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Arthropods settling a rose variety ‘Bonica 82’ in the urban greenery of Lublin (South-Eastern Poland)

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ABSTRACT

The present study consisted in conducting observations aimed at specifying the abundance of phytophages and useful arthropods that settled a multiflorous garden rose variety ‘Bonica 82’ under city conditions, depending on the degree of anthropopressure. The research was conducted in the area of Lublin, in the years 2008-2010. Two research sites were established: A site – a belt of shrubs alongside a road with heavy traffic; B site– shrubs growing within a large area of greenery, surrounded by other plants, in the neighbourhood of a forest and situated far from any communication routes. Collected arthropods were divided into trophic groups according to their nutritional preferences. The results of the study revealed that arthropods with piercing-sucking mouthparts were a dominant trophic group among those settling a multiflorous garden rose variety ‘Bonica 82’. In both study sites the most abundant was the aphid species *Macrosiphum rosae*. Moreover, alongside the aphids, numerous representatives of the Tetranychidae were encountered in the site by the road, and numerous representatives of the Cicadellidae were encountered in the B site. Among predators, beetles of the family Coccinellidae dominated in both sites. The most abundant predatory insects in the A site were representatives of the Cecidomyiidae, whereas representatives of the Syrphidae were the most abundant in the B site. Parasitoids observed on the studied plants were parasitic hymenopteran insects of the family Braconidae. Hymenopteran insects of the order *Aphidius* sp. dominated in both sites.

KEY WORDS: arthropods, *Rosa* sp., urban greenery, trophic groups

INTRODUCTION

It has been known for a long time that urban greenery improves the quality of life of city dwellers. Advantages for them consist not only in entering into active contact with plants while working in city gardens, but first and foremost, in plants' positive influence on people's well-being (Lohr & Relf, 2000; Nowak, 2003). Moreover, trees and shrubs reduce air pollution by intercepting dust molecules, and thus eliminating considerable amounts of heavy metals (Robinette, 1972). Greenery consisting of trees and shrubs, if planted in the right places, may reduce the level of air pollution by 75% (Skórkowska, 2012). In urbanized areas, phytoremediation (i.e. elimination or detoxification of harmful substances) conducted with the help of trees facilitates cheap and effective elimination of many harmful substances from the soil, ground water and the air (Lasat 2002; Nowak, 2005). Apart from that, plants are also effective in muffling traffic noise, which they are able to diminish by up to 50% (Costa & James, 1995). Furthermore, it is worth remembering, while selecting plants for city plantations, that many of them secrete phytoncides, which have germicidal, virucidal and fungicidal properties. Thus, they significantly improve the living conditions in cities (Skórkowska, 2012).

The most serious problem for plants dwelling in an urban environment is its xeratization (dryness) and toxification. Among basic factors which exercise harmful influence on urban greenery there are the following: pollution of natural soil and native vegetation, constant mechanical disturbances and salinization of soil (Chudzicka, 1979; Schmidt, 1984; Szczepanowska, 2001; Bach *et al*., 2006). What is more, traffic pollution is a major reason for soil alkalization (Konecka-Betley *et al*., 1984). Other factors which have a negative influence on the growth and development of urban greenery include direct proximity of concrete and asphalt roads, where both the soil and air are very dry (Gottschalk, 1991; Bugała, 2000; Popek, 2002; Seneta & Dolatowski, 2003). Accumulation of several factors (e.g. dryness and salinization of soil) has a considerably larger influence on plants than each of these factors occurring separately. Abiotic stress which affects plants under city conditions results in the appearance of distortions in plant morphology, their unfavourable growth and development, as well as the lowering of their decorative value (Fraedlich, 1994; Szczepanowska, 2001). For this reason, the flora located beside communication routes may be weakened and more vulnerable to pathogens and phytophages.

Cichocka & Goszczyński (1991), Wilkaniec (1994), Mackoś (2010) have stated that plants growing in areas strongly modified by man are settled in greater numbers by herbivorous arthropods which lower decorative value of the aboveground parts of the plants. In natural locations the abundance of phytophages is steady, whereas in a landscape subjected to strong anthropopressure there can take place a mass appearance of one phytophagous species (Lubiarz & Cichocka, 2005). Studies conducted so far with reference to various tree and shrub

species in by-the-road locations have shown the pauperization of species composition of phytophages with biting mouthparts, whereas the abundance of species with piercing-sucking mouthparts was on the increase (Chudzicka, 1979; Czechowska *et al*., 1979; Pisarski, 1979; Cichocka *et al*., 1990a and b; Cichocka & Goszczyński, 1991; Cichocka *et al*., 1998; Tykarska, 2001; Jaśkiewicz, 2005; Jaśkiewicz, 2006). According to studies conducted by Rychlik (1979) and Czechowska *et al*. (1979), species composition of the phytophagous fauna with piercing-sucking mouthparts was affected, apart from the increasing urbanization, also by the size of the green area. In many studies it has been proved that aphids and other arthropods with piercing-sucking mouthparts settle plants in far greater numbers in areas subjected to strong anthropopressure (by-the-road locations and locations in the proximity of industrial plants) in comparison with areas subjected to degradation to a considerably lesser degree (Cichocka & Sahajdak, 1996; Lubiarz & Cichocka, 2003; Jaśkiewicz, 2005; Karczmarz, 2010, 2011).

Roses have been part of Polish landscape since ancient times and even though they disappeared for some time from the landscape of cities, especially very large ones, they have found again their place in them due to their valuable features. Garden varieties of roses are an important component of Lublin greenery, both the greenery found in housing estates and by the roads. Genetic features of wild growing roses make them immune to diseases, pests and air pollution, especially exhaust fumes (Popek, 2002). However, garden rose varieties have partly lost such valuable immunity in the course of breeding which has enhanced their decorative value and thus they are more vulnerable to negative results of urban anthropopressure if planted to form green belts along the roads. The variety 'Bonica 82' discussed in the present study is widely used in flower beds and as a ground coverer. It is a highly frostproof shrub, recommended for planting in flower beds in city greenery, as well as by the roads, in parks and gardens (Monder, 2008).

Research on arthropods settling on plants of the genus *Rosa* has been conducted, i.a., in Warsaw (Cichocka, 2003; Cichocka & Jaśkiewicz, 2003) and Lublin (Jaśkiewicz, 1988; Jaśkiewicz, 1995; Jaśkiewicz, 1997; Jaśkiewicz & Gantner, 2000; Jaśkiewicz *et al*., 2001; Kmieć, 2004; Jaśkiewicz, 2003; 2005; Jaśkieicz & Kmieć, 2005; Kmieć, 2006, 2007). The studies have focused mainly on aphids encountered on wild and artificially bred varieties of roses. The present study is devoted to the observations on species composition and abundance of arthropods belonging to various trophic groups which settle "Bonica 82", a multiflorous garden rose variety, in the housing-estate and by-the-road locations in urban greenery of Lublin.

MATERIAL AND METHODS

The research was conducted in Lublin in the years 2008-2010. Two research sites were established: A site – a belt of shrubs alongside a road with heavy

traffic; B site – shrubs growing within a large area of greenery, surrounded by other plants, in the neighbourhood of a forest and situated far from any communication routes. In each site there were 15 shrubs of the multiflorous rose variety 'Bonica 82'. In both sites, random samples of 100 leaves were collected. The samples were collected every 10-14 days. In 2008, the material was collected in 18 series, in 2009 in 16 series, and in 2010 in 19 series. The samples were collected during the period from the middle of April until December. The material was then perused in a laboratory under a stereoscopic microscope. The collected arthropods were counted and described and photographic documentation was prepared. Identification of particular arthropod species was conducted according to the keys provided by Müller (1976), Kropczyńska (1999), Miczulski (1999), Szadziewski (1999), Blackman & Eastop (2000) and Miczulski (2001). The names of particular species were quoted after Fauna Europea (2011).

The arthropods collected for the purpose of the study were divided into groups according to their trophic preferences. Four trophic groups were differentiated: herbivorous, predatory, parasitic and those which displayed mixed nutritional preferences. Additionally, the arthropods were divided according to their mouthpart types: either biting or piercing-sucking, since the differences in acquiring nutrition had a significant influence on the visual appearance and development of plants these arthropods had settled.

RESULTS AND DISCUSSION

According to the conducted research, the number of arthropods collected in the B site gradually increased in the course of three years (2008-2010) and amounted to 1389-1618 specimens per 100 leaves (Tab. 1). During the same study period, in the A site, a considerably higher number of arthropods were encountered, however, in the years 2008-2009, their abundance levels remained almost the same during the whole period. In the third year (2010), the number of arthropods increased by ca. 40% in comparison to the previous years (Tab. 1).

During the whole study period, both in the B site and A site, herbivorous arthropods dominated (Tab. 1). Similar results, but regarding other species of ornamental plants, had been obtained by Cichocka & Goszczyński (1991), Wilkaniec (1994) and Mackoś (2010). In the B site the abundance of phytophages in the course of the following years was gradually increasing and ranged from 1202 to 1464 per 100 leaves. A percentage share of these arthropods in the B site varied in various years. The most herbivores were encountered in 2009, when they constituted 96% of all specimens, and the fewest were encountered in 2008, when they constituted 86% of the total number of collected specimens (Fig. 1A). During the years 2008-2009, in the A site, abundance levels of herbivorous arthropods remained roughly the same, whereas in the following year

2010 their abundance increased by ca. 40%. As for the percentage share of phytophages in that site, it showed a tendency for growth during the whole study period, beginning from the very first year (2008), and ranged from 93% to 98% of the total number of collected arthropods (Fig. 1B). Abundance levels of predators were similar in the B site and A site (Tab. 1). In the B site, in the first and second year of the study, a percentage share of predators was on a similar level and amounted to 6.7% and 5.1% respectively, whereas in the case of phytophages it amounted to 86.5% and 90.5% respectively. However, in 2009, in comparison with the other years, the percentage share of these arthropods was twice lower and constituted 2.6% of the total number of collected specimens, while the share of phytophages constituted 95.8%. Since the first year of the study, a gradual drop in the percentage share of predators was observed in the A site, whereas the share of herbivores was increasing year by year (Fig. 1A). During the whole study period, in the B site, parasitic arthropods constituted less than 5% of all collected arthropod specimens, and in the A site they were scarcely present (Fig. 1).

Arthropods feeding on mixed nutrients were not numerous in comparison to other groups. During the first year of the study, both in the B site and A site, their abundance levels were the highest, whereas in the remaining years they were encountered only sporadically (Tab.1).

Table 1. Total abundance of arthropods representing various trophic groups, collected in both research sited in the years 2008-2010 (specimens per 100 leaves)

	A site				**B site**			
	2008	**2009**	**2010**	**total**	**2008**	**2009**	**2010**	**total**
Herbivorous arthropods	1202	1360	1464	4026	3139	3105	5255	11499
Predatory arthropods	93	37	82	212	122	47	59	228
Parasitic arthropods	67	20	65	152	76	14	22	112
Arthropods feeding on mixed nutrients	27	3	7	37	24	16	4	44
Total	**1389**	**1420**	**1618**	**4427**	**3361**	**3182**	**5340**	**11883**

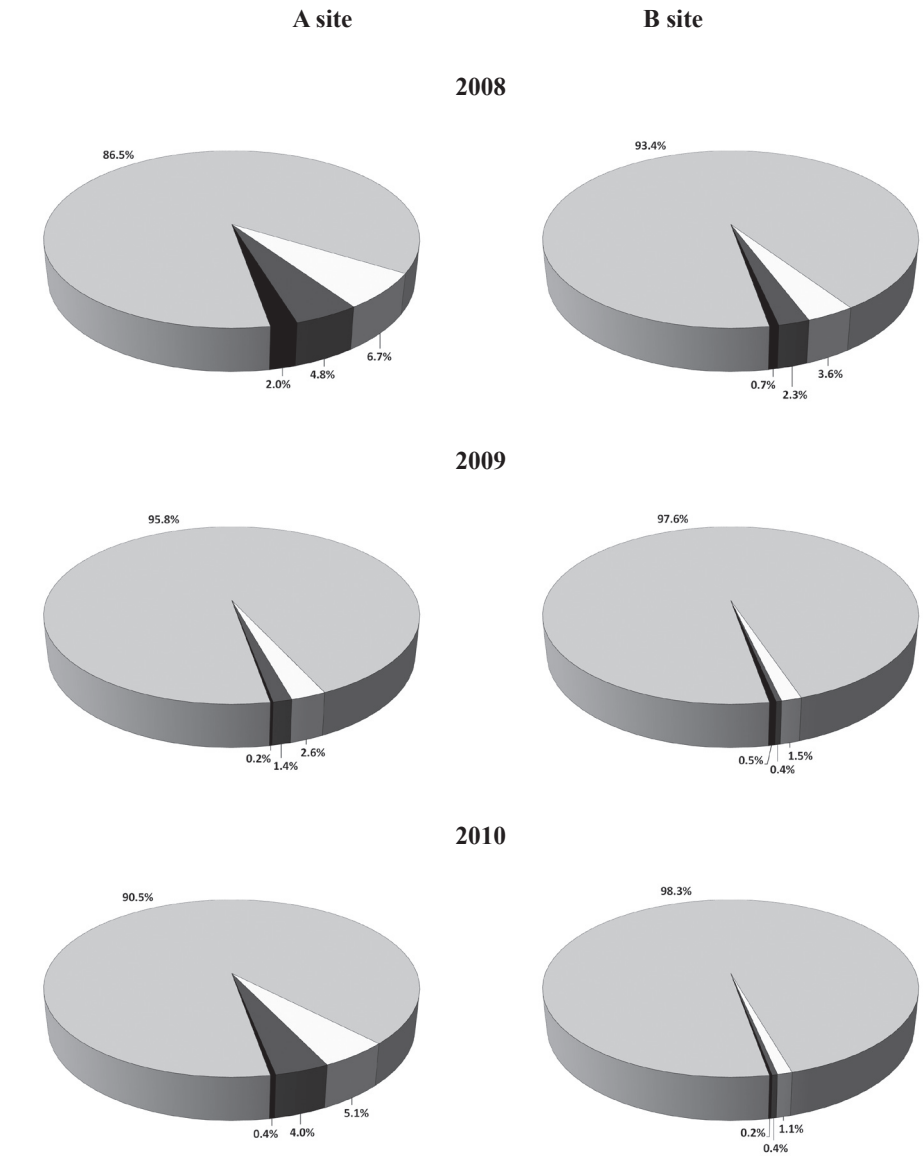

Figure 1. Percentage shares of arthropods representing particular trophic groups, settling a garden rose variety 'Bonica 82' in the years 2008-2010

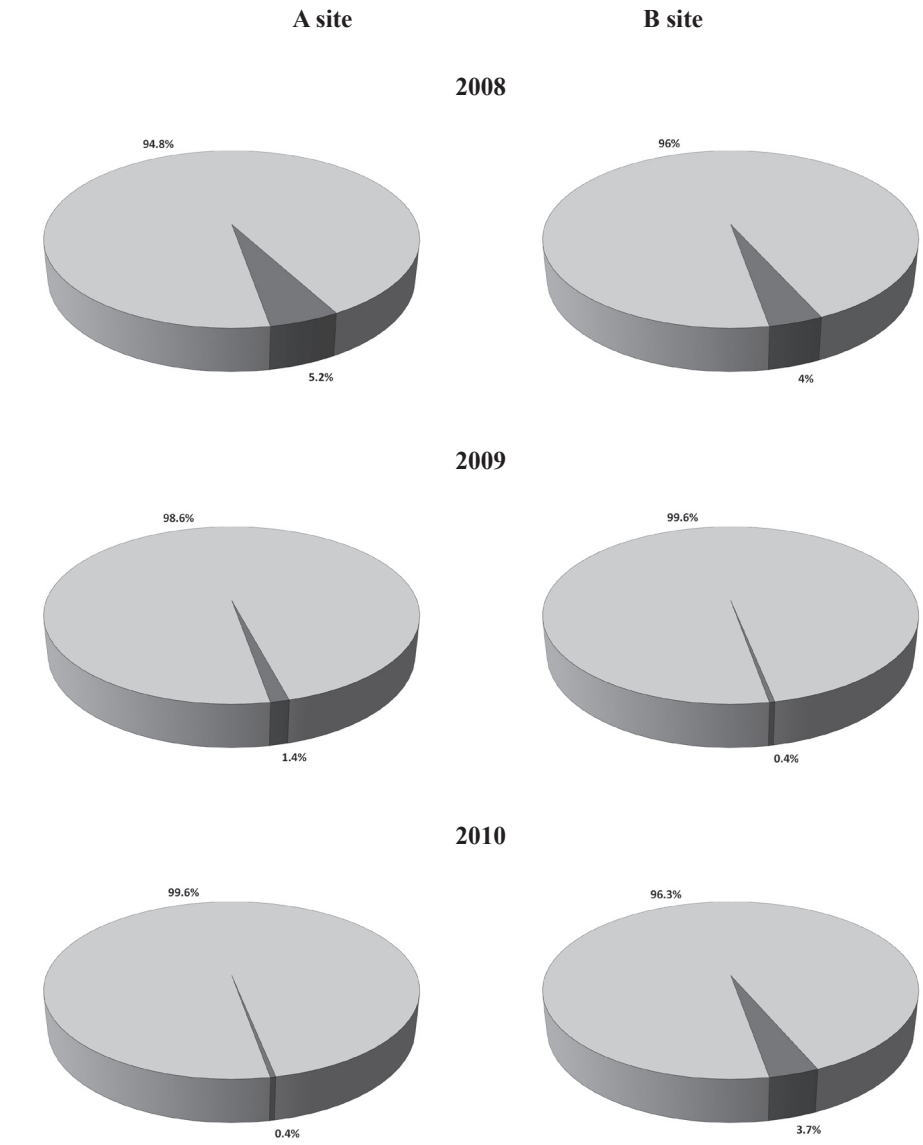

Figure 2. Percentage shares of arthropods with piercing-sucking and biting mouthparts settling a garden rose variety ‘Bonica 82’ in the years 2008-2010

A. Herbivorous arthropods

In the herbivorous group, arthropod species with piercing-sucking mouthparts clearly dominated (Fig. 2). These results confirmed, i.a., the results of studies conducted by Czechowska *et al*. (1979), Cichocka *et al*. (1990a and b) Cichocka & Goszczyński (1991); Wilkaniec (1994); Cichocka *et al*. (1998); Tykarska (2001) and Jaśkiewicz (2006), which had been devoted to many plant species characteristic of urban greenery. In the housing state site, piercing-sucking fauna constituted on average ca. 96% of the collected specimens, while in the A site it was slightly more abundant: the phytophages constituted ca. 99% of the total (Fig. 2).

Arthropods with piercing-sucking mouthparts were represented in greatest numbers by aphids (Fig. 3). The research conducted by Tykarska (2002) had proved that on the hybrid hawthorns *Crataegus* x*media* in Warsaw and Gdańsk, representatives of the Psylloidea were the most abundant.

Abundance of aphids in Lublin, regardless of the site, was increasing year by year. In the third year of the study (i.e. 2010), their number increased by 43% in comparison to the first year (i.e. 2008) (Fig. 3). The aphidophauna encountered on the studied rose variety was composed of the following species: *Macrosiphum rosae* (Linnaeus 1758), *Metopolophium dirhodum* (Walker 1849), *Maculolachnus submacula* (Walker 1848), *Myzaphis rosarum* (Kaltenbach 1843) and *Macrosiphum euphorbiae* (Thomas 1878). Similar data regarding other varieties of garden roses planted as part of urban greenery had been provided by Cichocka & Jaśkiewicz (2003), Jaśkiewicz (2005), Kmieć (2006), Kmieć (2007). Among the above mentioned aphid species, *Macrosiphum rosae* was the most abundant, whereas *Macrosiphum euphorbiae* was encountered only sporadically. It should be pointed out, however, that *Metopolophium dirhodum, Myzaphis rosarum* and *Macrosiphum euphorbiae* were encountered only in the A site, and no representatives of *Myzaphis rosarum* were recorded in 2009.

Percentage shares of the Aphididae in comparison to other arthropods with piercing-sucking mouthparts in particular years of the study, in the B site, amounted to 83%, 93.5% and 95.1%, respectively. In the A site, in particular years of the study, such percentage shares amounted to 93.8%, 96.5% and 98.8%, respectively. Both in the B site and A site, there was observed a growing tendency with regard to the percentage share of the Aphididae.

The highest number of the Cicadellidae, represented by *Edwardsiana rosae* (Linnaeus 1758), was observed in the first year of the study (2008) in the B site (72 specimens per 100 leaves). In the following years of the study (2009-2010) there was observed a gradual drop in the numbers of these arthropods. In the A site, representatives of the Cicadellidae were recorded in lower numbers, but still there was observed a clear drop in their numbers in the following years of the study (Fig. 3).

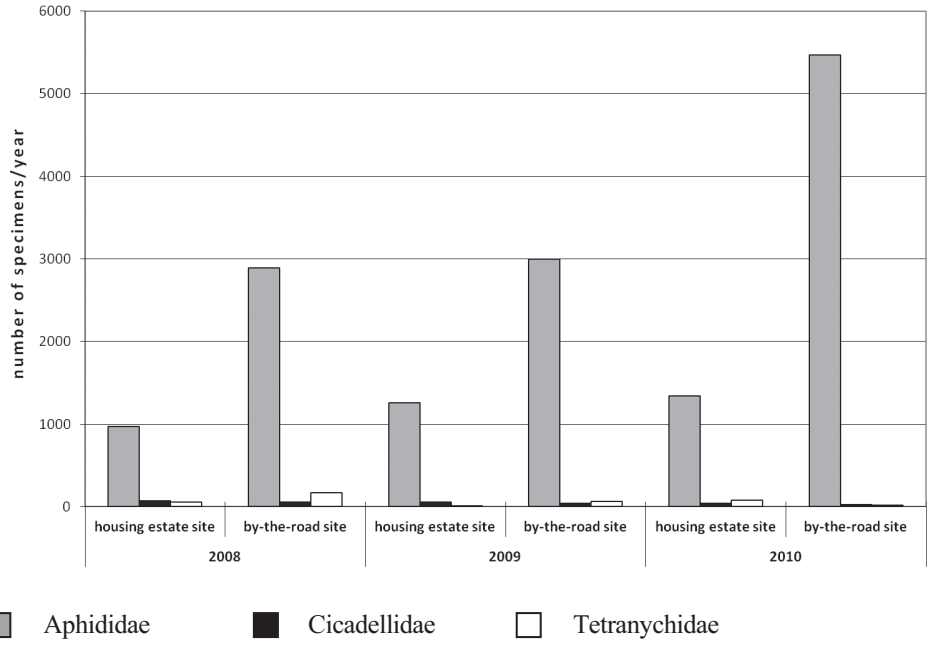

Figure 3. Abundance of the most numerous families of piercing-sucking arthropods settling a multiflorous garden rose variety 'Bonica 82' (2008-2010)

Apart from the Aphididae and Cicadellidae, there were observed large numbers of the Tetranychidae, whose abundance in the A site, during the three-year period of the study, was twice as high as in the B site (Fig. 3). It is worth noting that in that site, in the course of the first year of the study (i.e. 2008), the recorded number of spider mites was ten times higher in comparison to the last year (i.e. 2010). The family Tetranychidae was represented by *Tetranychus urticae* Koch 1836 and *Amphitetranychus viennensis* (Zacher 1920). During the three-year study cycle, *Amphitetranychus viennensis* (Zacher 1920), which had been known to settle roses only rarely, constituted 20% of all spider mites collected in the studied area. Moreover, in the studied sites there were recorded the representatives of the Thysanoptera, Cercopidae, Miridae, and the Auchenorrhyncha.

Arthropods with biting mouthparts were more abundant in the B site, thus confirming study results obtained earlier by Cichocka & Goszczyński (1991), Wilkaniec (1994) and Mackoś (2010). In the B site the prevalence of biting arthropods over piercing-sucking ones was the most significant in the first year of the study. Similar results were obtained in the A site (Fig. 2). Both in the B site and A site the most abundant were the larvae representing the family Tenthredinidae, constituting ca. 38% of all biting arthropods collected in these sites during the three-year study period.

The family was represented by the following species: *Allantus cinctus* (Linnaeus 1758), *Allantus calceatus* (Klug 1818), *Allantus truncatus* (Klug 1818), *Cladius pectinicornis* (Geoffroy 1785), *Blennocampa phyllocolpa* Viitasaari et Vikberg 1985, *Ardis pallipes* (Serville 1823) and *Cladardis elongatula* (Klug 1817). Some representatives of the order Hymenoptera were also recorded; they belonged to the family Argidae, represented by: *Arge pagana* (Panzer 1798) and *Arge ochropus* (Gmelin 1790). Those species constituted 20% of all biting arthropods collected in the study sites.

Larvae of hymenopterian insects fed mainly on rose leaves, either eating them up gradually or biting out irregular holes between veins. *Ardis pallipes* and *Cladardis elongatula* fed inside plant shoots, boring corridors for themselves. It seems noteworthy that hymenopterian insects from the family Tenthredinidae are also recorded in large numbers in nurseries of ornamental trees and shrubs (Soika & Łabanowski, 2000).

Among the remaining recorded arthropods there were identified representatives of the Coleoptera (*Phyllopertha horticola* (Linnaeus 1758) from the family Rutelidae and *Phyllobius argentatus* (Linnaeus 1758), *Anthonomus rubi* (Herbst 1795) from the family Curculionidae), caterpillars of several butterfly species which belonged to the Tortricidae, Lymantriidae, Geometridae and the Tischeriidae and larvae of *Dasineura rosae* (Bremi 1847), which represented dipteran insects from the family Cecidomyiidae. Feeding of these Diptera resulted in the development of galases caused by plant tissues being torn apart with biting mouthpart elements of those insects and cell walls being dissolved by the enzymes they secreted. Larvae of the Diptera fed mainly on the halves of small leaves oriented upwards, along the midrib (Szadziewski, 1999). It should be added, however, that they were not encountered in the A site during the whole three-year study cycle.

B. Predatory and parasitic arthropods

During the three-year study period, abundance levels of predatory arthropods were the same in both the B site and A site (Fig. 4). Among predators, beetles of the family Coccinellidae dominated in both sites. During the first year of the study, in the A site, their number was twice as high as in the following years. This phenomenon confirmed the results of a research by Czechowska *et al.* (1979), who had stated that insects from the family Coccinellidae were characterized by the lowest sensitivity to urban pressure factors. It was also a significant fact that apart from *Coccinella septempunctata* Linnaeus 1758 and *Adalia bipunctata* (Linnaeus, 1758) numerous specimens of *Harmonia axyridis* (Pallas 1773) were encountered. Representatives of that species constituted 32% of all collected ladybugs and were recorded more frequently in the B site. A major accusation against this Asian ladybug species is its expansiveness which may lead to

a reduction in the abundance of native ladybug species, or even to their extinction, not only due to foraging competition, but also due to its eating the larvae of the native species (Przewoźny *et al*., 2007; Pruszyński & Fiedler, 2009). Furthermore, among insects encountered in the B site, larvae of flies representing the family Syrphidae were encountered in considerable numbers. Among those that were bred, such species as *Syrphus vitripennis* Meigen 1822 and *Episyrphus balteatus* (De Geer 1776) were prevalent. Similar results had been obtained by Wnuk (2004), who had studied the occurrence of aphidivorous hoverflies in aphid colonies in the Botanic Garden of the Jagiellonian University in Kraków. As for the A site, in the course of the whole study cycle, there were encountered high numbers of larvae representing dipteran insects of the family Cecidomyiidae and larvae representing neuropteran insects of the family Chrysopidae. Three-year observation resulted also in recording not very numerous representatives of hemipteran insects from various families: Nabidae, Anthocoridae, Miridae, Reduviidae and Pentatomidae. These results confirmed the results of the research by Korcz (2000), who had concluded that zoophagous hemipteran insects were not very numerous in the agglomeration of Poznań but displayed a considerable species diversity.

Parasitic arthropods were less abundant in comparison to predatory ones. However, they were more frequently encountered in the B site (Fig. 4).

Parasitoids recorded on the studied rose variety were parasitic hymenopteran insects representing the genus *Aphidius.* In the site situated by the road, in two following study years (2008-2009), they constituted 60% and 70% of all parasites, respectively. In the last year of the study their abundance dropped by half and constituted 35% of the total number of parasites. Furthermore, in the housing estate state, during the whole study period, the most abundant among parasites were representatives of the genus *Ephedrus*, which were completely absent from the site by the road. The least abundant were representatives of the genus *Praon* sp. In the studied sites, in the first two years of the study (2008-2009), their abundance levels remained the same and equaled 50%, whereas in the last year (2010) they more frequently attacked aphids in the site by the road, constituting 66.7% of all parasites in that site. Abundance of parasitoids was identified mainly on the basis of the number of parasitized aphid mummies, while the name of a parasite was established on the basis of the color and shape of a mummy (Fig. 5).

C. Arthropods feeding on mixed nutrients

In both research sites, in the course of the entire study period, arthropods feeding on mixed nutrients were represented by species belonging to the Psocoptera and sporadically (individual specimens) by those belonging to the Tydeidae.

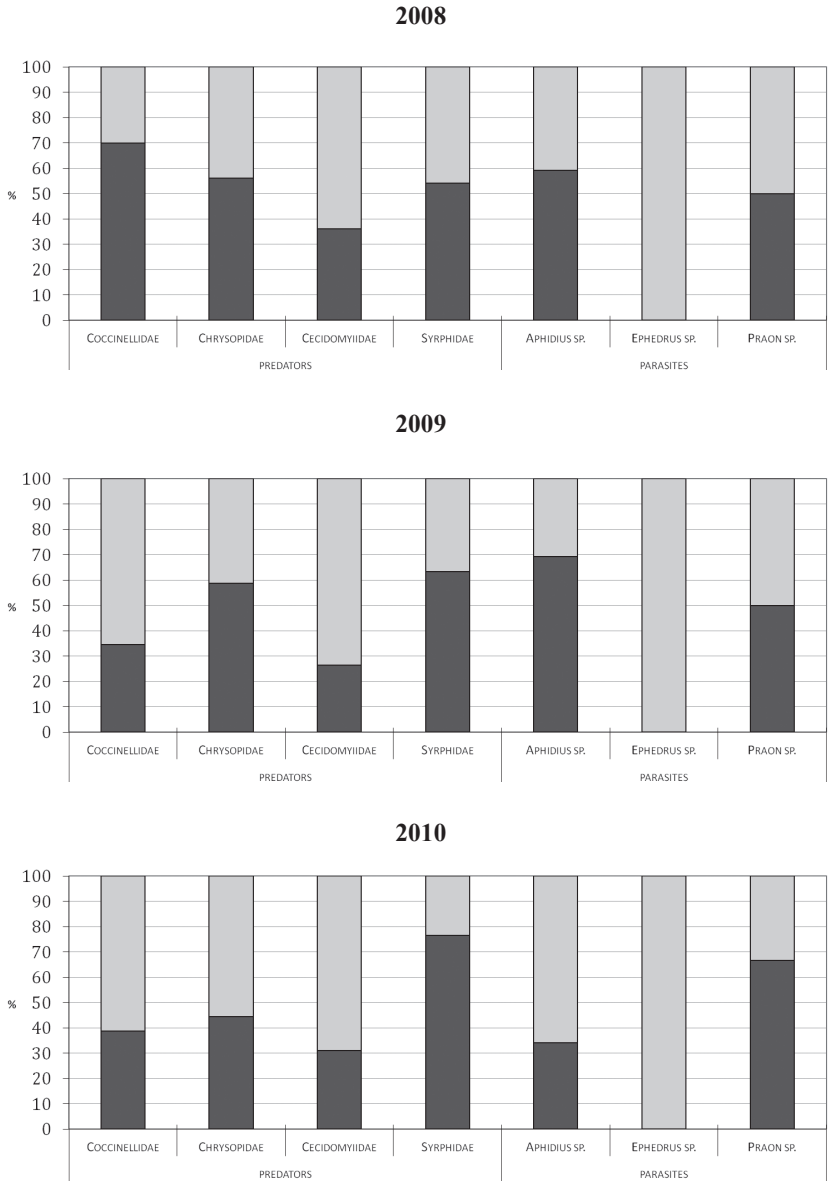

Figure 4. Percentage shares of the most abundant taxa of predators and parasites collected in both research sites in the years 2008-2010

Figure 5. Mummies of aphids parasitized by: a - *Aphidius* sp., b - *Ephedrus* sp., c - *Praon* sp.

CONCLUSIONS

According to the observations conducted in the years 2008-2010, herbivorous arthropods with piercing-sucking mouthparts were the dominant trophic group settling a multiflorous garden rose variety 'Bonica 82'. In both study sites the most abundant were representatives of the Aphididae, Auchenorrhyncha and Tetranychidae.

Biting arthropods were more abundant in the B site in comparison with the A site. In the B site the larvae of *Dasineura rosae* were recorded, which warped leaves by causing the appearance of swellings and red discoloration.

In the group of predators, the most abundant were beetles representing the family Coccinellidae. Among zoophages in the B site, apart from ladybugs, larvae of insects from the Syrphidae family were dominant, whereas in the A site the representatives of the Cecidomyiidae and Chrysopidae were recorded in high numbers.

Parasitoids observed on the studied rose plants were parasitic hymenoptera insects representing the family Aphidiidae. In both sites the Hymenoptera of the *Aphidius* sp. genus dominated. In comparison to the A site, the B site was characterized by a higher diversity both with respect to phytophages and zoophages.

Abundant presence of herbivorous arthropods on the studied plants resulted in much harm having been done to the leaves. Piercing-sucking arthropods feeding on leaves caused their deformation, whereas biting arthropods damaged leaf blades by biting off the epidermis and biting out holes in the leaves, as a result causing defoliation or development of galases lowering the esthetic value of plants.

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Stawonogi zasiedlające róże ogrodową odmiany 'Bonica 82' w zieleni miejskiej Lublina (południowo-wschodnia Polska)

STRESZCZENIE

W ramach niniejszych badań prowadzono obserwacje mające na celu określenie liczebności występowania fitofagów oraz stawonogów pożytecznych zasiedlających odmianę uprawną róży z grupy wielokwiatowych 'Bonica' 82' w warunkach miejskich, w zależności od nasilenia antropopresji. Badania prowadzone były na terenie Lublina

w latach 2008-2010. Wyznaczono dwa stanowiska badawcze: przyuliczne (A) – pas krzewów wzdłuż ruchliwej ulicy, osiedlowe (B) – krzewy rosnące w większym kompleksie zieleni, w otoczeniu innych roślin, w sąsiedztwie lasu, oddalone od tras komunikacyjnych. Zebrane stawonogi podzielono na grupy troficzne ze względu na preferencje pokarmowe. Z przeprowadzonych badań wynika, że dominującą grupą troficzną zasiedlającą odmianę uprawną róży z grupy wielokwiatowych ‘Bonica’ 82’ były stawonogi roślinożerne o kłująco-ssącym aparacie gębowym. W obu stanowiskach najliczniej występowała mszyca *Macrosiphum rosae*. Ponadto w stanowisku przyulicznym, obok mszyc bardzo licznie występowali przedstawiciele Tetranychidae, a w stanowisku osiedlowym Cicadellidae.

Wśród drapieżców w obu stanowiskach dominowały chrząszcze z rodziny Coccinellidae. Najliczniej występującymi owadami drapieżnymi w stanowisku przyulicznym byli przedstawiciele rodziny Cecidomyiidae, a w stanowisku osiedlowym Syrphidae. Parazytoidami obserwowanymi na badanych krzewach były pasożytnicze błonkówki z rodziny Braconidae. W obu stanowiskach dominowały błonkówki z rodzaju *Aphidius* sp.