

**ARMORED SCALE INSECTS (DIASPIDIDAE), PESTS OF FRUIT ORCHARDS
AND THEIR CONTROL IN THE REPUBLIC OF GEORGIA**

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ABSTRACT

Several species of armored scale insects (Coccoidea: Diaspididae) are important pests of fruit trees in the Republic of Georgia, namely *Quadraspidiotus perniciosus* (Comstock), *Parlatoria oleae* (Colvee), *Lepidosaphes ulmi* (L.), *Epidiaspis leperii* (Signoret) and *Q. ostraeformis* (Curtis). The first species develops two annual generations in Georgia, the second, two to three, whereas the remaining species are univoltine. Populations of these pests are regulated considerably by the predators *Chilocorus bipustulatus* (L.) and *Ch. renipustulatus* (Scriba) and by the parasites *Encarsia pemiciosi* (Tower), *Aphytisproclia* (Walker), *A. maculiconiis* (Masi) and *A. mytilaspidis* (Le Baron). Chemical control of the pests is carried out by application of DNOC or mineral oils, which are effective against the overwintering stages, and by organophosphorous or pyrethroid preparations against the hatching crawlers.

KEY WORDS: Coccoidea, Diaspididae, scale insects, natural enemies, life history, pesticides.

Climatic and soil conditions in the Republic of Georgia are most favorable for the cultivation of fruit trees, which thus constitute an economically important crop in the agriculture of this country.

Among numerous pests of fruit trees the armoured scale insects (Homoptera: Diaspididae) are significant pests. The damage caused by them has recently increased due to the extensive use of nonselective pesticides. The most damaging species are: *Quadraspidiotus perniciosus* (Comstock), *Q. ostraeformis* (Curtis), *Q. pyri* (Lichtenstein), *Parlatoria oleae* (Colvee), *Lepidosaphes ulmi* (L.) and *Epidiaspis leperii* (Signoret). In this report attention is paid to three species.

Parlatoria oleae is widespread in Georgia, particularly in its eastern part. It damages the trunk, main branches and twigs as well as fruits. It overwinters mainly as adults and partly as second-instar larva. When the temperature reaches 10°C in spring, the scale resumes its development. The scales may survive under low temperatures. In the second half of April they begin to oviposit; up to 50 eggs/female. The highest number of eggs is oviposited by females that develop on plums. In Tbilisi, *P. oleae* has two generations; the third is facultative. In Georgia the scale aestivates at temperatures higher than 34°C (Konstantinova and Kozarzhevskaya, 1990).

Lepidosaphes ulmi is particularly harmful in the eastern regions of Georgia, the site of vast areas of fruit orchards. It overwinters in the egg stage under the scale cover of dead females. Hatching begins at the end of May. The nymphs mature by July–August and oviposition begins in August–September. Females lay 30–40 eggs; the greatest number of eggs are oviposited by females developing on apple. It develops one generation per year (Batiashvili, 1960).

Quadraspidiotus perniciosus was first introduced into Georgia in 1929. Recently it has spread and has become one of the main pests of fruit crops in Georgia. It damages almost all species of fruit crops, but prefers apple trees. Among the different apple varieties, the comparatively resistant ones to the pest are “Kechura” and “Georgian sinap,” and the more susceptible — “Shampan renet” and “Kirimula” (Enukidze et al., 1983). It overwinters mainly in the stage of first-instar and second-instar larvae and sexually mature females, which die at -6°C during the winter. First-instar larvae are more resistant to low temperatures and die only at -30°C after a 2-hour exposure. In East Georgia hibernation is terminated in the second half of April, and in the western regions at the end of March. Overwintering larvae mature within 2 months. Depending on climatic conditions, the scale develops 2 annual generations. The number of hatching larvae/female is about 100. Plant damage is 38% on unsprayed trees and 6% on sprayed ones; the threshold of economic damage is 2–3 scale insects per cm^2 of trunk (Enukidze et al., 1983).

Scale populations are limited by climatic factors, such as: temperature fluctuations in winter and spring, protracted dryness in summer, heavy rains and wind in the period of mass crawler hatch (Rubtsov, 1954).

Natural enemies

The following natural enemies were recorded in Georgia: *Chilocorus bipustulatus* (L.), *Ch. renipustulatus* (Scriba), *Exochomus quadripustulatus* (L.), *Encarsia* (= *Prospaltella*) *perniciosi* (Tower), *Aphytis proclia* (Walker) and *A. maculicornis* (Masi). Some data on the bioecology of several of these species are given below.

Coccinellidae are the main regulating factor of scale insect populations. All these predators occur together and have a similar mode of life. However, the similarity in food composition does not exclude their different reaction towards the environment.

E. quadripustulatus is widespread in East Georgia and *Ch. renipustulatus* in West Georgia; *Ch. bipustulatus* is widespread in both East and West Georgia. The beetles overwinter in the trees, in branch crotches and under fallen leaves, in the places where they feed. The coming out of overwintering begins at an average temperature of 9°C in March, and mass oviposition, in the first 10 days of April (Aleksidze, 1980). Eggs are deposited in groups in bark cracks and other covered places. Fecundity is 100–130 eggs/female. The developmental duration of the first generation is about 2 months.

The *Chilocorus* species have 2–3 generations per year: the 1st in April–May and the 2nd in June–July. The adults of the third generation, which overwinters, appear at the end of August. One adult coccinellid consumes 300–500 larvae and adult scale insects in a month. Larvae devour nearly 300 scale insects during their developmental period (Batiashvili, 1960).

The effectiveness of *Chilocorus* spp. depends directly on the scale population density. At high pest density, predators develop intensively, and thus their beneficial role increases. On the other hand, at low density scale parasites are more effective.

In Georgia the coccinellid number is regulated by the parasites *Tetrastichus coccinella* (Kurdjumov) and *Homalotylus flaminus* (Dalman). Infestation by *Perilitus terminalis* (N.) often reaches 70–80%.

In the subtropical regions of Georgia a method was developed for *Chilocorus* spp. mass rearing and release in the field (Telenga, 1955). However, this method was neither profitable, nor efficient. It is of great interest to enhance the useful role of predators by improvement of overwintering conditions and control of their parasites.

In order to demonstrate the adverse effect of synthetic pesticides on coccinellids, the following preparations were investigated: dimethoate, formathion, azinphos-methyl, trichlorfon, fenclorophos and malathion. Results have shown that all these preparations at the concentrations recommended by the industry, cause 100% larval and imaginal mortality. Eggs are more resistant; e.g. dimethoate and fenclorophos had no ovicidal effect. Trichlorfon and phosalone showed some evident toxicity (35–47% kill). These data point out that in order to preserve populations of Coccinellidae in orchards during the period of mass larval hatching (the second half of April), it is necessary to refrain from the use of broad-spectrum pesticides.

Encarsia (= *Prospaltella*) *perniciosa*, the internal parasite of San José scale, was introduced from the USA in 1947, and from Korea and China in 1957. It acclimatized well in the Black Sea shore area. Eggs overwinter in the scale larvae. In spring the hatching larvae feed on the body of the scale insects and pupate there. The adult female is parthenogenetic and lays its eggs in the body of the different instars of the host, except for crawlers. Fecundity is 30–50 eggs/female. The duration of development is 35–40 days. There are up to 6 generations per year. It is a frost-resistant species (Rubtsov, 1954). Parasitism often reaches 95% (Konstantinova and Kozarzhevskaya, 1990). In the Northern Caucasus a method for mass rearing and release of this species in the orchards for the control of San José scale was developed.

Aphytis proclia, an external parasite of various scale species, is widely distributed. Larvae overwinter under the dead scale insects. Adult parasites emerge in the period of the appearance of the San José female scales. The females deposit eggs on the scale body, through the scale covering. Development of one generation lasts 30–40 days. Female fecundity is 40–45 eggs (Rubtsov, 1954).

Aphytis maculicornis parasitizes females of *P. oleae*. The parasite overwinters, as 1st and 2nd instars, in the host females, and pupates under the scale covering. The emerging adults pierce the scale cover and after additional feeding begins to oviposit (Yasnosh and Mindiashvili, 1973). Fecundity is 20–30 eggs/female. The developmental cycle is about 30 days. Generally, one egg is laid on the scale body and sometimes 2 eggs. In East Georgia parasitism is 12–13% in spring and 40–50% in summer (Karumidze, 1971). The same author also reported that populations of *P. oleae* is greatly reduced by the mite *Hemisarcoptes* sp.

Recently, as a result of use of nonselective pesticides, the biocenological balance in orchards has been disrupted and the activity of beneficial insects often reduced to a minimum. This is why the problem of restoring of and regulation of relations between the members of the biological system “predator–prey” is of topical and practical interest. For a solution of this problem it is necessary to find the optimal relation between the members of this system, at which entomophages can reduce the scale insect numbers to the minimum without interference from toxicants (Aleksidze et al., 1983).

Finally, studies on the influence of pesticides on scale insects have shown that the more

effective preparations were DNOC (1%) and mineral oil emulsion (5%), applied at the phase of overwintering larvae, and in summer the use of phosalone, etaphos, chlorpyrifos and pirimifos-methyl (0.2%), causing 95–99% mortality of crawlers of the first generation.

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