistic review of the Yugoslavian Chalcidoidea (Parasitic Hymenoptera). *Acta Entomologica Jugoslavica* **13** (Supplement), 1–145.

Guerrieri, E. & Noyes, J.S. (2000) A revision of European species of genus *Metaphycus* Mercet (Hymenoptera: Chalcidoidea, Encyrtidae), parasitoids of scale insects (Homoptera: Coccoidea). *Systematic Entomology* **25**, 147–222.

Herting, B. (1972) *Homoptera. A catalogue of parasites and predators of terrestrial arthropods. Section A. Host or Prey/Enemy. 2*. 210 pp. Slough, UK, Commonwealth Agricultural Bureau.

Japoshvili, G.O. & Noyes, J.S. (2005) *Checklist and new data on Encyrtidae of Transcaucasica and Turkey* (*Hymenoptera: Chalcidoidea*). Zoological Institute, St Petersburg. *Zoosystematica Rossica* **14**, 135–145.

Kawecki, Z. (1958) Studies on the genus *Lecanium* Burm. IV. Materials to a monograph of the brown scale, *Lecanium corni* Bouche, Marchal (female nec male) (Homoptera, Coccoidea, Lecaniidae). *Annales Zoologici.* Warszawa **17**, 135–216.

Khadzhibeili, Z. (1983) Coccids of the subtropical zone of Georgia. *Georgian Academy of Sciences, 'Mecniereba'*, 1–293 (in Russian).

Kosztarab, M. & Kozar, F. (1988) *Scale Insects of Central Europe*. 456 pp. Budapest, Hungary, Akademiai Kiado.

Magurran, A.E. (1988) *Ecological Diversity and Its Measurements*. 179 pp. New Jersey, Princeton University Press.

Mitic-Muzina, N. (1964) Role des parasites et des prédateurs dans la reduction de la population de lecanium du prunies (*Parthenolecanium corni* Bouché) en Serbie. *Zastita Bilja, Beograd* **80**, 359–378.

Mitic-Muzina, N. (1967) Paraziti kuglaste stitaste vasi (*Sphaerolecanium prunastri* Fonsc., Homoptera, Coccoidea). *Zastita Bilja, Beograd* **18** (93–95), 183–187.

Nikolskaya, M. & Yasnosh, V. (1966) *Aphelinids of the European Part of the USSR and the Caucasus*. 294 pp. Moscow and Leningrad, Nauka (in Russian).

Noyes, J.S. (2006) Universal Chalcidoidea Database. www.nhm.ac.uk/entomology/chalcidoids/index.html.

Noyes, J.S. & Hayat, M. (1994) *Oriental Mealybug Parasitoids of the Anagyrini* (*Hymenoptera: Encyrtidae*). 398 pp. Oxon, UK, CAB International.

Rzaeva, L.M. (2002) *Chalcids* (*Hymenoptera: Chalcidoidea*) *of East Transcaucasus and Its Economical Importance*. 356 pp. Elm, Baku (in Russian).

Sentenac, G. & Kuntzmann, P. (2003) Study of scale insects and their antagonists associated with vineyards in Bourgogne and Alsace during 2000 to 2002. *Bulletin. Section Regionale Ouest Palaearctique, Organisation Internationale de Lutte Biologique* **26** (88), 247–252.

Sikharulidze, A.M. & Tavamaishvili, L.E. (1977) *Parthenolecenium corni* – pest of persimmon and its control. *Subtropicheskie Kul'tury* **4**, 89–92.

Sugonjaev, E.S. (1976) Zha'tsitsy roda Microterys. Thomson (Hymenoptera, Chalcidoidea, Encyrtidae) – parazity lozhnoshchitovok (Homoptera, Coccoidea) SSSR. *Entomologicheskoe Obozrenie* **55** (4), 912–927.

Sugonjaev, E.S. (1984) *Chalcid Parasitoids* (*Hymenoptera: Chalcidoidea*) *of the Scale Insect* (*Homoptera: Coccoidea*) *Fauna of the USSR*. 117 pp. Leningrad, Nauka, Academy of Sciences (in Russian).

Thompson, W.R. (1954) A catalogue of the parasites and predators of insect pests. Section 2. Host parasite catalogue. Part 3. 240 pp. Ottawa, Canada, Commonwealth Institute of Biological Control, Commonwealth Agricultural Bureau.

Trjapitzin, V.A. (1975) Contribution to the Knowledge of parasitic *Hymenoptera* of the genus *Metaphycus* Mercet, 1917 (Hymenoptera, Chalcidoidea, Encyrtidae) of the Czechoslovakian fauna, *Studia Entomologica Forestalia* **2** (1), 5–17.

Trjapitzin, V.A. (1978) Hymenoptera II. Chalcidoidea 7. Encyrtidae. pp. 236–328 *in* Medvedev, G.S. (*Ed.*) *Opredeliteli Nasekomykh Evropeyskoy Chasti SSR, Vol. 3*. Leningrad, Nauka.

Trjapitzin, V.A. (1989) *Parasitic Hymenoptera of the Fam. Encyrtidae of Palaearctics*. 489 pp. Leningrad, Zoologicheski Institut Akademii Nauk SSR.

Tudor, C. (1982) Species of chalcidoid parasites of some injurious coccids. *Studii si Cercetari de Biologie* (*Seria Biologie Animala*) **34** (2), 87–91.

Yasnosh, V., Chkhaidze, L. & Tabatadze, E. (1996) Ecologisation of citrus protection. *Journal of Plant Protection and Quarantine, Moscow*, **8**, 12–14 (in Russian).

https://doi.org/10.1017/S0007485307005378 Published online by Cambridge University Press