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THE OCCURRENCE OF APHIDS AND THEIR NATURAL ENEMIES ON JUNIPER SHRUBS IN THE AREA OF LUBLIN

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ABSTRACT

The subject of the studies conducted in the years 1999-2001 was the occurrence of aphids and their natural enemies on the shrubs of common and Pfitzer juniper. Observations were carried out in the green areas of the city in a street (A) and a park (B) sites. The studies established the presence of one aphid species of *Cinara juniperi* De Geer. Aphids occurred in the largest numbers on common juniper shrubs in 2001, and on Pfitzer juniper in 2000. It was also observed that on both species of juniper the population of aphids was bigger in site A than in site B.

A clear influence on the population dynamics of *C. juniperi* was exerted by weather conditions. A delayed period of vegetation, high temperatures (over 30°C) as well as heavy rainfalls in the season inhibited the development of aphids. Early and warm spring with the rains within the norm favoured more numerous occurrences of aphids, which were observed already during the first decade of April. Predators (ladybirds, *Syrphidae*, golden-eyed flies, spiders) and parasitoids (*Aphidius ervi*) had little effect on the reduction of aphid population. On the other hand, no aphidophagous species were found on Pfitzer juniper. Regardless of their number, *C. juniperi* aphids caused the injuries that clearly lowered the decorative value of those plants. No distinct injuries were observed on Pfitzer juniper, which was probably due to the short and scarce occurrence of the aphid.

Key words: *Cinara juniperi* De Geer, *Juniperus communis* L., *Juniperus × pfitzeriana* (L. Späth) P. A. Schmidt, city green areas, natural enemies

INTRODUCTION

The increasing importance of city green areas in parks, squares and housing estates, which create suitable places for relaxation, is followed by a greater role and application of coniferous shrubs. Together with deciduous plants, lawns and flowerbeds, they form very effective compositions. The richness of their species, varieties and forms as well as their ever greenness make them desirable plants in cities. Coniferous plants have a positive effect on the microclimate, increasing the air humidity and giving off oxygen and medicinal ethereal oils. These plants include for example junipers: *Juniperus communis* L. and *J. × pfitzeriana* (L. Späth) P. A. Schmidt (a cross of *J. chinensis* L. and *J. sabina* L.).

Worse and worse ecological conditions in city agglomerations make the plants weaker, increasing their susceptibility to pests and disease. The city entomofauna is characterized by a dynamic development of arthropods with a stinging-sucking mouth apparatus [5, 21], among which the aphids make a group of most dangerous pests. The notion “pest” refers in urbanized settings to those species that lower the decorative value of ornamental shrubs, in this case of junipers. Despite the practical and aesthetic values of these plants, there is a lack of studies on the occurrence of aphids throughout the whole vegetation period.

The purpose of the present paper was to establish the species composition, the numbers and dynamics of the aphid population and their natural enemies on the shrubs of common and Pfitzer juniper in street and park sites.

MATERIALS AND METHODS

Observations were performed in the years 1999-2001 in the green areas close to the Rector’s Office of the Agricultural University (area A) and in the Housing estate “Czechów” (area B). Area A can be treated as a street site (heavy traffic), while area B is a park site in the centre of a housing estate (no traffic). Five shrubs of common juniper and five of Pfitzer juniper were chosen in both sites, A and B. Those plants were not submitted to any protective treatments. The presence of aphids and their natural enemies was observed on five shoots (of similar length) of each shrub. The plants were monitored from early spring till late autumn with about 10-days’ intervals. When the weather conditions were unfavourable (rainfalls), the observations were put off onto the following days.

Meteorological data were obtained from the Institute of Agrometeorology of the University of Agriculture in Lublin.

The studies made use of the ecological index – constancy of appearance (C), or – in other words – frequency index (F), which was calculated according to the following formula:

$$C = \frac{q}{Q} \cdot 100$$

where:

q – number of samples where a given species was observed,

Q – number of all the samples.

Basing on the directions included in the paper by Górný and Grüm [6] and Trojan [18], 4 classes of constancy (frequency) were distinguished:

Class I (euconstants) – 0.76-1 (76-100%),

Class II (constants) – 0.51-0.75 (51-75%),

Class II (accessory species) – 0.26-0.50 (26-50%),

Class IV (accidents) – ≤ 0.25 ($\leq 25\%$).

RESULTS

The studies conducted on the shrubs of *Juniperus communis* L. as well as on *J. × pfitzeriana* found out the presence of one aphid species – *Cinara juniperi* (De Geer) from the family *Lachnidae*, the subfamily of *Lachninae*. The course of the weather is presented in [figure 1](#). The information concerning the numbers, dates of occurrence of early aphids, the maximum of the population and the disappearance of the colonies as well as the constancy of occurrence on common and Pfitzer juniper is included in [tables 1](#) and [2](#). The aphid population dynamics on common juniper is shown in [figure 2](#), while in Pfitzer juniper in [figure 3](#). The numbers and periods of occurrence of pests are included in [table 3](#), while the data on the occurrence of primary and secondary parasitoids are in [tables 4](#) and [5](#).

Figure 1. General decadal information about the weather (1999-2001)

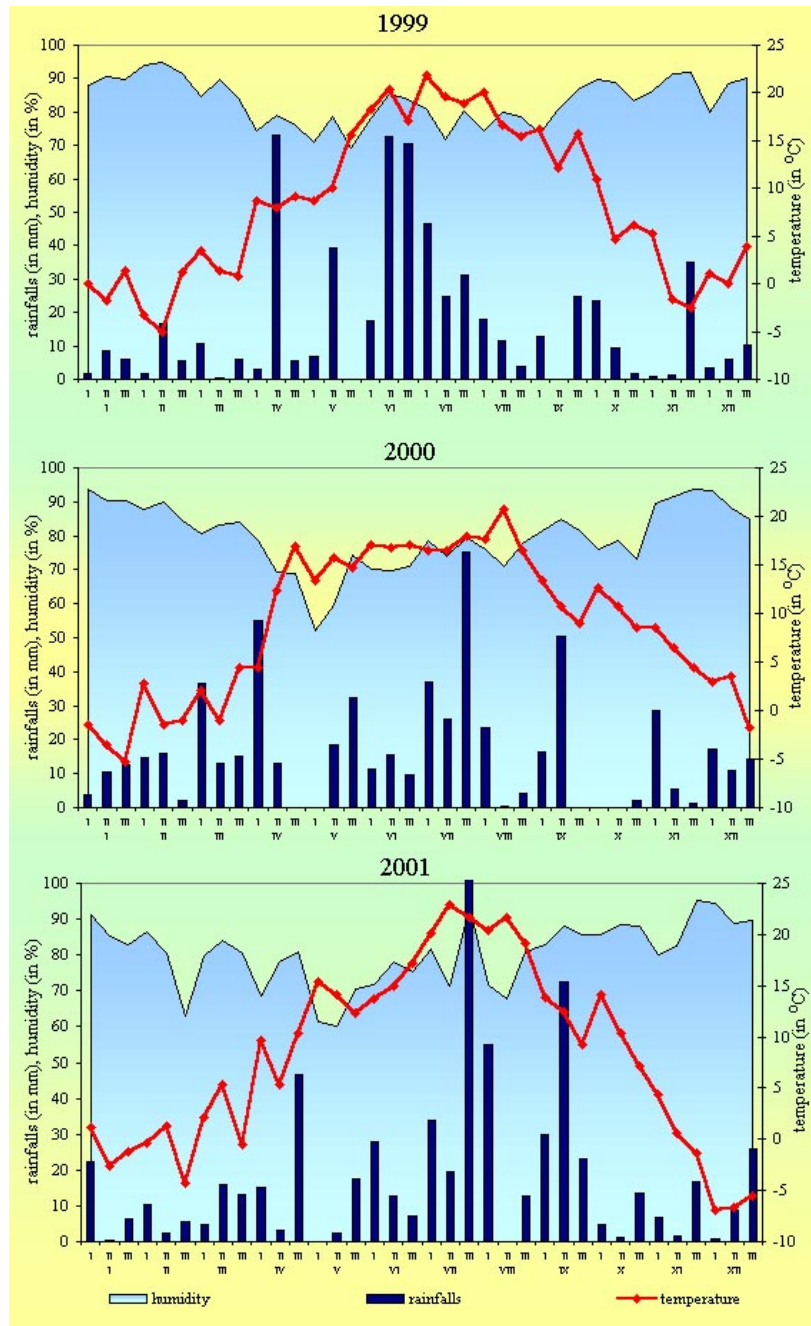


Figure 2. Dynamics of number *Cinara juniperi* (De Geer) on *Juniperus communis* L.

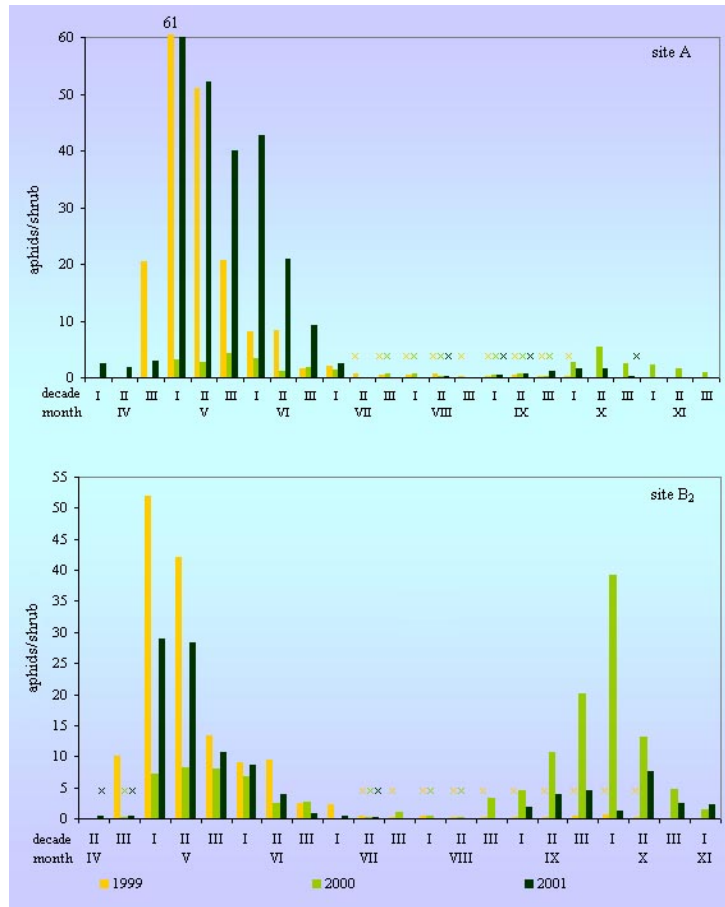
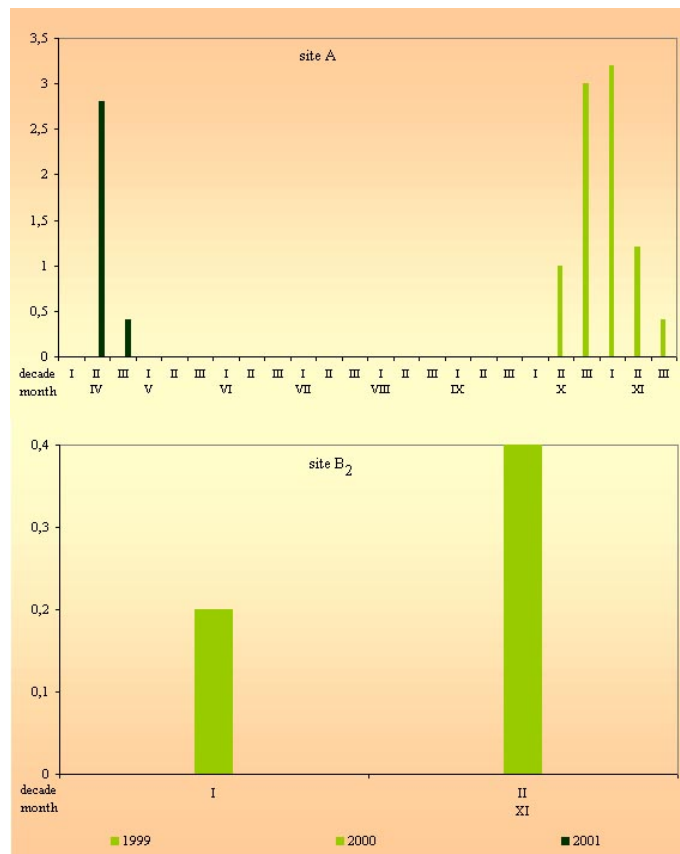


Figure 3. Dynamics of number *Cinara juniperi* (De Geer) on *Juniperus × pfitzeriana*



Cinara juniperi (De Geer) on the shrubs of *Juniperus communis* L. ([Photo 1](#) and [2](#))

Photo 1. *Cinara juniperi* (De Geer) on *Juniperus communis* L.



Photo 2. Colony of *Cinara juniperi* (De Geer) on *Juniperus communis* L.



Table 1. The occurrence of aphids *Cinara juniperi* (De Geer) on *Juniperus communis* L. and *Juniperus × pfitzeriana* (L. Späth) P. A. Schmidt

Year	Site	The appearance of aphids (decade/month)	Number of aphids		Summer disappearance of aphids (decade/month)	Autumn disappearance of aphids (decade/month)	Term of maximum (decade/month)
			Bs	Us			
<i>Juniperus communis</i> L.							
1999	A	III d.IV	132.2	0.8	-	II d.X	I d.V
	B	III d.IV	99.4	0.6	-	III d.X	I d.V
2000	A	I d.V	34.8	0.8	-	I d.XII	II d.X
	B	III d.IV	133.2	1.2	-	II d.XI	I d.X
2001	A	I d.IV	237.6	2.6	-	I d.XI	I d.V
	B	II d.IV	103.6	3	-	II d.XI	I d.V
Total	A	I d.IV-I d.V	404.6	4.2	-	II d.X-I d.XII	I d.V, II d.X
	B	II d.IV-III d.IV	336.2	4.8	-	III d.X-II d.XI	I d.V, I d.X
<i>Juniperus × pfitzeriana</i> (L. Späth) P.A. Schmidt							
1999	A	-	-	-	-	-	-
	B	-	-	-	-	-	-
2000	A	II d.X	8.8	-	-	I d.XII	I d.XI
	B	I d.XI	0.6	-	-	III d.XI	II d.XI
2001	A	II d.IV	3.2	-	I d.V	-	II d.IV
	B	-	-	-	-	-	-
Total	A	II d.IV, I d.X	12	-	I d.V	I d.XII	II d.IV, I d.XI
	B	I d.XI	0.6	-	-	III d.XI	II d.XI

d – decade, Bs – wingless aphids, Us – winged aphids

Due to the delayed period of vegetation in 1999, the first small colonies (of green brown and dark brown, strongly waxed aphids) were found on young juniper shoots in the sites where observations were performed in the third decade of April. The maximum numbers were observed already in the next observation – in the first decade of May (A – 51 aphids/shrubs and B – 39 aphids/shrub). Beginning with the second decade of May the numbers started to decrease. The reason could have been frequent stormy rains, and after the heat waves between the second decade of June and the middle of July, only singular individuals were found on the shrubs. After the repeated heat in August, subsequent observations did not find any increase of the numbers. The dynamics of the population of this species was analogous in both sites. This aphid is a one-home species; its disappearance in site A took place in the second decade, while in site B in the third decade of October.

After a mild winter of 2000, the first aphids were observed in site A in the first decade of May, while in site B – in the third decade of April. Warm spring and summer with the rains within the norm favoured the development of aphids. Despite that, beginning with September, they occurred with changing intensity. Exceptionally in that period, the maximum of their numbers was found out in October, in site A (5.4 aphids/shrub) in the second decade, and in site B (39.2 aphids/shrub) in the first decade. The number of aphids in site B that year was four times as high as in site A. In 2000 the vegetation was exceptionally long (warm October and November). In site A aphids disappeared in the first 10 days of December, and in site B already in the second decade of November.

After a mild winter and early spring of 2001, the first single individuals appeared already in April, in site A – in the first decade, and in site B – in the second decade. That year the number of aphids in site A was the highest as compared with the former years of studies. Beginning with the third decade of April, the studies observed a rapid increase of the number of aphids, which reached the maximum in the first 10 days of May (A – 60 aphids/shrub, B – 29 aphids/shrub). The subsequent observations found out a slow decrease of their population. Only single individuals were observed till September. In area A the aphids disappeared in the first decade, while in area B – in the second decade of November.

Totally, during the three years of studies, 404.6 wingless individuals/shrub and 4.2 winged ones/shrub were observed in site A, while 336.2 wingless individuals/shrub and 4.8 winged ones/shrub were found in site B.

Constancy (frequency) of aphid appearance. Considering the constancy of occurrence, in 1999 and 2000 this species belonged to I frequency class – euconstant, while in 2001 it was included in II frequency class – constant ([tab. 2](#)).

Table 2. The population and frequency of aphid species inhabiting *Juniperus communis* L. and *Juniperus × pfitzeriana* (L. Späth) P. A. Schmidt

Host plants	Year	Site A		Site B	
		L	C	L	C
<i>Juniperus communis</i> L.	1999	665	0.809 (I)	500	0.857 (I)
	2000	178	0.792 (I)	672	0.792 (I)
	2001	1201	0.708 (II)	533	0.708 (II)
	Total	2044	0.768 (I)	1705	0.783 (I)
<i>Juniperus × pfitzeriana</i> (L. Späth) P. A. Schmidt	1999	0	0	0	0
	2000	44	0.208 (IV)	3	0.083 (IV)
	2001	16	0.083 (IV)	0	0
	Total	60	0.101 (IV)	3	0.029 (IV)

L – Number (in),
 C – Constancy of aphid appearance:
 (I) – class I (euconstant),
 (II) – class II (constant),
 (III) – class III (accessory species),
 (IV) – class IV (accident).

Symptoms of injuries. *Cinara juniperi* is a one-home species, hence, it was present throughout all period of vegetation, always in small colonies consisting of no more than several individuals. As a result of those insects feeding on the shrubs, the needles got discoloured and brown, and even the branches started to wither. Worse decorative character of those plants could have resulted from the numerous occurrences of scale insects from the species of *Carulaspis juniperi* (Bouché), which also fed on the twigs. This fact made it more difficult to determine the real damage done by *Cinara juniperi*.

Cinara juniperi (De Geer) on the shrubs *Juniperus × pfitzeriana* (L. Späth) P. A. Schmidt ([Photo 3](#) and [4](#))

Photo 3. Eggs *Cinara juniperi* (De Geer) on *Juniperus × pfitzeriana* (L. Späth) P. A. Schmidt



**Photo 4. Colony of *Cinara juniperi* (De Geer) on *Juniperus × pfitzeriana* (L. Späth)
P. A. Schmidt**



In 1999 no such aphid was found in either of the examined sites.

In 2000 this species occurred in site A only scarcely (8.8 aphids/shrub) and only between the second decade of October and the third decade of November. In that period the aphids laying eggs were observed. Only 3 individuals were found in area B (in the first decade – 1 aphid, and in the second decade – 2 aphids).

In 2001 that aphid was found only in site A during two observations in the second and third decades of April. Further observations in both areas did not reveal any aphids. During the three years of studies 12 wingless individuals/shrub were noted in site A, and 0.6 wingless individual/shrub in site B.

Constancy of occurrence (frequency) of aphids. A short period of that aphid's occurrence on *J. × pfitzeriana* was the factor that decided that on that plant it belonged to IV frequency class – accident ([tab. 2](#)).

Symptoms of injuries. Aphids stayed on the studied shrubs for a very short time and in small numbers; hence, probably they had no effect on lowering the decorative character of the plants.

The aphid colonies on *Juniperus communis* shrubs included the following **predators**: young and adult individuals of *Araneida*; larvae and adults of *Dermaptera*; larvae and adults of *Coccinellidae*; eggs and larvae of *Chrysopidae* and *Syrphidae*. Among them, the most important were probably *Chrysopidae*, whose numerous eggs were observed on the examined plants, and ladybirds from the subfamily of *Coccinellinae* from the genus of *Chilocorus* (Leach) – *Chilocorus bipostulatus* (L.) ([Photo 5](#)). Characteristic larvae of this ladybird were frequently observed on juniper twigs. In 2000 the total number of all the predators was the highest in comparison with the years 1999 and 2001 ([tab. 3](#)).

Cinara juniperi occurred on the shrubs *Juniperus × pfitzeriana* very scarcely and no aphidophagous species were observed in its colonies.

Photo 5. Larvae and pupa *Coccinellidae* from genus *Chilocorus* (Leach) on *Juniperus communis* L.



Table 3. The occurrence of aphid pests on *Juniperus communis* L. in sites A and B

Aphidophags		Site A							Site B						
		Period of occurrence (decade/month)			Number/shrub				Period of occurrence (decade/month)			Number/shrub			
		1999	2000	2001	1999	2000	2001	Total	1999	2000	2001	1999	2000	2001	Total
<i>Araneida</i>	young and adults	IIIdV	IIIdIX	-	0.4	0.4	-	0.8	IIIdV-IIIdIX	IdVI-IIIdVII	-	2.0	2.4	-	4.4
<i>Coleoptera Coccinellidae</i>	larvae	IIIdV-IIIIdVIII	IIIdV-IdIX	IIIdIV-IIIdIX	5.4	8.6	10.4	24.4	IdV-IIIIdVII	IIIIdIV-IdVIII	IIIdIV-IdVIII	2.4	2.8	3.2	8.4
	adults	-	IIIIdV-IIIdIX	IIIIdIV-IIIdVI	-	0.8	3.6	4.4	-	IdV-IIIdV	IIIdIV-IIIdVI	-	0.8	2.4	3.2
Dermaptera	larvae and adults	-	IdVIII	-	-	0.4	-	-	-	-	-	-	-	-	-
Diptera <i>Syrphidae</i>	eggs	IIIdV	-	IdV	0.8	-	0.4	1.2	-	-	-	-	-	-	-
	larvae	-	IIIIdX	-	-	0.4	-	0.4	IIIIdV	-	IdVI	0.4	0	0.4	0.8
<i>Heteroptera Anthocoridae</i>	larvae and adults	-	IIIdIX	-	-	0.4	-	0.4	-	-	-	-	-	-	-
Neuroptera <i>Chrysopidae</i>	eggs	IIIIdV-IdVIII	IIIdV-IIIdVIII	-	5.2	23.6	-	28.8	-	IIIdV-IdVIII	IIIdV-IIIIdVII	-	10.8	2	12.8
	larvae	-	IdVIII	-	-	0.4	-	0.4	-	-	-	-	-	-	-
	adults	-	-	-	-	-	-	-	-	IIIIdV	-	-	0.4	-	0.4

d - decade

Table 4. The population and occurrence of aphids and aphid mummies, the population and the date of departure of parasitoids and hyperparasitoids obtained from aphid mummies

Host plant	Aphids			Period of occurrence	Aphids parasitized			Period of occurrence	Primary and secondary parasitoids			
	Year	Number of individuals			Year	Number of individuals			Year	Number of individuals		Period of occurrence
		A	B			A	B			A	B	
<i>Juniperus communis</i> L.	1999	665	500	IV-XI	1999	20	15	IV-XI	1999	3	1	IV-VIII
	2000	178	672		2000	41	39		2000	2	3	
	2001	1201	533		2001	42	16		2001	21	4	
	Total	2260	1922		Total	103	70		Total	26	8	

Table 5. The population, dates of departure of parasitoids and hyperparasitoids obtained from aphid mummies *Cinara juniperi* (De Geer) occurring on *Juniperus communis* L.

Primary parasitoids and hyperparasitoids (family, species)	Number of parasitoids												Total	Terms of appearance (months)
	1999				2000				2001					
	A		B		A		B		A		B			
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀		
Primary parasitoids <i>Aphidiidae</i> <i>Aphidius ervi</i> Haliday							1		2	5	1	2	11	IV-VIII
Hyperparasitoids <i>Cynipidae</i> <i>Charpis victrix</i> Westwood		1						2	1				4	V-VIII
<i>Pteromalidae</i> <i>Coruna clavata</i> Walker	1	1							2	1		1	6	IV-XI
<i>Asaphes vulgaris</i> Walker				1		2			3	5			11	V-X
Encyrtidae <i>Leptomastidea bifasciata</i> Mayr									1				1	VI
Megaspilidae <i>Dendrocercus carpenteri</i> Curtis									1				1	V-VIII

Photo 6. *Aphidius ervi* Haliday



Photo 7. *Charips victrix* Westwood



Photo 8. *Coruna clavata* Walker



Photo 9. *Leptomastidea bifaciata* Mayr



Photo 10. *Dendrocerus carpenteri* Curtis (♀)



Photo 11. *Dendrocerus carpenteri* Curtis (♂)



The three-year-long observations on *Juniperus communis* found out the presence of parasitized aphids. Totally, 173 mummies were found: 35 individuals in 1999, 80 individuals in 2000, and 58 individuals in 2001 ([tab. 4](#)). Some of them were empty mummies, from which parasitic *Hymenoptera* had flown away, while the others were taken for culture. Their occurrence was observed between April and November, most frequently in May and June. There were more aphid mummies and parasitoids obtained from the culture in site A (103 individuals) as compared to site B (70 individuals). It was found out that aphid parasitisation on the shrubs of *J. communis* ranged in the years of studies from 3.35% (site B) to 4.35% (site A). The culture of parasitised aphids gave adult individuals of *Hymenoptera* (34 individuals), which were included in primary and secondary parasitoids ([tab. 5](#)). Primary parasitoids belonged exclusively to the family of *Aphidiidae* from the subfamily of *Aphidiinae*. The following were defined as hyperparasitoids: *Hymenoptera* from the family *Cynipidae* from the subfamily *Charpinae* – *Charpis victix* Westwood ([Photo 7](#)), from the family *Pteromalidae* of the subfamily *Pteromalinae* – *Coruna clavata* Walker ([Photo 8](#)) and subfamily *Asaphinae* – *Asaphes vulgaris* Walker from the family *Encyrtidae* of the subfamily *Encyrtinae* – *Leptomastix bifasciata* Mayr ([Photo 9](#)) as well as from the family *Megaspilidae* of the subfamily *Megaspilinae* – *Dendrocerus carpenteri* Curtis ([Photos 10, 11](#)). The culture gave 11 individuals of primary parasitic *Hymenoptera* from the species *Aphidius ervi* Haliday, which constituted about 32% of all the obtained parasitoids ([Photo 6](#)). Hyperparasitoids, which limited the numbers of *A. ervi*, constituted 68% of all the obtained *Hymenoptera*. The highest numbers were characteristic of the species *A. vulgaris* (11 individuals) and *Coruna clavata* (6 individuals). The number of the other three species ranged from 1 to 4 individuals.

DISCUSSION

Analyzing the three years of studies it was found out that the shrubs of common juniper and Pfitzer juniper are the host plants for one species of aphids – *C. juniperi*. This is a one-home aphid, found on those plants by other authors [12, 13, 15, 16, 17]. The population dynamics (the whole season of vegetation) of this aphid on common juniper was earlier studied by Jaśkiewicz [7, 8, 9]. Szeleńiewicz [17] states the presence of *Cinara mordvilkoii* on common juniper. This aphid rarely occurs in Poland and but only in the Carpathian area. Many years of studies in the area of Lublin did not confirm its presence.

C. juniperi occurred on the twigs of common juniper from early spring till the end of November, with changing intensity. The values of its maximum occurrence, which inform about the date of the greatest threat for the plants, were within the range of 5.4 and 60.0 aphids/shrub. Annually, but with an exception of 2000, this aphid

occurred in greater numbers in area A (street site). Cichocka and Goszczyński in Warsaw [5] and Wilkaniec in Poznań [21] compare the populations of aphids in parks and street sites, finding out more numerous populations in the latter.

Single individuals of *C. juniperi* were observed on Pfitzer juniper in areas A and B in 2000, while in 2001 only in area A. The numbers ranged from 0.6 to 8.8 aphids/shrub. The occurrence of *C. juniperi* on those shrubs could have been related to the neighbourhood of common juniper in the studied sites.

Weather conditions in a given year had an effect on the population, dates of occurrence, the maximum and disappearance of aphids and laying eggs. One of the important factors is the date of vegetation and temperatures in the spring period. With an early spring, the first aphids were observed on the examined plants as early as in April (especially in 2001). During the studies, high temperatures of 30°C to 35°C occurred frequently, and they caused decrease of the aphid population. The population of aphids also decreased due to the rainfalls, especially in 1999. Warm and long autumn favoured the laying of eggs. Ground frosts destroyed the oviparous females and freshly laid eggs. The effect of the weather on the development of aphids is confirmed in the studies by other authors [3, 4, 5, 10, 11, 22].

The aphid population in the vegetation season is also influenced by natural enemies [1, 2, 3, 14]. The greatest influence in limiting the aphid population on the shrubs of common juniper could have been exerted by *Chrysopidae*, whose numerous eggs were already observed in May, as well as ladybirds from the genus *Chilocorus* (*Ch. bipostulas* L.). Larvae of this ladybird were observed on juniper twigs in spring (single individuals), and in greater numbers in July and August. Individual larvae of *Syrphidae* occurring in June and October did not have any significant effect on the reduction of aphid population. The appearance and activity of aphid-eaters were related to the weather; they occurred in greater numbers in warm spring with little rain [23]. When the temperature drops to 12°C, ladybirds do not feed [10], and these data were partly confirmed by results of the present studies. In 2000 the total number of predators was higher as compared to the years 1999 and 2001. It was also established that parasitoids had an effect on the reduction of aphid population. Aphid parasitisation in the years of studies on *J. communis* ranged between 3.35% (site B) and 4.35% (site A). The culture gave 11 individuals of primary parasitoids from the species of *Aphidus ervi* Haliday, which constituted 32% of all the obtained parasitoids. The effect of parasitoids on the population of *C. juniperi* was shown in the studies by Werstak and Wiackowski [19] as well as Wiackowski et al. [20].

C. juniperi aphids occurred on the shrubs of *J. × pfitzeriana* only for a short time and in small numbers. No aphidophagous species were observed.

C. juniperi most frequently fed on one-year-old, more rarely two-year-old, juniper shoots between the needles. They occurred individually or in small colonies. The following were the results of the juices sucked out of the plants: inhibition of the shoot growth, little growth, discoloration, twisting, browning and even drying of the needles. The injuries caused by those aphids clearly lowered the ornamental value of juniper shrubs. The data from the present studies confirmed earlier observations by Jaśkiewicz [7, 8, 9] in the areas of parks and housing estates in Lublin. On the other hand, the results from the years 1999-2001 showed a longer period of this aphid's occurrence and they were different as to the numbers. Aphids were observed from April, sometimes till November, and the population was higher depending on the year.

CONCLUSIONS

1. The shrubs of *Juniperus communis* L. and *Juniperus × pfitzeriana* (L. Späth) P. A. Schmidt were inhabited only by one aphid species, namely ***Cinara juniperi* (De Geer)**.
2. The studies found out a greater population of aphids (on both juniper species) in the street site (A) as compared to the park site (B).
3. After a mild winter and a warm spring with the rainfalls within the norm the aphids occurred in greater numbers (in 2000 and 2001), while a negative effect on the dynamics of their population was exerted by a delayed period of vegetation, high temperatures (over 30°C) and heavy rainfalls (in 1999).
4. The population of aphids on *J. communis* was not much affected by the presence of predators and parasitoids. No aphidophagous species were found on the shrubs of *J. × pfitzeriana*.
5. The injuries caused by *C. juniperi* clearly lowered the ornamental value of common juniper shrubs.

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