

Biology and harmfulness of *Planococcus vovae* (Nassonov) (Hemiptera: Pseudococcidae) in Belgrade area

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Received: January 31, 2014

Accepted: March 27, 2014

SUMMARY

Planococcus vovae (Nassonov) (Hemiptera: Pseudococcidae) is an important pest on plants of the family Cupressaceae. Its numerous populations have been present in recent years on *Juniperus* spp. in Belgrade. Feeding by sap-sucking on all aboveground plant organs, it causes growth stagnation, chlorosis, drying of needles and branches, and even of entire plants under heavy infestation. Additionally, the scale excretes large quantities of honeydew, on which sooty mold develops, reducing photosynthesis and causing faster plant deterioration.

Throughout 2007 and 2008, *P. vovae* was recorded on *Juniperus* spp. in 12 localities in Belgrade, and on *Thuja* sp. in a single locality. The pest was found to develop three generations per year and overwinter on branches at the egg or second instar stages. The first generation adults were observed at the end of May, the second generation at the beginning of August, while the third generation was recorded at the beginning of October. Different overwintering modes, and variable oviposition, embryonic and larval development periods led to an overlapping of generations and continuous presence of all developmental stages on plants.

In different localities the infestation of plants varied in abundance from a few individual specimens to very large colonies. The highest infestation intensity was recorded in the localities Bežanija, Dorćol and Voždovac.

The predatory species *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) and *Nephus bipunctatus* (Kugelann) (Coleoptera: Coccinellidae) were found in the scale colonies. Regarding *N. bipunctatus*, this was its first record as a new species in the Serbian fauna.

Keywords: *Planococcus vovae*; Hemiptera; Scales; Infestation

INTRODUCTION

Planococcus vovae belongs to the mealybug or Pseudococcidae family. It is distributed across the Palearctic region and has also been introduced into Brazil and Argentina (Danzig and Gavrillov, 2010). It infests plants of the family Cupressaceae (Ben-Dov, 2008) and in many countries it is an important pest on *Juniperus* spp., *Cupressus* spp. and *Thuja* spp. (Uygun et al., 1998; Ulgenturk and Canakcioglu, 2004; Moghadam, 2006). As a result of its feeding by sap-sucking on the aboveground plant organs, it causes needle and shoot development disorder, discoloration and drying of needles and branches. It also excretes large amounts of honeydew, which covers plant organs and makes favorable conditions for the development of sooty molds, which additionally reduce photosynthesis and transpiration and consequently lead to physiological weakening of plants and even drying.

Many years ago, *P. vovae* was observed on *Juniperus communis* L. and *J. oxycedrus* L. in Serbia, and occasional high infestation levels ensued (Kozarzhevskaya and Mihajlović, 1983). In 2005, it was found in large numbers in nurseries, as well as in parks and gardens of Belgrade and its environs (Glavendekić, 2006).

During 2007 and 2008, high infestation levels were recorded in Belgrade on *Juniperus* spp., which are used as ornamental plants in parks and other urban greeneries (Graora et al., 2008).

Since *P. vovae* has been insufficiently studied in our country and literature data are scarce, our objective was to survey its distribution in the City of Belgrade, and to study its life cycle, harmfulness and natural enemies.

MATERIAL AND METHODS

The presence, biology and harmfulness of *P. vovae* were monitored on *Juniperus* spp. in parks and other greeneries in 12 localities across Belgrade (Autokomanda, Bežanija, Blok 44, Bulevar Zorana Đinđića, Bulevar Mihajla Pupina, Centar Sava, Dorćol, Dušanovac, Hala Pionir, Opština Novi Beograd, Tošin bunar, Voždovac, Zemun) in 2007 and 2008.

Each plant was visually inspected and infestation level was determined on the scale of Borhsenius (1963): 0 - no scales on plant; 1 - individual specimens on plant; 2 - individual specimens and small colonies on plant; 3 - small and large colonies on plant; 4 - entire plant organs covered with large colonies.

During the vegetation period, plant material was sampled every 7-15 days and once a month during plant dormancy. From each infested plant, four two-year-old

or one-year-old branches, each 20 cm long, were cut and checked in the laboratory for the presence of scales, their numbers and infestation level.

In order to monitor the life cycle of scales, the sampled branches were placed in glass cylinders or photoelectors and scales and their natural enemies, i.e. predators found within their colonies, were reared there. The scales' oviposition, number of eggs, duration of embryonic and post-embryonic development, number of generations and their overwintering mode were investigated.

Preimaginal stages of the scales' predators were reared into the imaginal stage and then mounted and identified to species level.

For the purpose of morphological trait analysis of *P. vovae*, permanent mounts were made according to the method of Kosztarab and Kozar (1988).

RESULTS

Morphological traits of *P. vovae*

P. vovae is characterized by pronounced sexual dimorphism. The female has an oval body of pink-yellow or brown colour with a well-developed mouth apparatus for piercing and sucking, legs and antennae. Its body is covered with mealy wax excretion (Figure 1). The male has a ringed, spindly body with reduced mouth apparatus and developed antennae, legs and one pair of wings. Two long wax filaments are present at the end of the body (Figure 2). During its development, the female goes through two larval stages, and the stages of pronymph and nymph. All development stages are mobile. A sexually mature and fertilized female forms a white ovisac at the end of its body and lays eggs into it. The body of an adult female, which is always visible at the end of the ovisac, is characteristic of this species (Figure 3).



Figure 1. Female of *P. vovae*



Figure 2. Male of *P. vovae*



Figure 3. Female with eggs

Distribution and intensity of attack

In Belgrade, *P. vovae* was registered on *Juniperus virginiana* L., *Juniperus sabina* L., and on *Thuja occidentalis* L.

On *J. virginiana*, it was found in 12 localities with different infestation levels. The highest, estimated as 4, was registered in Bežanija, Dorćol and Voždovac, where all plant organs were covered by numerous specimens forming dense colonies.

The infestation level was estimated as 3 in a locality near Hala Pionir, while it was 2 near Centar Sava and in Blok 44. Individual scales on plants (infestation level 1) were found in the localities Autokomanda, Bulevar Zorana Đinđića, Bulevar Mihajla Pupina, Dušanovac, Opština Novi Beograd and Zemun.

On *J. sabina* in the locality Tošin bunar, scales formed dense colonies and their infestation level was 4.

Besides plants of the genus *Juniperus*, *Thuja occidentalis* L. was also found to host scales, but only in the locality Voždovac. Numerous colonies were found spread over entire plants and the infestation level was estimated as 4.

Biology

P. vovae was found in our investigation to have three generations annually and to overwinter as eggs or second instar larvae on branches.

Larvae hatch from overwintering eggs during the first decade of April (Table 1), depending on weather conditions, particularly on temperature. In 2007, the average monthly temperatures for the January-April period were a little higher than in 2008 (Table 2) and resulted in six or seven days earlier hatching of larvae. Larvae started hatching on April 4 in 2007 and on April 10 in 2008. Immediately after hatching, the first instar larvae infested younger and juicier plant organs and started feeding on them. Their development takes 13-16 days, so that the second instar larvae were registered in the last ten days of April, i.e. on April 20 of 2007 and on April 26 of 2008. Sexual differentiation takes place at that larval stage. The development of second instar females takes 14-16 days, so that the third instar larvae were registered on May 6 of 2007 and on May 12 of 2008. The development of third instar larvae takes 18-19 days, after which females emerge. Females were observed on May 24 of 2007 and on May 30 of 2008.

The development of second instar males lasts 14-16 days, following which pronymphs and nymphs appear. Their development takes 9 days each, so that males appeared on May 24 of 2007, and on May 30 of 2008, i.e. at the same time as females. The overall duration of the development of larval stages was 50 days for both sexes.

Developed females feed for about ten days and form ovisacs after copulation. The number of eggs in a sac is 230-310, and embryonic development takes 10-12 days.

The duration of all development stages of *P. vovae* is very similar in the other two generations. Oviposition for the second generation was recorded to begin on June 6 of 2007, and on June 12 of 2008, while adults were observed on August 4 and August 10 of 2007 and 2008, respectively. Oviposition for the third generation was recorded on August 14, 2007, and on August 20, 2008, while adults were observed on October 8, 2007, and on October 14, 2008. The overall duration of larval development in the second generation was 47 days, and 45 days in the third generation.

When *P. vovae* overwintered as second instar larvae, which was also found in our investigation, the first

generation adults appeared at the end of April, i.e. one month earlier than the emergence of adults from overwintering eggs. The situation was the same with the second and third generation, when adults were detected at the beginning of July and in September, respectively.

Different overwintering modes and variable periods of oviposition, embryonic and larval development, lead to an overlapping of generations and simultaneous presence of all development stages on plants throughout the vegetative period.

Table 1. The emergence time of *Planococcus vovae* by development stage and year

Year	2007		2008	
	Female development	Male development	Female development	Male development
Development stage				
N ₁	04. 04.	04. 04.	10. 04.	10. 04.
N ₂	20. 04.	20. 04.	26. 04.	26. 04.
N ₃	06. 05.	-	12. 05.	-
pn	-	06. 05.	-	12. 05.
n	-	15. 05.	-	21. 05.
Females	24. 05.	-	30. 05.	-
Males	-	24. 05.	-	30. 05.
Eggs	06. 06.	06. 06.	12. 06.	12. 06.
N ₁	18. 06.	18. 06.	24. 06.	24. 06.
N ₂	02. 07.	02. 07.	08. 07.	08. 07.
N ₃	16. 07.	-	22. 07.	-
pn	-	16. 07.	-	22. 07.
n	-	25. 07.	-	31. 07.
Females	04. 08.	-	10. 08.	-
Males	-	04. 08.	-	10. 08.
Eggs	14. 08.	14. 08.	20. 08.	20. 08.
N ₁	24. 08.	24. 08.	30. 08.	30. 08.
N ₂	06. 09.	06. 09.	12. 09.	12. 09.
N ₃	20. 09.	-	26. 09.	-
pn	-	20. 09.	-	26. 09.
n	-	29. 09.	-	05. 10.
Females	8. 10.	-	14. 10.	-
Males	-	08. 10.	-	14. 10.
Eggs	18. 10.	18. 10.	24. 10.	24. 10.

N₁ - first instar „crawler”, N₂ - second instar, N₃ - third instar, pn - prepupa, n - pupa

Table 2. Meteorological data for the region of Belgrade in 2007 and 2008

Month	Temperature (°C)		Relative humidity (%)		Precipitation (mm)	
	2007	2008	2007	2008	2007	2008
January	7.6	3.2	66.0	75.0	49.3	44.6
February	7.2	6.3	69.0	64.0	56.0	48.3
March	10.2	9.1	61.0	62.0	99.6	78.7
April	14.9	13.8	44.0	61.0	93.8	34.9
May	19.5	19.3	62.0	57.0	79.0	60.9
June	23.8	23.0	58.0	59.0	107.6	43.3
July	25.8	23.7	46.0	56.0	17.5	48.5
August	24.2	24.0	59.0	54.0	72.5	45.6
September	16.2	17.0	68.0	66.0	84.1	68.5
October	11.8	14.8	78.0	68.0	103.6	18.4
November	5.2	9.1	76.0	68.0	131.5	51.0
December	1.1	4.6	83.0	75.0	34.5	79.0

Damage and damage symptoms

P. vovae forms numerous and dense colonies on *Juniperus* spp. plants, which are easy to notice owing to their white waxy substance and particularly to the white female ovisacs. Larvae are mainly concentrated on needles and females usually on the lower side of branches (Figure 4). Male pronymphs and nymphs are found in white cotton-like cocoons on branches and needles. As a result of feeding by sap-sucking, the scales exhaust their plant hosts, causing chlorosis and drying of needles, drying of individual branches and, in case of severe infestation, even of the entire plant. Additionally, scales excrete large quantities of honeydew, making the aboveground plant organs become shiny and sticky, black in a later stage due to the development of sooty mold (Figures 5 and 6), which reduces photosynthesis and generally causes physiological weakening of the plant.

Infested plants are also usually inhabited by wasps, bees, bumblebees, ants and flies, which feed on honeydew and thus additionally signal the presence of scales. Their presence was observed in large numbers on *J. virginiana* in the localities Bežanija, Dorćol and Voždovac, and their highest infestation level was estimated as 4. This high infestation level caused not only chlorosis, drying and falling of needles, but also the drying of branches and whole plants, which led to plant grubbing and replacement with new ones.

In other localities that had lower infestation levels (2 and 1), symptoms included partial needle chlorosis, which reduced the plants' ornamental value.

Numerous scale colonies on *Thuja occidentalis* in Voždovac caused the drying of needles and individual branches, and by the end of vegetation the whole infested plants dried out.



Figure 4. Colony of *P. vovae* on *J. virginiana*

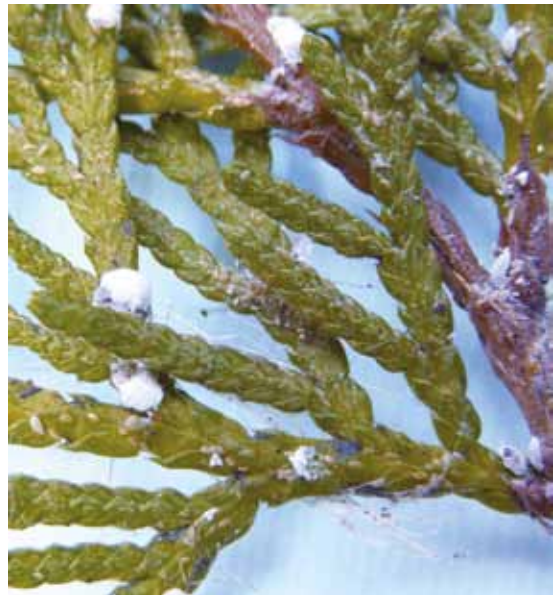


Figure 5. *T. occidentalis* covered with honeydew



Figure 6. Branches of *J. virginiana* covered with sooty mold

Natural enemies

During the investigated period two predatory species were collected and reared from the colonies of *P. vovae*: *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae)

and *Nephus bipunctatus* (Kugelann) (Coleoptera: Coccinellidae). Both species were found in colonies at pre-imaginal stages (eggs and larvae) and were reared into adulthood on sampled infested branches in the laboratory. *Ch. carnea* larvae and *N. bipunctatus* larvae and adults were feeding on all development stages of *P. vovae* (Figures 7 and 8).

In this study, the species *Nephus bipunctatus* was detected for the first time in Serbia.



Figure 7. *Nephus bipunctatus*



Figure 8. Larvae of *Nephus bipunctatus*

DISCUSSION

P. vovae was found in the present study to develop three generations annually and to overwinter as eggs or second instar larvae on plants. No detailed research of the life cycle of this species had been carried out in our country before. In the Mediterranean climate, this pest develops 2-4 generations annually, while it carries a single generation throughout spring and summer

in the temperate climate (Samani, 2007). In Russia, it has one generation annually and overwinters as the second instar larvae and rarely as first instar larvae (Козаржевская, 1992), while it develops two generations annually in Turkey (Ulgenturk et al., 2004).

In Belgrade, *P. vovae* was found on *J. virginiana*, *J. sabina* and *Thuja occidentalis*. Different infestation levels led to partial chlorosis or drying of needles and even of entire plants. The results of this investigation also showed that this pest inhabits conifers, primarily plants of the genera *Juniperus* and *Cupressus*, in the surveyed area. Very high infestation of these plants, as high as 80%, had been recorded in Turkey and Georgia (Japoshvili and Karaca, 2002). Damage had also been recorded in Iran (Talebi et al., 2008), Israel (Samani, 2007) and Cyprus (Sisman and Ulgenturk, 2010). The low number of its natural enemies is one of the causes of high density of scale populations and hence high damage caused to plants (Samani, 2007).

Due to the limited use of insecticides in urban areas, natural enemies could have a role of importance in reducing the strength of scale populations (Francardi and Covassi, 1992). Therefore, special attention is focused on parasitoid wasps of the family Encyrtidae and predatory species of the families Coccinellidae, Lygaeidae and Chrysopidae (Lotfalizadeh and Ahmadi, 2000; Kaydan et al., 2006; Talebi et al., 2008). The predatory ladybird *Nephus bipunctatus*, which was recorded for the first time in Serbia during this investigation, is commercially produced in the USA for the purpose of biological control of species in the family Pseudococcidae (Mahr et al., 2001).

As *P. vovae*, like some other scale species, can be easily transferred with seeding material, legal provisions on healthy seedlings for distribution and planting are the crucial preventive measure aimed at protecting plants from this pest.

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Biologija i štetnost *Planococcus vovae* (Nassonov) (Hemiptera: Pseudococcidae) na području Beograda

REZIME

Planococcus vovae (Nassonov) (Hemiptera: Pseudococcidae) je značajna štetočina na biljkama iz porodice Cupressaceae. Poslednjih godina je na području Beograda prisutna u brojnim populacijama na *Juniperus* spp. Hraneći se na svim nadzemnim delovima biljaka dovodi do zastoja u porastu, hloroze i sušenja četina, sušenja grana, a pri jakoj infestaciji i celih biljaka. Osim toga, važno izlučuje velike količine medne rose na kojoj se razvijaju gljive čađavice koje utiču na smanjenje fotosinteze i brže propadanje biljaka.

Na teritoriji Beograda *P. vovae* je tokom 2007. i 2008. godine utvrđena na *Juniperus* spp. na 12 lokacija i na *Thuja* sp. na samo jednoj lokaciji. Ustanovljeno je da razvija tri generacije godišnje i da prezimljava u stadijumu jajeta i larve drugog stupnja na granama biljaka. Imaga prve generacije registrovana su krajem maja, druge generacije početkom avgusta, a treće početkom oktobra. Različit način prezimljavanja, neujednačen period ovipozicije, kao i embrionalnog i larvenog razvića, dovode do preklapanja generacija i stalnog prisustvo svih razvojnih stadijuma na biljkama.

Na različitim lokacijama, naseljenost biljaka vašima kretala se od pojedinačnih jedinki do veoma brojnih kolonija, pri čemu je najjači intenzitet napada zabeležen na lokacijama Bežanija, Dorćol i Voždovac.

U kolonijama vaši registrovane su predatorske vrste *Chrysoperla carnea* (Stephens) (Neuroptera, Chrysopidae) i *Nephus bipunctatus* (Kugelann) (Coleoptera, Coccinellidae), pri čemu je *N. bipunctatus* nova vrsta za faunu Srbije.

Ključne reči: *Planococcus vovae*; Hemiptera; štitaste vaši; infestacija