Natural Enemies of Cypress Tree Mealybug, *Planococcus vovae* (Nasonov) (Hem., Pseudococcidae), and their Parasitoids in Tehran, Iran

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**ABSTRACT**

The cypress tree mealybug, *Planococcus vovae* (Nasonov) (Hem., Pseudococcidae) is one of the most important pests of cypress trees, especially *Cupressus sempervirens fastigiata* L. in Iran. A survey was carried out to determine the natural enemies of cypress tree mealybug in Tehran Province, during 2004-2005. As a result of this study, 17 species of predators, parasitoids and hyperparasitoids belonging to 10 families and 15 genera were collected and identified. Among the natural enemies associated with *P. vovae* three species, *Coccidoxenoides perminutus* Girault (Hym., Encyrtidae), *Aprostocetus ceroplastae* (Girault) (Hym., Eulophidae) and *Pachyneuron bonum* Xu and Li (Hym., Pteromalidae) were recorded here for the first time from Iran. The diagnostic morphological characteristics of the newly recorded species are given here and illustrated. The host range and economic importance of its natural enemies are reviewed and discussed.

**Keywords**: Biological control, Cypress tree mealybug, Iran, Natural enemies, *Planococcus vovae*.

**INTRODUCTION**

*Planococcus vovae* (Nasonov) was first recorded in 1999 in Iran (Williams and Moghaddan, 1999) and is now a major pest of cypress trees, especially *Cupressus sempervirens* var. *fastigiata* L. (Lotfalizadeh and Ahmadi, 2000). This pest infests the leaves and branches of cypress trees. It is a strictly oligophagous species feeding entirely on cypress, in contrast with its congener, *P. citri* (Risso), which is polyphagous and occurs on a wide range of flowering plants (Bartlett, 1978; Williams, 1985). Its females pass through three nymphal instars before reaching adulthood and the nymphs differ from the adult females by having a much thinner wax covering and fewer antennal segments (Cox, 1989). The cypress tree mealybug is a Trans-palearctic species, occurring from sub-alpine forests in Central Europe to sea level in most Mediterranean countries. In the Middle East the pest was first noted in the early 1980s (Cox, 1989; Francardi and Covassi, 1992), and has also been reported in the last few years from the adjacent country, Turkey (Japoshvili and Karaca, 2002).

The pest can cause both direct and indirect damage. The direct feeding activity of *P. vovae* leads to the desiccation of twigs. Damage is also caused by the development of a sooty mould on its honeydew which weakens heavily infested trees. The mealybugs produce wax and this covers the bodies of most instars. The curled wax filaments are also found on the surfaces of ovisacs,
droplets of honeydew and ostiole exudates. Because of this waxy layer, chemical application on the cypress tree mealybug has no significant effects. In any case, the use of insecticides in urban ecosystems faces legal restrictions and causes environmental pollution. Therefore, biological control may be a useful alternative candidate (Francardi and Covassi, 1992).

Information on the biology and natural enemies of P. vovae is scanty and only a few attempts have been made to study it Iran. Lotfalizadeh and Ahmadi (2000) investigated the natural enemies of P. vovae in Shiraz. Two parasitoid wasps, Anagyrus pseudococci Girault and Dusmetia fuscipennis Noyes and Hayat, as well as several coccinelids and chrysopids were identified as natural enemies of P. vovae. A different assemblage of natural enemy species was recorded in Italy, these included the parasitoids Lepptomastidea matriptensis Mercet, L. bifasciata Mayer, Allotropa mecrida (Walker) (Hym., Platygasteridae) and Charotcerus subaeneus Förster, along with the predatory coccinelids Nephus bisignatus Bohemann and Scymnus interruptus Goeze (Francardi and Covassi, 1992).

Several attempts have been made to integrate the impact of natural enemies with pesticide chemicals for control of pseudococcids (Mineo and Viggiani, 1977; Luppino, 1979; Raciti et al., 1997). Natural enemies have also been introduced into some countries in which pseudococcids attack crops (Mani, 1994; Barbagallo et al., 1993; Nargaratti et al., 1992). Indigenous natural enemies may have a significant effect on populations of cypress tree mealybug, because it only became a significant pest following the extensive use of pesticides. Successful programs of biological control depend on the correct identification of the natural enemies of the target pest species. The present work provides a first survey and identification of P. vovae natural enemies in Tehran.

**MATERIALS AND METHODS**

During a field survey conducted in Tehran Province (Iran) from 2004 to 2006, the natural enemies of cypress tree mealybugs, eggs, larvae and pupae of lacewings, coccinellids, syrphids, chammamaeids as well as parasitized pseudococcids were collected from infested cypress in urban areas and parks. These were subsequently reared in the laboratory and the adults identified. The insects were kept within transparent plastic boxes with mesh for ventilation, and were held in a growth cabinet with constant conditions of 25±5°C, RH: 70±5% and a 16L: 8D photoperiod. Mealybug nymphs were fed on by predators, as was observed directly for 3-4 weeks. Some insects, which did not feed on the mealybugs in the laboratory, were rejected.

Six parasitoids were dissected subsequently for microscopic studies. The external morphology of parasitoids was illustrated using a phase contrast microscope with a drawing tube. Notes are given on the morphology and taxonomy of the newly recorded natural enemies of the cypress tree mealybug. Synonyms and terminology used are mainly based on Noyes (2006) and Gibson et al. (1998), respectively. All species of parasitoids and predators of P. vovae were sent to taxonomic experts for the definitive identification. Material examined is deposited in the Insect Collection of Tarbiat Modares University (Tehran). Descriptions of the newly recorded species are provided to help Iranian workers in identifying those species.

**RESULTS**

Six species of chalcidoid wasps (Hym., Chalcidoidea) were associated with the P. vovae and their predators along with 9 species of predatory insects. These include three new records for the fauna of I. R. Iran. These are marked with an asterisk follows:
Parasitoids and hyperparasitoids

*Anagyrus pseudococci* (Girault) (Hym., Encyrtidae)
*Coccidoxenoides perminutus* Girault (Hym., Encyrtidae)*
*Aprostocetus ceroplastae* (Girault) (Hym., Eulophidae)*
*Pachyneuron bonum* Xu and Li (Hym., Pteromalidae) *
*Marietta picta* (Andre) (Hym., Aphelinidae)
*Homalotylus sinensis* Xu and He (Hym., Encyrtidae) 

Predators:
*Oenopia conglobata* (L.) (Col., Coccinellidae)
*Exochomus nigromaculatus* (Goeze) (Col., Coccinellidae) 
*E. quadripustulatus* (L.) (Col., Coccinellidae)
*Chilocorus bipustulatus* (L.) (Col., Coccinellidae)
*Nephus bipunctatus* (Kugelann) (Col., Coccinellidae)
*Hyperaspis femorata* (Motschulsky) (Col., Coccinellidae)
*Hyperaspis* sp. (Col., Coccinellidae)
*Geocoris quercicola* Linnavaouri (Hem., Lygaeidae)
*Leucopomyia sogdiana* Tanasijtshuk (Dip., Chamaemyiidae)
*Sympherobius pygmaeus* (Rambur) (Neu., Hemerobiidae)
*Chrysoperla carnea* (Stephens) (Neu., Chrysopidae)

Notes on the Newly Recorded Species

*Coccidoxenoides perminutus* Girault, 1915 (Hym., Encyrtidae)


Diagnosis: Head wide, spherical, compound eyes slightly prominent laterally, lateral portions of the face (gena) with sparse hairs; antennae inserted at middle of face, between the compound eyes (Figure 2A), antennae 8-segmented, ring 2-segmented, funicle and club 3-segmented (Figure 2B); maxillary palp 2-segmented; forewing with short submarginal and relatively long marginal vein with several short erected setae in margin, postmarginal vein rudimentary, stigmatic vein short with small triangular stigma (Figure 2D); mesoscutum wide with few long setae
in behind margin, axilla separated completely, scutellum sub-quadrate with 2 longitudinal line divided the segment to 3 parts, lateral parts with two long setae (Figure 2C), tarsi 4-segmented (Figure 2F, G, H), ovipositor protrudes beyoned end of the gaster (Figure 2E).

**Pachyneuron bonum** Xu and Li, 1991 (Hym., Pteromalidae)

**Material examined:** Tehran, Peykanshahr, 25.VI.2005- 8 males, 7 females; 5.VII.2005- 5 males, 11 females; 20.VII.2005- 5 males, 8 females; 8.VIII.2005- 2 males, 4 females;

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**Figure 1.** Morphological characteristics of female *Coccidoxenoides perminutus* Girault, A. Head; B. Dorsal aspect of thorax; C. Dorsal aspect of gaster; D. Forewing; E. Antenna; F, G, and H. Fore, mid and hind legs, respectively.
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Diagnosis: Head with relatively fine sculpture, antennae inserted at upper half of the face, maxillary and labial palps 3-segmented, labial palp with very small middle segment (Figure 3A); antennae 11-segmented in males and 10-segmented in females, ring 2-segmented in males and 3-segmented in females (Figure 3D); forewing with long submarginal vein, relatively long and thickened marginal vein, postmarginal vein as long as marginal vein of a little

Figure 2. Morphological characteristics of female Aprostocetus ceroplastae (Girault), A. Head; B. Antenna; C. Thorax; D. Forewing; E. Ovipositor; F, G and H. fore, mid and hind legs, respectively.
longer, stigmal vein equal to marginal vein, speculum open at base with unique line of the short setae at proximal side (Figure 3D); mesoscutum with developed notaulices, not reaching the middle of mesocutum, punctuated with sparse short setae in front part, scutellum with 3 short setae at each sides (Figure 3B); tarsi 5-segmented, foreleg with curved tibial spur (Figure 3F, G, H); ovipositor sheath short, and ovipositor extended as half long as gaster (Figure 3E).

**DISCUSSION**

The occurrence of such a diversity of natural enemies indicates a good potential for biological control of *P. vovae* in Tehran.
The species of the genus Anagyrus Howard (Hym., Encyrtidae) are primary parasitoids of mealybugs. A. pseudococci is a well-known parasitoid of the citrus mealybug, P. citri, in many parts of the world (Noyes and Hayat, 1994). It has been previously recorded as a parasitoid of P. citri and Nipaecoccus filamentosus (Cockerell) in Iran (Chojai, 1968). This parasitoid also attacks closely related species such as Pseudococcus comstocki (Kuwana). Currently, it is being used to suppress a new invasive pest, the vine mealybug, P. ficus in California, USA (Daane et al., 2004).

C. perminutus is an asexual parasitoid of P. citri (Ceballo and Walter, 2004), which is of Australian origin (Noyes and Hayat, 1994). This parasitoid has been introduced to some countries for the biological control of citrus mealybug. There is no other record of parasitization of P. vovae by this parasitoid in Iran. We found the parasitoid in a few locations, but only in low numbers. High temperature has been proposed as a factor that limits the ability of this parasitoid (Davies et al., 2004). The parasitoid is also distributed in Africa (Noyes and Prinsloo, 1998), Cuba (Noyes, 2000), India (Hayat, 1986) and Israel (Trijapitzin, 1989).

A. ceroplastae had been recorded as an active parasitoid of third instar nymphs and adults of Ceroplastes destructor Newstead (Hom., Coccidae) in Africa (Wakagari, 2001). This parasitoid was also reared from Gascardia brevicauda (Hall) (Hom., Coccidae) (Prinsloo, 1984) and Pulvinaria elongata Newstead (Panis, 1975). Its distribution extends from Africa to Australia, China, Lebanon, Egypt and Turkey (Noyes, 2006).

The genus Pachyneuron Walker includes primary and secondary parasitoids of syrphids, aphids, coccids, psyllids and Diptera. The species associated with coccids are hyperparasitoids of other chalcidoids or Diptera (Ben-Dov and Hodgson, 1997). This genus is represented in Iran by three species. These are P. aphidis (Bouché) (Talebi et al., 2001a), P. muscarum (Linnaeus) (Lotfalizadeh and Ahmadi, 2000) and P. formosum Walker (Anonymous, 1971). This parasitoid has been reared on Ericerus pela Chavannes (Hom., Coccidae) from China (Xu et al., 1991) and it is the second record in the world.

The genus Marietta Motschulsky is represented in Iran by one species, Marietta picta. All species of Marietta are hyperparasitoids of other parasitic Hymenoptera, including species of Chalcidoidea. Secondary hosts include homopterous insects and have been reared from diaspidids, pseudococcids, cer-copids and psyllids (Ben-Dov and Hodgson, 1997). M. picta is known throughout the Palaearctic region, though it has also been reported from some parts of Oriental, Neotropical and Nearctic regions (Hayat, 1986). This species was previously known as a hyperparasitoid of A. pseudococci from Fars Province (Lotfalizadeh and Ahmadi, 2000).

The genus Homalotylus Mayr comprises one of the most important parasitoids of Coccinellidae with about 50 species worldwide (Noyes, 2006). We reared H. sinensis from fourth instar larvae and pupae of Exochomus nigromaculatus and Exochomus quadripustulatus as new host records. H. sinensis was first described from China by Xu and He (1997) and has most recently been reported from Shiraz Province (Fallahzadeh et al., 2006). This species will possibly extend its distribution area towards other Near Eastern countries. Seven species of parasitoids of ladybirds are previously reported from Iran. These include Homalotylus quaylei Timberlake on Scymnus subvillo-sus (Goeze) (Maafi et al., 1998), H. nigricornis Mercet on Scymnus sp. (Lotfalizadeh and Ebrahimi, 2001), H. ephippium (Ruschka) on E. quadripustulatus (Xu and Lotfalizadeh, 2000), H. turkmenicus Myart-seva on Hyperaspis transversoguttata Fald-ermann (Trijapitzin, 1989), H. flavinu-s (Dalman) on Nephus bipunctatus (Kugelmann) (Fallahzadeh et al., 2006), Metastenus concinnus Walker (Hym., Pteromalidae) on Cryptoaemus monterouzieri Mulsant (Gharizadeh and Hesami, 2003) and Perilitus coccinellae (Schrank) (Hym., Braconi-dae) on Coccinella septempunctata L.
(Bagheri, 1998). Homalotylus flaminius Dalman is reported as a larval parasitoid of E. nigromaculatus in Russia (Trjapitzin, 1989). Also, Japoshvili (2000) reported H. flaminius as a parasitoid of E. quadripustulatus in Georgia. Up to 95% parasitism of Chilocorus bipustulatus L. was recorded from North Africa by H. flaminius (Hym., Encyrtidae) and more than 90% parasitism in Chilocorus species around the Black Sea by a complex of H. flaminius and Oomyzus scaposus (Thomson) (Hym., Eulophidae) (Majerus, 1994). Therefore, further studies are necessary to understand better the influence of Homalotylus spp. on ladybird beetle population dynamics.

Ladybird beetles (Col., Coccinellidae) are the most common and best studied of the natural enemies of aphids, soft scales, armored scales, whiteflies and mites (Majerus, 1994). The coccinellids were commonly found associated with P. vovae in large numbers from January to August, and played a significant role in reducing the pest population.

Different species of Hyperaspis are predators of Homoptera, mainly scale insects (Ben-Dov and Hodgson, 1997). P. vovae is a new prey recorded for H. femorata. Whose larvae and adults were the active predators of P. vovae in Tehran Province.

The species of Geocoris sp. are generally regarded as beneficial because they prey upon numerous kinds of insect and mite pests of turf, ornamental and agricultural crops (Schuh and Slater, 1995). G. quercicola Linnavouri was recorded for the first time from Iran (Fars province) by Lotfalizadeh and Ahmadi (2000). It is a polyphagous predator that feeds on mealybugs and phytophagous true bugs.

Two neuropteran species, S. pygmaeus and C. carnea were collected on cypress tree mealybugs in Tehran. The brown lace wing was previously recorded as a predator of Chromaphis juglandicola (Kaltenbach) (Hom., Aphididae) (Talebi et al., 2001b) but its preying on P. vovae is a new record for Iran. C. carnea is a very common predator in nature. Only the larval stages can feed on hosts, while the adult usually feeds on nectar, honeydew and other sugar sources.

Among the natural enemies, two ladybird beetle species, Exochomus nigromaculatus and E. quadripustulatus were the major predators. Comparative biology of these two species was recently studied by Ameri (2006). Both adults and larvae were found preying on the eggs, larvae and adults of P. vovae. A. pseudococci was the most common parasitoid attacking the cypress tree mealybug. It is a solitary internal parasitoid that specializes on the citrus mealybug, the grape mealybug (Noyes and Hayat, 1994) and on the cypress tree mealybug. The adult emerges through an irregular exit hole gnawed at the posterior end of the mummy.

Ultimately, it is hoped that this study will provide a general basis for study of the natural enemies of P. vovae in future works.

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REFERENCES


دشمنان طبیعی شیشک آرد آلو، سرو و پارازیتویدهای آنها در تهران، ایران

**Planococcus vovae** (Nasonov) (Hom., Pseudococcidae)

چکیده

شیشک آردآلو، سرو و پارازیتویدهای آنها در تهران، ایران در سال‌های 1383-1384 بیش از 70000 گونه گزارش گردیده و در تحقیقات این زمینه شامل 11 گونه هستند که شامل **P. vovae**، **Aprostocetus Ceroplastae** و **Coccidoxenoides perminutus** هستند. این گونه‌ها در اقتصادی و جغرافیایی پرداختن به پودر از دشمنان طبیعی برای اولین بار از ایران گزارش می‌شوند. نتایج بررسی این افراد به گونه‌های جدید برای فن در ایران و طور مختصر ارائه و ترسیم شده است. پراکنش جغرافیایی و اهمیت اقتصادی هر یک از دشمنان طبیعی مورد بررسی قرار گرفته است.