DOI: 10.17110/StudBot.2020.51.1.41 Studia bot. hung. 51(1), pp. 41–56, 2020

DIPTERA FLOWER VISITORS OF *ADONIS VERNALIS* IN THE BAKONY MTS (HUNGARY)

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Mészáros, T. & Tóth, S. (2020): Diptera flower visitors of Adonis vernalis in the Bakony Mts (Hungary). – *Studia bot. hung.* **51**(1): 41–56.

Abstract: The number of pollinators has decreased significantly in the last decades, producing a situation that is frequently mentioned as a "pollination crisis". In our study we document Diptera taxa collected on the early-flowering, legally protected *Adonis vernalis* L. According to our former observations, species of the Aculeata suborder (Hymenoptera) are the main pollinators of *A. vernalis*. Besides them many insects visit the flowers of *Adonis*, thus helping pollination directly or indirectly. Diptera taxa were collected in the spring of 2019 from three sites of the Bakonyvidék Mesoregion in Hungary. At Szentkirályszabadja and Veszprém-Kádárta villages the species *Sphaerophoria scripta* (19 and 10 individuals, respectively), on the Csatár Hill *Chrysotoxum vernale* and *Pipizella viduata* (3–3 individuals) were found the most frequent visitors. At each study site most of the collected insects were members of the Syrphidae family. Of the collected Diptera species only 2 species belonged to the Nematocera suborder, all the others belonged to the Brachycera suborder. At Veszprém-Kádárta we also found three Tephritidae larvae in the flowers.

Key words: flower-visiting insects, fly, protected plant species, *Sphaerophoria*, Syrphidae

INTRODUCTION

The number of pollinators has decreased significantly in the last decades, producing a situation that is frequently mentioned as a "pollination crisis". The crisis is partly due to the spread of agriculture at the expense of natural and semi-natural grasslands, which considerably decreases the food resources of flower visitor and pollinator insects. This phenomenon is not only economically worrying, but has unfavourable effects on biodiversity and nature conservation as well (Allen-Wardell *et al.* 1998, Novais *et al.* 2016).

Diptera taxa have a significant role in many pollination systems and networks (Kearns 2002, Kevan 2002, Ssymank *et al.* 2008). They get protein from pollen, while flowers provide them shelter and can function as place of meeting or breeding (Patkó 2017). Sun facing flowers provide a shelter that is warmer than the surrounding air temperature. Compared to Hymenoptera species, Diptera taxa have less hair on their body, and generally they do not have special pollen

collecting structures. Nevertheless, pollen can stick to their body, so they potentially can help pollination (Kearns 2002, Kevan 2002, Ssymank *et al.* 2008).

The number of Diptera species is estimated at 400,000–800,000. In spite of this large number, the order is poorly studied taxonomically. 115 Diptera families occur in Hungary, and among them hoverflies are most thoroughly studied (Soltész 2017). Most Diptera species are restricted to habitats that provide optimal circumstances for them. The species composition of Diptera fauna in forests and grasslands is very different (Tóth 1975).

Empididae species have strong proboscis. They are generally predatory flies hunting mainly for other fly species (cannibalism is frequent). Nonetheless, some of them are flower visitors feeding on nectar (Tóth 1975).

Stratiomyidae adults can often be collected on flowers as they feed on nectar and pollen. Their larvae usually evolve in water, and the adults also prefer humid habitats like marshes (Tóth 1975).

The larvae of Tephritidae live in different plant organs. Most of them evolve in Asteraceae species (Tóth 1975).

Bombyliidae species are generally medium sized and often hairy. They feed on nectar. Some species hover in the air over the flowers and use their long, straight proboscis to reach the nectar. Other species land on flowers to feed (Tóth 1975).

Hoverflies play important role in food chains, since both their adults and larvae are food resources to predatory insects and other arthropods, birds, and vertebrates (Tóth 2011). Adult hoverflies (Syrphidae) feed on nectar (Tóth 1975), but they eat honeydew and sap leaking from wounded trees as well. Hoverflies feeding on pollen and/or nectar (similarly to bees and other flower visiting insects) can take part in pollination as they fly from flower to flower. However, the larvae of some hoverflies (e.g. *Eumerus*, *Merodon*) damage the bulb of plants.

According to our earlier observations species of the Aculeata suborder (Hymenoptera) are the main pollinators of *A. vernalis* (Mészáros and Józan 2018). Besides them many insects are visiting the flowers of *Adonis,* thus helping pollination directly or indirectly.

Pollinators play a key role in the maintenance of genetic variability of *A. vernalis,* and in the survival of its populations (Denisow *et al.* 2014). The flowers of *A. vernalis* are nectarless, and thus provide only pollen as a reward for flower visitor insects (Denisow *et al.* 2014). The results of Chittka *et al.* (1999) show that nectarless species have fewer visitors than those producing nectars, even if they flower at the same time. Nectarless species develop other strategies to attract insects. Denisow and Wrzesień (2006) observed Diptera taxa on *A. vernalis* flowers, but they did not present the name of species.

Entomologists often curious about which plants are visited regularly or occasionally by different hoverfly species. Similar studies have been done in Hungary too, mainly in the Bakony Mts. The results were published in the monograph of the hoverfly fauna of the Bakony Mts (Tóth 2001). Foraging of adult hoverflies had been observed on 446 plant taxa. Plants visited by hoverflies are very various. According to the above-mentioned studies in the Bakony Mts, the most plant species were visited by *Eristalis tenax* (Linnaeus, 1758) (observed on 242 plant taxa), *Eristalis arbustorum* (Linnaeus, 1758) (237 plant taxa), and *Sphaerophoria scripta* (Linnaeus, 1758) (218 plant taxa).

Previous studies in the Bakony Mts have detected the following hoverflies on the flowers of *Adonis aestivalis* (which is a close relative of *A. vernalis*): *Cheilosia pagana* (Meigen, 1822), *Episyrphus balteatus* (De Geer, 1776), *Eristalinus aeneus* (Scopoli, 1763), *Eristalis arbustorum* (Linnaeus, 1758), *E. tenax* (Linnaeus, 1758), *Eupeodes corollae* (Fabricius, 1794), *Helophilus pendulus* (Linnaeus, 1758), *Melanostoma mellinum* (Linnaeus, 1758), *Platycheirus clypeatus* (Meigen, 1822), *P. europaeus* Goeldlin de Tiefenau, Maibach et Speight, 1990, *Scaeva pyrastri* (Linnaeus, 1758), *Sphaerophoria scripta* (Linnaeus, 1758). On the flowers of *A. vernalis* the following species have been identified: *Cheilosia grossa* (Fallén, 1817), *C. mutabilis* (Fallén, 1817), *C. pagana* (Meigen, 1822), *Eristalinus aeneus* (Scopoli, 1763), *E. sepulchralis* (Linnaeus, 1758), *Eristalis arbustorum* (Linnaeus, 1758), *E. pertinax* (Scopoli, 1763), *E. tenax* (Linnaeus, 1758), *Eupeodes corollae* (Fabricius, 1794), *Melanostoma mellinum* (Linnaeus, 1758), *M. scalare* (Fabricius, 1794), *Platycheirus albimanus* (Fabricius, 1781), *P. clypeatus* (Meigen, 1822), *P. europaeus* Goeldlin de Tiefenau, Maibach et Speight, 1990, *Sphaerophoria scripta* (Linnaeus, 1758), *Syrphus ribesii* (Linnaeus, 1758), *S. torvus* Osten-Sacken, 1875, *S. vitripennis* Meigen, 1822.

In our study we document Diptera taxa collected on the early-flowering, legally protected *Adonis vernalis* L.

MATERIALS AND METHODS

Study species

Adonis vernalis is a perennial, early-flowering member of the Ranunculaceae family. Its flowers are solitary and bisexual. The yellow, silky shining petals open to sunlight and have no nectaries (Anonymous 2000, Denisow *et al.* 2014, Jankowska-Błaszczuk 1988). In suitable weather the first buds open at the end of March, and the flowering can last until May. The longitudinal growth of primary shoots is simultaneous with the opening of the first flowers, and the appearance and growth of secondary shoots start at the same time. The flowers of

primary shoots open first at all times, the buds on secondary shoots open later. As a consequence, buds, flowers, and fruits can be seen simultaneously on the same individual (Máthé 1977).

Collecting Diptera

Diptera individuals were collected in the spring of 2019 from three sites of the Bakonyvidék Mesoregion in Hungary (Dövényi 2010) (Table 1). At Szentkirályszabadja and Veszprém-Kádárta villages the insects were collected in a 23-hour long period, while on the Csatár Hill the total length of collecting was 22 hours.

Only insects found on *A. vernalis* flowers were collected. The sites were scanned by 1–3 researchers continuously. Insects were collected with a butterfly net 30 cm in diameter, but the original net had been replaced by a dense and transparent tulle net.

Insects have been collected individually and put into glasses every hour. As a consequence, each individual has been counted once, representing a single flower visitation. For the sake of efficiency, the flies were not sorted according to their behaviour (e.g. feeding, sleeping, breeding in the flower). If larvae were found, they were put in glasses immediately.

The time of observation has been converted from standard time to summer time to make the comparison of data from different periods possible. The collected species have been identified by Sándor Tóth according to Majer (1977), Mihályi (1960, 1975, 1979), Tóth (1977) and Wéber (1975).

RESULTS

At Szentkirályszabadja village we collected 91 individuals representing 36 species (8 families). 53.8% of individuals were male (49 individuals) and 46.2%

Table 1. *Adonis vernalis* study sites.

Settlement	N	E	Nr of individuals	Habitat type	Study area (m^2)	Collecting days (2019)
Szentkirály-szabadja	47.035700	17.950291	*ca* 1,000	slope steppe	2,000	30, 31 March, 4, 6, 19 April
Csatár Hill	47.101894	17.853644	20,000–30,000	slope steppe	1,200	19, 30 March, 20, 21, 30 April, 1, 2, 3 May
Veszprém-Kádárta	47.108191	17.956996	*ca* 100	slope steppe	900	15, 17, 22, 24, 25, 27, 28 April

female (42 individuals) (Tables 2–3). The lowest number of individuals were collected between 10–11 a.m. and 3–4 p.m. (6 individuals per hour), whereas most specimens were observed between 11 a.m.–1 p.m. and 2–3 p.m. (22 individuals per hour) (Fig. 1). At Veszprém-Kádárta village 49 individuals of 23 species (10 families) were collected. The ratio of males was 51% (25 individuals) and that of females 49% (24 individuals) (Tables 4–5). The frequency of visitations was the lowest between 10–11 a.m. (3 individuals per hour) and the highest between 2–3 p.m. (17 individuals per hour) (Fig. 2). On the Csatár Hill we collected 24 individuals of 18 species (6 families). 29.2% of them was male (7 individuals) and 70.8% was female (17 individuals) (Tables 6–7). The lowest number of individuals were collected between 2–4 p.m. (0 individuals per hour), whereas most specimens were observed between 11–12 a.m. (12 individuals per hour) (Fig. 3). In sum, at the three sites the number of collected individuals was the lowest between 10–11 a.m. (14 individuals per hour), while the highest between 11–12 a.m. (41 individuals per hour) (Fig. 4).

At Szentkirályszabadja and Veszprém-Kádárta villages *Sphaerophoria scripta* (Linnaeus, 1758) was found the most frequent species (19 and 10 individuals), while on the Csatár Hill the species *Chrysotoxum vernale* Loew, 1841 and *Pipizella viduata* (Linnaeus, 1758) dominated with 3–3 individuals. At each site most of the collected insects were members of the Syrphidae family, only 2 belonged to the Nematocera suborder. All the others belonged to the Brachycera suborder. At Veszprém-Kádárta we also found three Tephritidae larvae in the flowers.

DISCUSSION

All Syrphidae species collected in our study had already been reported from the Bakony Mts, but not each of them had been observed on *Adonis vernalis* flowers. Tóth (2001) recognised 7 hoverfly species (*Eupeodes corollae*, *Melanostoma mellinum*, *Platycheirus albimanus*, *Sphaerophoria scripta*, *Syrphus ribesii*, *S. torvus*, *S. vitripennis*) on *A. vernalis*. We have recorded 24 Syrphidae species, so the list of hoverflies visiting *A. vernalis* increased by 17 new species. In contrast to former observations in the Bakony Mts, we have not noticed individuals of the following species on *A. vernalis* flowers: *Cheilosia grossa* (Fallén, 1817), *C. mutabilis* (Fallén, 1817), *C. pagana* (Meigen, 1822), *Eristalinus aeneus* (Scopoli, 1763), *E. sepulchralis* (Linnaeus, 1758), *Eristalis arbustorum* (Linnaeus, 1758), *E. pertinax* (Scopoli, 1763), *E. tenax* (Linnaeus, 1758), *Melanostoma scalare* (Fabricius, 1794), *Platycheirus clypeatus* (Meigen, 1822) and *P. europaeus* Goeldlin de Tiefenau, Maibach et Speight, 1990.

Table 2. *Adonis vernalis* flower visitor Diptera species listed in decreasing frequency (Szentkirályszabadja, 2019).

Species	Family	Nr of individuals	Male	Female	Time of visitation
Sphaerophoria scripta (Linnaeus, 1758)	Syrphidae	19	10	9	10 a.m.–3 p.m.
Syrphus vitripennis Meigen, 1822	Syrphidae	6	1	5	12–1 p.m., 2–3 p.m.
Brachypalpus valgus (Panzer, 1798)	Syrphidae	4	3	1	12–1 p.m.
Eupeodes corollae (Fabricius, 1794)	Syrphidae	4	1	3	1–3 p.m.
Myathropa florea (Linnaeus, 1758)	Syrphidae	4	1	3	11 a.m.–1 p.m.
Sepsis punctum (Fabricius, 1794)	Sepsidae	4	3	1	11–12 a.m.
Syrphus torvus Osten-Sacken, 1875	Syrphidae	4	2	2	10–12 a.m., 1–2 p.m.
Anthomyidae sp. indet.	Anthomyidae	3	1	2	11–12 a.m., 1–2 p.m.
Delia radicum (Linnaeus, 1758)	Anthomyidae	3	2	1	2–3 p.m.
Melanostoma mellinum (Linnaeus, 1758)	Syrphidae	3	2	1	11–12 a.m.
Meroplius minutus (Widemann, 1830)	Sepsidae	3	1	2	11–12 a.m.
Neoascia podagrica (Fabricius, 1775)	Syrphidae	3	2	1	1–2 p.m.
Syritta pipiens Le Peletier et Serville, 1828	Syrphidae	3	1	2	11–12 a.m.
Syrphus ribesii (Linnaeus, 1758)	Syrphidae	3	2	1	10–11 a.m., 2–3 p.m.
Delia cardui (Meigen, 1826)	Anthomyidae	2	2		3–4 p.m.
Gonia ornata Meigen, 1826	Tachinidae	2	1	1	12–1 p.m.
Platycheirus albimanus (Fabricius, 1781)	Syrphidae	2	2		12–1 p.m.
Anthomyia imbrida Rondani, 1866	Anthomyidae	1	1		3–4 p.m.
Carcelia sp. indet.	Tachinidae	1		1	12–1 p.m.
Catharosia pygmaea (Fallén, 1815)	Tachinidae	1	1		12–1 p.m.
Conophorus virescens (Fabricius, 1787)	Bombyliidae	1		1	2–3 p.m.
Culex pipiens pipiens Linnaeus, 1758	Culicidae	1	1		3–4 p.m.
Dasysyrphus venustus (Meigen, 1822)	Syrphidae	1	1		10–11 a.m.

Table 2. (continued)

Species	Family	Nr of individuals	Male	Female	Time of visitation
Empis opaca Meigen, 1904	Empididae	1	1		11–12 a.m.
Epistrophe eligans (Harris, 1780)	Syrphidae	1	1		3–4 p.m.
Epistrophe melanostoma (Zetterstedt, 1843)	Syrphidae	1		1	3–4 p.m.
Exorista larvarum (Linnaeus, 1758)	Tachinidae	1	1		2–3 p.m.
Gonia divisa Meigen, 1826	Tachinidae	1		1	1–2 p.m.
Hebia flavipes Robineau-Desvoidy, 1830	Tachinidae	1	1		1–2 p.m.
Leucophora personata (Collin, 1922)	Anthomyidae	1	1		1–2 p.m.
Meliscaeva cinctella (Zetterstedt, 1843)	Syrphidae	1		1	2–3 p.m.
Pollenia sp. indet.	Calliphoridae	1		1	10–11 a.m.
Rhamphomyia crassicornis Fallén, 1816)	Empididae	1	1		11–12 a.m.
Sphaerophoria taeniata (Meigen, 1822)	Syrphidae	1	1		2–3 p.m.
Tachina fera (Linnaeus, 1761)	Tachinidae	1		1	2–3 p.m.
Tachina lurida (Fabricius, 1781)	Tachinidae	1	1		10–11 a.m.
Total		91 (36 species)	49	42	10 a.m.–4 p.m.

Table 3. *Adonis vernalis* flower visitor Diptera families listed in decreasing frequency (Szentkirályszabadja, 2019).

Family	Nr of individuals	Male	Female	Time of visitation
Syrphidae	60	30	30	10 a.m.–4 p.m.
Anthomyidae	10	7	3	11–12 a.m., 1–4 p.m.
Tachinidae	9	5	4	10–11 a.m., 12–3 p.m.
Sepsidae	7	4	3	11–12 a.m.
Empididae	2	2		11–12 a.m.
Bombyliidae	1		1	2–3 p.m.
Calliphoridae	1		1	10–11 a.m.
Culicidae	1	1		3–4 p.m.
Total	91	49	42	10 a.m.–4 p.m.

Table 4. *Adonis vernalis* flower visitor Diptera species listed in decreasing frequency (Veszprém-Kádárta, 2019).

Species	Family	Nr of individuals	Male	Female	Time of visitation
Sphaerophoria scripta (Linnaeus, 1758)	Syrphidae	10	8	2	1–3 p.m.
Tachina ursina Meigen, 1824	Tachinidae	4	2	2	12–1 p.m., 2–3 p.m.
Empis chioptera Meigen, 1804	Empididae	4		4	2–4 p.m.
Anthomyidae sp. indet.	Anthomyidae	4	3	1	3–4 p.m.
Syrphus ribesii (Linnaeus, 1758)	Syrphidae	3	3		11–12 a.m., 2–3 p.m.
Rhamphomyia atra Meigen, 1822	Empididae	3	1	2	10–11 a.m.
Syrphus vitripennis Meigen, 1822	Syrphidae	2	1	1	2–3 p.m.
Gonia ornata Meigen, 1826	Tachinidae	2	1	1	2–3 p.m.
Empis femorata Fabricius, 1798	Empididae	2	1	1	3–4 p.m.
Atylostoma tricolor (Mik, 1884)	Tachinidae	2	1	1	12–1 p.m.
Sepsis punctum (Fabricius, 1794)	Sepsidae	1	1		11–12 a.m.
Platystoma seminationis (Fabricius, 1775)	Platystomatidae	1		1	3–4 p.m.
Oxyna parietina (Linnaeus, 1758)	Tephritidae	1		1	11–12 a.m.
Oxyna flavipennis (Loew, 1844)	Tephritidae	1		1	11–12 a.m.
Limnophora tigrina Am Stein, 1860	Muscidae	1		1	2–3 p.m.
Hemipenthes morio (Linnaeus, 1758)	Bombyliidae	1		1	2–3 p.m.
Eupeodes corollae (Fabricius, 1794)	Syrphidae	1		1	11–12 a.m.
Empis albicans Meigen, 1822	Empididae	1	1		2–3 p.m.
Empididae sp. indet.	Empididae	1		1	2–3 p.m.
Chrysotoxum verralli Collin, 1940	Syrphidae	1		1	11–12 a.m.
Chrysotoxum vernale Loew, 1841	Syrphidae	1	1		11–12 a.m.
Carcelia tibialis (Robineau-Desvoidy, 1863)	Tachinidae	1	1		3–4 p.m.
Actina chalybea (Meigen, 1804)	Stratiomyidae	1		1	2–3 p.m.
Total		49 (23 species)	25	24	10 a.m.–4 p.m.

Table 5. *Adonis vernalis* flower visitor Diptera families listed in decreasing frequency (Veszprém-Kádárta, 2019).

Family	Nr of individuals	Male	Female	Time of visitation
Syrphidae	18	13	5	11–12 a.m., 1–3 p.m.
Empididae	11	3	8	10–11 a.m., 2–4 p.m.
Tachinidae	9	5	4	12–1 p.m., 2–4 p.m.
Anthomyidae	4	3	1	3–4 p.m.
Tephritidae	2		2	11–12 a.m.
Bombyliidae	1		1	2–3 p.m.
Muscidae	1		1	2–3 p.m.
Platystomatidae	1		1	3–4 p.m.
Sepsidae	1	1		11–12 a.m.
Stratiomyidae	1		1	2–3 p.m.
Total	49	25	24	10 a.m.–4 p.m.

* = 3 larvae were found as well

Although the total length of collecting was similar at each site (23, 23 and 22 hours), the number of both individuals and species differed significantly. The study site at Szentkirályszabadja village appeared to be the most species rich, and the highest number of individuals was recorded here (91 individuals of 36 species). It may be the consequence of the fact that this area is bordered by forests

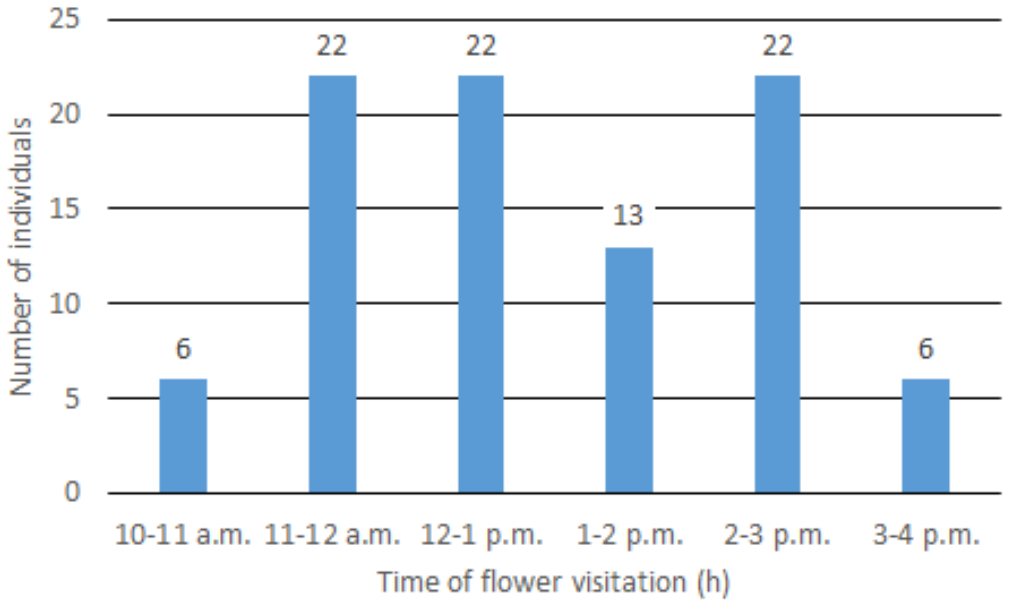

Fig. 1. Temporal distribution of *Adonis vernalis* flower visitor Diptera taxa at Szentkirályszabadja (2019).

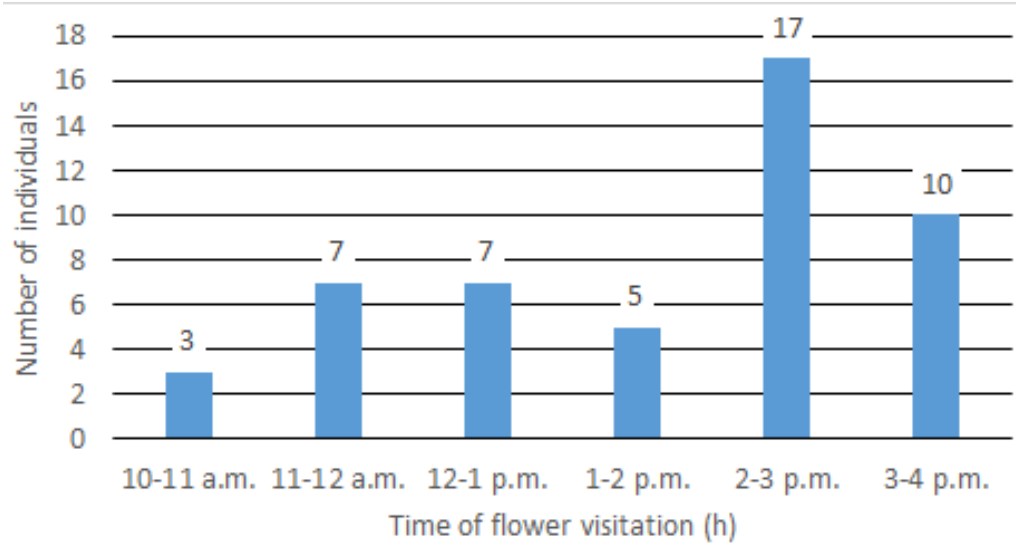

Fig. 2. Temporal distribution of *Adonis vernalis* flower visitor Diptera taxa at Veszprém-Kádárta (2019).

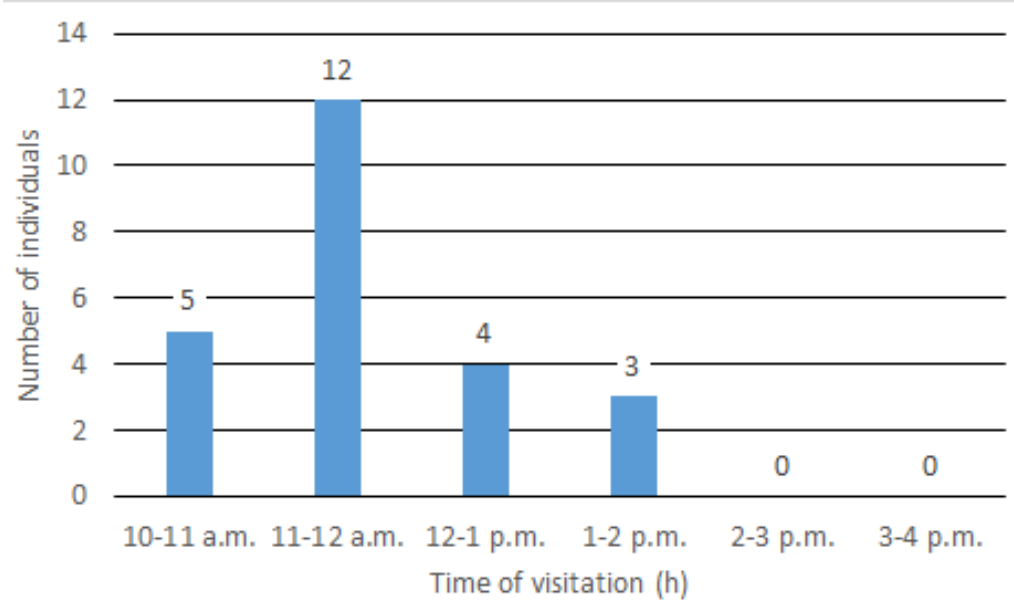

Fig. 3. Temporal distribution of *Adonis vernalis* flower visitor Diptera taxa on the Csatár Hill (2019).

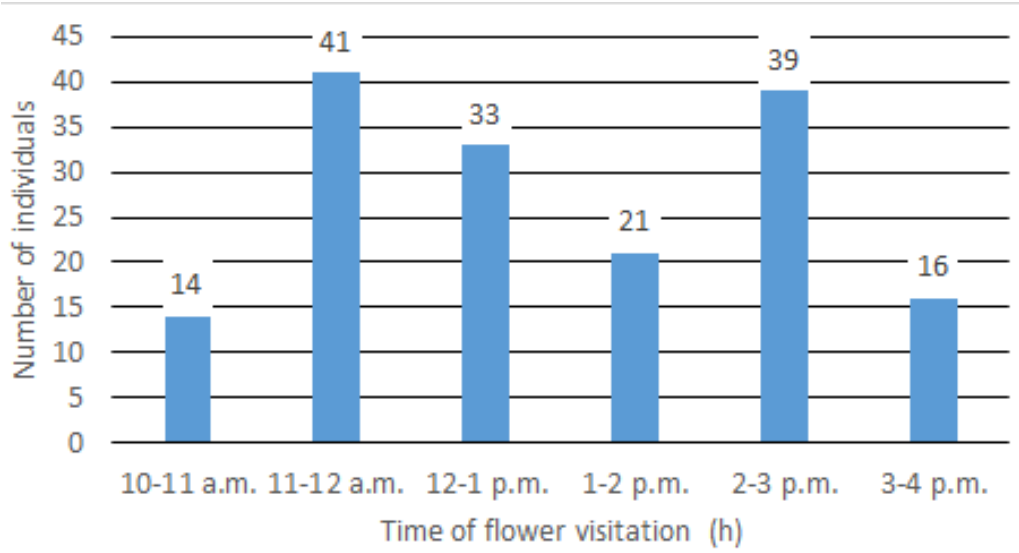

Fig. 4. Temporal distribution of *Adonis vernalis* flower visitor Diptera taxa at Szentkirályszabadja, Veszprém-Kádárta and on the Csatár Hill (2019).

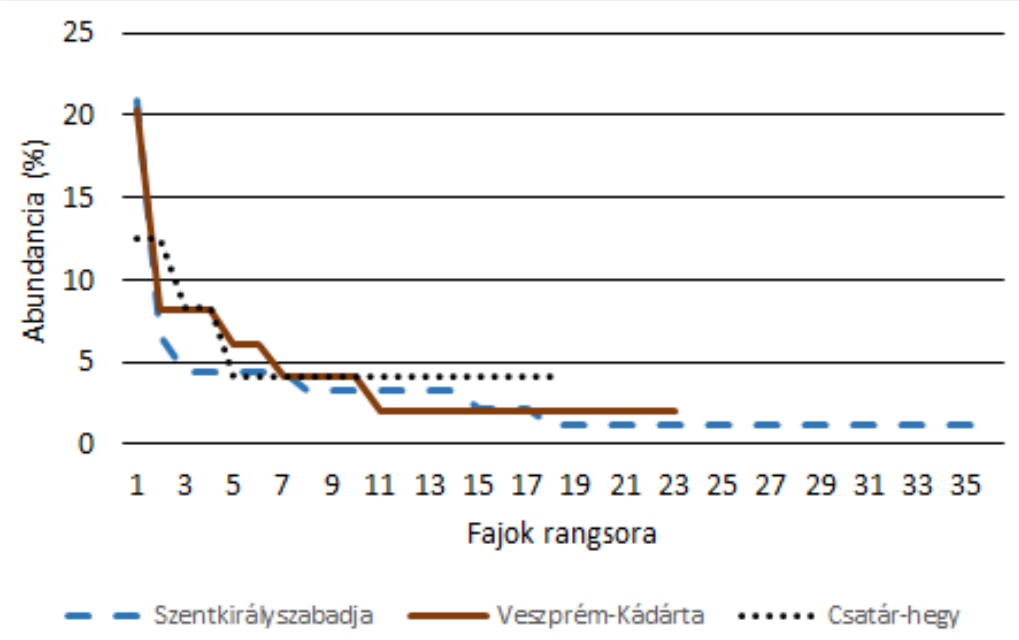

Fig. 5. Rank abundance of *Adonis vernalis* flower visitor Diptera species.

Table 6. *Adonis vernalis* flower visitor Diptera species listed in decreasing frequency (Csatár Hill, 2019).

Species	Family	Nr of individuals	Male	Female	Time of visitation
Chrysotoxum vernale Loew, 1841	Syrphidae	3	1	2	11 a.m.–1 p.m.
Pipizella viduata (Linnaeus, 1758)	Syrphidae	3	1	2	10–11 a.m., 1–2 p.m.
Delia sp. indet.	Anthomyidae	2	1	1	11–12 a.m.
Empis albicans Meigen, 1822	Empididae	2	1	1	11–12 a.m.
Anthomyia pluvialis (Linnaeus, 1758)	Anthomyidae	1		1	1–2 p.m.
Empis chioptera Meigen, 1804	Empididae	1		1	11–12 a.m.
Epistrophe diaphana (Zetterstedt, 1843)	Syrphidae	1		1	11–12 a.m.
Episyrphus balteatus (De Geer, 1776)	Syrphidae	1		1	1–2 p.m.
Exorista larvarum (Linnaeus, 1758)	Tachinidae	1		1	10–11 a.m.
Exorista tubulosa Herting, 1967	Tachinidae	1	1		11–12 a.m.
Pipizella divicoi (Goeldlin de Tiefenau, 1974)	Syrphidae	1	1		10–11 a.m.
Sphaerophoria scripta (Linnaeus, 1758)	Syrphidae	1		1	12–1 p.m.
Tachinidae sp. indet.	Tachinidae	1		1	10–11 a.m.
Xanthogramma laetum (Fabricius, 1794)	Syrphidae	1		1	11–12 a.m.
Sphaerophoria loewi Zetterstedt, 1843	Syrphidae	1		1	11–12 a.m.
Empis livida Linnaeus, 1758	Empididae	1		1	12–1 p.m.
Aedes cinereus Meigen, 1818	Culicidae	1	1		11–12 a.m.
Oxyna parietina (Linnaeus, 1758)	Tephritidae	1		1	11–12 a.m.
Total		24 (18 species)	7	17	10 a.m.–2 p.m.

Table 7. *Adonis vernalis* flower visitor Diptera families listed in decreasing frequency (Csatár Hill, 2019).

Family	Nr of individuals	Male	Female	Time of visitation
Syrphidae	12	3	9	10 a.m.–2 p.m.
Empididae	4	1	3	11 a.m.–1 p.m.
Anthomyidae	3	1	2	11–12 a.m., 1–2 p.m.
Tachinidae	3	1	2	10–12 a.m.
Culicidae	1	1		11–12 a.m.
Tephritidae	1		1	11–12 a.m.
Total	24	7	17	10 a.m.–2 p.m.

that provide proper circumstances for Diptera. We collected the lowest number of individuals and species on the Csatár Hill. It can probably be explained by the surrounding orchards which function as pollen sources when *A. vernalis* is in bloom, thus they offer a feeding option for Diptera. Edge effect can be another factor because the area is located next to a road, and dust pollution, air movements and sound effects caused by traffic can have negative effects on Diptera. The study site on the Csatár Hill is situated far away from forests, what can also be a reason for the lowest number of individuals and species. According to our experiences, this area was windier in warm, sunny weather, while the other two sites were specifically warm and windless.

In Szentkirályszabadja and Veszprém-Kádárta *Sphaerophoria scripta* was the most frequent species, but on the Csatár Hill only one individual was found. According to previous Hungarian studies this species plays a prominent role in pollination. It is a widespread and frequent in Hungary. It is a typical xerothermic species of open areas, mainly occurring in dry grasslands, and active around midday. During the studies in the Bakony Mts it has been collected on *Adonis vernalis* as well. It was formerly known from Szentkirályszabadja as Sándor Tóth collected 1 male and 5 females on 27.06.1999 (Tóth 2001, 2011). The rank abundance curves (Fig. 5) show that in Szentkirályszabadja and Veszprém-Kádárta one species (*Sphaerophoria scripta*) was dominant, the number of collected individuals of other species was much lower. The two curves decrease sharply: at Szentkirályszabadja the dominant *Sphaerophoria scripta* (20.9%) was followed by *Syrphus vitripennis* Meigen, 1822 (representing 6.6%), while in Veszprém-Kádárta *Sphaerophoria scripta* (20.4%) was followed by *Tachina ursina* Meigen, 1824 and *Empis chioptera* Meigen, 1804 (both reaching 8.2%). The first section of the curve constructed at the Csatár Hill site decrease slightly because no species was dominant, 3, 2 and 1 individuals were collected from every species (12.5%, 8.3% and 4.2%). The last section of all of the three curves reached a plateau. This section proved to be the longest at Szentkirályszabadja site, because we collected 1 individual from most species (14) here.

Both individuals of collected Culicidae species were males, who feed on plant liquid (Tóth 1975). As *A. vernalis* is a nectarless species, these insects visited the flower for other services (shelter, warming, *etc.*), which shows the presence of combined plant functions.

Although the study of Tóth (1975) showed that adult Stratiomyidae live in rather humid habitats, we have found them in dry grasslands, too.

The three collected Tephritidae larvae also prove that flowers have many different and combined functions, and flowers can serve as breeding or growing places for insects in different periods of their life-cycle.

The ratio of males and females was nearly equal at Veszprém-Kádárta. At Szentkirályszabadja the number of males was higher, while on the Csatár Hill more females were found. These results show that there is no significant difference in the flower visiting behaviour of males and females.

The temporal distribution of flower visitations was also different at the three sites. At Veszprém-Kádárta the period between 2–4 p.m. was the most effective (Fig. 2), while on the Csatár Hill no individuals were collected in this period. At the latter site insects were most active between 11–12 a.m. (Fig. 3). At Szentkirályszabadja the temporal distribution was more balanced between 11 a.m. and 3 p.m. The number of flower visitations decreased only between 1–2 p.m. (Fig. 1). If we analyse the data collected on the three sites together, we can see that the temporal distribution of flower visitations had peaks before mid-day (11–12 a.m.) and in early afternoon (2–3 p.m.) (Fig. 4).

Adonis vernalis offers forage (pollen) for insects already in early spring. The food resources provided by *A. vernalis* are extremely valuable because in the early period of year the number of flowering plants is limited. Diptera can carry pollen to stigmas as they move in flowers, so they can take part in pollination as well. Besides forage flowers provide other services as well, such as shelter, place of rest, breeding, warming, larval evolution. These functions are very important for Diptera and help maintain biodiversity. Our results are contributions to the knowledge of ecology of *A. vernalis*, and provide data about flower visiting behaviour of Diptera in general.

* * *

Acknowledgements – We would like to thank Dénes Péteri and Gábor Barad for their help in insect collection. We would like to thank Judit Bódis for her comments on the manuscript. The publication is supported by the EFOP-3.6.3-VEKOP-16-2017-00008 project. The project is co-financed by the European Union and the European Social Fund.

Összefoglaló: Az utóbbi évtizedekben a megporzó rovarok száma jelentősen visszaesett, így a napjainkban sokat emlegetett „pollinációs krízis" nyilvánvalóvá vált. Tanulmányunkban a kora tavaszi virágzású, védett *Adonis vernalis* L. virágokon gyűjtött kétszárnyúakat (Diptera) ismertetjük. Korábbi megfigyeléseink alapján az *A. vernalis* fő megporzói az Aculeata alrendből kerülnek ki. Az Aculeata fajokon kívül azonban számos rovar látogatja a virágokat, melyek közvetlenül vagy közvetve hozzájárulhatnak a megporzáshoz. A gyűjtéseket 2019 tavaszán végeztük három területen, melyek földrajzilag a Bakonyvidék középtáj területén helyezkednek el. Szentkirályszabadján és Veszprém-Kádártán *Sphaerophoria scripta* (Linnaeus, 1758) egyedből gyűjtöttük a legtöbbet (19 és 10 egyed), a Csatár-hegyen pedig *Chrysotoxum vernale* Loew, 1841 és *Pipizella viduata* (Linnaeus, 1758) egyedekből (3–3 egyed). A legtöbb egyed mindhárom területen a zengőlegyekből (Syrphidae) került ki. Az összes gyűjtött Diptera egyedből csupán 2 egyed tartozott a Nematocera alrendbe, a többi egyed a Brachycera alrendet képviselte. Veszprém-Kádártán három Tephritidae lárvát is találtunk a virágokban.

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(submitted: 08.01.2020, accepted: 16.07.2020)