

# EFFECTS OF TEMPERATURE AND PRECIPITATION ON DIPTERA SPECIES, AND FLOWER PREFERENCE OF DIPTERA SPECIES IN AN *ADONIS VERNALIS* POPULATION

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## Abstract

One aim of our study was to examine the effects of temperature and precipitation on Diptera visitors of *Adonis vernalis*. Another aim was to describe flower preference of Diptera species. *Adonis vernalis* visitors were studied between 3–13 April 2020 in the slope steppe of the Csatár Hill near Veszprém city. Diptera individuals found on every flowering plant species were collected. Data of *Adonis vernalis* visitors was compared to our results from the previous year. Meteorological data was shared by the Hungarian Meteorological Service. The number of Diptera visitors of *A. vernalis* decreased significantly in the second year. Our results show that compared to temperature precipitation has stronger effect on the flower visiting activity of Diptera taxa. Six plant species were flowering on the study area, but flies were collected only on *Adonis vernalis* and *Lamium purpureum*. The total number of collected flies was 19 representing 5 species. *Lamium purpureum* was visited only by Bombyliidae species. The

number of male flower visitors was higher on both plant species. Although none of the collected fly species was flower specific, we still found differences in their flower preference. Fly species are not primarily mentioned as pollinators and pollination studies mainly focus on bees, it would be important to carry out further studies on the role of Diptera species in pollination.

**Keywords:** Bombyliidae, flower visitor, fly, *Lamium purpureum*

### *Összefoglalás*

Kutatásunk egyik célja az volt, hogy megállapítsuk, hogy az *Adonis vernalis* Diptera viráglátogatóit milyen mértékben befolyásolja a hőmérséklet és a csapadék. Másik célunk az volt, hogy felmérjük, hogy az egyidejűleg nyíló kora tavaszi virágok közül a Diptera fajok melyikeket részesítik előnyben. A megfigyeléseket 2020. április 3-13. között végeztük a Veszprém melletti Csatár-hegy lejtősztyeppjében. Az összes Diptera egyedet begyűjtöttük, melyek a terület virágaira szálltak. Az *Adonis vernalis* virágok esetében kapott eredményeket előző évi gyűjtéseinkkel hasonlítottuk össze, melyhez az Országos Meteorológiai Szolgálattól kapott időjárás adatokat használtuk fel. Az *A. vernalis* Diptera látogatóinak száma a második évben jelentősen csökkent. Kutatásunkkal rámutattunk arra, hogy a Diptera fajok korai tavaszi viráglátogatói tevékenységét nagyobb mértékben befolyásolhatja a csapadék, mint a hőmérséklet. A területen egyidejűleg 6 faj virágzott, de legyeket csak az *Adonis vernalis* és a *Lamium purpureum* virágokon gyűjtöttünk. Az összesen begyűjtött legyek száma 19 volt, melyek 5 fajhoz tartoztak. A *Lamium purpureum* kizárólag Bombyliidae látogatókkal rendelkezett. Mindkét növényfaj esetében a hím viráglátogatók voltak többségben. Bár a gyűjtött légyfajok egyike sem virágspecifikus, mégis különbségeket találtunk a fajok virágválasztásában. Habár a hazánkban előforduló légy fajok elsődlegesen nem pollinátorokként vannak számon tartva, és a megporzó rovarokat vizsgáló kutatások is főleg

méhekre irányulnak, a legyek megporzásban betöltött szerepét fontos lenne tovább kutatni és feltárni.

**Kulcsszavak:** Bombyliidae, *Lamium purpureum*, légy, viráglátogató

### *Introduction*

Conditions of dry grassland species are changing continuously nowadays, thus some species become threatened. Agricultural expansion, regression of grazing or even overgrazing, afforestation, natural succession are all threatening factors (Forycka et al., 2004, Łuszczynski and Łuszczynska, 2009). *Adonis vernalis* L. still has a large distribution area, but the abovementioned factors threaten the survival of some populations. Due to its decreasing populations *Adonis vernalis* L. became a potentially endangered species and is listed in red data books of the relevant countries (Cites, 2000). The IUCN Red List evaluates it as a Vulnerable species (Schnittler-Günther, 1999). It is an early-flowering species important for insects too, providing food especially for Hymenoptera species. In beekeeping literature it is mentioned as an important pollen producing plant (Denisow and Wrzesień, 2006). Our former studies confirmed that *A. vernalis* is mainly pollinated by Aculeata species (Mészáros and Józán, 2018; 2020). The flowers of *A. vernalis* are nectarless, and 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. The species which can not offer high caloric reward ensure pollen transfer with alternative strategies. The dichogamous flowers of *A. vernalis* are partly protogynous. Dichogamy depends on the activity of pollinators as well (Denisow et al., 2014). Stigma receptivity starts about one day before the anthers of the same flower start to shed pollen. Pollen viability is increasing during the life-span of the plant (Lloyd and Webb, 1986).

According to our observations, flowers are visited by Diptera individuals as well. The role of Diptera species in pollination is underrated, but while they are moving in the flower pollen can stick on their body so they can carry the pollen to the stigma. Our former studies showed that *Adonis vernalis* flowers are mainly visited by Syrphidae taxa, but Empididae, Anthomyidae, Tachinidae, Culicidae and Tephritidae species were collected too (Mészáros and Tóth, 2020). One aim of our study was to examine the effects of temperature and precipitation on Diptera visitors of *Adonis vernalis*, based on two-year results. Another aim was to describe flower preference of Diptera species.

### ***Materials and methods***

*Adonis vernalis* visitors were studied between 3–13 April 2020 (22 hours long period in 6 days) in the slope steppe of the Csatár Hill near Veszprém city. The area of the study site is 1200 m<sup>2</sup>. About 130 flowering *Adonis vernalis* individuals can be found in the grassland. According to our former study the grassland can be classified as a Chrysopogono-Caricetum humilis Zólyomi (1950) 1958 association. Besides *A. vernalis* two more protected species was found: *Erysimum odoratum* Ehrh. and *Stipa pennata* L. (Mészáros et al., 2018). The co-flowering species during the study period: *Adonis vernalis* L., *Euphorbia seguieriana* Neck., *Lamium purpureum* L., *Muscari neglectum* Guss. ex Ten. s. l., *Potentilla arenaria* Borkh. and *Taraxacum officinale* agg.

Diptera individuals found on every flowering plant species were collected. The site was scanned 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. The species have been identified by Sándor Tóth according to Mihályi (1975) and Tóth (1977; 2017).

Data of *Adonis vernalis* visitors was compared to our results from the previous year (Mészáros and Tóth, 2020). Meteorological data was shared by the Hungarian Meteorological Service.

### ***Results and discussion***

Although our aim was to study both Diptera suborders (Nematocera and Brachycera), in 2020 only Brachycera individuals were collected. Six plant species were flowering on the study area, but flies were collected only on *Adonis vernalis* and *Lamium purpureum* (Table 1).

*Table 1. Flower visiting fly species collected on the Csatár Hill (2020)*

Species	<i>Adonis vernalis</i>			<i>Lamium purpureum</i>		
	Male	Female	Total	Male	Female	Total
<i>Bombylius discolor</i> Mikan, 1796				4	4	8
<i>Bombylius major</i> Linnaeus, 1758				1	5	6
<i>Bombylius pictus</i> Panzer, 1794					2	2
<i>Musca autumnalis</i> De Geer, 1776		1	1			
<i>Sphaerophoria taeniata</i> (Meigen, 1822)	2		2			
<b>Total:</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>5</b>	<b>11</b>	<b>16</b>

The total number of collected flies was 19, representing 5 species. Two species were collected on *Adonis vernalis* (3 individuals of 2 families) and 3 on *Lamium purpureum* (16 individuals of 1 family) (Table 2). The number of male flower visitors was higher on both plant species. The two species had no common Diptera visitors (Table 1).

*Table 2: Flower visiting fly families collected on the Csatár Hill (2020)*

Families	<i>Adonis vernalis</i>			<i>Lamium purpureum</i>		
	Male	Female	Total	Male	Female	Total
Bombyliidae				5	11	16
Muscidae		1	1			0
Syrphidae	2		2			0
<b>Total:</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>5</b>	<b>11</b>	<b>16</b>

24 individuals of 18 species were collected in 2019, and only 3 individuals of 2 species were recorded in 2020, so the number of Diptera visitors of *A. vernalis* decreased significantly in 2020, despite the fact that the length of the study period was nearly the same in both years (20 and 22 hours). In 2020 *A. vernalis* was flowering earlier than in 2019 (between 20 April- 3 May). In 2020 we had to study the Diptera species earlier because our aim was to investigate the visitation activity of insects in the same phenological stage of *A. vernalis*. Probably, insects could not adapt so fast to warmer weather. The mean daily temperature varied between 0.5 and 17.3 °C, the average of mean daily temperature was 10.6 °C. The values fluctuated widely, the temperature was not balanced (Figure 1).

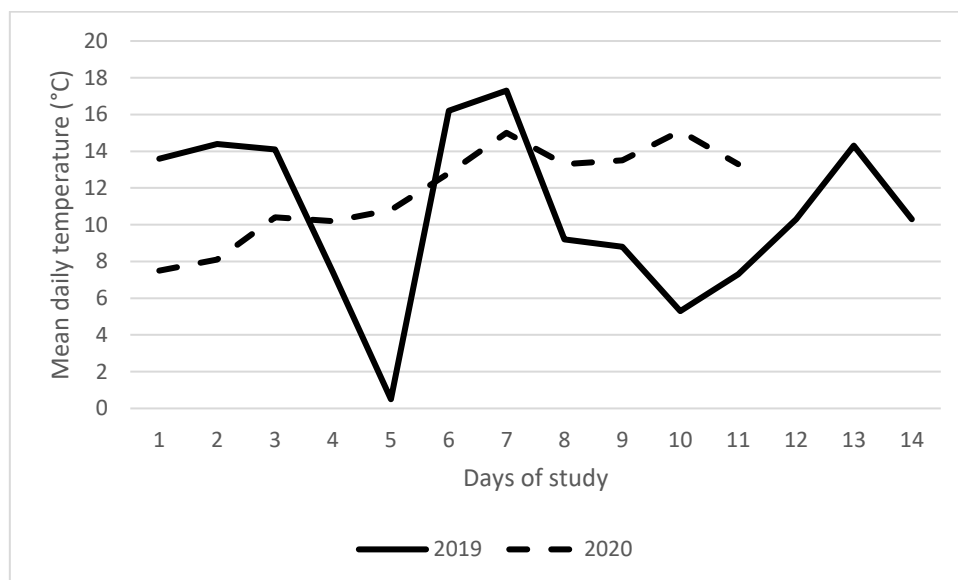


Figure 1: Mean daily temperature values (Kab Hill) according to the data of the Hungarian Meteorological Service

In the second year mean daily temperature altered between 7.5 and 15.5 °C, the average of mean daily temperature was 11.8 °C. Although temperature values were more balanced, the number of Diptera individuals still decreased significantly. According to precipitation data of the Hungarian Meteorological Service it rained seven times during the study period (8.1 mm in total) in 2019. In 2020 it rained only once (2.7 mm), on the last day of the study period, thus it

had no effect on our observations (Figure 2). The lack of precipitation obviously could cause the drastic decrease of Diptera species (Figure 2).

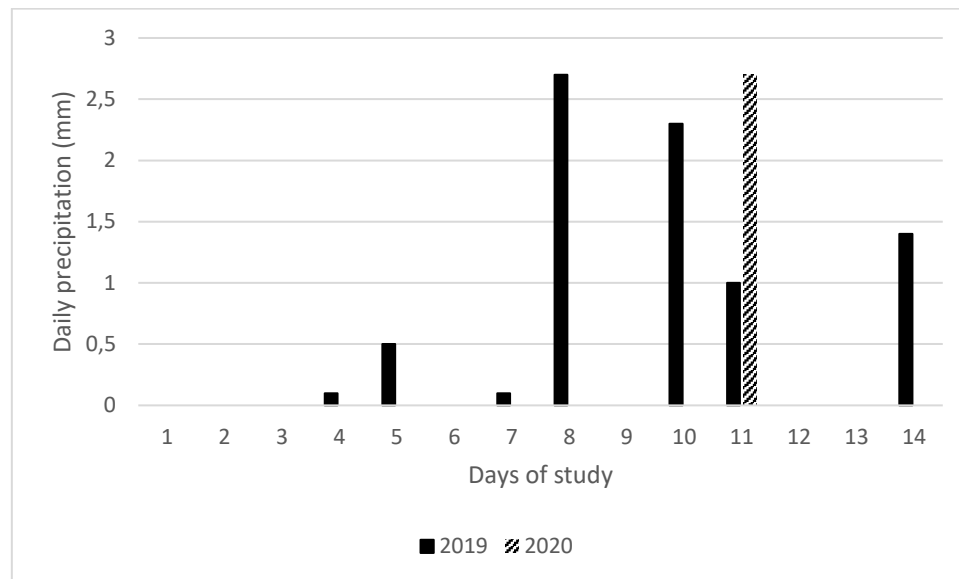


Figure 2: Daily precipitation values according to the data of the Hungarian Meteorological Service

Syrphidae species were dominant in both years. Adults mainly feed on nectar, honeydew and pollen, they have a role in plant pollination. In contrast to 2019 one Muscidae individual was found in 2020. Some common and frequent Diptera taxa are members of this family. Their body is strongly bristled. They have various feeding behaviour, they feed on manure, nectar, sugar containing materials, fruits, but adults can be predator as well. Some species are hematophagous, others lick nasal discharge and sweat (Mihályi, 1975). *Musca autumnalis* is native to Europe and Western Asia, it feeds on the eyes and lip of horses and cattle. The larvae develop in horse and bison manure (Krafsur and Moon, 1997). Its occurrence on the Csatár Hill can be explained by the presence of riding halls near the study area. As this species does not feed on pollen, its occurrence on *Adonis vernalis* proves the fact that flowers not only function as pollen and nectar resources for insects but provide place for resting and warming as well. Our study on the flower preference of Diptera taxa in 2020 showed, that insects visited only 2 from the 6 flowering species (*Adonis vernalis* and *Lamium purpureum*). *Lamium purpureum*

was visited only by Bombyliidae species. The members of this family feed on nectar and pollen as well. 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 (Panov, 2007; Tóth, 1975; 1977). In early spring we can observe *Bombylius major* individuals sucking nectar mainly from *Pulmonaria* and other Lamiaceae species (Tóth, 2014).

Our results show that compared to temperature precipitation has stronger effect on the flower visiting activity of Diptera taxa. Although none of the collected fly species was flower specific, we still found differences in their flower preference. Fly species are not primarily mentioned as pollinators and pollination studies mainly focus on bees, it would be important to carry out further studies on the role of Diptera species in pollination.

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