

Sambucus nigra L. as a reservoir of beneficial insects (Diptera, Syrphidae)

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ABSTRACT

Black elder (*Sambucus nigra* L.) commonly occurs throughout the country – it can be found in forests, thickets, parks, balks or in home gardens. It is a valuable reservoir of food for beneficial insects and a place of refuge or wintering. Almost every part of the elderberry plant has some uses: the fruits, flowers, leaves, roots, pith and bark. Its fruits and flowers are used in herbal medicine and in the kitchen. *S. nigra* is a primary host of *Aphis sambuci* L. feeding, which weakens plant growth, reduces flowering and fruiting, and decreases the ornamental value of these shrubs. Aphid populations are limited by a group of predatory and parasitic organisms, among which an important role is played by predatory Syrphidae. Observations were conducted in the years 2009 and 2010 in Krakow (south Poland, 19°57'E, 50°03'N). Significantly more numerous *A. sambuci* colonies were observed in 2009 – in the maximum of their abundance, 960 specimens per shoot were noted. Seven syrphid species were noted in *A. sambuci* colonies: *Episyrphus balteatus* (Deg.), *Epistrophe eligans* (Harr.), *Sphaerophoria scripta* (L.), *Syrphus ribesii* (L.), *Syrphus vitripennis* Meig., *Scaeva pyrastris* (L.) and *Eupeodes corollae* (Fabr.). *E. balteatus* dominated in both years of research. Research on the effectiveness of Syrphidae was performed on four commonly occurring species – the most voracious were *Epistrophe eligans* (Harr.) larvae, eating up to 676 *A. sambuci* aphids during their development.

Key words: effectiveness, elderberry, elder aphid, syrphids

INTRODUCTION

Black elder (*Sambucus nigra* L.) is grown in a wide range of habitats both in rural and urban areas: in woodlands, hedgerows and scrub, on waste ground and railway embankments, and in graveyards. It tolerates a wide range of soils, but prefers moist, humus ones (Seneta 1991). Growing in production or in the wild may have the widest range of applications of all small fruits. It may have a multitude of uses, including riverbank stabilization and windbreaks, wildlife food and refuge, crafts, and games; also as a human food source and multipurpose medicinal

plant (Charlebois et al. 2010). Due to its decorative value (large clusters of white flowers), black elder is often planted in parks or gardens, especially in several cultivars (Aurea, Aureomarginata, Black Beauty, Laciniata) which differ in the colour and shape of the leaves and flowers (Kawecki et al. 2008).

Its creamy-white flowers attract insects and its berries provide an important food source for birds. It is also a valuable reservoir of food for beneficial insects as a place for alternative food development, and a place of refuge or wintering (Starý and

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Němec 1986, Goszczyński and Osak 2007). Black elder is also used to tempt parasites and predators near fields and orchards (Bribosia et al. 2005).

It has a wide range of medicinal (decoction, syrup, juice or poultice) and culinary uses. The berries are used to prepare pies, jelly, jams, wine or liqueurs. The flowers can be added to pancakes, muffins, or waffles. Wine as well as tea can be made from elderberry flower. A number of available products containing elderberry juice or pureed or dried elderberries are used as a food colorant. In medicine, the flowers are used to relieve the symptoms of rashes of allergic origin and intestinal problems. They are reported to be effective as a diuretic and laxative as well. The berries are used to treat colic, constipation, diarrhoea, sore throat, colds and rheumatism. They are known to show anti-inflammatory, antiviral, antioxidative and antibacterial actions (Charlebois et al. 2010).

Elder products have become increasingly popular, so for this purpose orchards of elder have been planted in recent years (Ważbińska 2002, Charlebois et al. 2010). In a study conducted in Poland, Ważbińska et al. (2004) reported yields of berries varying between 1.3 kg/bush for wild-harvested and 16.6 kg/bush for cultivated 'Sampo' and 'Samyl'.

Black elder is attacked by aphid (*Aphis sambuci* L.) feeding, which weakens plant growth, reduces flowering and fruiting and decreases the ornamental value of these shrubs. During feeding, the aphids collect a toxic substance, called sambunigrin, which protects them against many f.e. *Coccinella septempunctata* predators (Nielsen et al. 2002, Nedvěd and Salvucci 2008).

Aphid populations are limited by a group of predatory and parasitic organisms, among which an important role is played by predatory Syrphidae (Bribosia et al. 2005, Gilbert 2005, Jankowska 2005, Wnuk 2005, Wojciechowicz-Żytka 2009).

The aim of this study was to determine *A. sambuci* population dynamics, the species composition of Syrphidae occurring in aphid colonies and to examine the effectiveness of syrphid larvae in relation to *A. sambuci*.

MATERIAL AND METHODS

Observations were carried out in 2009-2010 in Krakow (south Poland 19°57'E, 50°03'N). The site of the field sampling was an area near the Sudół stream with vegetation consisting of woodlots dominated by common alder (*Alnus glutinosa*), silver birch (*Betula pendula*), beech (*Fagus sylvaticus*), horse-

chestnut (*Aesculus hippocastaneum*), common ash (*Fraxinus excelsior*) and elder (*Sambucus nigra*).

From April until July aphids and associated predatory larvae of syrphids were counted on 10 marked shoots from each of five selected black elder shrubs. In each year of the study, eight observations were made. To determine the species composition of syrphids feeding in *A. sambuci* colonies, larvae of Syrphidae were collected from the remaining (not marked) shoots and reared in Petri dishes covered with wet tissue paper, in laboratory conditions, until they became adults and were then classified to the species used in the Bańkowska (1963) and Van Veen (2004) keys.

The study on effectiveness was carried out on four common syrphid species, the larvae of which was found in *A. sambuci* colonies: *Epistrophe eligans*, *Episyrphus balteatus*, *Syrphus vitripennis* and *Sphaerophoria scripta*. Syrphid eggs were collected from aphid colonies and emerged larvae were then raised separately in Petri dishes covered with wet tissue paper. Larvae were fed daily with a specific number of *A. sambuci*. Initially it was 10-20 aphids per day, then increased to about 200 specimens. Daily consumption was calculated as a difference between the amount of aphids being supplied every day and the amount of live aphids that had not been eaten till next day. All experiments were conducted in the laboratory, in five replications each, at a temperature of 22°C, relative humidity of 80% and a 14-hour photo-period.

The Duncan multiple test ($p = 0.05$) was used for the statistical analysis of the results.

RESULTS AND DISCUSSION

Differences in the infestation of elder (*Sambucus nigra* L.) by *A. sambuci* were registered in the years of observation. More aphids occurred in 2009 while less numerous colonies were noted in 2010. The first aphids appeared in the end of April (2009) to the beginning of May (2010) (Fig. 1). Similar information on the occurrence of *A. sambuci* was given by Goszczyński and Osak (2007) working on the occurrence of *A. sambuci* in the Lublin area, whereas Holb et al. (2010) observed the first aphid colonies earlier in Hungary, in late March. The authors studied the aphid population dynamics in two production systems (integrated and organic) in two black elder orchards and noted the first aphid colony 1-2 weeks earlier in the organic production system than in the integrated one.

The colonies grew in number and they reached their maximum in the beginning of June. At this

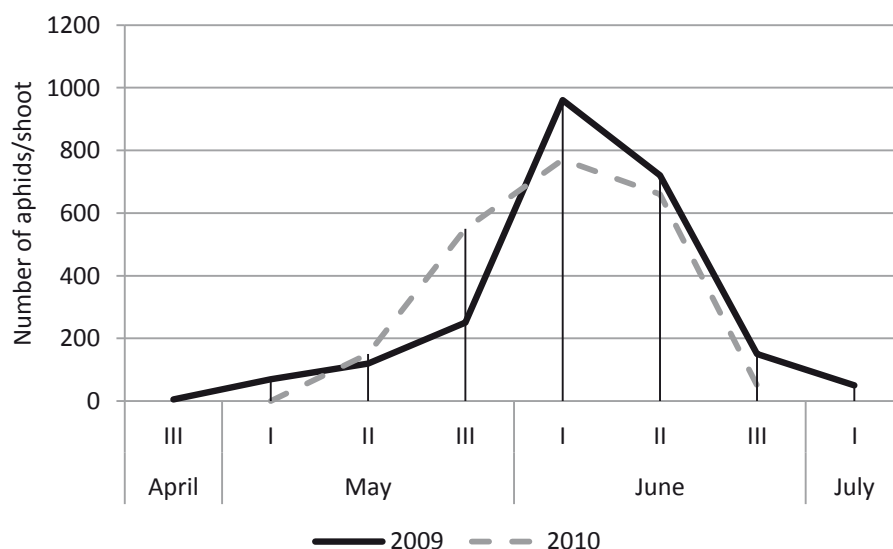


Figure 1. Population dynamic of *Aphis sambuci*

time, they constituted colonies from 960 (2009) to 770 (2010) specimens/shoot. Aphids fed on the top part of young shoots, the upper side of leaves and inflorescences. They weakened the plants, inhibited shoot growth, and shrubs were covered with honeydew on which sooty mould developed, covered the leaves, and limited the assimilating area and decreased the ornamental value of those plants. According to Holb et al. (2010), aphids reached the maximum two weeks earlier in Hungary – in mid-May.

From the end of June, the number of aphids decreased as a result of migrations to summer hosts as well as predator activity (Fig. 1). Research conducted by Holb et al. (2010) in Hungary confirms that the number of aphids decreased and reached

a zero value in mid-June in the integrated production system and in early July in the organic one. Bribosia et al. (2005) observed that all *A. sambuci* colonies disappeared in mid-June in Belgium whereas Sadeghi et al. (2014) reported that elder aphids had colonies on the young shoots of elder during the early season, but towards the end of August the colonies disappeared, probably due to the activity of its predators (ladybirds as well as syrphid larvae) or migration to other host plants.

Information on the secondary hosts of *A. sambuci* can be found in the works of Szelegiewicz (1968), Blackman and Eastop (1994), Goszczyński and Osak (2007) and Depa (2010). The authors presented several species of herbal plants from

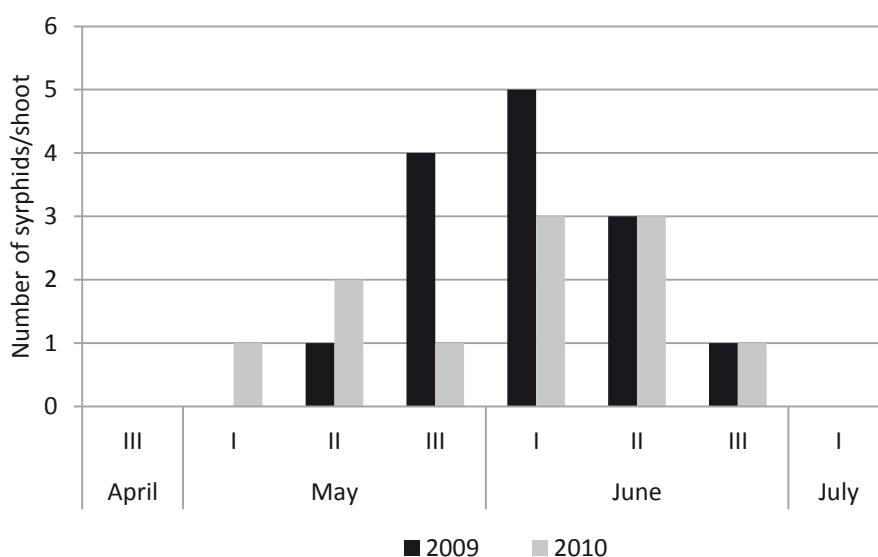


Figure 2. Population dynamics of Syrphidae

the *Rumex* genera, and a few genera of the Caryophyllaceae family.

Syrphids were noted a few days later than when the first aphids occurred (in the beginning of May in 2010 and in mid-May in 2009). Their maximum of abundance was observed in the beginning of June after the maximum of aphids, in both years of observations (Fig. 2). Five species of Syrphidae (*Episyrphus balteatus* (Deg.), *Epistrophe eligans* (Harr.), *Sphaerophoria scripta* (L.), *Syrphus ribesii* (L.), *Syrphus vitripennis* Meig.) were noted in 2009 and seven species (the same species as in 2009 and also *Scaeva pyrastris* (L.) and *Eupeodes corollae* (Fabr.) were noted in 2010 (Fig. 3). *E. balteatus* dominated in both years of research, constituting from 33 to 43% of all collected syrphids.

There are no comprehensive studies in the literature on the occurrence and voracity of syrphid

larvae in relation to *A. sambuci*. Working on aphid colonies of herbs, shrubs and trees, Gilbert (2005) found *A. sambuci* prey the most preferred by *S. ribesii* and *E. balteatus* larvae. According to Sadeghi et al. (2014), *Aphis sambuci* was the least preferred aphid prey of *E. balteatus* larvae and most preferred of *S. ribesii* on elder. Working on the oviposition preferences of syrphids in response to different aphid species, Almohamad (2009) found that *E. balteatus* females lay their eggs in response to some aphid species such as *Metopolophium dirhodum* and *Acyrtosiphon pisum*, but not to others such as the *A. sambuci* on elder. In another study (Sadeghi and Gilbert 2000), *A. pisum* and *Macrosiphum rosae* were more preferred hosts of *E. balteatus* and *S. ribesii* females than *A. sambuci*.

The role of common elder to promote aphidophagous Syrphidae in apple orchards was

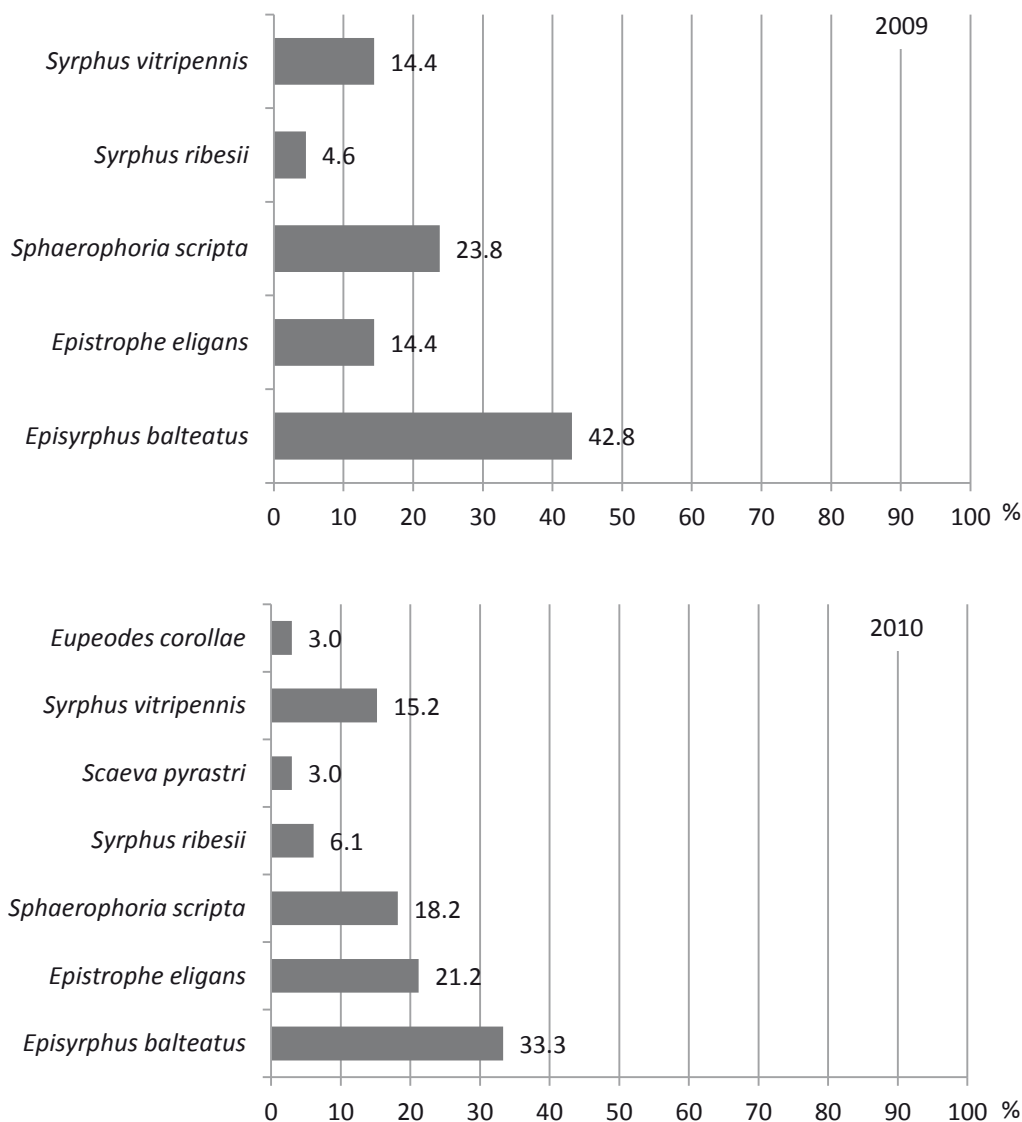


Figure 3. Species composition of Syrphidae (%)

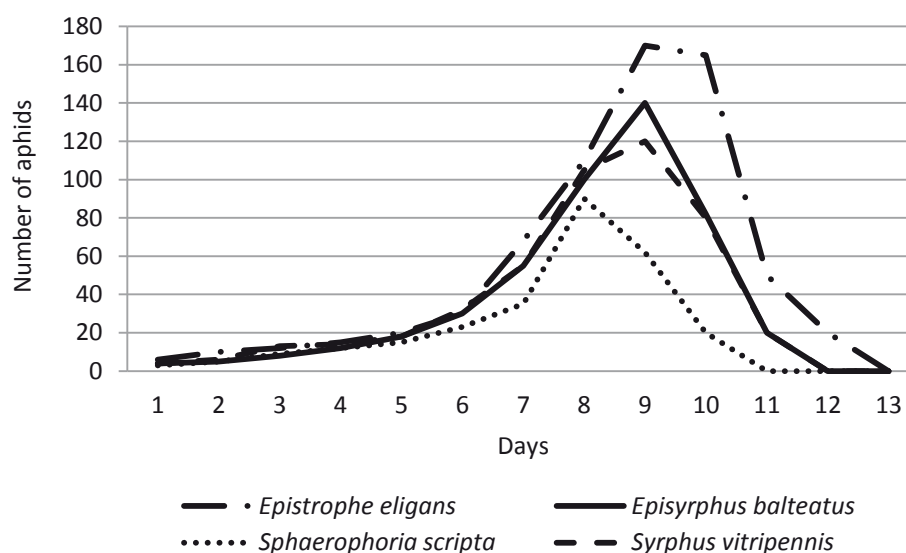


Figure 4. Number of aphids eaten daily by syrphid larvae

investigated by Bribosia et al. (2005). The authors recorded the larvae of seven syrphid genera from the *A. sambuci* colonies. The most abundantly represented were *Episyrrhus*, *Syrphus*, *Scaeva* and *Epistrophe*, whereas the larvae of *Platycheirus*, *Eupeodes* and *Meligramma* were the least numerous.

Data on the occurrence of syrphid larvae in aphid colonies on different ornamental shrubs can be found in publications by Cichocka and Goszczyński (1991), Jaśkiewicz (2004), Wnuk (2000, 2004), Wojciechowicz-Żytko (2004, 2009), Wojciechowicz-Żytko and Jankowska (2011).

The presence of 10 aphidophagous syrphid species with dominant *E. eligans* were noted by Wnuk and Gospodarek (1999) and Wnuk (2000) in *A. fabae* colonies on various host plants. The most frequently reported syrphid species by Gospodarek (2007) on syringe bushes were: *E. eligans*, *E. balteatus*, *S. ribesii* and *S. vitripennis*. According to Wnuk (2005) and Wojciechowicz-Żytko (2009), aphids developing in early spring on trees and shrubs are a valuable source of food for the first syrphid larvae.

Data related to the voracity of syrphid larvae under investigation are presented in Tables 1 and 2 and Figure 4. Larvae in the first and second stages

Table 1. Number of *A. sambuci* aphids eaten by syrphid larvae

Syrphidae species	Development period		Number of eaten aphids	
	range	average	range	average
<i>Epistrophe eligans</i> (Harr.)	11-13	12	645-710	676 c*
<i>Episyrrhus balteatus</i> (Deg.)	10-12	11	450-515	474 b
<i>Sphaerophoria scripta</i> (L.)	9-11	10	255-300	274 a
<i>Syrphus vitripennis</i> Meig.	10-12	11	440-500	467 b

*Values marked with the same letter do not differ significantly at $p < 0.05$ according to the Duncan test

Table 2. Mean number of *A. sambuci* eaten by syrphid larvae in various stages of development

Stage of larval development	Species							
	<i>Epistrophe eligans</i>		<i>Episyrrhus balteatus</i>		<i>Sphaerophoria scripta</i>		<i>Syrphus vitripennis</i>	
	number	%	number	%	number	%	number	%
I	16	2.4	9	1.9	8	2.9	10	2.1
II	77	11.4	68	14.3	36	13.2	77	16.5
III	583	86.2	397	83.8	230	83.9	380	81.4
Total	676 c*	100.0	474 b	100.0	274 a	100.0	467 b	100.0

*Explanations: see Table 1

of development ate small amounts of aphids but from the 5-6 days an increase in prey consumption was noted. The maximum voracity of *Epistrophe eligans* larvae was observed between the 9-10 days of their development, *Syrphus vitripennis* and *Episyrphus balteatus* between the 8-9 days and *Sphaerophora scripta* between the 7-8 days. The maximum number of aphids consumed daily ranged from 90 (*S. scripta*) to 170 (*E. eligans*) specimens. Larvae in the third stage appeared to be the most voracious (more than 80% of total aphids eaten) due to their mobility, searching ability and high nutrient demand (Tab. 2). After the maximum voracity, a decrease in aphid consumption by larvae was observed and next, before pupation, the larvae stopped feeding (Fig. 4). The differences in the number of aphids consumed by different syrphid species were statistically significant. The smallest *S. scripta* larvae ate an average of 274 aphids, while the second homogeneous group – *E. balteatus* and *S. vitripennis* – ate from 440 to 515, and the largest *E. eligans* ate 676 aphids during their life (Tab. 1, Fig. 4). Based on this investigation it can be stated that due to the high voracity the most efficient predators were *E. eligans* larvae but on the other hand also *E. balteatus* larvae which were less voracious but the most numerous in *A. sambuci* colonies.

There are rather few studies that investigate the voracity of syrphid larvae in relation to *A. sambuci*. The effectiveness of syrphid larvae on different aphid species was studied by Wnuk (2005). The author noted that *E. balteatus* larva ate 387-536 *B. brassicae* aphids during its life, 200-253 *A. fabae* and 382-479 *A. pomi*, whereas *S. scripta* ate 260-375 *B. brassicae*. Wojciechowicz-Żytka (2000, 2007) found that the smallest larvae of *S. scripta* ate 190-300 *A. fabae* while the largest *S. ribesii* ate about 800 during their development; however, the same syrphid species feeding on *Myzus cerasi* ate 296-338 and 591-639 specimens, respectively. Research conducted by Sundby (1966) and Natskova (1985) confirm that larval feeding capacity depends on many factors affecting the developmental rate, such as temperature and humidity, therefore sometimes the data of other authors working on syrphid larvae voracity differ even if the same aphids and larvae are studied.

The effectiveness of predators also depended on the predator-prey ratio. According to Wnuk (2005) and Wojciechowicz-Żytka (2007), a predator-prey ratio from 1:50 to 1:100 is the most effective in the case of common aphidophagous syrphids. Observations showed that an even less profitable

predator-prey ratio can prevent a further increase of the aphid population.

Black elder is easy to grow and offers a wide range of applications. The production and processing of elderberry fruit and flowers is well established in Europe. The problem is the control of pests, especially *A. sambuci*. Muller (1977) describes the difficulties in controlling *A. sambuci* using sprays. Therefore, alternative pest management is necessary. Biological control methods can reduce the legal, environmental and health hazards of using chemicals in *S. nigra* orchards.

CONCLUSIONS

1. *Sambucus nigra* is a valuable reservoir of food for syrphids (nectar and pollen for adults and *A. sambuci* for larvae) and could be used to tempt predators near fields and orchards.
2. Seven syrphid species were noted in *A. sambuci* colonies, and *E. balteatus* dominated in both years of research.
3. The voracity depended on the syrphid species: the smallest was noted for *S. scripta* larvae, which ate an average of 274 aphids during their life, while the largest was *E. eligans* at 676.
4. Based on the result of this study we can conclude that syrphid larvae can be considered an effective biological control agent of *A. sambuci* on black elder.

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AUTHOR CONTRIBUTIONS

Both authors contributed equally to this work. E.W.Ż. and B.J. – designed and performed the experiments, analysed the data and wrote the paper.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

REFERENCES

- ALMOHAMAD R., VERHEGGEN F.J., HAUBRUGE E., 2009. Searching and oviposition behavior of aphidophagous hoverflies (Diptera: Syrphidae): a review. *Biotechnol. Agron. Soc. Environ.* 13(3): 467-481.

- BAŃKOWSKA R., 1963. Klucze do oznaczania owadów Polski. XXVII Muchówki – *Diptera*. Zesz. 24, *Syrphidae*. PWN, Warszawa, Poland.
- BLACKMAN R.L., EASTOP V.F., 1994. Aphids on the World's Trees. An Identification and Information Guide. The Natural History Museum, London.
- BRIOSIA E., BYLEMANS D., HUYSMAN S., SCHWEITZER P., MIGON M., IMPE G., 2005. The use of common elder *Sambucus nigra* to promote aphidophagous syrphids in apple orchards. *Commun. Agric. Appl. Biol. Sci.* 70(4): 527-538.
- CHARLEBOIS D., BYERS P.L., FINN C.E., THOMAS A.L., 2010. Elderberry: botany, horticulture, potential. In: *Horticulture Reviews*. J. Janic (ed.), Wiley-Blackwell, New Jersey, USA, 37: 213-280.
- CICHOCKA E., GOSZCZYŃSKI W., 1991. Mszyce zasiedlające drzewa przyuliczne w Warszawie. In: *Mszyce, ich biologia, szkodliwość i wrogowie naturalni*. PAN, Warszawa: 9-18.
- DEPA Ł., 2010. Possibility of overwintering of *Aphis sambuci* Linnaeus, 1758 (Hemiptera, Aphididae) on secondary host in climate conditions of Poland. *Aphids and Other Hemipterous Insects* 16: 21-25.
- GILBERT F., 2005. Syrphid aphidophagous predators in a food-web context. *Eur. J. Entomol.* 102: 325-333.
- GOSPODAREK J., 2007. *Diptera, Syrphidae* in urban environment with various degree of pollution. *Ecol. Chem. Eng.* 14(9): 949-956.
- GOSZCZYŃSKI W., OSAK M., 2007. *Sambucus nigra* L. in Lublin area landscape and its aphid fauna. *Aphids and Other Hemipterous Insects* 13: 107-113.
- HOLB I.J., FODOR B., LAKATOS P., ABONYI F., BALLA B., FAZEKAS M., GALL J.M., 2010. Effect of production system and pruning on *Aphis sambuci* dynamics over time and on elderberry yield. *J. Appl. Entomol.* 134(8): 615-625.
- JANKOWSKA B., 2005. Predatory syrphids (*Diptera, Syrphidae*) occurring in the cabbage aphid (*Brevicoryne brassicae* L.) colonies on the different cabbage vegetables. *J. Plant Prot. Res.* 45(1): 9-16.
- JAŚKIEWICZ B., 2004. Aphids (*Homoptera, Aphidodea*) inhabiting the shrubs of *Cotoneaster divaricatus* Rehder et E.H. Wilson in the urban area of Lublin. Part II. Domination and frequency of aphids, their natural enemies and the injuries caused by aphids. *EJPAU, Horticulture*, 7(2). Available online at <http://www.ejpau.media.pl>; cited on 10 Nov 2016.
- KAWECKI Z., PŁOSZAJ B., WĄŻBIŃSKA J., 2008. Drzewa i krzewy liściaste. UWM, Olsztyn, Poland.
- MULLER W., 1977. Is the production of elderberries without its problems? *Schweizerische Zeitschrift für Obst und Weinbau* 113(24): 578-580.
- NATSKOVA V., 1985. The effect of basic ecological factors on the feeding capacities of some predators of aphids during their larval period. *Ecologia* 15: 35-42.
- NEDVĚD O., SALVUCCI S., 2008. Ladybird *Coccinella septempunctata* (Coleoptera: Coccinellidae) prefers a toxic prey in laboratory choice experiment. *Eur. J. Entomol.* 105: 431-436.
- NIELSEN F.H., HAUGE M.S., TOFT S., 2002. The influence of mixed aphid diets on larval performance of *Coccinella septempunctata* (Col., Coccinellidae). *J. Appl. Entomol.* 126(4): 194-197.
- SADEGHI H., GILBERT F., 2000. Oviposition preferences of aphidophagous hoverflies. *Ecol. Entomol.* 25(1): 91-100.
- SADEGHI H., ROTHERAY G., LASKA P., GILBERT F., 2014. Host preferences of aphidophagous hoverflies from field distribution of their larvae. *Egypt. J. Biol.* 16: 1-16.
- SENETA W., 1991. *Dendrologia cz. 2*. PWN, Warszawa, Poland.
- STARÝ P., NĚMEC C., 1986. Common elder, *Sambucus nigra*, as a reservoir of aphids and parasitoids (Hymenoptera, Aphidiidae). *Acta Entomol. Bohemoslov.* 86(4): 271-278.
- SUNDBY R.A., 1966. A comparative study of the efficiency of three predatory insects *Coccinella septempunctata* Z. (Col. Coccinellidae), *Chrysopa carnea* St. (Neur. Chrysopidae) and *Syrphus ribesii* L. (Dipt. Syrphidae) at two different temperatures. *Entomophaga* 11: 395-405.
- SZELEGIEWICZ H., 1968. Mszyce (Aphidodea). *Katalog fauny Polski*. PWN, Warszawa.
- VAN VEEN M.P. 2004. Hoverflies of Northwest Europe. Identification keys to the *Syrphidae*. KNNV Publishing, Utrecht, The Netherlands.
- WĄŻBIŃSKA J., 2002. Bez dla sadowników. *Szkółkarstwo* 6.
- WĄŻBIŃSKA J., PUCZEL U., SENDEROWSKA J., 2004. Yield in elderberry cultivars grown on two different soils in 1997-2003. *J. Fruit Ornament. Plant Res.* 12: 175-181.
- WNUK A., 2000. Ornamental shrubs in the food chain on aphidophagous *Syrphidae* (*Diptera*). *Protection of Plant Collections Against Pest and Diseases I*: 45-52.
- WNUK A., 2004. Occurrence of aphidophagous syrphid (*Diptera, Syrphidae*) in colonies of *Macrosiphum rosae* (L.) on roses in Botanic Garden of the Jagiellonian University Cracov. *Protection of Plant Collections Against Pest and Diseases II*: 44-48.
- WNUK A., 2005. Roślinność w łańcuchu pokarmowym dla mszycożernych bzygowatych (*Diptera, Syrphidae*). In: *Ochrona środowiska naturalnego w XXI wieku – nowe wyzwania i zagrożenia*. Fundacja na rzecz wspierania badań naukowych WO AR w Krakowie: 95-103.
- WNUK A., GOSPODAREK J., 1999. Occurrence of aphidophagous *Syrphidae* (*Diptera*) in colonies of *Aphis fabae* Scop., on its various host plants. *Annal. Agr. Sci. Series E – Plant Protection* 28(1/2): 7-15.
- WOJCIECHOWICZ-ŻYTKO E., 2000. The effectiveness of aphidophagous syrphid larvae (*Diptera, Syrphidae*) in the control of *Aphis fabae* Scop. (*Homoptera, Aphidodea*) on broad bean. *J. Plant Prot. Res.* 40(2): 152-157.

- WOJCIECHOWICZ-ŻYTKO E., 2004. The occurrence of *Liosomaphis berberidis* Kalt. (Homoptera, Aphidodea) and its predators on the *Berberis vulgaris* L. Protection of Plant Collections Against Pest and Diseases II: 70-73.
- WOJCIECHOWICZ-ŻYTKO E., 2007. Rola bzygowatych (Diptera, Syrphidae) w regulacji populacji mszycy wiśniowej – *Myzus cerasi* (F.) (Homoptera, Aphidodea). Zesz. Nauk. AR w Krakowie 443: 321.
- WOJCIECHOWICZ-ŻYTKO E., 2009. Predatory syrphids (Diptera, Syrphidae) and ladybird beetles (Coleoptera, Coccinellidae) in the colonies of *Aphis fabae* Scopoli, 1763 (Hemiptera, Aphidoidea) on *Philadelphus coronarius* L. Aphids and Other Hemipterous Insects 15: 168-181.
- WOJCIECHOWICZ-ŻYTKO E., JANKOWSKA B., 2011. Aphids and their predators occurring on same shrubs in the Botanic Garden of the Jagiellonian University in Krakow. Aphids and Other Hemipterous Insects 17: 147-156.

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