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Phenacoccus madeirensis Green (Hemiptera: Pseudococcidae), a recently introduced exotic pest in Japan

Abstract - Previous reports of the Mexican mealybug, *Phenacoccus gossypii* Townsend & Cockerell in Japan were confirmed to be misidentifications of the Madeira mealybug, *Phenacoccus madeirensis* Green. The Madeira mealybug is reported from the Bonin Islands, Kyushu, Shikoku, and the Ryukyu Islands where it is widespread. Distribution of the Madeira mealybug and 25 host records in Japan are given.

Key words: Madeira mealybug, *Phenacoccus gossypi. Phenacoccus madeirensis.*

INTRODUCTION

The Madeira mealybug, *Phenacoccus madeirensis* Green has been often misidentified for the Mexican mealybug, *P. gossypii* Townsend & Cockerell. These misidentifications have resulted from the use of descriptions and illustrations by Ferris (1950) and McKenzie (1967), a problem discussed by Williams (1987) and Williams & Granara de Willink (1992). Previous reports of the Mexican mealybug in Japan (Kawai 1990, Kinjo et al. 1996) are confirmed to be misidentifications of the Madeira mealybug. The mealybug has become an important insect pest in Japan attacking various plants of economic importance.

MATERIALS AND METHODS

Mealybugs were collected in the field or from plastic houses by the authors and various persons (see acknowledgements). All scale insects were slide mounted and studied under a compound microscope for identification. The mealybugs were all slide mounted according to the procedure discussed by Kawai (1980). The mealybugs were identified by using the keys of Williams (1987) and/or Williams & Granara de Willink (1992). Insects that were previously identified as *Phenacoccus gossypii* were also re-examined.

RESULTS

The Madeira mealybug is found in the Ogasawara (Bonin) Islands, Kagoshima Prefecture (Kyushu), Kochi Prefecture (Shikoku) and in the islands of Aka, Iriomote, Ishigaki, Izena, Kume, Minna, Miyako, Okinawa and Tonaki of the Ryukyu Islands. The Madeira mealybug can cause malformation of leaves, growth stunt and damage by sooty moulds that grow on their honeydew. The Madeira mealybug is commonly collected on *Bidens pilosa* L. along road sides in the Ryukyu Islands. Other common hosts include species of Red Pepper, *Lantana* and *Hibiscus*. The Madeira mealybug also attacks fruit crops such as Mango, Soursop, and Passion fruit. Other plants of economic importance such as Soybeans, Mung beans, Myoga Ginger, Jute, and Sweet Basil are also fed upon. The hosts of the Madeira mealybug in Japan includes 25 species of plants in 15 families. These are: Anacardiaceae, Asteraceae, Brassicaceae, Euphorbiaceae, Fabaceae, Geraniaceae, Lamiaceae, Malvaceae, Menispermaceae, Passifloraceae, Ranunculaceae, Solanaceae, Tiliaceae, Verbenaceae and Zingiberaceae (Table 1.).

Table 1 - Distribution and host records of the Madeira mealybug in Japan.

Locality	**Host**	**Family**	**Date**
Kyushu, Kagoshima	*Lantana camara* L.	Verbenaceae	10/16/1997
Ryukyus, Okinawa Isl., Chinen	*Capsicum annuum* L.	Solanaceae	07/30/1993
Ryukyus, Okinawa Isl., Gushityan	*Capsicum frutescens* L.	Solanaceae	03/08/2001
Ryukyus, Okinawa Isl., Chinen	*Clematis tashiroi* Maxim.	Ranunculaceae	07/30/1993
Ryukyus, Okinawa Isl., Chinen	*Cyclea insularis* (Makino) Hatsushima	Menispermaceae	07/30/1993
Ryukyus, Okinawa Isl., Chinen	*Bidens* sp. (*biternata* or *pilosa*)	Asteraceae	07/30/1993
Ryukyus, Okinawa Isl., Chinen	*Bidens pilosa* var. *radiata* Sch. Bip.	Asteraceae	07/30/1993
Ryukyus, Okinawa Isl., Chinen	?		07/30/1993
Ryukyus, Okinawa Isl., Kitanakagusuku	*Salvia splendens* Sellow ex Roem. & Schult.	Lamiaceae	07/15/1993
Ryukyus, Okinawa Isl., Naha	*Bidens* sp. (*biternata* or *pilosa*)	Asteraceae	07/30/1993
Ryukyus, Okinawa Isl., Naha	*Lantana camara* L.	Verbenaceae	07/30/1993
Ryukyus, Okinawa Isl., Naha	*Bidens* sp. (*biternata* or *pilosa*)	Asteraceae	07/30/1993
Ryukyus, Okinawa Isl., Nago	*Acalypha wilkesiana* Müll. Arg. cv. Willincki	Euphorbiaceae	11/26/1993
Ryukyus, Okinawa Isl., Nago	*Hibiscus rosa-sinensis* L.	Malvaceae	11/25/1993
Ryukyus, Okinawa Isl., Nago	*Mangifera indica* L.	Anacardiaceae	11/26/1993
Ryukyus, Okinawa Isl., Nishihara	*Bidens pilosa* var. *minor* (Blume) Sherff	Asteraceae	06/23/1997
Ryukyus, Okinawa Isl., Ogimi	*Hibiscus rosa-sinensis* L.	Malvaceae	08/28/1996
Ryukyus, Okinawa Isl., Okinawa	*Hibiscus rosa-sinensis* L.	Malvaceae	06/20/1997
Ryukyus, Okinawa Isl., Tomigusuku	*Capsicum annuum* var. *grossum* (L.) Sendtn.	Solanaceae	07/20/2000

(Table 1. continued)

Locality	Host	Family	Date
Ryukyus, Okinawa Isl., Tomigusuku	*Ocimum basilicum* L.	Lamiaceae	
Ryukyus, Okinawa Isl., Yomitan	*Mangifera indica* L.	Anacardiaceae	04/17/1996
Ryukyus, Aka Isl.	*Hibiscus rosa-sinensis* L.	Malvaceae	08/09/1999
Ryukyus, Iriomote Isl.	*Bidens pilosa* L.	Asteraceae	10/04/1999
Ryukyus, Ishigaki Isl., Takeda	*Bidens* sp. (*biternata* or *pilosa*)	Asteraceae	08/01/1993
Ryukyus, Ishigaki Isl.	*Bidens pilosa* L.	Asteraceae	10/22/1999
Ryukyus, Ishigaki Isl., Takeda	?		08/01/1993
Ryukyus, Ishigaki Isl.	*Brassica oleracea* var. *capitata* L.	Brassicaeae	05/16/1997
Ryukyus, Ishigaki Isl.	*Capsicum annuum* var. *grossum* (L.) Sendtn.	Solanaceae	01/09/2001
Ryukyus, Izena Isl.	*Bidens pilosa* L.	Asteraceae	10/09/1999
Ryukyus, Kume Isl.	*Bidens pilosa* L.	Asteraceae	04/12/2000
Ryukyus, Kume Isl.	*Lantana camara* var. *aculeata* (L.) Moldenke	Verbenaceae	04/12/2000
Ryukyus, Minna Isl.	*Bidens pilosa* L.	Asteraceae	11/08/1999
Ryukyus, Miyako Isl., Gusukube	*Annona montana* Macfad.	Annonaceae	08/03/1993
Ryukyus, Miyako Isl.	*Bidens pilosa* L.	Asteraceae	09/12/1999
Ryukyus, Miyako Isl., Gusukube	*Bidens pilosa* var. *radiata* Sch.Bip.	Asteraceae	05/19/1999
Ryukyus, Miyako Isl.	*Bidens pilosa* var. *radiata* Sch. Bip.	Asteraceae	11/30/1993
Ryukyus, Miyako Isl., Gusukube	*Brassica campestris* subsp. *rapifera* Metzg.	Brassicaceae	06/11/1999
Ryukyus, Miyako Isl., Gusukube	*Corchorus olitorius* L.	Tiliaceae	07/21/1999
Ryukyus, Miyako Isl., Hirara	*Curcuma longa* L.	Zingiberaceae	08/03/1993
Ryukyus, Miyako Isl.	*Manihot esculenta* Crantz	Euphorbiaceae	06/16/1998
Ryukyus, Miyako Isl.	*Pelargonium zonale* (L.) L'Hér. ex Aiton	Geraniaceae	06/16/1997
Ryukyus, Miyako Isl., Hirara	*Phyllanthus debilis* Klein ex Willd.	Euphorbiaceae	11/30/1993
Ryukyus, Tonaki Isl.	*Bidens pilosa* L.	Asteraceae	08/17/1999
Shikoku, Kochi, Aki	*Capsicum annuum* L.	Solanaceae	04/13/2000
Shikoku, Kochi, Aki	*Solanum integrifolium* Poir.	Solanaceae	12/11/2000
Shikoku, Kochi, Aki	*Zingiber mioga* (Thunb.) Roscoe	Zingiberaceae	04/12/2000
Tokyo, Ogasawara Is., Chichi Isl.	*Glycine max* (L.) Merr.	Fabaceae	08/19/1987
Tokyo, Ogasawara Is., Chichi Isl.	*Hibiscus* sp.	Malvaceae	05/15/1990
Tokyo, Ogasawara Is., Chichi Isl.	*Hibiscus sp.* or *Malvaviscus arboreus* Cav.	Malvaceae	03/15/1995
Tokyo, Ogasawara Is., Chichi Isl.	*Passiflora edulis* Sims	Passifloraceae	08/19/1987
Tokyo, Ogasawara Is., Chichi Isl.	*Phaseolus aureus* Zuccagni	Fabaceae	08/19/1987
Tokyo, Ogasawara Is., Chichi Isl.	*Solanum nigrum* L.	Solanaceae	07/20/1990

DISCUSSION

Phenacoccus madeirensis was first reported from the Bonin islands as *P. gossypii* in 1990 Kawai 1990). It was probably about this time when the insect was introduced since the record of this species does not appear in previous scale insect studies in the islands (Beardsley 1966, Kawai 1973, 1980, Kawai *et al.*, 1971, Kuwana 1909). The distribution of the Mexican meallybug appears to be restricted to California and Mexico. The Madeira mealybug was recorded on mango seedlings in Naha, Okinawa in 1993 (Kinjo *et al.* 1996, Kondo 1996). The mealybug was probably introduced around this time since it was not recorded in previous studies (Kawai, 1980) and collecting trips of the scale insect fauna of Okinawa conducted by the first author during 1991. In the present, the Madeira mealybug is found in 9 of the Ryukyu Islands and all the main islands of Japan except for Honshu and Hokkaido.

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Pseudococcidae

Planococcus ficus (Signoret)
Planococcus citri (Risso)

The first outbreaks of grape mealybugs in Italy were reported in the 1950s (Rui, 1948; Manzoni & Carli, 1952; Gambaro, 1953). The species causing severe crop losses, considered to be *Planococcus citri* Risso, reached the economic importance of downy mildew (Manzoni & Carli, 1952). In the subsequent years the impact of grape mealybugs appeared lower until the 1970s when outbreaks were reported in Italy and other countries (Tranfaglia & Viggiani, 1978). De Lotto (1975) found that *P. ficus* was typically associated to grapevines. Tranfaglia (1976) confirmed that *P. ficus* was much more frequent than *P. citri* in southern Italian vineyards.

Observations on the life history of *P. ficus* were reported by Tranfaglia *et al.* (1980) for central and southern Italy. The life cycle and the phenology of *P. ficus* were studied in details in northern Italy to develop a sampling program predicting damage level and making decision on insecticide application (Duso, 1989). Females, and to a lesser extent nymphs, overwintered under the bark, more frequently on the cordon or in the upper trunk. During the vegetative season basal leaves and leaves opposite to the grape bunch were colonised by mealybugs more continuously than leaves located on upper parts of the shoots. Grape bunches close to the trunk and located over the cordon were more infested than those located far from the trunk or under the cordon. Overwintering females, protected under the bark, started to lay eggs in mid-April. Nymphs spread on leaves but their density was not relevant. The first generation completed development in June. Females of this generation laid eggs from late June onwards mostly remaining under the bark. Newly hatched nymphs migrated along the shoots in July and completed their cycle mostly in the bunches. In these protected sites, females laid eggs in August and nymphs were recorded on leaves from late August onwards. Additional migrating nymphs originated from the reproduction of females on the cordon or the trunk. Females of the third generation were noticed from September onwards. Population densities on leaves showed three peaks respectively in May, mid-July and early September, corresponding to 3 generations. In southern Italy, *P. ficus* can develop 4-6 generations (Tranfaglia & Viggiani, 1978; Tranfaglia *et al.*, 1980; Longo *et al.*, 1991).

Crop losses associated to *P. ficus* infestation may be important because mealybugs feed actively and excrete honeydew that promotes the growth of sooty mould (Tranfaglia & Viggiani, 1978). In addition, *P. ficus* can transmit two viruses: leaf roll and corky bark (Rosciglione & Castellano, 1985; Rosciglione & Gugerli, 1989; Tanne *et al.*, 1989).

Among factors affecting mealybug increases in the 1970s and 1980s, the nitrogen fertilization and the use of some grapevine training systems were suggested (Tranfaglia & Viggiani, 1978; Deligia *et al.*, 1980). The impact of insecticides on mealybug natural enemies was also suspected (Laccone *et al.*, 1982) but infestations were also recorded in unsprayed vineyards (Duso, 1989).

The influence of climatic conditions on grape mealybug populations is relevant. Migration phases of nymphs are affected by frequent and heavy rains (Manzoni & Carli, 1952). Heat regulation, trough irrigation, caused a reduction of *P. ficus* populations when performed continuously after blooming onwards (Duso *et al.*, 1985). In contrast, irrigation after grape ripening did not reduce the pest densities. Watering of the foliage affected the migration of juveniles into grape bunches and probably their survival and development.

In central and southern Italy natural enemies (mainly Coccinellidae, Chamaemyiidae and Encyrtidae) were not able to prevent *P. ficus* outbreaks (Tranfaglia & Viggiani, 1978). In northern Italy, natural enemies are sometimes effective in reducing the stock of overwintering females (Duso, 1989). Among predators recorded in northern Italy we could mention *Mallada prasinus* Burm. (Neuroptera, Chrysopidae), *Sympherobius pygmaeus* Ram. (Neuroptera, Hemerobiidae), *Leucopis alticeps* Serv. (Diptera, Chamaemyiidae) and *Scymnus* spp. (Coleoptera, Coccinellidae). The most important parasitoid was *Anagyrus pseudococci* Girault (Hymenoptera, Encyrtidae) (Duso, 1989). Numerous mealybugs were infected by pathogens, mainly belonging to Entomophtorales.

In Israel, the release of two hymenoptera, i.e. *Coccidoxenoides peregrinus* (Timberlake) (= *Pauridia peregrina*) and *Leptomastix dactylopii* (Howard) provided successful results in controlling *P. ficus* (Gol'berg *et al.*, 1981). Results obtained by Tranfaglia & Viggiani (1978) contrast with these findings since *L. dactylopii* did not respond to *P. ficus* populations.

Chemical control is often necessary to reduce the impact of grape mealybugs. Dormant insecticide applications, e.g. mineral oils, were not effective. In-season insecticides should be applied when nymphs are spreading on the vegetation and penetrating in the grape bunches (Tranfaglia & Viggiani, 1978; Laccone *et al.*, 1982). Empirical economic thresholds ranging from 1-5 % of infested bunches have been proposed (Tranfaglia & Viggiani, 1978). In northern Italy a single insecticide application in mid-July can control GBMs and mealybugs (Girolami *et al.*, 1989). Moderate use of insecticides can allow for an effective response to infestations by natural enemies. In a Sardinian vineyard, *P. ficus* populations were controlled by the coccinellid *Cryptolaemus montrouzieri* (Muls.), which had been previously released in contiguous citrus orchards (Deligia *et al.*, 1980).

Heliococcus bohemicus Sulč

This species has been recently recorded in Italy in vineyards of the Veneto region (Marotta & Tranfaglia, 1990). It is also present in Piedmont, Lombardy, Emilia-Romagna and Tuscany. Its main host plants are grapevine, plane tree, poplar, oak, and black locust (Kosztarab & Kozár, 1988).

In the Veneto region *H. bohemicus* develops 2 generations per year. Nymphs overwinter under the bark. Males occur from the late March to mid April, females from April to June. Oviposition starts in late May and lasts till June. Females lay eggs under their bodies and the crawlers migrate to the vegetation preferring leaf

INTRODUCTION

Vine cultivation is one of the important branches of Georgian Agriculture. Commercial vine-growing territories are located predominantly in the regions of Eastern Georgia with dry climate with comparatively humid regions of the Black Sea coast.

Several scale insects are constantly distributed in the vineyards (Hadzibeyli, 1960; 1983). Among them the cottony maple scale *Neopulvinaria innumerabilis* (Rathvon) (Coccidae) and the vine mealybug *Planococcus ficus* (Signoret) (Pseudococcidae) are serious pests in the dry eastern regions. In the humid regions the mealybug *Pseudococcus viburni* (Signoret) is sometimes very noxious in the vineyards. The other coccids *Parthenolecanium corni* (Bouché), *P. persicae* (F.), *Pulvinaria betulae* L. are usually present, but at low population levels, and have no economic importance. In this paper, present information on economic importance, natural enemies and their role in the number regulation of pests are given.

MATERIALS AND METHODS

Observation and collection of the material were carried out in Kakheti region, in Tbilisi and its surrounding areas. Scale density was studied by use of periodical calculation methods. The number of the cottony maple scale nymphs was counted on 10 leaves/plant on 10 plants/hectare (from different sides of vineyards) while the number of females was counted on 10 cm long trunk of the same plant.

The rearing of the parasitoids and collection of predators were conducted by generally accepted methods (Nikolskaya & Yasnosh, 1966; Tryapitzin *et al.*, 1982).

Ecology and efficiency of *C. montrouzieri* were studied according to the methods of Gaprindashvili (1977).

RESULTS AND CONCLUSION

Planococcus ficus (Signoret)

Planococcus ficus is widespread in Georgia, particularly in its eastern parts and damages vines, figs, platans. In Eastern Georgia the mealybug has 4 generations per year. The fourth is facultative. It overwinters as adult females and nymphs of all instars. In April the females begin to lay eggs. The last generation is the most dangerous because ripe grapes are injured.

The natural enemies complex comprises several species, which are mainly represented by the parasitoids *Anagyrus pseudococci* (Girault) (Chalcidoidea, Encyrtidae) and *Allotropa mecrida* (Walker) (Proctotrupoidea, Platygasteridae), the predaceous beetles *Nephus* spp. and larvae of *Leucopis alticeps* Czerny (Diptera). *P.*

ficus is the main host of *Anagyrus pseudococci.* In Georgia it is known also as a parasitoid of *Pseudococcus comstocki* (Kuwana) (Yasnosh,1962). Presently *A. pseudococci* is not effective enough in Georgia. *Allotropa mecrida* is an internal parasitoid of nymphs of all instars and of adult females of the Vine Mealybug. This parasitoid is often reared from mealybugs overwintering on *Platanus* trees in Tbilisi, but in the vineyards it is not present. In Georgia the parasitoid's number is regulated by the hyperparasitoids *Pachyneuron muscarum* (L.), *Chartocerus subaeneus* (Forster) (Signiphoridae) and *Marietta picta* (André) (Aphelinidae).

Neopulvinaria innumerabilis (Rathvon)

This American species was found in Georgia in 1952 and described by Hadzibeyli (1955) as *N. imeretina.* Later, *N. imeretina* was synonymized with *N. innumerabilis* (Rathvon, 1854) (Danzig & Matile-Ferrero,1990). This pest is recorded in Armenia, France and Italy (Pellizzari Scaltriti,1977). Presently *N. innumerabilis* is widespread in many eastern regions (Kacheti, Tbilisi, Mchxeta) and some western regions of Georgia. Nowadays it is a key pest of vine in Georgia, although sometimes it could be recorded on some other plants, especially apple trees.

The cottony maple scale has one generation/year. Fertilised females overwinter on the branches and trunk of the vine. After winter, the development continues in April. Each female lays from 300 to 800 eggs. Eggs hatch in June-July . The crawlers crawl over plants and settle on both sides of leaves, mainly on the upper side. The nymphs produce abundant honeydew which pollutes leaves and grapes. Saprophytic fungi will develop in this environment and will blacken green parts of plants and grapes: quality will be reduced greatly.

In 1996, the average number of ovipositing females on 10cm long trunk was 4.5 in Kakheti region. In 1999, the number of females in the same plots increased to 7-8. The number of females was lower (5-6) during the same period in Tbilisi. Oviposition is completed in Kakheti by June 10 and earlier in Tbilisi. The average number of nymphs per leaf in Kakheti is higher than in Tbilisi and varies between 33.8 and 52.2 with a maximum of 160 nymphs per leaf (Rtskhiladze, 2000). Presently the cottony maple scale has no specific natural enemies in Georgia. Three species of generic parasitoids (Chalcidoidea, Aphelinidae) were reared from cottony maple scale in Georgia. They are: *Coccophagus maculipennis* (Jasnosh), *C. palaeolecanii* (Jasnosh) and *Coccophagus lycimnia* Walker. *C. maculipennis* was detected for the first time as a parasitoid of *Neopulvinaria innumerabilis*; its natural host is *Acanthopulvinaria orientalis* (Nassonov). *C. palaeolecanii* was known as parasitoid of *Palaeolecanium bituberculatum* (Signoret) and *Lichtensia viburni* Signoret. *Coccophagus lycimnia* is a common parasitoid of many species of coccids in Georgia. The level of parasitization of all the above mentioned species varies from 4 to14.1%. The eggs of the Cottony Maple Scale are preyed upon by larvae of *Leucopis alticeps* (Czerny) (Diptera: Chamaemyiidae) and lacewings *Chrysopa* sp. (Neuroptera ,Chrysopidae). Predators are rare in the colonies of this species.

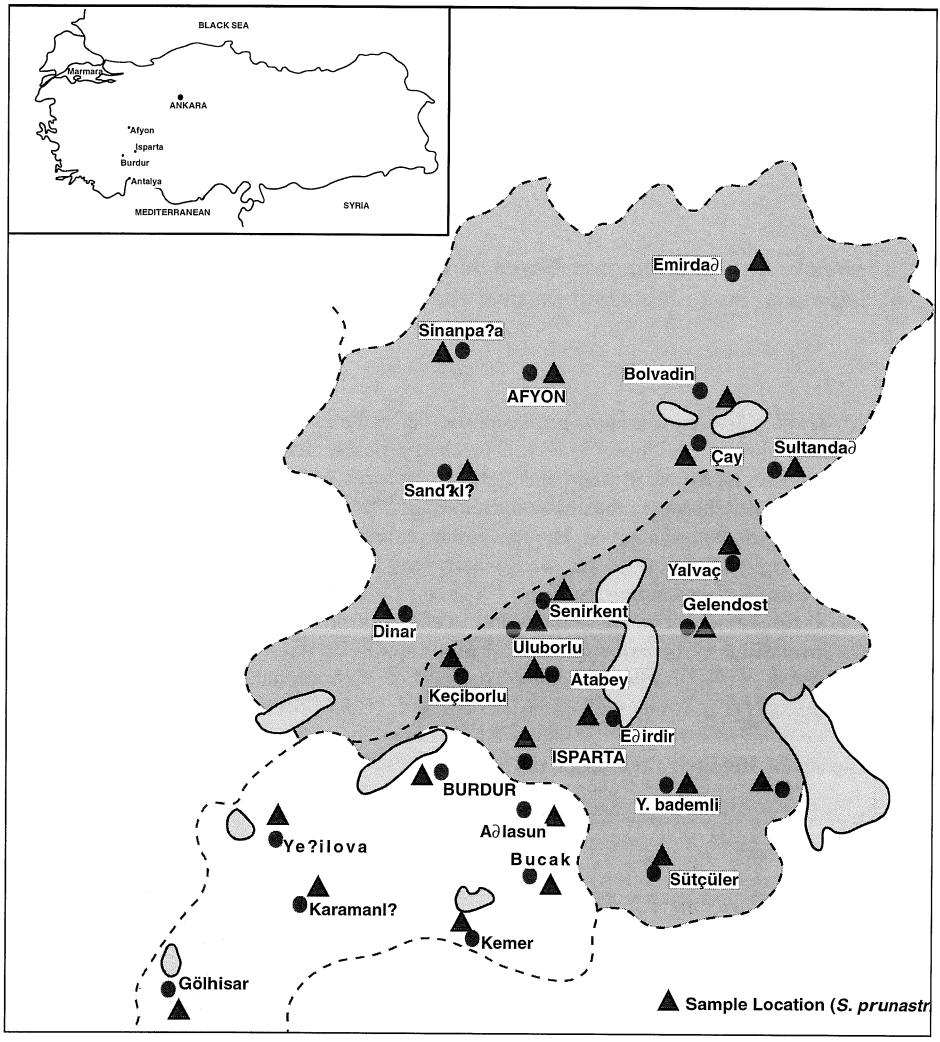

Fig.1 - Sample location of *S. prunastri* in Turkish Lake district.

In the Palaearctic Region, *S. prunastri* has a large parasitoid complex (Ben-Dov, 1968; Tranfaglia, 1972; Öncüer, 1977; Kozár *et al.* 1982; Bakogiannis, 1984; Moglan, 1988). Chalcidoid parasitoids of *S. prunastri* are: *Coccophagus differens* Jasnosh, *C. lycimnia* (Walker), *C. proximus* Jasnosh, and *Coccophagus* sp. nr. *palaeolecanii* Jasnosh (Aphelinidae); *Microterys lunatus* (Dalman), *Metaphycus dispar* (Mercet), *M. silvestri* Sugonyaev, *Blastothrix longipennis* Dalman, *Discodes aeneus* (Dalman), *D.*

coccophagus Ratz and *Cerapterocerus mirabilis* Westwood (Encyrtidae); *Aprostocetus tryapitzini* (Kostjukov) (Eulophidae); *Pachyneuron concolor* (Först.) and *P. muscarum* L. (Pteromalidae). Predators of *S. prunastri* are: *Orius minutus* L. (Heteroptera; Anthocoridae); *Cybocephalus fodori* Endrödy-Younga, *Cybocephalus fodori minor* Endrödy-Younga (Coleoptera; Cybocephalidae); *Scymnus apetzi* Mulsant, *S. interruptus* (Goeze), *Synharmonia conglabata* (L.) and *Exochomus quadripustulatus* (L.) (Coleoptera; Coccinellidae) (Soydanbay, 1976; Öncüer, 1977; Ülgentürk, 2001). Kozár *et al.* (1982) recorded a parasitization rate of 30% on *S. prunastri* by *D. coccophagus* in Turkey. On untreated plum trees in Italy, Tranfaglia (1972) observed that parasitic Hymenoptera caused 48.5% mortality of Plum Scale, and large numbers of *E. quadripustulatus* were present; but on trees treated with carbaryl, populations of this coccinellid fell sharply.

This study was carried out to determine distribution, host plants and natural enemies of *S. prunastri* in the Turkish Lake District.

MATERIALS AND METHODS

Twigs infested with *S. prunastri* were randomly collected from sampling sites in 22 villages in the Turkish Lake District (Afyon, Burdur and Isparta provinces). Samples were collected from infested stone fruit trees every 3 weeks between April and October, when Plum Scale was active. The distal portions of twigs in the lower canopy were taken randomly. Collected twigs were examined under the stereomicroscope and any other scale insect species or other insects were removed. Some samples were placed in 70% ethanol; others were placed in glass vials 15 cm x 10 cm under laboratory conditions (25±1°C; 16:8 (L:D); relative humidity 60±10%), to await parasitoid

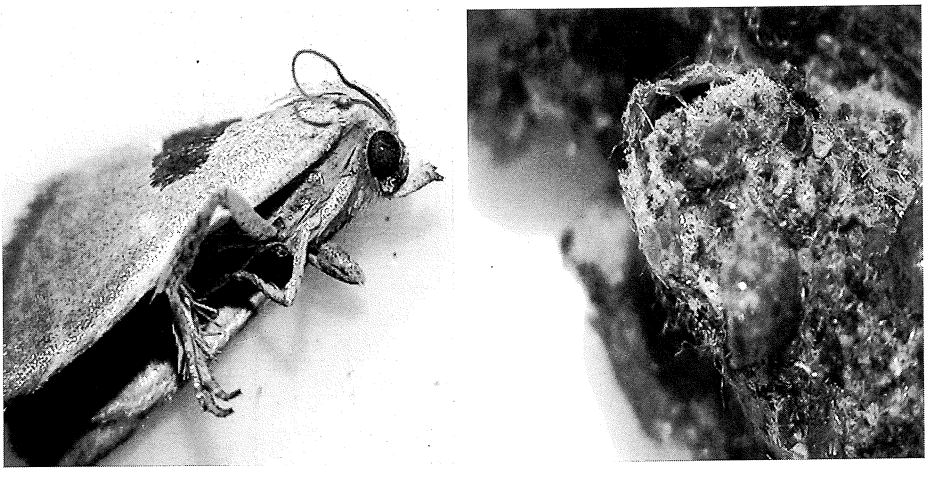

Fig 2 - a) Adult of *Calymma communimacula* . b) Cocoon of *Calymma communimacula* larvae.

differed from that in natural mountain districts, apparently because the systematic use of chemicals against the pests in orchards also kills their natural enemies.

In this study, Plum Scale was found to be a common and economically important pest on stone fruits in Turkish Lake District. Nine chalcidoid parasitoids (three of them secondary parasitoids) and six predators were identified on *S. prunastri*. We suppose that the effectiveness of the primary parasitoids of *S. prunastri* was reduced by the activity of the secondary parasitoids. Further research on the protection of natural enemies to increase their effectiveness will improve the control of *S. prunastri*.

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