

Parasitoids and Predators of Pseudococcidae (Hemiptera: Coccoidea) in Ankara, Turkey

M.B. Kaydan,^{*,1} N. Kilincer,² N. Uygun,³ G. Japoshvilli,⁴
and S. Gaimari⁵

Natural enemies of mealybugs were surveyed in Ankara, Turkey, during the years 2001 to 2003. Twenty-three predatory species belonging to the insect orders Coleoptera (Coccinellidae, 17), Diptera (Chamaemyiidae, 3) and Neuroptera (Chrysopidae, 2; Hemerobiidae, 1); and 22 parasitoid species belonging to Hymenoptera (Aphelinidae, 2; Encyrtidae, 14; Platygasteridae, 1; Pteromalidae, 3; Signiphoridae, 2) were determined. The following ten species are newly recorded for the Turkish fauna: *Sidis biguttatus* Motchulsky, *Nephus sinuatomaculatus* Sahlberg (Coccinellidae), *Leucopomyia alticeps* Czerny, *Parochthiphila (Euestelia) decipia* Tanasijtshuk (Chamaemyiidae), *Leptomastidea matritensis* Mercet, *Prochiloneurus bolivari* Mercet, *Rhopus* sp.nr. *acaetes* (Walker), *Stematosteres* sp., *Eunotus acutus* Kurdjumov, and *Chartocerus kurdjumovi* (Nikol'skaya) (Chalcidoidea).

KEY WORDS: Mealybugs; Pseudococcidae; predators; parasitoids; Ankara; Turkey.

INTRODUCTION

Many scale insects (Hemiptera: Sternorrhyncha: Coccoidea) are notorious pests especially on perennial plants, fruit and nut trees, ornamental shade trees and shrubs, forest trees, and in greenhouse and indoor plantings. In urban environments they often build very high populations on trees (9). Mealybugs (Pseudococcidae), the second largest family in the Coccoidea (2), are usually thinly or thickly covered with a mealy or cottony wax secretion. Their main damage is caused by feeding on plant sap, including reduced vigor, chlorotic areas at feeding locations, premature leaf drop, and distortion of the stems and bark. While many scale insect species are not economically important under natural conditions in forests, they may become major pests in urban areas on ornamental and cultivated plants and forest trees because of increased air pollution and environmental stress. On the other hand, the population densities of their natural enemies are reduced by poorly regulated pesticide use, further contributing to increased scale insect population density. Generally, natural enemies provide regulatory effects by directly killing their host/prey, thereby reducing their reproductive potential or by making them susceptible to death from other causes (23). For these reasons one potentially useful method to control

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¹Plant Protection Dept., Agriculture Faculty, Yüzüncü Yıl University, 65080 Kampüs, Van, Turkey. *Corresponding author [e-mail: borakaydan@yyu.edu.tr].

²Plant Protection Dept., Agriculture Faculty, Ankara University, 06610 Dışkapı, Ankara, Turkey [e-mail: kilincer@agri.ankara.edu.tr].

³Plant Protection Dept., Agriculture Faculty, Çukurova University, Balcalı, Adana, Turkey.

⁴Inst. of Zoology, Georgian Academy of Sciences, Tbilisi, Georgia.

⁵California State Collection of Arthropods, California Dept. of Food & Agriculture, Plant Pest Diagnostics Branch, Sacramento, CA 95832-1448, USA [e-mail: sgaimari@cdfa.ca.gov].

harmful scales is to use natural enemies. For successful biological control, both pest species and natural enemies, and the relationship between them, should be well known. Parasitoids and predators of coccoids on plants in nature can serve as alternative hosts to the harmful species on cultivated plants. Determining the fauna on the natural flora will help us to understand the relationship between scale insect pests and their natural enemies. In the research for this paper, natural enemies of mealybugs on ornamental and naturally occurring plants in Ankara province, Turkey, were investigated.

MATERIALS AND METHODS

Surveys were carried out in Ankara in Middle Anatolia, Turkey, between 2001 and 2003. Sampling was carried out twice a week during spring and summer. Mealybug specimens were taken from ornamental, cultivated, greenhouse and indoor plants and from plants in nature. Infested plant parts were inspected visually for adult predators and if present they were collected by sucking tube (aspirator), and by shaking the infested branch onto a stainer funnel. Immature stages of the predators were brought to the laboratory with mealybugs on infested plant parts and were placed in plastic jars to complete their development. To obtain parasitoids, infested plant parts were placed in plastic bags and adult emergence was monitored. The emerging adult parasitoids were transferred into vials of 70% ethyl alcohol.

Preparation of mealybug specimens for identification entailed using the methodology of Kosztarab and Kozár (10), and identifications were made using the keys and plates of Danzig (4), Kosztarab and Kozár (10), Tereznikova (16), Ter-Grigorian (17) and Williams (24). Specimens of the predators and parasitoids were deposited in the Plant Protection Department of the Agriculture Faculty, Yüzüncü Yıl University, Van, Turkey; the Plant Protection Department of the Agriculture Faculty, Çukurova University, Adana, Turkey; the California State Collection of Arthropods, Plant Pest Diagnostics Branch, California Department of Food and Agriculture, Sacramento, CA, USA; and the Institute of Zoology, Georgian Academy of Sciences, Tbilisi, Georgia.

RESULTS AND DISCUSSION

In this study 23 predatory species belonging to Coccinellidae (17), Chrysopidae (2), Hemerobiidae (1) and Chamaemyiidae (3), and 22 parasitoid species (3 of which are hyperparasitoids) belonging to Aphelinidae (2), Encyrtidae (14), Playgasteridae (1), Pteromalidae (3) and Signiphoridae (2) were determined on 22 mealybug species.

TABLE 1. Predators associated with species of Pseudococcidae on various host plants in Ankara, Turkey

Predator	Host mealybug	Host plant
ORDER: COLEOPTERA		
Family: Coccinellidae		
<i>Adalia bipunctata</i> L.	<i>Phenacoccus aceris</i>	<i>Fraxinus excelsior</i> ; <i>Acer negundo</i> , <i>Acer pseudoplatanus</i>
<i>Adalia fasciatapunctata revelierei</i> (Mulsant)	<i>Phenacoccus aceris</i>	<i>Fraxinus excelsior</i>
<i>Chilocorus bipustulatus</i> L.	<i>Phenacoccus aceris</i>	<i>Fraxinus excelsior</i> ; <i>Acer negundo</i> , <i>Acer pseudoplatanus</i>
<i>Exochomus nigromaculatus</i> (Goeze)	<i>Planococcus vovae</i> <i>Puto pilosellae</i>	<i>Juniperus</i> sp. <i>Sanguisorba minor</i>

TABLE 1. con't.

Predator	Host mealybug	Host plant
<i>Exochomus quadripustulatus</i> (L.)	<i>Phenacoccus aceris</i>	<i>Acer negundo</i> , <i>Acer pseudoplatanus</i> , <i>Fraxinus excelsior</i>
<i>Hyperaspis quadrimaculatus</i> Redtenbacher	<i>Planococcus vovae</i>	<i>Juniperus</i> sp.
<i>Hyperaspis syriaca</i> Weise	<i>Phenacoccus pumilus</i>	<i>Eryngium campestre</i> , Undetermined plant
<i>Nephus kreissli</i> Fürsch & Uygun	<i>Phenacoccus pumilus</i>	Undetermined plant
	<i>Mirococcus inermis</i>	<i>Chenopodium</i> sp., <i>Chenopodium album</i>
	<i>Peliococcus turanicus</i>	<i>Cardaria draba</i> , <i>Descuvaria saptia</i>
	<i>Phenacoccus pumilus</i>	Compositae, <i>Descuvaria saptia</i>
	<i>Trionymus multivorus</i>	<i>Plomis</i> sp.
<i>Nephus nigricans</i> Weise	<i>Peliococcus turanicus</i>	<i>Diplotaxis tenuifolia</i>
	<i>Peliococcopsis caucasicus</i>	<i>Cynodon dactylon</i>
	<i>Phenacoccus bicerarius</i>	<i>Cynodon dactylon</i>
	<i>Phenacoccus ferulae</i>	<i>Cynodon dactylon</i>
	<i>Phenacoccus pumilus</i>	<i>Melilotus alba</i> , <i>Eryngium campestre</i> , <i>Matthiola longipetale</i>
	<i>Planococcus vovae</i>	<i>Juniperus</i> sp.
	<i>Puto pilosellae</i>	<i>Sanguisorba minor</i>
	<i>Trionymus aberrans</i>	<i>Triticum vulgare</i> , <i>Lolium perenne</i> , <i>Festuca</i> sp.
	<i>Trionymus multivorus</i>	<i>Erodium</i> sp., <i>Salvia</i> sp. <i>Sideritis</i> sp., <i>Glaucium</i> sp., <i>Stachys</i> sp.
	<i>Pseudo larvae</i>	<i>Polygonum</i> sp.
<i>Nephus sinuatomaculatus</i> Sahlberg	<i>Puto pilosellae</i>	<i>Sanguisorba minor</i>
<i>Nephus</i> sp. (Female)	<i>Phenacoccus pumilus</i>	<i>Descuvaria saptia</i>
	<i>Peliococcus turanicus</i>	<i>Descuvaria saptia</i>
<i>Platynaspis luteorubro</i> (Goeze)	<i>Phenacoccus pumilus</i>	<i>Eryngium campestre</i> , Undetermined plant
<i>Scymnus levaillantii</i> Mulsant	<i>Phenacoccus avenae</i>	<i>Cardus pycnophelus</i>
	<i>Heliococcus saxatilis</i>	<i>Cardus pycnophelus</i>
	<i>Heliococcus raditicola</i>	<i>Cardus pycnophelus</i>
	<i>Trionymus multivorus</i>	<i>Cardus pycnophelus</i>
<i>Scymnus quadriguttatus</i> Fürsch	<i>Trionymus multivorus</i>	<i>Salvia</i> sp.
<i>Scymnus rubromaculatus</i> (Goeze)	<i>Phenacoccus pumilus</i>	<i>Sinapis arvensis</i>
<i>Scymnus (Pullus) mediterraneus</i> (Khnzorian)	<i>Mirococcus inermis</i>	<i>Chenopodium album</i>
<i>Sidus biguttatus</i> Motschulsky	<i>Trionymus aberrans</i>	<i>Lolium perenne</i>
	<i>Phenacoccus pumilus</i>	<i>Sisymbrium</i> sp.
ORDER: DIPTERA		
Family: Chamaemyiidae		
<i>Parochthiphila (Euestelia) decipia</i> Tanasijtshuk	<i>Trionymus aberrans</i>	<i>Agropyron cristatum</i>
<i>Leucopomyia alticeps</i> Czerny	<i>Phenacoccus aceris</i>	<i>Acer negundo</i> , <i>Fraxinus excelsior</i>
	<i>Planococcus ficus</i>	<i>Vitis vinifera</i>
	<i>Planococcus vovae</i>	<i>Juniperus</i> sp., <i>Taxus</i> sp.
<i>Leucopomyia silesiaca</i> Egger	<i>Phenacoccus aceris</i>	<i>Acer negundo</i> , <i>Fraxinus excelsior</i>
ORDER: NEUROPTERA		
Family: Chrysopidae		
<i>Chrysoperla carnea</i> (Stephens)	<i>Planococcus vovae</i>	<i>Juniperus</i> spp., <i>Taxus</i> sp.
<i>Dichochrysa prasina</i> Burmeister	<i>Puto tauricus</i>	<i>Digitalis</i> sp.
	<i>Atrococcus parvulus</i>	<i>Digitalis</i> sp.
Family: Hemerobiidae		
<i>Symphorobius pygmaeus</i> (Rambur)	<i>Phenacoccus aceris</i>	<i>Acer negundo</i> , <i>Acer pseudoplatanus</i> , <i>Fraxinus excelsior</i>
	<i>Planococcus vovae</i>	<i>Juniperus</i> spp.
	<i>Planococcus ficus</i>	<i>Vitis vinifera</i>

TABLE 2. Parasitoids associated with species of Pseudococcidae on various host plants in Ankara, Turkey

Parasitoid	Host mealybug	Host plant
ORDER: HYMENOPTERA		
Family: Aphelinidae		
<i>Coccophagus</i> sp.	<i>Planococcus vovae</i>	<i>Juniperus</i> sp.
<i>Marietta picta</i> (André)	<i>Peliococcopsis caucasicus</i>	<i>Cynodon dactylon</i>
	<i>Planococcus vovae</i>	<i>Juniperus</i> spp.
	<i>Puto pilosellae</i>	<i>Sanguisorba minor</i>
Family: Encyrtidae		
<i>Anagyrus aligarhensis</i> Agarwal and Alam	<i>Phenacoccus pumilus</i>	<i>Eryngium campestre</i>
<i>Anagyrus pseudococci</i> (Girault)	<i>Planococcus citri</i>	<i>Nerium oleander</i>
	<i>Planococcus ficus</i>	<i>Vitis vinifera</i>
	<i>Planococcus vovae</i>	<i>Juniperus</i> sp.
<i>Anagyrus schoenherri</i> Westwood	<i>Phenacoccus aceris</i>	<i>Acer negundo</i> , <i>Acer pseudoplatanus</i> , <i>Aesculus hippocastanum</i> , <i>Cydonia oblonga</i> , <i>Ficus carica</i> , <i>Fraxinus excelsior</i> , <i>Juglans regia</i> , <i>Morus alba</i> , <i>Platanus orientalis</i> , <i>Prunus</i> sp., <i>Prunus domestica</i>
<i>Cheiloneurus</i> sp.	<i>Peliococcopsis caucasicus</i>	<i>Cynodon dactylon</i>
	<i>Phenacoccus bicerarius</i>	<i>Cynodon dactylon</i>
<i>Coccidoxenoides perminutus</i> Girault	<i>Planococcus vovae</i>	<i>Juniperus</i> spp., <i>Thuja</i> sp.
<i>Ericydnus robustior</i> Mercet	<i>Mirococcus inermis</i>	<i>Chenopodium</i> sp.
	<i>Peliococcopsis caucasicus</i>	<i>Cynodon dactylon</i>
<i>Leptomastidea matritensis</i> Mercet	<i>Planococcus ficus</i>	<i>Kalanchoe blossfeldia</i>
	<i>Planococcus vovae</i>	<i>Juniperus</i> spp., <i>Thuja</i> sp.
<i>Leptomastix flava</i> Mercet	<i>Phenacoccus pumilus</i>	<i>Eryngium campestre</i>
	<i>Trionymus multivorus</i>	Undetermined plant, <i>Verbascum</i> sp.
<i>Mayridia formosula</i> Mercet	<i>Trionymus aberrans</i>	<i>Lolium perenne</i> , <i>Triticum</i> sp.
<i>Mayridia pulchra</i> Mercet	<i>Phenacoccus bicerarius</i>	<i>Cynodon dactylon</i>
<i>Prochiloneurus bolivari</i> Mercet	<i>Trionymus multivorus</i>	<i>Verbascum</i> sp.
	<i>Atrococcus larvae</i>	<i>Verbascum</i> sp.
<i>Rhopus</i> sp. nr. <i>acaetes</i> (Walker)	<i>Peliococcopsis caucasicus</i>	<i>Cynodon dactylon</i>
<i>Stematosteres</i> sp.	<i>Atrococcus achilleae</i>	Labiatae
<i>Tetracnemoidea</i> sp.	<i>Peliococcopsis caucasicus</i>	<i>Cynodon dactylon</i>
	<i>Phenacoccus bicerarius</i>	<i>Cynodon dactylon</i>
	<i>Phenacoccus ferulae</i>	<i>Cynodon dactylon</i>
Family: Pteromalidae		
<i>Eunotus</i> sp.	<i>Phenacoccus avenae</i>	<i>Hordeum</i> sp.
<i>Eunotus acutus</i> Kurdjumov	<i>Peliococcus turanicus</i>	Gramineae
<i>Pachyneuron concolor</i> Förster	<i>Phenacoccus aceris</i>	<i>Acer negundo</i> , <i>Aesculus hippocastanum</i> , <i>Fraxinus excelsior</i> , <i>Morus alba</i>
Family: Signiphoridae		
<i>Chartocerus kurdjumovi</i> (Nikol'skaya) (Hyperparasitoid)	<i>Heterococcus tritici</i>	<i>Cynodon dactylon</i>
	<i>Peliococcopsis caucasicus</i>	<i>Cynodon dactylon</i>

TABLE 2. con't.

Parasitoid	Host mealybug	Host plant
<i>Chartocerus subaeneus</i> (Förster) (Hyperparasitoid)	<i>Trionymus aberrans</i>	<i>Festuca</i> sp.
	<i>Heterococcus tritici</i>	<i>Cynodon dactylon</i>
Family: Platygasteridae	<i>Planococcus vovae</i>	<i>Juniperus</i> spp., <i>Thuja</i> sp.
	<i>Trionymus aberrans</i>	<i>Festuca</i> sp.
<i>Allotropa mecrida</i> (Walker)	<i>Phenacoccus aceris</i>	<i>Acer pseudoplatanus</i> , <i>Fraxinus excelsior</i>

Species of Neuroptera (Table 1) are well known as predators, and some species have been used as biological control agents in IPM programs, with the most important families being Chrysopidae and Hemerobiidae, attacking many agricultural and ornamental pests including scale insects, aphids and whiteflies (5). In this study, three Neuroptera species (*Chrysoperla carnea* (Stephens), *Dichochrysa prasina* Burmeister (Chrysopidae) and *Sympherobius pygmaeus* (Rambur) (Hemerobiidae)) were recorded, with the most common being *S. pygmaeus*. Larvae of this species were observed in colonies of hibernating *Phenacoccus aceris* Signoret immatures, feeding on them during suitable weather conditions. On the other hand, during summer, they were also found on *Planococcus vovae* (Nasonov) and *Planococcus ficus* Signoret at different locations in Ankara, and they are reported to attack *Planococcus citri* (Risso) in Antalya, Turkey (19). Another species of *Sympherobius*, *S. fallax* Navas, was recorded attacking *P. citri* in citrus orchards at Adana, Antalya and Içel, Turkey (8,19). It was also recorded as a predator of *Parthenolecanium corni* (Bouché) (10).

Coccinellidae (Coleoptera) (Table 1) are the most important predatory group in biological control of pests in general, and this common, worldwide family specializes in feeding upon scale insects, mealybugs, aphids and whiteflies (5). In this study, coccinellids were the most common group encountered, with 17 species as natural enemies of mealybugs. *Adalia bipunctata* (L.), *A. fasciata punctata revelierei* (Mulsant), *Chilocorus bipustulatus* (L.) and *Exochomus quadripustulatus* L. were commonly found on *P. aceris* and *P. vovae* which were feeding on branches of ornamental plants. These species have been reported to attack various other scale species in different parts of Turkey (1,11,12,21). In the current study, they were typically observed feeding on immature stages of the mealybugs, especially on eggs within an ovisac. Other species in the genera *Nephus*, *Hyperaspis*, *Platynaspis*, *Scymnus* and *Sidis* were usually collected from colonies of mealybugs on plants (some being on roots or in the leaf sheaths) in nature rather than cultivated. Most of these species were in their immature stages when they were collected, and were reared in the laboratory to obtain adults. The coccinellid species *Nephus sinuatomaculatus* Sahlberg and *Sidis biguttatus* Motschulsky are newly recorded for the Turkish fauna. Other species were recorded by several authors in different habitats (mostly citrus orchards) in different locations in Turkey (7,8,12,18,21,22). Among the coccinellid species, *E. quadripustulatus* was observed to be the most abundant attacking mealybugs on ornamental plants, while the other common species, *Nephus nigricans* Weise, was observed mostly on mealybugs feeding on plants in nature.

Chamaemyiidae (Diptera) (Table 1) are a cosmopolitan family of predators, particularly of aphids, adelgids, felt scales, mealybugs and soft scale insects (3,10,13-15). In the

present study three species were collected, two of which (*Leucopomyia alticeps* Czerny and *Parochtiophila (Euestelia) decipia* Tanasijtshuk) are new records for Turkish fauna. *Leucopomyia alticeps* and *L. silesiaca* Egger are each known from more than 20 coccoid hosts, feeding on eggs within ovisacs of their prey (3,10,13-15). Both species are quite widespread throughout the Palaearctic region. Ülgentürk (20) reported that larvae of *L. silesiaca* have been found feeding within ovisacs of *Filippia follicularis* Targioni Tozzetti in Ankara, usually with only one larva per ovisac. In the present study the *Leucopomyia* species were reared from ovisacs of different mealybug species. On the other hand, *P. decipia* was collected inside leaf sheaths of *Agropyron cristatum* infested with a species of *Trionymus*, a mealybug genus previously reported as prey for this species by Tanasijtshuk (15).

Chalcidoidea (Hymenoptera) (Table 2) are one of the most important groups of parasitic wasps, with rather high biodiversity and with many economically important species. Aphelinidae and Encyrtidae are the most successful groups of insects to have been used in biological control of pest scales (6). Species of Encyrtidae are especially important natural enemies of mealybugs as primary parasitoids. In this study 21 chalcidoid species (2 Aphelinidae, 14 Encyrtidae, 3 Pteromalidae, 2 Signiphoridae), and one platygasterid species totalling 22 species were determined, of which six are newly recorded for the Turkish fauna. Among these, *Anagyrus schoenherri* Westwood and *Allotropa mecirida* (Walker) were observed to be the most abundant species attacking *P. aceris*, while *Leptomastidea matritensis* Mercet and *Coccidoxenoides perminutus* Girault were the most common species attacking *P. vovae*. Both of these mealybug species are very common on ornamental plants.

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