APHIDS AND OTHER HEMIPTEROUS INSECTS	Vol. 16 (2010) 79–90

Changes in aphid migration dynamics around Winna Góra (Wielkopolska) in 2000-2008

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Abstract

In years 2000-2008 aphid migrations were studied using suction traps in Winna Góra in the region of Wielkopolska. The research on dynamics of many years' long flights showed an increased number of aphids in the catches every other year. In the composition of the caught species amounting to 56 – 106 taxons there were all those most harmful to crop plants. The analysis of aphid seasonal flights pointed out to a clear tendency to decrease the disproportion between total number of aphids caught in the suction trap in spring, summer and autumn. One could observe that high temperatures lasting for a long time in summer had an unfavourable impact on the course of aphid migration as it led to a severe hampering of aphid flights. In case of some species it even reduced their entire populations. A clear increase in aphid numbers in autumnal suction trap catches was connected with a greater number of warm and sunny days which took place more and more often and which favoured aphid migration at this time.

Introduction

Out of many aphid species which occur in Poland most of them are harmful to host plants by directly sucking juices out of plants and thus infecting them with plant viruses. The role of aphids as plant pests is enhanced by genetic diversity within species and extensive biological flexibility and adaptation ease in the changing environmental conditions which may always result in their sudden and mass presence on crops. The phenomenon of migration which is related to a seasonal change of host plant is a permanent element in the process of aphid population development and for many species it is simply indispensable for a complete generation transformation during growth season. Such short outline of aphids and their biological abilities shows, in the face of a potential threat posed by pests to crops every year, how important a role is played by permanent monitoring of the onset of migration and dynamics of their development on host plants during the entire growth season.

One of the most objective and effective methods of assessment of aphid population flights is Johnson's suction trap (12.2 m – 40 feet tall) which catches aphids as specific air plankton out of those layers of the air in which aphids are densely distributed which allows one to state the presence of winged aphids in the air a few days earlier in comparison with the possibility of finding them directly on host plants in a field (BROOK, 1973).

The first kind of this trap was established by Johnson in 1950 and later was modified by Taylor. Johnson's suction trap catches carried out in large and open areas signal the appearance of winged aphids up in the air around few days in advance in comparison with the possibility of finding them on crops (JOHNSON, 1969).

Such kinds of suction traps are applied in Western Europe and in Poland. They are used to catch and measure the density of migrating aphid populations in the air. They do not attract or repel insects, collecting samples effectively and systematically from large air volumes in all kinds of atmospheric conditions. At present in Poland there are four suction traps catching aphids: one in Poznań operating since 1970 and three new ones with identical technical parameters strictly cooperating with one another: one in Winna Góra (Wielkopolska region) established in 1998, one in Sośnicowice (Silesia) since 2006 and one in Białystok (in an experimental station of the Institute of Plant Protection in Poznań) since 2008. In the nearest future several others will be launched with exactly the same construction: in Rzeszów and Toruń, thus initiating the program of widening of the national monitoring of aphid migration. The obtained results of aphid suction trap catches determine precisely the composition of aphid fauna migrating in the monitored areas and register all its modifications taking place as a result of climate and environmental changes. Moreover, they quickly inform one about the changes in the extent of some species and mass flights to new areas and crops. An important element of the analysis of aphid migration as registered by the suction trap is the registration of the onset of flights of economically important pests on crops and an assessment of dynamics of their seasonal flights. The determination of first migrants of harmful aphid species and in particular virus vectors' flight time on the basis of suction trap catches as well as the examination of the rhythm of seasonal flights have a practical use in plant protection. The results of this research enable one to early signal the appearance of many harmful pests. They allow one to plan the protective treatment, if necessary, during growth season and to create realistic basis to work out short- and long-term forecasting methods to assess the increase in numbers of some aphid species. All the important information on the seasonal migration of aphids taken from the suction trap in Winna Góra and Sośnicowice is provided on the website of the Department of Methods of Forecasting and Pest Registration at the Plant Protection Institute in Poznań.

Methods

The research on aphid migration was carried out in a field experimental station of the Institute of Plant Protection in Winna Góra (Wielkopolska region) at which in year 1998 a new Johnson suction trap was installed. This trap is 12.2-meter-high, it has a tubus which is 9-meter-long and the diameter of which is 25 cm. Inside the cabin there is a ventilator sucking air in through the tubus into a cone-shaped filter, at the end of which there is a container filled with water into which insects are caught.

Between the years 2000 – 2008 systematic aphid catches from the air were conducted using the Johnson's suction trap. Each year the trap was set up at the beginning of May and was catching aphids daily between 7 am until 10 pm until the migration ceased at the end of November. In all the years the same division of the growth season into three periods was applied: spring – from the beginning of aphid migration until 30 June, summer – from 1 July until 14 August and autumn – from 15 August until the ending of aphid flights. This division does not correspond with the calendar seasons. It was adapted on the basis of observations of times of appearance of particular species' various morphs and the environmental factor impact. The container with insects caught every day was exchanged at the same time of each day (1 pm) and the insects were stored in 70% alcohol. The species of isolated aphids were instantly identified and specimens difficult to identify were mounted on microscope slides and identified under a magnifying microscope.

Results and discussion

In 2000 – 2008 extensive changeability in aphid flight dynamics was observed in the region of Wielkopolska in around the village of Winna Góra. In the subsequent years rises and falls in the total number of aphids in Johnson's suction trap catches took place regularly every other year (ZŁOTKOWSKI & WOLSKI, 2008). A characteristic diagram of aphid frequency showing their two year cycle of increased migrations was formed (Fig. 1).

Maximum aphid numbers in suction trap catches were observed on a higher and higher level, whereas the minimum number of aphids did not fall below 5 thousand and throughout all the years it fluctuated between 5 – 6 thousands of aphids.

In the analysis of aphid migration the assessment of composition of species caught had a large significance. Across the research years (2000-2008) quite a stable number of species caught every year, ranging from 56 (in year 2003) up to 109 (2008), among which there were all the most harmful and the strongly migrating crop plant pests were recorded (Tab. 2). The highest number of identified aphid species caught in the Johnson's suction trap in Winna Góra was observed in 2008 and it is presented as an example in table 1.

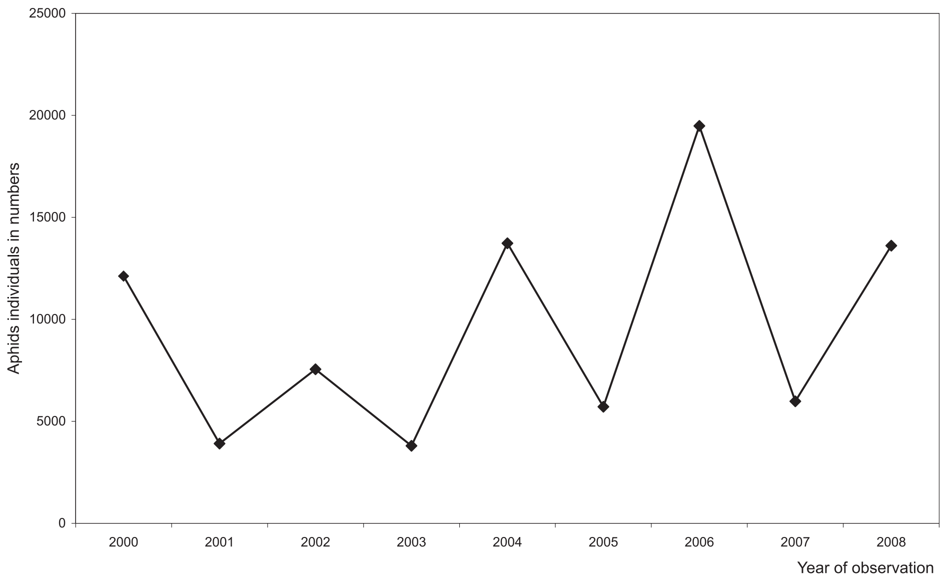

Figure 1. Dynamics of several years of aphid flights in the Johnson suction trap, Winna Góra (2000-2008)

Table 1. Index of aphid species and number of individuals registered by the Johnson suction trap in Winna Góra, (2008)

Aphid species	Spring	Summer	Autumn	Total
Rhopalosiphum padi	1489	368	1002	2859
Cavariella aegopodi	1147	14	9	1170
Chaitophorus spp.	1033	40	5	1078
Anoecia corni / vagans	10	33	995	1038
Phorodon humuli	771	3	-	774
Hyalopterus pruni	373	139	106	618
Aphis spp.	192	113	186	491
Adelgidae spp.	215	39	225	479
Pemphigus bursarius	123	67	237	427
Myzus persicae	193	51	133	377
Euceraphis punctipenis	311	14	26	351
Brachycaudus helichrysi	232	60	24	316
Dysaphis crataegi	168	38	56	262
Rhopalosiphum inserthum	52	22	143	217
Sitobion avenae	127	76	11	214
Brevicorynae brassicae	47	54	87	188
Aphis fabae	91	32	44	167
Drepanosiphum platanoidis	149	-	1	150
Drepanosiphum aceris	136	-	5	141
Tetraneura ulmi	15	26	94	135
Hyperomyzus lactucae	98	-	24	122
Acyrthosiphon pisum	71	30	5	106
Metopolophium dirhodum	79	23	3	105
Cavariella theobaldi	84	12	2	98
Cryptomyzus galeopsidis	87	4	3	94
Therioaphis trifolii	69	10	10	89
Eucalipterus tiliae	65	16	-	81
Capitophorus hipophes	72	6	-	78
Aphis nasturtii	34	27	-	61
Tinocalis platani	52	8	-	60
Brachycaudus rumexicolens	52	5	-	57
Capitophorus eleagni	47	-	7	54
Aphis frangulae	38	10	6	54
Thelaxses driophilla	48	6	-	54
Dactynotus sp.	33	7	12	52
Periphyllus coracinus	50	-	-	50
Pterocalis alni	29	17	-	46
Macrosiphum rosae	41	-	-	41
Tuberculoides annulatus	41	-	-	41
Macrosiphoniella tapuske	32	7	-	39

Myzus lythri	38	-	1	39
Hyperomyzus pallidus	16	12	7	35
Sitobion fragariae	17	12	1	30
Eulachnus agilis	24	-	2	26
Dysaphis plantaginea	21	3	1	25
Dactynotus jaceae	7	18	-	25
Aulacorthum solani	18	6	-	24
Eriosoma ulmi	8	6	10	24
Myzus cerasi	17	7	-	24
Nasonovia ribisnigri	19	3	-	22
Ovatus crategarius	11	10	1	22
Pemphigus spirotecae	4	7	10	21
Cinara boerneri	17	2	1	20
Calipterinella caliptera	3	17	-	20
Dactynotus cirsii	8	7	2	17
Aphis viburni	9	8	-	17
Acyrthosiphon pelargonii	16	-	-	16
Pleotrichophous glandulosus	14	1	1	16
Hayhurstia atriplicis	12	3	-	15
Macrosiphoniella sp.	4	11	-	15
Aphis sambuci	10	2	2	14
Phyllaphis fagi	14	-	-	14
Brachycandus cardui	12	-	1	13
Macrosiphoniella usquertensis	10	3	-	13
Anuraphis farfarae	4	8	-	12
Dactynotus similis	2	9	-	11
Thecabius affinis	3	6	2	11
Cinara laricis	11	-	-	11
Cryptomyzus ribis	9	1	-	10
Macrosiphum euphorbiae	8	2	-	10
Myzaphis rosarum	7	3	-	10
Metopolophum festucae	7	2	-	9
Sipha glyceriae	9	-	-	9
Lipaphis erisimi	3	4	1	8
Dysaphis spp.	1	6		7
Cinara sp.	-	2	5	7
Salthusaphis spp.	5	2	-	7
Dysaphis pyri	6	1	-	7
Pterocomma salicis	1	6	-	7
Forda formicaria	4	1	2	7
Periphyllus aceris	7	-	-	7
Macrosiphoniella arthemisiae	-	6	-	6
Microlophium evansi	6	-	-	6
Schizolachnus pineti	-	6	-	6
Geoica utricularia	-	5	1	6

Periphyllus testudinaceus	6	-	-	6
Hyadaphis foeniculi	4	1	-	5
Aphis viburni	4	-	1	5
Schizaphis graminum	4	1	-	5
Aphis idei	3	2	-	5
Eulachnus brevipilosus	4	1		5
Rhodobium porosum	5	-	-	5
Rhopalosiphum maydis	-	5	-	5
Myzus ajuge	4	1	-	5
Amphorophora rubi	4	1	-	5
Hyadaphis tataricae	4	-	-	4
Coloradoa arthemisiae	-	4	-	4
Corylobium avelane	4	-	-	4
Cavariella archangelicae	3	-	-	3
Acyrthosiphon loti	2	1	-	3
Laingia psammae	2	1	-	3
Dysaphis radicola	3	-	-	3
Atheroides serrulatus	3	-	-	3
Calistaphis flava	-	3	-	3
Myzus lygustri	-	2	1	3
Tuberculoides annulatus	-	2	-	2
Cinara pini	1	-	1	2
Dysaphis radicola	2	-	-	2
Myzus myosotidlis	-	2	-	2
Hyperomyzus rinanthi	1	-	-	1
Microlophium evansi	-	1	-	1
Pemphigus fenax	-	-	1	1
Myzus certus	-	1	-	1
Izyfia bufo	1	-	-	1
Megoura viciae	-	1	-	1
Longicaudus trirhodus	-	1	-	1
Total	**8482**	**1616**	**3516**	**13614**

Seasonal presence in Johnson's trap catches in Winna Góra was only 109 aphid taxons which was not impressive taking into account nearly 800 species found in Poland. One has to remember that most of them are rare species or those which are not present every year in a given area in which suction trap catches are conducted. Not all the species are caught in the trap in the same intensity throughout the whole growth season. *Anoecia* spp., especially *Anoecia corni* and *Anoecia vagans* can be used as a good example as they were caught intensively in the suction trap only during autumn, while in the spring and summer only single specimens were recorded. Table 2 presents 8 species which were caught in highest numbers in particular years. Out of aphids migrating throughout the entire growth season of particular years, *Rhopalosiphum padi* was a decisive dominant. The number of this species specimens caught much exceeded the remaining species and in 2007 it amounted up to 60% of the total number of aphids caught. The second place on the list of the most numerous species is taken by aphids of the *Anoecia* spp. genus, which decidedly migrate in highest numbers in autumn. Migration of the six remaining species as stated in table 2 was much smaller in the discussed period and amounted from 2.1 – 3.9% of all the aphids caught.

Table 2. Percentage share of most frequently caught aphid species in the Johnson suction trap, Winna Góra, (2000-2008)

Year	***Rhopalosiphum padi***	***Anoecia corni***	***Cavariela aegopodi***	***Sitobion avenae***	***Myzus persicae***	***Hyalopterus pruni***	***Brevicoryne brassicae***	***Phrodon humuli***
2000	21.4	5.0	2.3	3.8	4.1	4.4	0.8	0.6
2001	30.1	4.4	1.5	0.1	2.8	5.2	1.8	1.7
2002	23.2	7.3	7.6	4.4	3.6	6.9	6.6	1.5
2003	29.6	6.5	1.2	3.9	2.6	5.2	2.0	1.7
2004	15.6	6.6	3.4	17.4	4.2	1.7	3.4	2.8
2005	34.6	7.5	3.4	0.9	3.0	2.4	7.5	0.5
2006	46.5	16.9	5.5	0.6	3.1	1.2	0.3	2.6
2007	57.8	5.8	2.4	3.2	9.5	1.0	0.5	2.7
2008	21.0	7.6	8.6	1.6	2.7	4.5	1.4	5.6
average	31.1	6.6	3.9	3.8	3.6	3.1	2.5	2.1

From the plant protection point of view, seasonal dynamics is an important element of the analysis of aphid migration across the year, it is of key importance for a quick signalling of the onset of appearance of the most important crop pests which also provides essential data to assess the short and midterm forecasting of their populations development in the growth season. Figure 2 presents the course of aphids seasonal migration during the period since the beginning of suction trap catches in Winna Góra from 1998 until 2008. The obtained results were graphically compared also with the results of previous identical catches results as conduced in Poznań in 1976-1980. When analyzing the course of aphid migration in 1998-2008 one can (especially after 2008) observe a progressing gradual decrease of the disproportion in the increase of flights in spring, summer and autumn (ZŁOTKOWSKI, 2005). Favourable temperature during autumn, which prolongs and intensifies migration, influences such a course of annual migration and is more and more observed either after a warm and dry summer or an excessively rainy and cold summer which hampers aphid flight dynamics. When comparing the course of aphid seasonal migration in 1998-2008 in Winna Góra with previous research in Poznań in 1976-1980 (Fig. 2) one could trace large differences showing a strong increase in aphid flights in the surroundings of Poznań, mainly in summer, after which their number was smaller and autumnal migration shorter.

When considering the impact of weather conditions on the migration course during the entire growth season, one could on the basis of research results from years 2007 and 2008 identify three groups of species (Tabs. 3 and 4), which reacted differently to long periods of high temperature which appeared more and more often in the season provoking an increase of soil draught leading directly to a hampering of aphid migration (Tab. 3):

first: numerously and rather evenly migrating aphids during the entire growth season, with the exception of periodical failure of flights in summer related to the biology of this species;

second: numerously migrating aphids during spring, and after a clear failure of migration in summer there was a return to numerous flights in autumn;

third: species, the populations of which following the failure of migration in summer often because of unfavourable weather conditions did not regenerate in terms of quantity and flew in small numbers.

Table 3. Dynamics of seasonal flights of selected aphid species in the Johnson suction trap, Winna Góra (2007)

Species	Spring	Summer	Autumn	Total	Group
Rhopalosiphum padi	417	165	699	1281	I-st
Hyalopterus pruni	125	94	42	261	
Aphis spp.	106	31	116	253	
Pemphigus bursarius	67	18	43	128	
Aphis fabae	49	34	39	122	
Brevicoryne brassicae	11	9	32	52	
Myzus persicae	87	34	125	246	II-nd
Acyrtosiphon pisum	124	16	88	228	
Phorodon humuli	127	25	8	160	III-rd
Cavaliera aegopodi	108	16	23	147	

Table 4. Seasonal flight dynamics of selected aphid species, in the Johnson suction trap, Winna Góra, (2008)

Species	Spring	Summer	Autumn	Total	Group
Rhopalosiphum padi	1489	368	1002	2859	I-st
Hyalopterus pruni	373	139	106	618	
Aphis spp.	192	113	186	491	
Brevicoryne brassicae	47	54	87	188	
Aphis fabae	91	32	44	167	
Adelgidae	215	31	225	478	II-nd
Pemphigus bursarius	123	67	237	427	
Myzus persicae	193	51	133	377	
Cavaliera aegopodi	1147	14	9	1170	III-rd
Chaitophorus spp.	1033	40	5	1078	
Phorodon humuli	771	3	-	774	

Years 2007 and 2008, though so different in terms of the total number of aphids caught in the Johnson's suction trap point out to a large similarity in the registered seasonal dynamics of flights (Fig. 3).

Following quite intensive spring flights, especially in 2008 there was a sudden failure of migration in the beginning of summer, largely related to high temperatures and especially in 2008 – a progressing draught in the region of Wielkopolska, Kujawy and Central Poland (Tab. 4). In the discussed year the greatest increase of soil draught was recorded (WALCZAK, 2008). During the later part of the growth season a gradual awakening of aphid migration was observed until a clear increase in their number in suction trap catches in autumn. A similar course of seasonal migration of aphids was recorded in 2007 in suction trap catches in the Sośnicowice area (ZŁOTKOWSKI & WOLSKI, 2008).

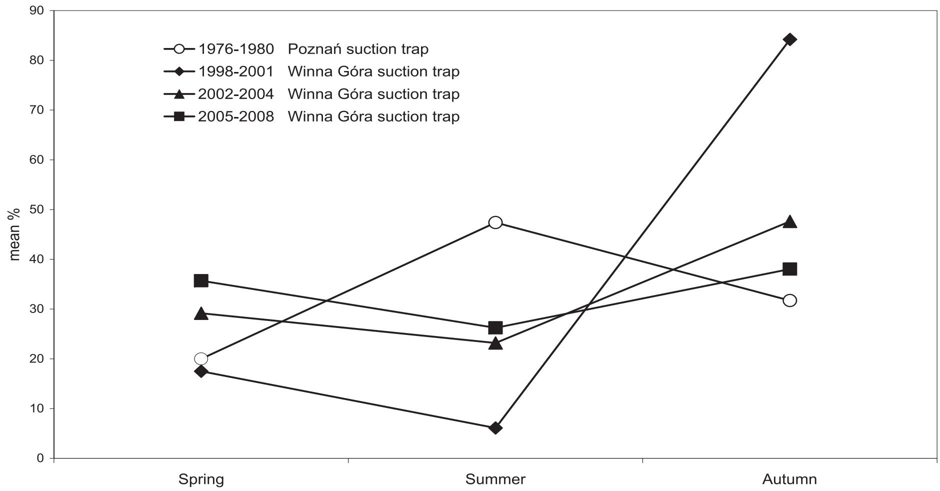

Figure 2. The comparison of seasonal aphid flight dynamics in the Johnson suction trap in Winna Góra (1998-2008) and in Poznań (1976-1980)

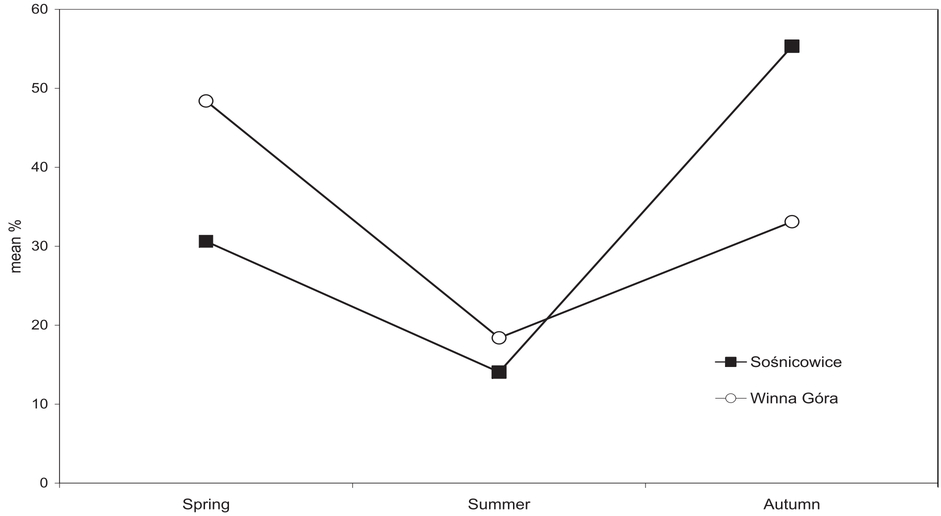

Figure 3. Comparison of seasonal aphid flight dynamics in the Johnson suction trap in Winna Góra and in Sośnicowice (2007)

Conclusions

1. As a result of aphid suction trap catches in 2000-2008 in Winna Góra a high changeability in their flight dynamics was recorded. The total number of all the species of aphids caught in subsequent years of the research pointed out to a two-year-long cycle of intensified migrations.
2. The analysis of species composition of the migrating aphids in the studied years pointed out to the presence in the catches of 56-109 taxons, including the most harmful crop pests.
3. In all the years of the research *R. padi* aphids clearly dominated in the catches throughout the whole growth season. It exceeded the number of the remaining species. Periodically (in 2007) this species reached 60% of all the aphids caught in the suction trap.
4. The analysis of seasonal flights of aphids showed especially after 2002 a tendency to decrease the disproportion in the total numbers of aphids caught in the suction trap in spring, summer and autumn. Results from years 2000-2008 were compared with previous similar research results from Poznań conducted in 1976-1980, in which the greatest migration of aphids was recorded mainly in summer.
5. An unfavourable impact on the course of aphid migration of long-lasting temperatures in summer led to a severe limiting of aphid flights, and in case of some species it led to a significant reduction of their populations and the impossibility to regenerate quantitatively in autumn.

6. A clear increase in the number of aphids in suction trap catches which was registered for some time in autumn is connected with a greater number of warm and sunny days which were more and more frequent, favouring migration at this time.

7. In literature describing systems of enhancement concerning decision making in aphid control for particular crops, it is the onset of migration of harmful species or their confirmed first flights onto plants which is a signal to apply chemical treatment. In this context the monitoring of their flights during the entire growth season acquires large significance for crop protection against aphids.

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Zmiany w dynamice migracji mszyc w okolicach Winnej Góry (Wielkopolska) w latach 2000-2008

Streszczenie

W latach 2000-2008 badano migracje mszyc przy użyciu pułapki ssącej Johnsona usytuowanej w Winnej Górze (Wielkopolska). Badania dynamiki wieloletniej lotów wykazały zwiększoną liczbę mszyc w odłowach co drugi rok. W składzie odławianych gatunków liczącym 56 – 109 taksonów znajdowały się wszystkie najgroźniejsze szkodniki roślin uprawnych. Analiza sezonowych lotów mszyc wykazała wyraźną tendencję do zmniejszania się dysproporcji pomiędzy ogólną liczbą mszyc odłowionych aspiratorem wiosną, latem i jesienią. Stwierdzono, że niekorzystny wpływ na przebieg migracji mszyc ma długotrwałe panowanie w czasie lata wysokich temperatur prowadzące do znacznego ograniczenia lotów mszyc, a w przypadku niektórych gatunków nawet do redukcji całych ich populacji. Rejestrowany aspiratorem Johsnona od pewnego czasu wyraźny wzrost liczby mszyc w odłowach jesienią ma związek z występującą coraz częściej większą liczbą pogodnych i ciepłych dni sprzyjających migracji w tym czasie.