

**CARULASPIS JUNIPERI (BOUCHE) – JUNIPER PEST (JUNIPERUS SPP.)  
IN THE BELGRADE AREA**

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*Abstract* – The scale insect, *Carulaspis juniperi* (Bouché) (Hemiptera: Diaspididae), is a significant pest on juniper (*Juniperus* spp.). Its population number has increased in the Belgrade area in recent years. It is present in large numbers on plant twigs, needles and cones, and causes a slowdown in growth, needle chlorosis and premature needle fall, the loss of aesthetic value, drying of branches and whole plants. The presence and attack intensity of *C. juniperi* were determined on *Juniperus* spp. in 19 localities in the Belgrade area in 2007 and 2008. Its life cycle and harmfulness were also studied. *C. juniperi* develops one generation per year and overwinters as a fertilized female on juniper branches and needles. Oviposition starts at the end of April and beginning of May. The number of eggs laid by a single female is 16-44. First instar larvae hatch in May and second instars appear at the beginning of June. At the end of June and in July males and females form. After copulation the males die and the fertilized females remain on the plants feeding until overwintering.

*Key words:* *Carulaspis juniperi*, *Juniperus* spp., Belgrade, life cycle

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## INTRODUCTION

*C. juniperi* is a European species with a cosmopolitan distribution and the status of a very dangerous juniper pest (*Juniperus* spp.) in plant nurseries, parks, gardens and other green areas, especially urban environments. Its presence has also been determined on other conifers, such as species of the genera *Biota*, *Chamaecyparis*, *Cryptomeria*, *Cupressocyparis*, *Cupressus*, *Libocedrus*, *Picea*, *Pinus*, *Sequoia*, *Sequoiadendron*, *Taxodium*, *Taxus* i *Thuja* (Borchsenius, 1966; Charles and Henderson, 2002; Danzig and Pellizzari, 1998; Zahradnik, 1990).

In the whole distribution area, there is information that refers to the harmful effects of the species, especially on *Juniperus* spp. which is often used to green urban environments. In many countries in recent decades it has become an economically important species, as confirmed by numerous authors (Ward, 1977; Kozar, 1985; Soria et al., 1993; Charles and Henderson, 2002; Wiech and Sliwa, 2004; Ulgenturk and Canakcioglu, 2004; Erler, 2004; Jansen, 2004; Miller, 2005; Ripka, 2005).

In the 1980's *Carulaspis juniperi* was registered as a potentially dangerous pest on *Juniperus* spp. in Serbia (Kozarževskaja and Vlainić, 1981, 1982; Kozarževskaja and Mihajlović, 1983). In recent years a significant increase in the numbers of its populations has been noted both in conifer nurseries and green areas in Belgrade (Glavendekić, 2006) and which was reflected in the very bad condition of plants (Galečić et al., 2007).

Due to the increased number of *C. juniperi* populations and frequent juniper drying observed in the Belgrade area, the aim of the paper was to investigate the distribution and attack intensity and to study its life cycle and harmfulness.

## MATERIAL AND METHODS

The presence, attack intensity and harmfulness of *C. juniperi* was determined using the visual and sampling methods of attacked plant material from parks, private properties and other green areas in 19 localities on the Belgrade territory (Ada Ciganlija,

Autokomanda, Banovo Brdo, Bežanija, Block 19, Block 23, Block 45, Block 70, Dedinje, Dorćol, Lešće, Novi Merkator, Opština Novi Beograd, Surčin, Šumice, Tošin bunar, Ušće, Voždovac, Zemun).

The visual method was used for the examination of every infested plant and the attack intensity was determined according to the Borhsenius scale (1963): 0 - no scale insects on the plant; 1 - there are individual specimens on the plant; 2 - there are individual specimens and small colonies on the plant; 3 - there are small and large colonies on the plant; 4 - all parts of the plant are covered with large colonies.

Sampling of the plant material was carried out every 7-15 days during vegetation and once a month in the dormancy period. Four one-year-old and two-year-old 20 cm long branches were taken from opposite sides of each infested plant. A detailed investigation in the laboratory was carried out in order to determine the number of scales and their developmental stage.

A scale rearing method on infested branches was used for the observation of life cycle, i.e. oviposition period, the number of laid eggs, duration of embryonic and postembryonic development, number of generations and overwintering mode.

For the purpose of the analysis of *C. juniperi* morphological characters, permanent microscopic slides of females were made according to the Kosztarab and Kozar method (1988).

## RESULTS

### *Morphology of C. juniperi*

*C. juniperi* is characterized by sexual dimorphism manifested in the different test and body construction of females and males.

The test of a female is 0.5-2.0 mm in diameter, oval, convex, white, with two yellow central or sub-central larval exuviae (Fig.1). The test of a male is elongated, white, with a slight median longitudinal ridge and one yellow terminal larval exuvia at the apex (Fig.2).



Fig. 1. *C. juniperi* - female tests on branches and cone



Fig. 2. *C. juniperi* - male test

The female is without eyes, wings and legs, whereas the male is winged, with well-developed legs and eyes.

The exact identification of the species is based on the morphological characteristics of female.

The body of the female is yellow, oval, 0.4 – 0.9 mm long, and 0.4-0.8 mm wide (Fig.9). Anterior spiracles (as) are with 1-2 disc glands. The antennae (ant) are reduced to unsegmented papillae bearing one spine. The mouthpart (mp) is for piercing and sucking, situated at the level of the anterior spiracles. The pygidium is broadly triangular, rounded at the apex, with small paraphyses (p). The medial lobes ( $L_1$ ) are longer than wide. The second pair of lobes ( $L_2$ ) is bilobed and the third pair ( $L_3$ ) vestigial. The gland spines (gs) are well developed. The marginal macroduct (marg) is larger than the submar-



Fig. 3. *C. juniperi* - overwintering females

ginal macroduct (smarg). One marginal macroduct is between the bases of the median lobes. The pygidium has 5 groups of perivulvar pores (pvp), 6-16 (6-18) 6-12, arranged around the vulva (v).

First instar larva or “crawler” is yellow, with well-developed legs, eyes and antennae. Besides the male, this is the only mobile stage, providing species dispersion.

#### *Distribution and attack intensity*

In the Belgrade area *C. juniperi* was determined on *Juniperus horizontalis* Moench and *Juniperus virginiana* L.

On *Juniperus horizontalis*, often used for the greening of urban surfaces in the Belgrade area, the species was recorded in all 19 localities, with attack intensity from 1 to 4.

The strongest attack intensity was estimated to be 4, recorded in Blocks 23 and 45, Zemun, Dorćol and Bežanija, where all parts of the plant were infested with numerous specimens forming dense colonies. The presence of scales, particularly females, was determined on juniper cones.

In Autokomanda, Banovo Brdo, Blocks 70 and 19 and the wider region of the New Belgrade muni-

cipality, the attack intensity was slightly weaker and estimated to be 3, whereas in Šumice, Ušće and around New Merkator, it was 2.

The presence of individual scales on plants, estimated to be 1 according to attack intensity scale, was recorded in Ada Ciganlija, Dedinje and Lešće.

On *Juniperus virginiana* in Tošin bunar and Voždovac localities, scales formed dense colonies, so the infestation level was estimated to be 4 and 3, respectively.

Apart from juniper (*Juniperus* spp.), the species was also registered on *Thuja occidentalis* in Surčin, with an attack intensity of 3, as well as on *Hebe ochracea* in a private garden in Voždovac, with an attack intensity of 4.

#### *Life cycle of C. juniperi*

During the two-year-long research, it was determined that *C. juniperi* has one generation yearly and overwinters as fertilized females on juniper branches and needles (Fig.3). In spring, the oviposition is at the end of April and beginning of May, depending on weather conditions, and in particular, temperature.

In 2007, the average monthly temperatures in the period January – April were a little higher than in 2008 (Table 1), which affected the beginning of oviposition. It differentiated by seven days in the researched years. Similar weather conditions during May and June also caused slight differences in postembryonic development. Therefore, in 2007, the beginning of oviposition was recorded on April 25, and in 2008 on May 2 (Tab. 2). The duration of the oviposition period is around one month and one female lays 16 to 44 eggs on average (Fig. 4). The duration of embryonic development is 12 days. First instars or “crawlers” (Fig. 5) appear in the first half of May, i.e. May 7, 2007, and on May 14, 2008. After hatching, larvae move actively on the plant searching for an appropriate place to attach to. This active moving lasts from several hours to one day. When they find the appropriate place (most often

**Table 1.** Meteorological data for the Belgrade region in 2007 and 2008

Months	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

**Table 2.** The emergence time of *Carulaspis juniperi*, development stages by year

Year	2007		2008	
	Female development	Male development	Female development	Male development
eggs	25.04.	25.04.	02.05.	02.05.
N <sub>1</sub>	07.05.	07.05.	14.05.	14.05.
N <sub>2</sub>	25.05.	25.05.	02.06.	02.06.
prepupa	-	02.06.	-	11.06.
pupa	-	11.06.	-	20.06.
male	-	20.06.	-	29.06.
female	21.06.	-	30.06.	-

N<sub>1</sub> – first instar larva, N<sub>2</sub> – second instar larva

small needles or even cones) the larvae calm down, put their legs under their bodies and insert stylets into the plant's tissue. Because of the prolonged oviposition period, "crawler" larvae are present in nature for around 25 days. Their development lasts for 18 or 19 days, so the second instars appear at the end of May (May 25, 2007), or beginning of June (June 2, 2008). At this developmental stage, sexual differentiation takes place. The development of second instars of future

females (Fig.6) is 27-28 days, after which females appear, on June 21, 2007 and June 30, 2008. The entire development of females is 57-59 days.

The development of second instars of future males takes 8-9 days after which prepupae and pupae appear. Pupal development lasts 9-10 days, so that the beginning of eclosion was observed on June 20, 2007 and June 29, 2008. The overall development of males lasts 56-58 days.



Fig. 4. *C. juniperi* - eggs

Due to the prolonged period of oviposition and larval development, adults form during the whole of July. After copulation the males die and the fertilized females remain on the plants, feeding until overwintering.

The presence of females in the population during both research years was 63-65% and males 35-37%.

#### *Damage symptoms and harmfulness*

*C. juniperi* feeds by sucking plant sap from needles, twigs, branches and cones. Damage symptoms manifest as needle chlorosis, drying and premature falling, poor twig growth and a general physiological weakening of the plants, resulting in branch and even whole plant drying. The infested plants lose their aesthetic worth. Dry tests of scale insects from the previous year which remain on the host plant, contribute to this.

The most serious damage was recorded on *Juniperus horizontalis* in the localities of Blocks 23 and 45, Zemun, Dorćol and Bežanija, and on *Juniperus virginiana* in the localities of Tošin bunar and Voždovac. The high infestation level caused not only chlorosis, drying and shedding of needles (Fig.7), but also the drying of whole branches and plants (Fig.8), therefore requiring their clearing and substitution with new plants.



Fig. 5. *C. juniperi* - first instar larvae, "crawlers"

In other localities where the attack intensity was lower, the symptoms manifested as partial needle chlorosis and drying of individual twigs, which was reflected in the decrease of the aesthetic value of the plants.

Numerous colonies of scales on *Thuja occidentalis* in Surčin caused the drying of needles and individual branches, whereas the plant *Hebe ochracea*, entirely covered with dense colonies, completely withered.

#### DISCUSSION

Like other species of scale insects, *Carulaspis juniperi* is easily transmitted by seedlings, which has contributed to its cosmopolitan distribution nowadays.

In appearance and life cycle it is very similar to the species *Carulaspis minima* (Targioni-Tozzetti) (syn. *caruelli*) which mostly infests cypress (*Cupressus* spp.). The basic difference between these two species is in the morphological characteristics of female. On the female body of *C. juniperi* there is a macroduct between the bases of median lobes, while *C. minima* has no macroduct between the bases of median lobes. (Kosztarab and Kozar, 1988; Dancig, 1993). Although they have the same host plants, *C. juniperi* prefers *Juniperus* spp., while *C. minima* prefers *Cupressus* spp.



Fig. 6. *C. juniperi* - second instar larvae of future females



Fig.7. Non-infested and infested branches

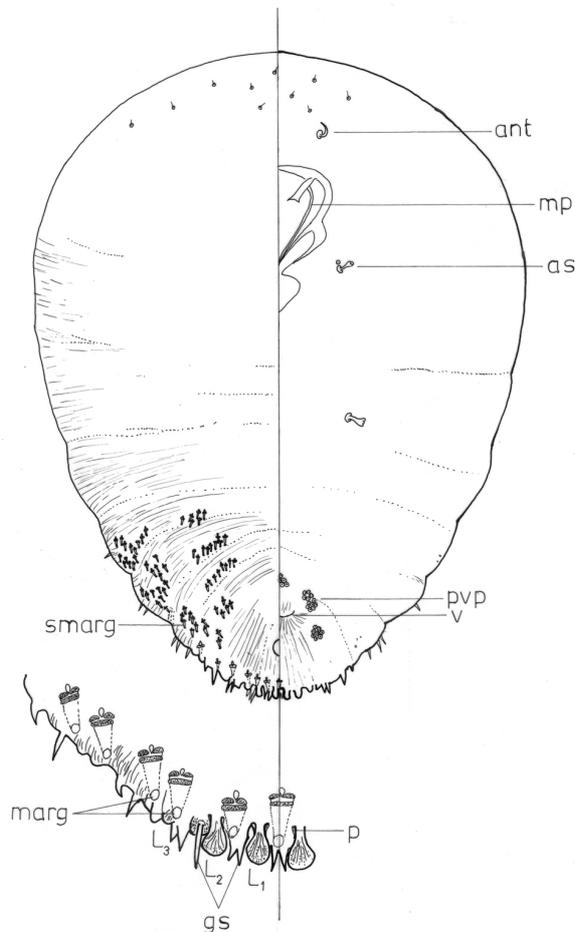
Data on the life cycle of *C. juniperi* on the Belgrade territory coincide with the results of other authors (Davidson and Miller, 1990; Kosztarab and Kozar, 1988). There are differences only in regard to oviposition activity, which was recorded at the end of April and beginning of May in our researches, while in Russia it was recorded at the end of May and beginning of June, and in the USA, beginning of April (Dancig, 1993; Lambdin et al., 2001).



Fig. 8. Dried plants of juniperus

In the Belgrade area *C. juniperi* was registered on *Juniperus horizontalis*, *Juniperus virginiana*, *Thuja occidentalis* and *Hebe ochracea*. The scales form numerous and dense colonies on infested plants. Physiologically exhausting the hosts, they cause partial or complete drying, apparent on almost all examined plants.

This species is a dangerous conifer pest in the whole area of distribution, especially on *Juniperus* spp. The damage was recorded in the USA (Davidson and Miller, 1990; Steinhauer, 1975), Poland (Logowska, 1986), Foldi (2001), the Netherlands (Jansen, 2004) and many other countries. In addition, *C. juniperi* also infests other plant species, where it causes smaller or greater damage. In Turkey it was found on *Biota orientalis*, *Cedrus libani*, *Cupressus* sp., *Cupressus sempervirens*, *Platycladus orientalis*, *Thuja* sp., *T. occidentalis* (Ulgenturk et al., 2004; Akkuzu et al., 2006), in Hungary on *Chamaecyparis* spp., *Thuja* spp. (Ripka, 2005), in Poland on *T. occidentalis* (Wiech and Sliwa, 2004), in Spain on *Sequoiadendron giganteum* (Soria et al., 1993), and in New Zealand on *Cupressus* spp., *Cryptomeria japonica* and *Sequoiadendron giganteum* (Charles and Henderson, 2002).



**Fig. 9.** Female *C. juniperi* - morphology: ant - antenna; mp - mouth-part; as - anterior spiracle; pvp - perivulvar pores; v - vulva; marg - marginal macroducts; smarg - submarginal macroducts; p - paraphyses; gs - gland spines; L1, L2, L3 - median, second and third lobe

As a polyphagous species, until now *C. juniperi* has been determined on plants from the families Cupressaceae, Pinaceae and Taxodiaceae (Zahradnik, 1990). The list of host plants expanded to the family Scrophulariaceae after the species was found, during our investigations, on *Hebe ochracea*.

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