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DYNAMICS OF POPULATION AND BIONOMICS OF *Panaphis juglandis* (Goeze, 1778) (*Homoptera, Phyllaphididae*) ON COMMON WALNUT (*Juglans regia* L.) IN LUBLIN'S PARKS AND GARDENS

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Abstract. Common walnut, due to decorative habit of its crown, is a frequently growing tree in Lublin's parks and gardens. Its presence in the town landscape provokes deeper analysis of the fauna occurring on it. The aim of this paper was to trace the changes in numerical force with reference to the weather conditions system, as well as to establish the bionomics of *Panaphis juglandis* (Goeze) occupying the trees of *Juglans regia* L. Studies were conducted on common walnut (*Juglans regia* L.) in Lublin in 2006–2008. Three locations were designed for observation: garden (A), park (B) and street-side (C). Numerical strength and bionomics of *P. juglandis* were determined. The greatest number of aphids was reported in the year 2007 in the park location. The course of weather conditions significantly affected the terms of spring and autumn presence of aphids. Warm spring with not very intense precipitation enhanced the development of *P. juglandis*. However, torrential rains and air temperatures exceeding 30ºC in summer limited the population dynamics of this aphid. In the developmental cycle the appearance of subsequent generations was observed from family founders through virginoparous females to sexual generation. Studies on female fecundity were performed. In all the study years the highest mean fecundity was that of the family founders, and the lowest was found in the females of sexual generation. The most fecunde virginoparous females (68.4 larvae · female^{-1}) were observed in spring 2006 in the street location. Observations were also undertaken, which concerned determining the place and term of aphid occurrence, as well as the number of eggs on lignified sprouts of *Juglans regia* L. The highest number of eggs was reported in 2008 in the park location.

Key words: *Panaphis juglandis*, common walnut, town landscape, meteorological conditions

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INTRODUCTION

In more and more concreted towns many people feel mentally and physically tired, which, consequently, may lead to the deterioration of their physical health and incessant stress. Studies conducted in the United States documented the favorable effect of plants upon human physical and mental health [Lohr and Relf 2000]. Therefore municipal parks, small green areas, and even single trees are becoming more and more important. Besides, many research centers in the world inform us that trees take up, metabolize or accumulate various chemical substances which are harmful to human health, e.g. heavy metals, volatile organic and inorganic compounds. In urbanized areas, thanks to phytoremediation conducted with the use of trees soil, ground waters and air can be effectively and cheaply purified of many harmful substances [Lasat 2002, Nowak 2005]. Besides, these plants effectively suppress noise in cities (even up to 50%). Thus, together with the increased urban pressure, having trees as company around us cannot be overestimated.

Common walnut has been known in Poland for about 150 years [Pacyniak 1992]. It has been grown first of all as a fruit tree. However, due to its attractive habit (open, loose crown) and large leaves [Bugała 1991] it is also encountered in park plantings and in green areas. It enriches the urban, suburban and agricultural landscapes. It is an element that links the city and open spaces. Most often it grows individually, in loose groups or in long rows. Less frequently it is used for roadside tree plantings, as it very poorly tolerates the presence of carbon oxides in the air [Jaśkiewicz 2003]. It is sporadically encountered near transport tracks, usually in the form of self-sown trees of low decorative value.

Urban conditions do not enhance the growth of trees. Their development and esthetic value are significantly decreased by pests [Cichocka and Goszczyński 2008]. The presence of common walnut in urban landscape provokes more thorough analyzing of the fauna occurring on it.

A small group of herbivores pests on *Juglans regia* L. it includes, among others, mites: *Aceria tristriatus* (Nalepa), *Tetranychus vinnensis* Zacher, scale insects: *Eulecanium tiliae* L. and *Parthenolecanium corni* (Bouché) [Karczmarz, unpublished data], as well as aphids: *Chromaphis juglandicola* and *Panaphis juglandis* (Goeze) [Karczmarz 2010, Cichocka 1980]. The highest threat is constituted by aphids, which, due to their high reproductive ability and injuries caused by preying in large numbers decrease the decorative values of common walnut to a substantial extent through decoloration and deformation of leaf blade. In the urbanized landscape not only a species causing economic losses is a pest, but also a species that decreases the esthetics of trees [Jaśkiewicz 2003].

The aim of three-year studies was to establish the numerical strength and bionomics of *P. juglandis* settling the trees of *Juglans regia* L. in Lublin.

MATERIAL AND METHODS

Location description. Studies were conducted in the area of Lublin in the years 2006–2008. Three research locations were established:

1. Garden location (A) – it was situated in a single family housing estate (detached houses) (ul. Pułaskiego). In this location 7 common walnut trees grew close to each other, accompanied by maples: ash-leaved (*Acer negundo* L.), and sugar (*Acer saccharinum* L.), European ash (*Fraxinus exelsior* L.), plum (wild plum) (*Prunus domestica* L. subsp. syriaca), magnolia (*Magnolia* × *soulangiana* Soul.-Bod.) as well as coniferous trees and shrubs .

2. The park location (B) was situated on the Campus of the Faculty of Mathematics and Sciences of the Catholic University of Lublin. It had 8 common walnut trees, which grew surrounded by small-leaved linden (*Tilia cordata* Mill.), ash-leaved maple (*Acer negundo* L.), sycamore (*Acer pseudoplatanus* L.) and Norway maple (*Acer platanoides* L.)

3. The street-side location (C) was situated at the crossing of busy roads next to Statoil petrol station (al. Kraśnicka and al. Warszawska). In that location there grew 23 common walnut trees accompanied by orchard trees: apple, pear (*Malus* sp., *Pyrus* sp.) and ash-leaved maple (*Acer negundo* L.).

Methodology of sample collection. In each of the selected locations a sample of 100 leaves was collected at random. The samples were collected every 14 days from May to October. Only in justified cases (in unfavorable weather conditions – when it was raining, when the wind was too strong) the terms of sample collecting were slightly postponed. The collected material was viewed in a laboratory, under a stereoscopic microscope and the collected specimens of examined aphid species were counted. Identification of this aphid as to species was conducted on the basis of durable slides. Blacman and Eastop [2000] and Cichocka [1980] keys were used for determinations.

The meteorological conditions were characterized on the basis of the data obtained from Agricultural Meteorology Department of the University of Natural Science in Lublin, as well as from the website www.weatheronline.pl. Names of the arthropod species were fallowed after Bogdanowicz et al. [2004].

Methodology of fecundity determination. In each of the selected locations 10 leaves were sampled with females who had already had some of their larvae. Those leaves were chosen, on which single females were observed together with their offspring. Larvae present on the leaves were totted up. Females were put into 70% alcohol and skeletonized with a laboratory needle in order to isolate embryos. The number of larvae were totalized with the number of embryos. In this way fecundity per one female was obtained. Studies were performed every 10–14 days for family founders, as well as for spring and summer virginiparous females. In autumn oviparous females were collected – 10 pieces, which were also skeletonized to isolate the eggs. The number of eggs obtained from one female constituted its fecundity. In total, in each study year the fecundity of 10 females was counted and in the three-year cycle – that of 30 females.

Observations were also undertaken, which concerned the determination of place and time of occurrence, as well as number of aphid eggs on lignified sprouts of *Juglans regia* L.Each time 10 lignified sprouts, 10 cm long, were collected and examined at in

the laboratory, counting the noticed eggs. On *Juglans regia* L., besides *Panaphis juglandis* (Goeze), *Chromaphis juglandicola* (Kalt.) was also observed, the numerical force of which, at the same place and time of study, (the years: 2006–2008), was on average 15 times lower [Karczmarz 2010]. However, the eggs found on the sprouts were counted jointly. Assigning eggs to the particular species of aphid was impossible, because all the eggs looked similar.

RESULTS

Population dynamics of *Panaphis juglandis* (Goeze). The aphids *Panaphis juglandis* (Goeze) were most often encountered insects on common walnut, and their yellow-white hue with dark brown sclerites made identification with the species easy (photo 1). The aphids were observed from May to October (fig. 1). Throughout the whole study period 37 039 specimens were collected, of which in the garden location (A) – 10 968, in the park location (B) – 8140 and in the street-side location (C) – 17 931 specimens (tab. 3).

Phot. 1. Winged parthenogenous female of *Panaphis juglandis* (Goeze) with offspring, feeding on the upper side of a *Juglans regia* L. leaf. The colony is arranged in the characteristic herringbone pattern

Fot. 1. Uskrzydlona samica dzieworodna *P. juglandis* (Goeze) z potomstwem, żerująca na górnej stronie liścia *Juglans regia* L. Kolonia ułożona w charakterystyczną jodełkę

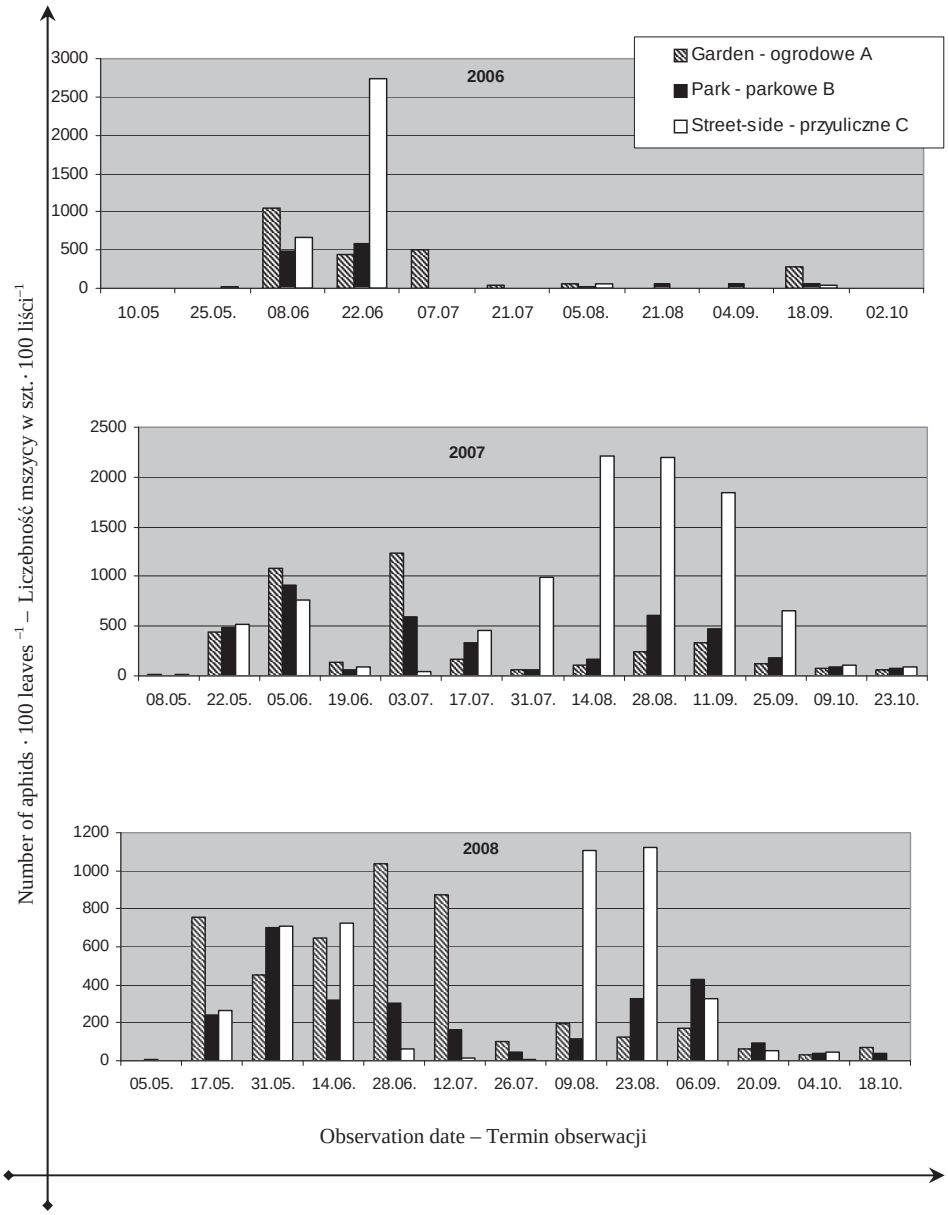


Fig. 1. Population dynamics of *Panaphis juglandis* (Goeze) on *Juglans regia* L. in 2006–2008
Ryc. 1. Dynamika liczebności *Panaphis juglandis* (Goeze) na *Juglans regia* L. w latach 2006–2008

In each study year the dynamics of these insects' numerical force was different.

In the year 2006, with the delayed vegetation period and torrential rains (tab. 1 and 2), the first single specimens of *P. juglandis* appeared in the location A in the 3rd decade of May (fig. 1). Moderately warm May and June, with precipitation approaching or below locationard, enhanced the development of aphids. The peak numerical force of these insects was reported in the 1st decade of June and it was 1042 pcs. · 100 leaves^{-1}. During subsequent observations the numerical force of aphids significantly decreased: in the 3rd decade of June 441 pcs. · 100 leaves^{-1} were reported. Slightly more insects appeared in the 1st decade of July (504 pcs. · 100 leaves^{-1}. The breakdown of aphid numerical force in the subsequent observation terms was significantly influenced by draught in July, alternating with torrential rains in August. These hemipterans remained on the examined trees until mid September with variable intensity, but during a single observation their numerical force was already significantly lower and did not exceed 281 pcs. · 100 leaves^{-1}.

Table 1. Weather conditions in 2006–2008
Tabela 1. Warunki pogodowe w latach 2006–2008

Month Miesiąc	Air temperature Temperatura powietrza, °C				Precipitation Opady, mm				Relative humidity Wilgotność względna, %		
	monthly means średnia miesięczna			multiannual means średnia roczna 1951–2000	monthly totals sumy miesięczne			multiannual monthly totals średnia roczna 1951–2000	monthly means średnia miesięczna		
	2006	2007	2008		2006	2007	2008		2006	2007	2008
January Styczeń	7.5	2.6	0.4	-3.6	15.7	51.5	36.2	21.7	88.0	85.0	78.0
February Luty	-4.3	-1.6	2.3	-2.8	36.7	22.3	17.8	24.8	94.0	89.0	78.0
March Marzec	-1.1	6.2	3.4	1.0	47.0	30.2	64.8	25.8	89.0	81.0	83.0
April Kwiecień	8.7	8.7	9.3	7.5	30.3	17.4	55.8	40.6	77.0	65.0	81.0
May Maj	13.6	15.0	12.8	13.0	59.5	81.5	101.6	58.3	73.0	76.0	85.0
June Czerwiec	16.9	18.1	17.7	16.5	37.9	87.8	25.9	65.8	76.0	78.0	75.0
July Lipiec	21.9	19.2	18.3	17.9	6.8	87.0	77.1	78.0	64.0	76.0	81.0
August Sierpień	17.4	18.4	19.3	17.3	199.2	37.6	45.0	69.7	86.0	80.0	78.0
September Wrzesień	15.7	13.0	12.6	12.9	11.0	129.8	102.9	52.1	83.0	86.0	90.0
October Październik	10.1	7.6	10.1	7.9	14.2	17.3	55.5	40.3	86.0	89.0	90.0
November Listopad	5.3	1.0	4.8	2.5	41.2	31.1	33.1	39.1	94.0	93.0	93.0
December Grudzień	3.0	-1.2	0.9	-1.4	18.6	14.9	43.8	31.5	92.0	95.0	94.0

Table 2. Dates with air temperatures above 30ºC and torrential rains in 2006–2008
Tabela 2. Daty występowania temperatut powyżej 30ºC i opadów typu burzowego w latach 2006–2008

Year Rok	Temperatures above 30ºC Temperatury powyżej 30ºC		Torrential rains Opady burzowe	
	month – miesiąc	day – dzień	month – miesiąc	day – dzień
2006	April – kwiecień	8, 9, 10, 11, 12, 13, 21, 22, 24, 25, 26, 27	April – kwiecień	2, 3
	May – maj		May – maj	16, 28
	June – czerwiec		June – czerwiec	1, 23, 27
	July – lipiec		July – lipiec	-
	August – sierpień		August – sierpień	7, 18, 20
2007	May – maj	15, 16, 17, 20, 22, 24 22, 23 -	May – maj	9, 11, 15, 23, 26, 27, 28, 29
	June – czerwiec		June – czerwiec	2, 10, 11, 16, 23
	July – lipiec		July – lipiec	4, 19, 20, 21, 22
	August – sierpień		August – sierpień	21
	September – wrzesień		September – wrzesień	5, 6, 28
2008	May – maj	12, 13 15,16 6 -	May – maj	1, 4, 18
	June – czerwiec		June – czerwiec	27
	July – lipiec		July – lipiec	7, 24, 25
	August – sierpień		August – sierpień	2, 4, 16
	September – wrzesień		September – wrzesień	4
	October – październik		October – październik	30

In the park location (B) the population level of aphids , compared to the two remaining locations, was significantly lower (tab. 3). The first aphids appeared in the 1st decade of May (fig. 1). In June the numerical force of these insects significantly increased and their peak number, falling on the 2nd decade of that month, equaled 579 pcs. · 100 leaves^{-1}. Because of heat-wave, no *P. juglandis* were observed on *Juglans regia* during July (tab. 2). The aphids appeared again in August and remained on the leaves of examined trees until the 1st decade of October with variable intensity. Nevertheless, their numerical force in particular samples did not exceed 70 pcs. · 100 leaves^{-1}.

Table 3. Number of *Panaphis juglandis* (Goeze) occupying trees (*Juglans regia* L.) in 2006–2008 (pcs.·100 leaves^{-1})
Tabela 3. Liczebność *Panaphis juglandis* (Goeze) zasiedlających drzewa *Juglans regia* L. w latach 2006–2008 (szt. · 100 liści^{-1})

Year – Rok	Location – Stanowisko		
	garden – ogrodowe (A)	park – parkowe (B)	street-side – przyuliczne (C)
2006	2390	1270	3505
2007	4104	4042	9983
2008	4474	2828	4443
Total on location Łącznie na stanowisku	10 968	8140	17 931

In the street-side location (C), like in the park location (B), the first single specimens were observed in the 1st decade of May (fig. 1). In June the numerical force rapidly increased and the peak number, which was 2735 pcs. · 100 leaves^{-1}, was reported in the 3rd decade of that month. In July no aphids were observed on the examined trees. Probably the reason for such situation was hot weather in that month (12 days with temperatures exceeding 30ºC). In the first decade of August the examined insects appeared again in the number of 55 pcs. · 100 leaves^{-1}. The torrential rains in August caused lack of aphids again between the 3rd decade of August and 1st decade of September (tab. 2). In the 2nd decade of September aphids were collected in the number of 43 pcs. · 100 leaves^{-1}, and single specimens were still observed until the 1st decade of October .

In the year 2007, after the mild winter, which contributed to the early start of vegetation (tab. 1), the first, scarce specimens of *P. juglandis* in the housing estate location (A) were found in the 1st decade of May (fig. 1). From the 3rd decade of May to the 2nd decade of June the aphids occurred irregularly. Their numerical force ranged from 1084 to 143 pcs. · 100 leaves^{-1}. The weather pattern (stormy May and June) at that time probably had a significant effect upon the fluctuations of aphid numerical force. The highest number in this location, which was 1240 pcs. · 100 leaves^{-1} was reported in the 1st decade of July. The observations made from mid July to the end of September revealed a sudden decrease in the population of this species, and some single specimens of *Panaphis juglandis* (Goeze) were still collected until the 3rd decade of October. It is supposed that such state of affairs could also the result of weather course – the air temperature above 30ºC in July and August, torrential rains in July and numerous precipitations twice exceeding multiannual monthly sums and storms accompanying them in September. In this study period the numerical force of aphids ranged from 336 to 60 pcs. · 100 leaves $^{-1}$. The last specimens of *P. juglandis* were reported in the 3rd decade of October.

In the park location (B) the first specimens of examined aphid species were collected after the 20th day of May. The peak numerical force, which was 920 pcs. · 100 leaves^{-1} occurred in the 1st decade of June. The last specimens, however were reported in the 3rd decade of October.

The street-side location (C), compared to the two remaining ones had the highest number of *P. juglandis* (tab. 3). In that location the first, single specimens of studied aphid were reported in the first decade of May. From the 3rd decade of May to the end of July the aphids occurred irregularly. Their population level ranged from 987 to 40 pcs. · 100 leaves^{-1}. In August a sudden increase in the number of this pest was observed, where the maximum numerical force corresponding to 2214 pcs. · 100 leaves^{-1} was repported in the 2nd decade of the analyzed month. The numerical force of *Panaphis juglandis* (Goeze)at the end of August remained on the similar level and equaled 2198 pcs. · 100 leaves^{-1}. In the next observations the number of aphids gradually decreased. The last specimens were observed in the 3rd decade of October.

In the year 2008 the presence of first *P. juglandis* colonies in the garden location (A) was found in the 2nd decade of May (fig. 1). From mid May to mid June aphids occurred irregularly, however their numerical force oscillated between 759–453 pcs. · 100 leaves^{-1}. Their peak number, which was 1037 pcs. · 100 leaves^{-1} was reported at the end of the

3rd decade of June. In mid July the number of aphids slightly decreased and was equal to 872 pcs. · 100 leaves^{-1}. In the subsequent observations the population of this species rapidly fell and systematically decreased. Such an arrangement was probably caused by heat (temperatures above 30ºC) and torrential rains in July and August (tab. 2). The total disappearance of *Panaphis juglandis* (Goeze)was reported at the end of October.

The park location (B), compared to the two remaining ones, had the smallest number of *P. juglandis* (tab. 3). In that location the observations of first, scarce aphid colonies also come from the 1st decade of May. The most numerous specimens (699 pcs. · 100 leaves^{-1}) were collected between May and June. In the remaining observations aphids occurred irregularly and in much smaller numbers. In June and August there was scarcity of rain (25,9 mm and 45 mm, which constituted respectively 40 and 60% of the multiannual monthly total) (tab. 1). Such a state of weather was unfavorable for the development of aphids. The last specimens of the examined hemipteran were collected about mid October.

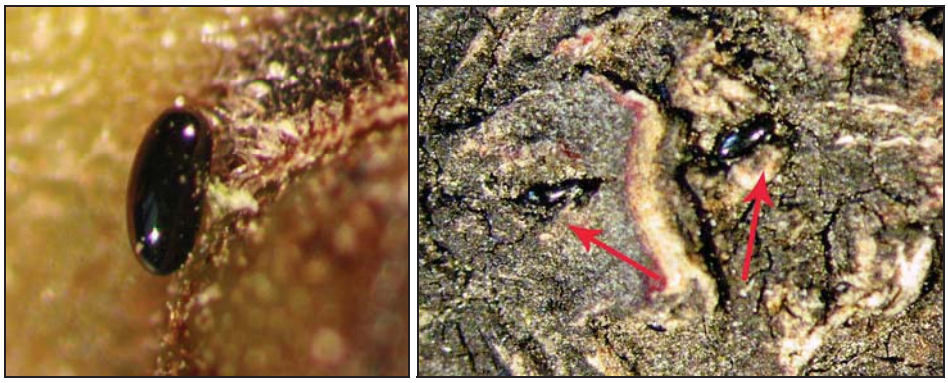
In the street-side location (C) single specimens of *P. juglandis* were observed in the 1st decade of May. From mid May to mid June the numerical force of aphids gradually increased and ranged from 724 to 267 pcs. · 100 leaves^{-1}. At the end of June a sudden breakdown of their numerical force was observed, and in the 3rd decade of July single specimens of the examined aphid species were reported (6 pcs. · 100 leaves^{-1}). That research period was accompanied by conditions which were unfavorable for the development of aphid population. In June there was scarcity of precipitation and, additionally, in July there occurred torrential rains and temperatures above 30ºC, which might have as well explained that situation (tab. 1 and 2). In August, in turn, the most numerous aphid specimens were collected, and their population level was on the level of 1107 pcs. · 100 leaves^{-1} – on the 9th day of August and 1120 pcs. · 100 leaves^{-1} – on the 23rd of August (the maximum numerical force). From the 1st decade of September to the 1st decade of October there were definitely less aphids settling on *J. regia*. Most probably one of the reasons for such a phenomenon was a very rainy September: in that month the precipitations twice exceeded the multiannual monthly totals (tab. 1). After the 15th day of October the examined trees were free from aphids.

Observations of *Panaphis juglandis* (Goeze) bionomy. The aphids of that species occupied the upper surfaces of leaves. They occurred in large numbers on the main vein. The larvae born by family founders and virginiparous females preyed one next to the other, forming compact and quite numerous colonies, arranged in the characteristic „herringbone pattern" (photo 1). The aphids were not very mobile and dispersion of the colony was observed only in the case of threat (photo 2).

Panaphis juglandis (Goeze) over winters in the form of oval, amber-black eggs. In the three-year study cycle (2006–2008) the first aphid eggs were observed in autumn (between the 2nd and 3rd decade of September) in the cracks of the bark of lignified common walnut sprouts and under the leaf buds (photo 3). The highest average number of eggs (20.5 pcs.·10 cm of sprout^{-1}) was observed in spring 2008 in the park location (tab. 4). At the beginning of May the larvae of family founders were hatched, which occupied the upper side of young leaf blades. In May also winged family founders appeared. In the first decade of June the first generations of winged virginiparous females were observed. No wingless females were observed. In the 2nd decade of September

Phot. 2. Dispersion of a *Panaphis juglandis* (Goeze) colony during threat
Fot. 2. Rozproszenie kolonii *P. juglandis* (Goeze) podczas zagrożenia

a) b)



Phot. 3. Oval, anber-black eggs of *Panaphis juglandis* (Goeze) wintering a) under leaf buds, b) in the cracks of lignified sprout bark
Fot. 3. Owalne bursztynowo-czarne jaja *P. juglandis* (Goeze) zimujące a) pod pąkami liściowymi, b) w spękaniach kory zdrewniałych pędów

winged males of *P. juglandis* were observed. At that time also wingless females of the bisexual generation (*oviparae*) appeared (photo 4). The process of egg laying by amphigonic females lasted from the third decade of September to the third decade of October. For instance in 2006 wingless oviparous females were observed from the 21st day of September and in the year 2008 – from the 9th day of October. These females laid their eggs individually or a few in clusters. On 10 cm of the sprout there were from 1 to 56 eggs (tab. 4).

Phot.4. Wingless amphigonic females of *Panaphis juglandis* (Goeze)
Fot. 4. Bezskrzydłe samice amfigoniczne *P. juglandis* (Goeze)

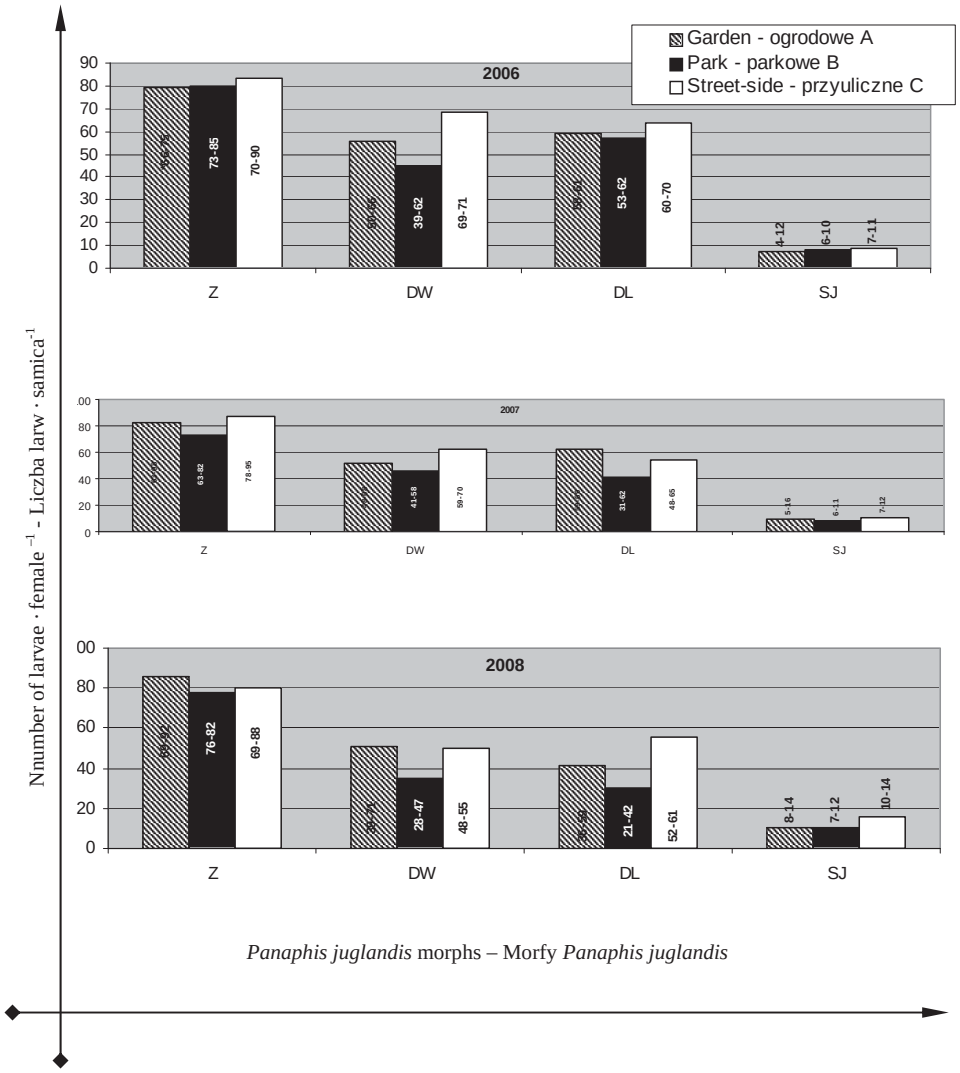
Table 4. Number of aphid eggs per 10 cm of sprout in 2006–2008 (pcs. · 10 cm of sprout $^{-1}$)
Taela 4. Liczba jaj mszyc na 10 cm pędu w latach 2006–2008 (szt. · 10 cm pędu^{-1})

Number of eggs per 10 cm of sprout Liczba jaj na 10 cm pędu	Study year – Rok badań								
	2006			2007			2008		
	Location – Stanowisko								
	A	B	C	A	B	C	A	B	C
Lowest – Najmniejsza	1	1	1	1	1	1	1	1	1
Highest – Największa	8	11	7	11	27	6	28	56	14
Mean – Średnio	6.25	5	3.75	5.25	8.5	3.25	10.33	20.5	6.17

A – garden – ogrodowe, B – park – parkowe, C – street-side – przyuliczne

For the three-year study period in all the research areas the highest fecundity was that of the family founders (fig. 2). The mean fecundity of these morphs often reached 80 larvae and the maximum observed number, reported in the second study year (2007), was 87 larvae female^{-1}.

The fecundity of virginiparous *P. juglandis* females of the spring generations was much lower compared to the fecundity of family founders and frequently exceeded 60 larvae. Spring virginiparous females with the highest mean fecundity (68.4 larvae · female^{-1}) were reported in 2006 in the street-side location. The virginiparous females of further (summer) generations were also less fertile compared to the family founders and spring virginiparous females. The number of larvae born by these females often reached 60 specimens. The most fertile summer virginiparous females



F – family founders (*fundatrices*); SPVir – spring virginoparous females, SUVir – summer virginoparous females, OF – oviparous females * – border values
Z – założycielki rodu; DW – dzieworódki wiosenne; DL – dzieworódki letnie; SJ – samice jajorodne
* – wartości graniczne

Fig. 2. Fecundity (mean and border values) of *Panaphis juglandis* (Goeze) virginoparous and oviparous females on *Juglans regia* L. in 2006–2008 (number of larvae · female^{-1})

Fig. 2. Płodność (średnie i wartości graniczne) samic dzieworodnych oraz samic jajorodnych *Panaphis juglandis* (Goeze) na *Juglans regia* L. w latach 2006–2008 (liczba larw · samica^{-1})

(63.8 larvae · female^{-1}) were reported in 2006 in the street-side location, whereas the oviparous females turned out to be the least fertile. Their fecundity frequently exceeded 10 eggs. The highest mean fecundity was observed in 2008 in the street-side location and it equaled the number of 15.7 eggs · female^{-1}.

In the three-year study cycle the aphids occupying the *J. regia* trees growing in the street-side location were usually characterized by the highest mean fecundity.

Phot. 5. Injuries caused by feeding of *Panaphis juglandis* (Goeze) on a leaf of *Juglans regia* L.
Fot. 5. Uszkodzenia powodowane żerowaniem *Panaphis juglandis* (Goeze) na liściu *Juglans regia* L.

Phot. 6. Colony of aphids *Panaphis juglandis* (Goeze) visited by ants
Fot. 6. Kolonia mszyc *Panaphis juglandis* (Goeze) odwiedzana przez mrówki

Panaphis juglandis (Goeze) preyed in compact colonies on the upper side of *J. regia* leaves, which led to dye penetration in the main vein into reddish-brown color and leaf deformation (photo 5). Besides, the examined aphids actively excreted honey-dew, on which parasitic honeydew fungi developed, forming a black deposit on the leaves. The excreta and fungi developing on them soiled and substantially limited the assimilation surface of leaves. This caused a significant decrease in the decorative value of the trees, deformation and premature shedding of leaves. Consequently, this contributed to poorer winter hardiness of the plants.

The aphid colonies were frequently and numerously visited by ants (photo 6), whereas the sticky honey-dew was eagerly used by wasps and bees.

DISCUSSION

On the trees of *J. regia* so far the occurrence of two aphid species has been found: *Panaphis juglandis* (Goeze) and *Chromaphis juglandicola*. *P. juglandis* has always been the predominant species on this plant. Similar information is given by Jaśkiewicz and Cichocka [2004], as well as Cichocka [1980]. However, the studies conducted in 2003–2005 by Jaśkiewicz and Kmieć [2007] indicated that *Ch. juglandicola* may sometimes predominate.

In the present study this aphid was present in each year in all the locations. In the greatest numbers it occupied the plants in the street-side location, which is consistent with the results of studies conducted in Spanish, Slovak and Polish research centers by Mackoś [2010], Lubiarz [2009], Milevoj and Kravanja [1999], Wilkaniec [1999a], Cichocka et al. [1998], Halbert'a et al. [1998], Cichocka and Goszczyński [1991] and Pisarski [1979]. These studies reveal that together with the increased urbanization, the numerical force of herbivores with stinging-sucking mouthparts.

The negative influence of urban pressure is observed through the pollution of soil, air and plants. To a greater extent it is a threat to the plants growing along the transport routes than to the greenery of housing estates, which is usually far away from large streets and occupies larger areas. Street side trees, planted as a green strip are more exposed to the increased contamination resulting from transport pollutants (heavy metals) and salinity, resulting from removing snow from roads (chlorine) [Bytnerowicz 1979; Molski and Sitarski 1979]. The protection mechanisms of such plants are less sensitive.

Common walnut is resistant to urban conditions-it copes quite well with air pollutants and draught [Zdyb 2009]. Unfortunately, it is sensitive to the contents of sulfur oxides in the air [Jaśkiewicz 2003], and that is why, when it grows next to transport routes, it can be weakened and less resistant to herbivores. Insects with stinging-sucking mouthparts take advantage of the poorer condition of a tree and fed in greater numbers, even more so that they are much more resistant to pollutants compared to the group of insects with stinging mouthparts [Chudzicka 1979]. Besides, observations were made, confirming that plants growing in locations with large accumulation of pollutants contain higher levels of nitrogen (protein). This, in turn, explains why these plants are more attractive for arthropods. Nitrogen deficiencies in a plant, causing, among others, the

pollution of air and soil, are supplemented by taking up nitrates from the soil and nitrogen oxides (NO and NO_2) from the air in the amounts sufficient to meet the need of nutrients for the roots and sprouts [Rennenberg et al. 1998, Mansfield 2004].

P. juglandis occupied the examined trees from spring to early autumn. Depending on the study year and the location the peak of its population level was found in various periods of the growing season. The highest numbers, however, were observed in June and August. Jaśkiewicz and Cichocka [2004], as well as Jaśkiewicz and Kmieć [2007] reported that common walnut was most frequently and numerously occupied by these aphids (maximum numerical force) in May and June.

The aphids were feeding in great numbers on the main vein of the upper side of leaf blade, causing leaf deformation, which had been previously described by: Cichocka [1980], Wilkaniec [1999b], Jaśkiewicz and Cichocka [2004], as well as Jaśkiewicz and Kmieć [2007].

The course of weather conditions significantly affected the dynamics of aphid population. Warm spring with not very intense precipitations enhanced their development. The numerical force of aphids in summer season was low. High air temperatures at that time (about 30ºC) and the accompanying draught caused low plant turgor, which probably made it difficult for the insects to take their food up freely. The summer torrential rains also limited the population level of *P. juglandis.* It can be supposed that they killed the insects and washed them out of the leaves, even more so that they preyed on the upper side of the leaf blade. The obtained data confirm the observations made by Jaśkiewicz and Cichocka [2004], as well as Kmieć [2007].

P. juglandis winters in the form of eggs laid in the cracks of the bark of lignified common walnut sprouts, as well as under leaf buds. According to Wilkaniec [1999b] the females of bisexual generation of *P. juglandis* lay eggs in the bark cracks on the tree trunk. In the 2nd decade of September winged females were observed, as well as apterous oviparous females of *P. juglandis*. The process of oviposition by amphigonic females lasted from the end of September to the end of October. Jaśkiewicz and Cichocka [2004], as well as Wilkaniec [1999] obtained similar results.

Depending on the study year and location the highest fecundity was that of the family founders, slightly lower was that of spring generations, and then the female fecundity decreased.

The lowest fecundity was that of the females from the bisexual generation. Similar results were obtained by Wilkaniec [1999b] in the studies conducted on the premises of Poznań, where the virginiparous females of *P. juglandis* from the first generation were the most fertile (50 larvae). In further generations fecundity decreased (25–40 larvae). The oviparous females laid about 20 eggs.

Winged males and females of the bisexual generation appeared at the end of September.

Blacman and Eastop [2000] reported that the first oviparous females and males can be observed as early as between August and September, and according to Wilkaniec [1999b] these morphs were observed in mid September.

CONCLUSIONS

1. The most numerous colonies of *P. juglandis* were observed on trees growing in the street-side location.

2. The *P. juglandis* aphids were observed throughout the whole growing period, but in variable intensity. The peak of their population level was usually in June or August.

3. The highest number of eggs per 10cm sprout (56 pieces)was reported in 2008 in the park location.

4. The first larvae of *fundatrices* appeared in the 1st decade of May .

5. The most fertile were family founders (on average about 80 larvae) and the fecundity of spring generations was slightly lower (often more than 60 larvae).

6. The highest fecundity of *fundatrigeniae* females was observed in spring 2006 in the street-side location (68.4 larvae · female^{-1}), and the lowest in summer 2008 in the park location (30 larvae · female^{-1}).

7. Winged virginiparous females of *P. juglandis* collected from the street-side location throughout the whole study period were usually more fertile than those from the park and garden locations.

8. Winged males and apterous females of the bisexual generation (*oviparae*) of *P. juglandis* appeared in the 3rd decade of September, and the oviposition process lasted until the 3rd decade of October.

9. *P. juglandis* occupied the upper part of leaf blade and its preting caused decoloration and deformation of leaves. Leaves fell off prematurely from the sprouts attacked by it more strongly, which caused poorer winter hardiness of these parts of the plant. Preying of *P. juglandis* on the trees of *J. regia* significantly decreased their decorative values.

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DYNAMIKA POPULACJI I BIONOMIA *Panaphis juglandis* (Goeze, 1778) (*Homoptera, Phyllaphididae*) ZASIEDLAJĄCEJ ORZECH WŁOSKI (*Juglans regia* L.) W PARKACH I OGRODACH LUBLINA

Streszczenie. Orzech włoski ze względu na dekoracyjny pokrój korony jest drzewem często spotykanym w parkach i ogrodach Lublina. Obecność orzecha włoskiego w krajobrazie miejskim prowokuje do głębszego przeanalizowania występującej na nim fauny. Celem pracy było prześledzenie zmian liczebności w nawiązaniu do układu warunków pogodowych oraz ustalenie bionomii *Panaphis juglandis* (Goeze) zasiedlającej drzewa *Juglans regia* L. Badania prowadzono na orzechu włoskim (*Juglans regia* L.) w Lublinie w latach 2006–2008. Do obserwacji wyznaczono trzy stanowiska: ogrodowe (A), parkowe (B) oraz przyuliczne (C). Określono liczebność i bionomię *P. juglandis*. Najliczniejsze mszyce notowano w roku 2007 na stanowisku parkowym. Przebieg warunków pogodowych znacząco wpływał na terminy wiosennego pojawu oraz jesiennego zaniku mszyc. Ciepła wiosna z niezbyt intensywnymi opadami sprzyjała rozwojowi *P. juglandis*. Natomiast ulewne deszcze typu burzowego i temperatury powietrza powyżej 30°C latem ograniczały liczebność tej mszycy. W cyklu rozwojowym zaobserwowano pojawienie się kolejnych pokoleń od założycielek rodów, przez samice dzieworodne aż do pokolenia dwupłciowego. Przeprowadzono badania płodności samic. We wszystkich latach badań najwyższą średnią płodnością charakteryzowały się założycielki rodów, a najniższą stwierdzono u samic pokolenia obupłciowego. Najbardziej płodne samice dzieworodne (68,4 larwy · samica^{-1}) obserwowano wiosną 2006 r. na stanowisku przyulicznym. Podjęto również obserwacje dotyczące określenia miejsca i terminu występowania oraz liczby jaj mszyc na zdrewniałych pędach *Juglans regia* L. Największą liczbę jaj odnotowano 2008 r. w stanowisku parkowym.

Słowa kluczowe: zdobniczka orzechowa, orzech włoski, krajobraz miejski, warunki meteorologiczne

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