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Structure of aphid communities (Hemiptera: Aphidoidea) in the Kórnik Arboretum near Poznań (West Poland)

JUSTYNA RATAJCZAK[1], BARBARA WILKANIEC[2]

Department of Entomology, Poznań University of Life Sciences, Dąbrowskiego 159, 60-594 Poznań, Poland, [1]e-mail: suncon2@onet.eu;
[2]e-mail: wilk@up.poznan.pl

ABSTRACT. The Kórnik Arboretum hosts 106 dendrophilic species of aphids, representing three families: Aphididae, Adelgidae and Phylloxeridae. *Phyllaphis fagi* is the eudominant there. Subdominants include species of Adelgidae, *Eucallipterus tiliae, Tinocallis platani* and *Myzocallis castanicola.* The distribution tail consisted of 101 species, of which 13 were recedents and 88 subrecedents. Such a structure confirms the quite high stability of the community.

KEY WORDS: aphidofauna, Hemiptera, Aphidoidea, trees, shrubs, park, Poland.

INTRODUCTION

Studies of the aphid fauna of trees have been conducted in Poland for several years, focusing on descriptions of the tree fauna of various green squares and parks in Warsaw (CICHOCKA & GOSZCZYŃSKI 1991), Poznań (WILKANIEC 1994, 1996, 1999, 2001, 2004, RUSZKOWSKA & WILKANIEC 2002, SZTUKOWSKA & WILKANIEC 2005, WILKANIEC et al. 2005), Lublin (JAŚKIEWICZ 1997), Gdańsk (TYKARSKA 2001) and Bytom and Katowice (OSIADACZ & WIECZOREK 2003, WIECZOREK & OSIADACZ 2005). They dealt mainly with the species composition and phenology of aphid occurrence; on the other hand, there are no detailed studies on the structure of aphid communities in those locations. So far no such study has been conducted in the Kórnik Arboretum either, where only a few aphid species have been found to date (ACHREMOWICZ 1967, 1972). This locality, abundant in indigenous and non-native trees and shrubs, is the perfect place for such research.

The purpose of the study was to define the species composition, abundance and

dynamics of aphid occurrence in the plant growth season in the aphid community infesting the Kórnik Arboretum dendroflora, and to compare the three communities that make up the local aphid fauna, namely those infesting the dendroflora of the Old Arboretum, the New Arboretum and the Zwierzyniec Experimental Forest.

STUDY AREA

The study was conducted in the Kórnik Arboretum during four growing seasons from 2005 to 2008. The Kórnik Arboretum, situated by Lake Kórnik between the towns of Kórnik and Bnin, 20 km south of Poznań, has long been widely known in Poland and abroad for its extensive collection of native and non-native trees and shrubs. In terms of the number of taxa it is among the largest dendrological parks in Central Europe with about 3500 species and varieties, and the number is still growing with new plants being added to the collection. It also boasts the oldest collections of trees and shrubs in Poland, dating back to the times when non-native trees and shrubs were first planted in the Kórnik park, i.e. the years 1826-1861, when the estate was owned by Tytus Działyński (BUGAŁA & BOJARCZUK 2003). The tree and shrub collections cover an area of 60 ha and are situated in the old park next to Kórnik Castle, in the so-called New Arboretum and in the Zwierzyniec Experimental Forest.

MATERIAL AND METHODS

Two study methods were used: Moericke traps and searching the plants for aphids.

The aphids were caught in Moericke traps from May until the end of October, the traps being emptied every ten days. 25 traps were placed throughout the Kórnik Arboretum at 1.5 m intervals. At the same time and intervals aphids were collected directly from trees and coniferous and deciduous shrubs. The extent of plant infestation by aphids was described using a five-level scale: level I – no aphids, level II – slight infestation (single specimens on plant organs), level III – moderate infestation (small and medium-sized colonies on plants), level IV – considerable infestation (large colonies on plant organs), level V – very substantial infestation (aphids cover whole plant organs). The aphids were preserved in test tubes with 75% ethyl alcohol. The material was classified using the keys by BLACKMAN & EASTOP (1994), HEIE (1980, 1982, 1986, 1992, 1994, 1995), MÜLLER (1976), SZELEGIEWICZ (1978, 1985) and TAYLOR (1984). In order to define the community structure of dendrophile aphids only some of the quantitative data obtained with the Moericke traps were used. This was based on the aphids collected in spring and summer, as the results of the autumn catch during the mass aphid migration were rejected. Then *Rhopalosiphum padi* was caught in the traps in large numbers. The species breeds in summer in grass and crops

– its secondary hosts – when populations are very numerous; their presence renders it very much more difficult to describe the structure of the aphid communities specifically related to the dendroflora.

The structure of the aphid communities was characterized on the basis of the following indices:

- the number of specimens (*N*);
- the number of species (*S*);
- the dominance index (*D*) (dominance is the percentage of specimens of particular species in the community);

the following dominance classes were adopted (according to DURAK & WOJCIECHOWSKI 2008):

eudominant – over 20% of the collected material,
dominant – 10 to 20% of the collected material,
subdominant – 5 to 10 % of the collected material,
recedent – 1 to 5 % of the collected material,
subrecedent – less than 1% of the collected material;

- Shannon's diversity index (*H'*) (SHANNON & WEAVER 1963)

$$H' = \sum_{i=1}^{S} \frac{n_i}{N} \log_2 \frac{n_i}{N}$$

where n_i – number of specimens of species *I*, *N* – total number of all specimens, *S* – the number of species;

- Pielou's evenness index (1966) (*J'*)

$$J' = \frac{H'}{H_{\max}} = \frac{H'}{\log_2 S}$$

where *S* – the number of species in the community;

- Simpson's index (1949) (*d*)

$$d = \frac{S-1}{\log N}$$

where *S* – the number of species in the community, and *N* – overall number of species

in community.

Finally, the Marczewski-Steinhaus index was applied (1959) (*MS*) to compare the community structures in terms of quality:

$$MS = \frac{c}{a+b-c} \times 100\%$$

where a and b – the number of species in the first and second community respectively, c – the number of species common to both compared communities.

Hutcheson's test (1970) was used to compare the quantity and quality of communities.

RESULTS AND DISCUSSION

In 2005-2008 the total of 186 aphid species or species groups found in the Kórnik Arboretum comprised the representatives of 3 families: Aphididae, Adelgidae and Phylloxeridae. 156 species or species groups were caught in Moericke traps, while plant searching yielded 96 species infesting the trees and shrubs of the Kórnik Arboretum. With such abundant material to hand, it was possible to describe the community structure of the Arboretum.

The community, containing 106 dendrophile aphid species collected in the Kórnik Arboretum, consisted of one eudominant and four subdominants, a total of 50.8% of the overall number of specimens. The eudominant was *Phyllaphis fagi* (D = 25.05%), while the subdominants included a group of Adelgidae (*Adelges* spp.) family species (D = 9.26%): *Eucallipterus tiliae* (D = 5.78%), *Tinocallis platani* (D = 5.56%) and *Myzocallis castanicola* (D = 5.12%). The proportion of the remaining 101 non-abundant species was 49.2%, with that of the 13 recedents reaching 35% and the 88 subrecedents 14.2%. Such a structure of the community is evidence for its high stability (Table 1, Fig. 1).

The dominance structures of aphid communities in the three studied sites of the Kórnik Arboretum varied (Fig. 2a,b,c).

Comparison of the aphid communities of particular parts of the arboretum, i.e. the Old Arboretum, the New Arboretum and the Zwierzyniec Experimental Forest, showed that the core of the communities and species represented numerously did not greatly vary. They were made up mainly of monophagous species. The communities of the Old Arboretum and New Arboretum were richer in the number of species and comprised 87 and 86 species respectively. Comparison of the figures presenting the structure of the communities at the three sites in question shows that the most stable community was the one in the Old Arboretum (Fig. 2a), whereas the poorest community was the one found in the Zwierzyniec

Experimental Forest owing to the lower number of species and rather simplified distribution of dominance classes (Fig. 2c).

Table 1. Dominance structure of dendrophile aphid communities collected in the Kórnik Arboretum in 2005-2007.

No.	Aphid species	2005-2007	
		Number of specimens	Dominance [%]
	EUDOMINANT		
1	*Phyllaphis fagi* (L.)	1331	25.05
	SUBDOMINANT		
2	*Adelges* spp.	492	9.26
3	*Eucallipterus tiliae* (L.)	307	5.78
4	*Tinocallis platani* (KALT.)	295	5.56
5	*Myzocallis castanicola* BAKER	272	5.12
	RECEDENT		
6	*Anoecia corni* (F.)	244	4.6
7	*Drepanosiphum platanoidis* (SCHRK.)	231	4.35
8	*Aphis* spp.	220	4.14
9	*Myzocallis coryli* GOETZE	167	3.14
10	*Phorodon humuli* (SCHRK.)	165	3.11
11	*Euceraphis betulae* (KOCH)	156	2.94
12	*Aphis fabae* SCOP.	153	2.88
13	*Cavariella aegopodii* (SCOP.)	126	2.37
14	*Rhopalosiphum padi* (L.)	112	2.11
15	*Periphyllus testudinaceus* (FERN.)	93	1.75
16	*Chaitophorus populialbae* (B. de F.)	73	1.37
17	*Hyalopterus pruni* (GEOFF.)	63	1.19
18	*Tuberculatus borealis* (KRZYW.)	54	1.02
	SUBRECEDENT		
19	*Chaitophorus populeti* (PANZ.)	47	0.88
20	*Clethrobius comes* (WALK.)	43	0.81
21	*Drepanosiphum aceris* KOCH	43	0.81
22	*Calaphis betulicola* (KALT.)	33	0.62

23	*Pterocallis alni* (DE GEER)	29	0.55
24	*Aphis sambuci* L.	28	0.53
25	*Brachycaudus divaricate* SHAP.	27	0.51
26	*Cavariella konoi* TAKAH.	27	0.51
27	*Chaitophorus leucomelas* KOCH	26	0.49
28	*Cavariella theobaldi* (GILL. et BRAGG)	25	0.47
29	*Cavariella pastinacea* (L.)	23	0.43
30	*Schizolachnus pineti* (F.)	23	0.43
31	*Tuberculatus annulatus* (HTG.)	22	0.41
32	*Eriosoma ulmi* (L.)	20	0.38
33	*Aphis pomi* DE GEER	18	0.34
34	*Brachycaudus cardui* (L.)	18	0.34
35	*Metopolophium dirhodum* (WALK.)	18	0.34
36	*Pterocomma populeum* (KALT.)	17	0.32
37	*Euceraphis punctipennis* (ZETT.)	15	0.28
38	*Acyrthosiphon pisum* HARRIS	12	0.23
39	*Calaphis flava* MORD.	12	0.23
40	*Anuraphis farfarae* (KOCH)	11	0.21
41	*Monaphis anntenata* KALT.	10	0.19
42	*Myzus ligustri* (MOSL.)	10	0.19
43	*Pterocomma pilosum* BUCKT.	10	0.19
44	*Betulaphis quadrituberculata* (KALT.)	9	0.17
45	*Aphis craccivora* KOCH	8	0.15
46	*Brachycaudus persicae* (PASS.)	8	0.15
47	*Hormaphis betulae* (MORD.)	8	0.15
48	*Prociphilus bumeliae* (SCHRK.)	8	0.15
49	*Cinara costata* (ZETT.)	7	0.13
50	*Dysaphis pyri* (B. De F.)	7	0.13
51	*Cryptomyzus galeopsidis* (KALT.)	6	0.11
52	*Eulachnus rileyi* (WILL.)	6	0.11
53	*Anuraphis subterranea* (WALK.)	5	0.09
54	*Aphis idaei* V. D. GOTT	5	0.09
55	*Kaltenbachiella pallida* (HAL.)	5	0.09
56	*Mindarus abietinus* KOCH	5	0.09

57	*Tetraneura ulmi* (L.)	5	0.09
58	*Brachycaudus helichrysi* (KALT.)	4	0.08
59	*Chaitophorus salicti* (SCHRK.)	4	0.08
60	*Cinara pilicornis* (HTG.)	4	0.08
61	*Ovatus insitus* (WALK.)	4	0.08
62	*Rhopalosiphum nymphaeae* (L.)	4	0.08
63	*Sitobion fragariae* (WALK.)	4	0.08
64	*Thelaxes dryophila* (SCHRK)	4	0.08
65	*Amphorophora rubi* (KALT.)	3	0.06
66	*Corylobium avellanea* (SCHRK.)	3	0.06
67	*Callipterinella tuberculata* (HEYD.)	3	0.06
68	*Dysaphis plantaginea* (PASS.)	3	0.06
69	*Hyadaphis foeniculi* (PASS.)	3	0.06
70	*Myzus cerasi* (F.)	3	0.06
71	*Ovatus crataegarius* (WALK.)	3	0.06
72	*Pemphigus* sp.	3	0.06
73	*Prociphilus pini* (BURM.)	3	0.06
74	*Thecabius affinis* (KALT.)	3	0.06
75	*Callipterinella calliptera* (HTG.)	2	0.04
76	*Ceruraphis eriophori* (WALK.)	2	0.04
77	*Elatobium abietinum* (WALK.)	2	0.04
78	*Glyphina betulae* (L.)	2	0.04
79	*Melanaphis pyraria* (PASS.)	2	0.04
80	*Myzus lythri* (SCHRK.)	2	0.04
81	*Periphyllus acericola* (WALK.)	2	0.04
82	*Periphyllus aceris* (L.)	2	0.04
83	*Periphyllus hirticornis* (WALK.)	2	0.04
84	*Phylloxera* spp.	2	0.04
85	*Acyrthosiphon caraganae* (CHOL.)	1	0.02
86	*Capitophorus elaeagni* (DEL GU.)	1	0.02
87	*Cavariella archangelicae* (SCOP.)	1	0.02
88	*Chaitophorus tremulae* KOCH	1	0.02
89	*Cinara pruinosa* (HTG.)	1	0.02
90	*Cryptomyzus korschelti* BÖRN.	1	0.02

91	*Drepanosiphum acerinum* (WALK.)	1	0.02
92	*Eulachnus brevipilosus* BÖRN.	1	0.02
93	*Hyperomyzus lactucae* (L.)	1	0.02
94	*Hyperomyzus pallidus* H. R. L.	1	0.02
95	*Illinoia azaleae* (MASON)	1	0.02
96	*Liosomaphis berberidis* (KALT.)	1	0.02
97	*Macrosiphum* sp.	1	0.02
98	*Macrosiphum rosae* (L.)	1	0.02
99	*Metopolophium albidum* H. R. S.	1	0.02
100	*Myzus persicae* (SULZ.)	1	0.02
101	*Nasonovia ribisnigri* (MOSL.)	1	0.02
102	*Neomyzus circumflexum* (BUCKT.)	1	0.02
103	*Panaphis juglandii* GOEZE	1	0.02
104	*Rhopalosiphum insertum* (WALK.)	1	0.02
105	*Therioaphis tenera* (AIZENB.)	1	0.02
106	*Tuberculatus quercus* (KALT.)	1	0.02
Number of specimens:		**5313**	**100**
Number of species:		**106**	

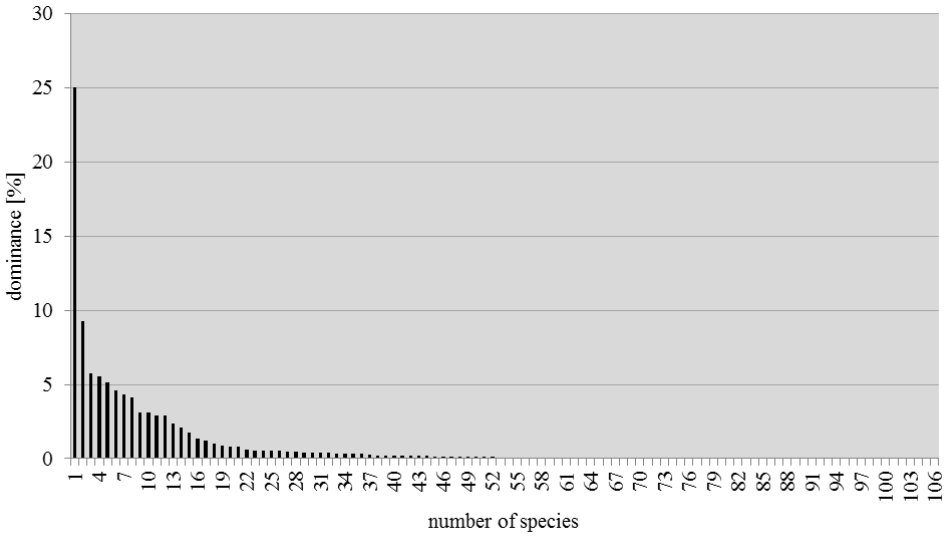
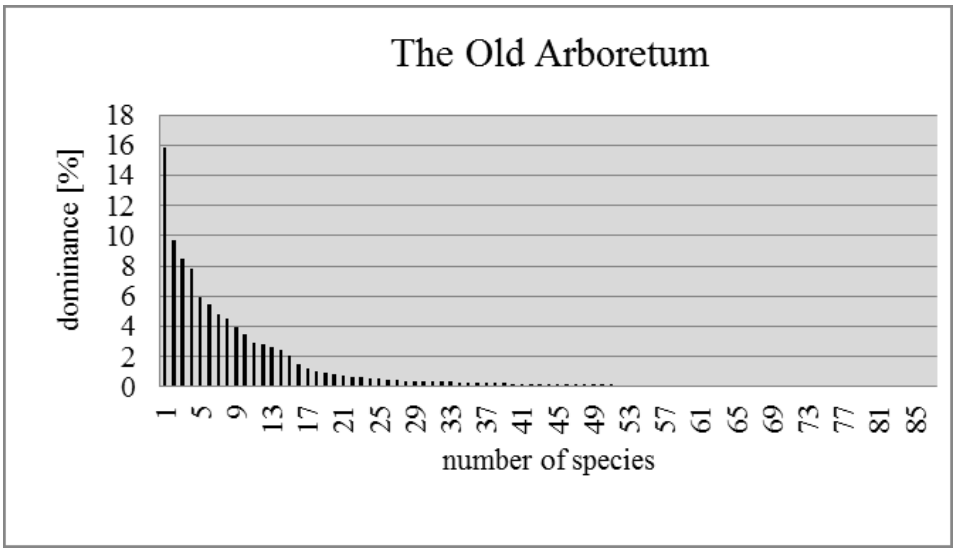
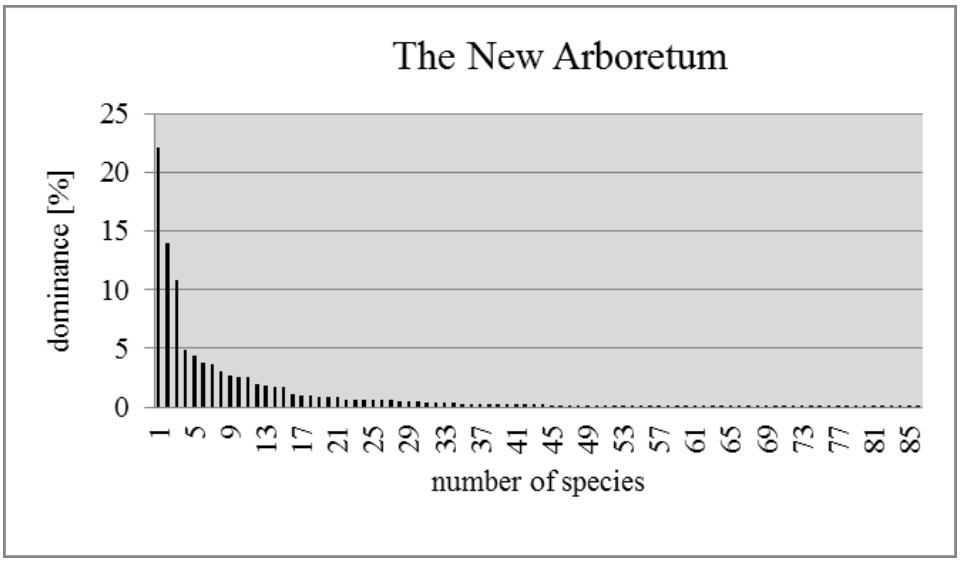


Fig. 1. Dominance structure of the dendrophile aphid communities in the Kórnik Arboretum.

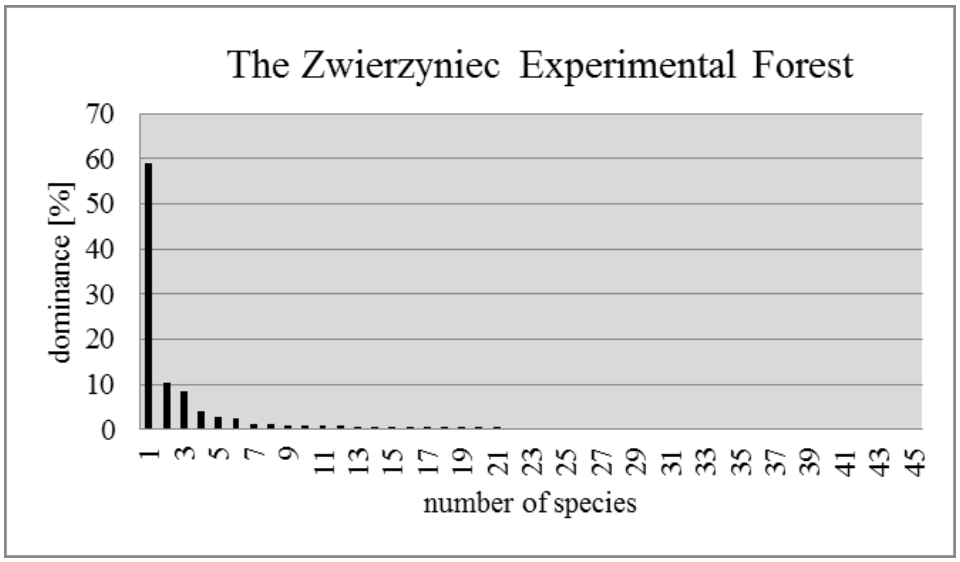


a)



b)

Fig. 2 a, b. Dominance structure of the dendrophile aphid communities in: a) the Old Arboretum, b) the New Arboretum of the Kórnik Arboretum in 2005-2007.



c)

Fig. 2 c. Dominance structure of the dendrophile aphid communities in the Zwierzyniec Experimental Forest of the Kórnik Arboretum in 2005-2007.

Shannon's diversity index (*H'*) for the whole Kórnik Arboretum reached 4.48 in the study. An analysis of its values for particular sites in the Kórnik Arboretum showed it to vary, thus giving reason to believe that the quality and quantity structures of those communities also greatly varied. The index reached its peak value in the Old Arboretum (4.62), was smaller in the New Arboretum (4.41), and least in the Zwierzyniec Experimental Forest (2.57) (Table 2).

Pielou's evenness index (*J'*) for the whole Kórnik Arboretum also reached the high value of 0.67. The aphid community in the Old Arboretum had the highest index (0.72), which demonstrates that the community was made up of species more evenly distributed than the other ones. The lowest value of the index was in the Zwierzyniec Experimental Forest (0.47) (Table 2).

Simpson's index of species abundance (*d*) for the whole aphid community reached 28.2. It may be inferred from a comparison of the communities on the basis of this index that the most abundant aphid fauna was in the Old Arboretum (25.8); a slightly lower abundance was calculated for the New Arboretum (25.2) and a much lower one was found in the Zwierzyniec Experimental Forest (15.2) (Table 2).

Table 2. Biocenotic indices characterizing aphid communities at particular sites in the Kórnik Arboretum.

Sites	Number of specimens (*N*)	Number of species (*S*)	*H'*	*J'*	*d*
The Old Arboretum	2138	87	4.61*	0.72	25.8
The New Arboretum	2383	86	4.41*	0.69	25.2
The Zwierzyniec Experimental Forest	792	45	2.58*	0.47	15.2
The Kórnik Arboretum	5313	106	4.48	0.67	28.2

* – significance level of difference between values (t-test) = 0.05

After comparing the communities in terms of quality using the Marczewski-Steinhaus index (*MS*) it was established that the communities of the Old and New Arboreta had a similar species composition (Table 3). *MS* showed that the species structures of the aphids infesting those habitats were identical at 64.8%. More significant differences in species composition were observed among the aphids caught in the New Arboretum and the Zwierzyniec Experimental Forest as well as in the Old Arboretum and the Zwierzyniec Experimental Forest. A comparison of the species composition of aphids reported from those sites indicates that the degrees of similarity of the aphid species structure were not very different – 40% and 41% respectively.

Hutcheson's test was applied to compare the aphid communities of particular parts of the Arboretum both quantitatively and qualitatively, and the differences between them were proven statistically on the basis of Shannon & Weaver's formula (Table 2).

The results may be compared with those of studies carried out at the Botanical Garden or the Dendrological Garden in Poznań using similar methods.

In the 2000 study on aphid occurrence conducted in the Dendrological Garden, Poznań (WILKANIEC 2001) with two methods (Moericke traps and searching plants for aphids), a total of 105 aphid species was found, 78 of which were caught in yellow traps and 64 were found directly on plants. The dominant species were *Rhopalosiphum padi*, *Drepanosiphum platanoidis*, *Anoecia corni* and several species of the *Periphyllus* genus.

Table 3. The values (%) of the Marczewski-Steinhaus index (*MS*) for aphid communities.

Sites	The Old Arboretum	The New Arboretum
The Old Arboretum	–	64.8%
The Zwierzyniec Experimental Forest	41%	40%

Further studies, during which by searching trees and shrubs in the Poznań Dendrological Garden were searched in seasons 2001 and 2002 (SZTUKOWSKA & WILKANIEC 2005), yielded 47 aphid species infesting 26 tree and 38 shrub species. These studies indicated that species diversity was the highest in spring and that the species most frequently reported in samples was *Periphyllus testudinaceus.*

Similar results were obtained in studies in the Botanical Garden of the Adam Mickiewicz University, Poznań (WILKANIEC 2004). In 2002-2003 107 aphid species were reported from there. 93 species were caught in Moericke traps, the most numerous being *Rhopalosiphum padi* and *Anoecia corni*. Searches of trees and shrubs yielded 29 aphid species on trees and 17 species on shrubs. The most numerous species infesting trees were *Rhopalosiphum padi, Anoecia corni, Drepanosiphum platanoidis*, *Periphyllus testudinaceus*, *Phyllaphis fagi, Aphis fabae* and *Aphis cytisorum.* Those numerous on shrubs include *Aphis fabae, Anoecia corni, Aphis cytisorum* and *Aphis pomi*.

On the other hand, studies of the aphid fauna of Poznań parks (WILKANIEC et al. 2005) conducted in the Botanical Garden of the Adam Mickiewicz University and Dendrological Garden of the August Cieszkowski University of Life Sciences, Poznań, in the early years of the 21st century yielded a total of 130 aphid species. 100 species were caught in Moericke traps, while direct collection of aphids from trees and bushes produced a further 30 species in the parks which had not been caught in yellow traps. After an analysis of the study results, 10 species were found which occurred in the parks regularly and numerously. They included *Rhopalosiphum padi*, *Anoecia corni*, *Drepanosiphum platanoidis*, *Periphyllus testudinaceus*, a group of species of the genus *Adelges*, *Phorodon humuli, Eucallipterus tiliae*, *Aphis fabae*, *Phyllaphis fagi* and *Tinocallis platani*.

A comparison of the study results obtained at the Kórnik Arboretum and the Dendrological and Botanical Gardens in Poznań shows that the Kórnik Arboretum has a much richer aphid fauna. The main reason for such abundance is the richness of its

greenery (c. 4000 taxa). The differences in species composition concern mainly the species that are not abundant in communities, while all the taxa defined as dominant were the same in all the communities studied and can thus be deemed characteristic of the local dendroflora.

To sum up the results of the present study: the Kórnik Arboretum is an attractive habitat for dendrophile aphids, evidence for which is the abundant aphid fauna collected there.

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