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Natural Enemies of *Planococcus vovae* (Nasonov) (Hemiptera: Coccoidea: Pseudococidae), the Main Pest of Lawson's Cypress Trees, in Northeast Iran

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ABSTRACT

There is increasing interest in using natural enemies to control pests in urban green spaces, but this is often hampered by a lack of information on enemies of particular pest groups. Here we provide an assessment for the first time of seasonal population of coccid species and its natural enemies on *Chamaecyparis lawsoniana* (A. Murray) Parl, 1864. The main coccid pest, *Planococcus vovae* (Nasonov, 1909), is attacked by parasitoids and predators. According to the gathered data, the peak population of both coccids and their natural enemies was observed in spring. The most common species in natural enemies was, *Scymnus syriacus* Marseul,1868. Biodiversity indexes of the natural enemies community in the selected stations demonstrated the highest and lowest amounts for both Shanon winner and Margalef index in S3 and S1 before and after for the Simpson index in S1 and S4,5. This study suggests that the natural enemies of coccids on conifer trees may be more complex and diverse than what was observed in the present study.

Keywords: Conifers, Cupressaceae, Predator, Parasitoid, Pest.

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INTRODUCTION

Compared with other metropolises, Mashhad has been particularly affected by rapid urbanization and associated socio-ecological dynamics. In the last census in 2016, the population of 3,312,090 was recorded for Mashhad. Also, more than 27,000,000 visitors annually are incoming Mashhad from all over the world (Ghaderpoori et al, 2016). It has been suggested that urban greening confers a wide variety of socio-ecological benefits to residents and urban environment, a fact that is increasingly appreciated (Lo et al, 2017). Stresses, such as drought, high temperatures and even the factors arising from anthropogenic disturbance, may expose trees to pest attacks, resulting in the pests establishing and increasing in density (Paap et al, 2017). Conifers are one of the most important trees in the most regions of urban green spaces (Heidari et al, 2020).

The coccid species, *Planococcus vovae* (Nasonov, 1909), a secondary insect pest of Cupressaceae species (Japoshvili & Karasa, 2002), is found on most of Lawson cypress trees *Chamaecyparis lawsoniana* (A.Murray bis) Parl., in Iran (Talebi et al, 2008). *P. vovae* presence occurs frequently, but little insecticide is used for its control because it rarely reaches economically damaging levels as well as using insecticide side effects on the environment in urban green spaces are more than their benefit (Choumert et al, 2008). However, short-lived outbreaks in some cases cause considerable damages, which is need led to various control measures (Vesey-Fitzgerald, 1953).

Natural enemies' abundance is a major factor that affects the population dynamics of herbivorous insects (Heidari Latibari et al, 2021, Diaxon and Kindmann, 1990). *P. vovae* uses specific host plant species of family Cupressaceae, with the no previous report of this species in northeast of Iran (Moghaddam, 2013). Although few studies have been done on *P. vovae* in Iran (Moghaddam & Nematian, 2020), the limited evidence suggests that natural enemies play a major role in control of this pest (Tamoli Torfi et al, 2020). Here, we report results of the first enclosure field survey on *P. vovae* and its natural enemies in northeast of Iran.

MATERIAL AND METHODS

Study sites and sampling design

Sampling was carried out in the planted Lawson's cypress planted in the urban green spaces of Mashhad, Khorasan Razavi province, Iran (36°15'N, 59°37'E, 985 m a.s.l). The maps both were elaborated by Google Earth (Fig. 1). Sampling was conducted weekly from March 2020 to February 2021 in the four seasons of six preselected sites. Fifteen Lawson cypress trees approximately with 2m height were selected. on the basis of previous samplings that revealed severe infestations by coccids. The sampling unit was 20cm terminal branches haphazardly selected from two vertical divisions of the canopy. Each branch was separately put inside a plastic bag and then cut and moved to the laboratory for more studies (Heidari Latibari et al, 2016).

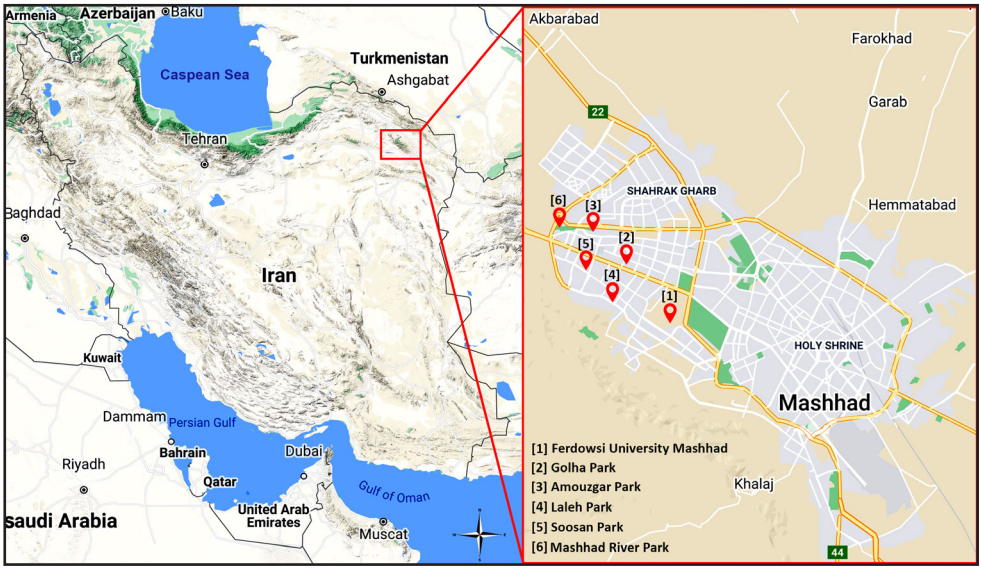

Figure 1. Location of the study area and the selected stations in Mashhad city (Razavi Khorasan province, Iran).

Collection, preparation, and identification

Infested branches were immersed in water and kept individually inside cylindrical cages. Upperparts of cages were covered with mesh to allow sufficient ventilation. Also, some branches were put inside the Petri dishes. Each cage and Petri dishes were properly labeled with the collection date and the serial number of the contained branches. The branches and Petri dishes were transferred in a growth chamber set at 25°C, 56% (RH), and a 16:8 (L:D) h photoperiod, till emerging the adults of parasitoids as well as coccinellids. Adult newly emerged insects were stored in 75% ethanol and were labeled using the new pinning block after preparation and mounting (Ghafouri Moghaddam et al, 2017). All collected coccid species were preserved into 75% ethanol. Some specimens, were slide-mounted on Canada balsam for more details. Coccids and their natural enemies were identified using available keys (Hayat, 1983; Nedved, 2015). Expert taxonomists reidentified and confirmed adult specimens to the species level.

Statistical analysis

Coccids and their natural enemies in the samples were separated and counted. The mean number of coccids per branch and the total number of coccids were calculated. Frequencies of coccids and their natural enemies, and biodiversity indexes; Margalef, Shanon winner, and Simpson were estimated for natural enemies. Data were statistically analyzed in SPSS V 22.

RESULTS

Collected species

The coccid species, *P. vovae* and eleven species of natural enemies have been collected. A total of 2495 pine-feeding coccid species were found on Lawson cypress from six station in urban green spaces of Mashhad. It is first report of *P. vovae* from Razavi Khorasan province. The coccids population on *C. lawsoniana* reached its peak abundance at the end-March till the mid-May in station number 4 and also there was a minor peak between mid-November and end-December in station number 3. During subsequent weeks a gradual decrease in the coccid density was observed, but it did not reach zero (Fig. 2).

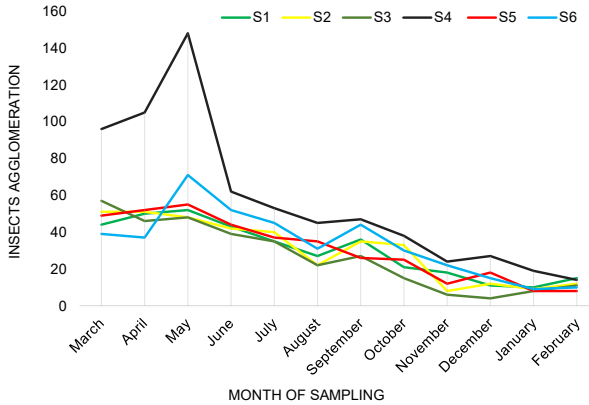

Figure 2. Population dynamics of Planococcus vovae during March 2020-February 2021 at stations 1 to 6 (S1-S6).

Natural enemies

Over the period 2020–2021, we collected and identified 337 individuals of coccid natural enemies belonging to three order four family and eight species (Table 1). According to their densities on Lawson cypress trees, *Scymnus syriacus* Marsuel, 1868 with the highest occurrence frequency among collected specimens, were considered as the dominant species (bolded in table 1). In contrast, *Scymnus nubilus* Mulsant, 1850 and *Coccinella septempunctata* (Linnaeus, 1758) were much less common. The coccinellid species *Chilocorus bipustulatus* (Linnaeus, 1758) pre-dominated. *Chrysoperla carnea* (Stephens, 1836) recorded as a predator as well. Only two species of parasitoids wasps; *Aphytis mytilaspidis* Le Baron, 1870 and *Aphycus secundus* (Mercet, 1925) have been observed from parasitized coccids (Table 1). The low numbers of natural enemies were present in winter but density peaked between early spring and also kept approximately till the start of fall. A comparison of biodiversity indexes showed that S3 and S1 stations had the highest and lowest Shannon Wiener values between selected stations (Fig 3). For Margalef, the highest and lowest amounts

were observed in S3 and S1 (Fig 4) while for Simpson, the highest and lowest values were also observed in S1 and S4,5 (Fig 5).

Table 1. The frequency of natural enemies at selected stations during March 2020 and February 2021.

Family	Species	Station	Spring	Summer	Fall	Winter
Coccinellidae	*Chilocorus bipustulatus* *Coccinella septempunctata* *Nephus bipunctatus* *Scymnus nubilus* *Scymnus syriacus*	1, 3, 4, 6, 5 1, 2, 3, 5, 6 3, 4, 5 2, 3, 6 1, 2, 3, 4, 5, 6	21 10 27 13 57	13 5 10 1 41	7 10 1 5 20	5 7 3 0 8
Chrysopidae	*Chryspoerla carnea*	3, 4, 5	20	18	5	6
Aphelinidae	*Aphytis mytilaspidis*	3	1	2	0	0
Encyrtidae	*Aphycus secundus*	2	0	1	0	0

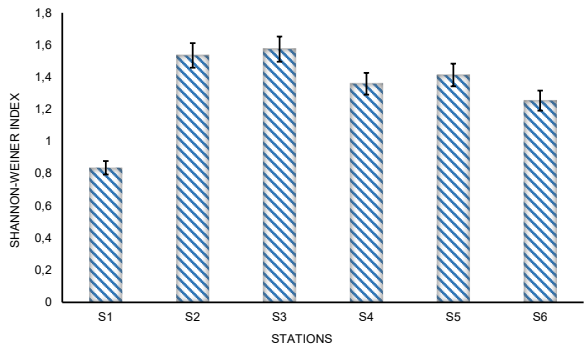

Figure 3. Shannon-Wiener diversity index of natural enemies at each sampling station.

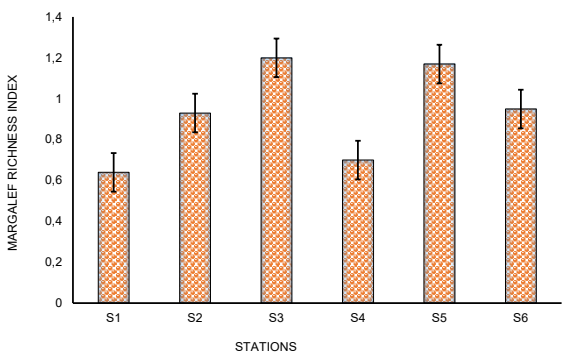

Figure 4. Margalef diversity index of natural enemies at each sampling station.

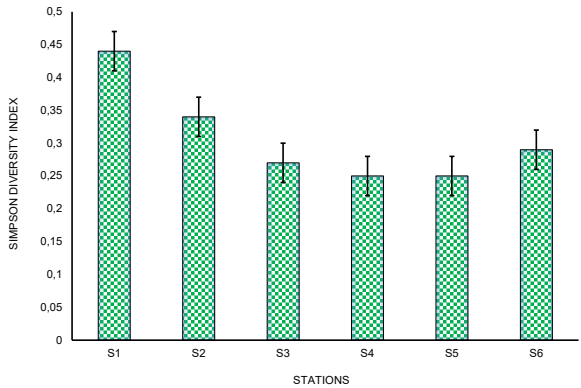

Figure 5. Simpson diversity index of natural enemies at each sampling station.

DISCUSSION

The abundance and diversity of insects are both affected by urbanization. Determining how pests and natural enemies are affected by urban environments will help inform how we design more resilient urban landscapes that protect tree health and functioning (Parsons & Frank, 2019). Here, we selected six sampling sites with Lawsonia trees that were infested by colonies of coccids with different amounts, to examine how the urban environment affects the recruitment of coccids and their natural enemies structure, which in turn will feedback and affect hence plant traits.

Based on our collected date, *P. vovae* is likely to face attacks from a community of natural enemies (Stathas et al, 2021). Despite the lack of conclusive evidence of their level of effectiveness, they could potentially contribute to the control of this species (Perez-Alvarez et al, 2019). This study has revealed that two parasitoid and six predator species are active as attacking *P. vovae* in the urban green space of Mashhad. The wide distribution and large number of *S. syriacus* collected suggests that this species is the most abundant predator of *P. vovae* in the selected regions. The importance of predators as natural enemies of *P. vovae* was alluded to in the literature from last century (Flanders, 1943; Beardsley, 1955; Pimentel, 1963). We observed *S. syriacus* as the abundant species in natural enemy's complex of scales, however *Nephus bipunctatus* (Kugelann, 1794), *C. bipustulatus* and *C. carnea* were more common in previous literatures (Lotfalizadeh & Ahmadi, 2001; Talebi et al, 2008). This appears to be the first publication that refers to *C. septempunctata, S. syriacus*, *A. secundus* and *A. mytilaspidis* as natural enemies of *P. vovae* in Iran.

In the future studies related to the biological control of populations of *the P. vovae*, recommended a special importance given to *S. syriacus* as it seems this species have potential to control population of this pest. This study enlightened to have a holistic approach for the better management of economically important coccids by using

potential natural enemies (particularly coccinellids) to increase the health quality of conifers in urban green spaces.

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