

# FLOWER PREFERENCE OF BRACHYCERA SPECIES IN A DRY GRASSLAND WITH A *PULSATILLA GRANDIS* POPULATION

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## Abstract

The aim of our study was to investigate the importance of *P. grandis* flowers for Brachycera communities. We also studied the attractiveness of other plant species flowering together with *P. grandis*. We aimed to measure the effect of temperature and precipitation on the number of Diptera visitors of *Pulsatilla grandis* in two consecutive years, so we compared the data of the present study with our former results. 135 individuals were collected, 46% of them were female and 54% male. The highest number of *Brachycera* individuals occurred on *Potentilla arenaria*. The ratio of males and females was various. 91% of the collected individuals represented the Bombyliidae family, rest of the individuals were member of Tachinidae (6%), Syrphidae (2%) and Calliphoridae (1%) families. Mean precipitation values and mean daily temperature correlate with the number of flies of *Pulsatilla grandis* flowers.

**Keywords:** Bombyliidae, female, fly, male, precipitation

### *Összefoglalás*

Tanulmányunkban arra a kérdésre kerestük a választ, hogy a *P. grandis* virágai milyen mértékben fontosak a Brachycera közösségek számára. Fel kívántuk tární, hogy a gyepszintben egyidejűleg virágzó fajok milyen mértékben vonzzák a legyeket, és milyen mértékben látogatják ezzel párhuzamosan a *Pulsatilla* virágokat. Kíváncsiak voltunk továbbá arra, hogy a *Pulsatilla grandis* virágok légy látogatóinak száma két egymást követő évben hogyan változik a hőmérséklet és a csapadék függvényében. Kutatásunk során összesen 135 egyedet fogtunk be, melynek 46%-a nőstény, 54%-a pedig hím volt. A legtöbb Brachycera egyed a *Potentilla arenaria* fajon fordult elő. A hímek és a nőstények aránya változó volt. Az összes begyűjtött egyed 91%-a tartozott a Bombyliidae családba, ezután a Tachinidae (6%), a Syrphidae (2%) és a Calliphoridae (1%) család következett. A gyűjtési idő alatti átlag csapadék mennyiségek és napi átlaghőmérsékletek korreláltak a begyűjtött legyek számával.

**Kulcsszavak:** Bombyliidae, csapadék, hím, légy, nőstény

### *Introduction*

Dry grasslands are species rich and threatened habitats in Europe, containing many endemic plant and animal species. Their area considerably decreased in the last 200 years (Csecserits et al., 2018). The abandonment of grassland management can result in litter accumulation, spread of competitor species, succession and loss of valuable species (Valkó et al., 2012). *Pulsatilla grandis* Wender. is one of these valuable and endangered species, which provides important nectar and pollen resources for insects in early-spring.

The aim of our study was to investigate the importance of *P. grandis* flowers for Brachycera communities. We also studied the attractiveness of other plant species flowering together with *P. grandis*. We aimed to measure the effect of temperature and precipitation on the number of

Diptera visitors of *Pulsatilla grandis* in two consecutive years, so we compared the data of the present study with our former results.

Members of the Diptera order has only one pair of membranous wings, the second pair evolved into mechanosensory organs (halteres). The order is very species rich, its representatives are characterized by various morphology and ecology. Most Diptera taxa (flies and mosquitos) lay eggs and undergo complete metamorphoses. About 120 000 Diptera species has been described worldwide. In Hungary the estimated number of species is 10000. But the fauna is still not well-described (Tóth, 2009). The number of described species in Hungary is about 6000 (Papp, 2001). Dipterans play important role in decomposition, sewage cleaning, pest reduction, pollination etc. Damages caused by Diptera is related to the various feeding of their larvae.

Former studies in the Bakony Mts found *Platycheirus fulviventris* (Macquart, 1829) and *Rhingia campestris* Meigen, 1822 on *Pulsatilla nigricans* Störck (Tóth 2001). According to our study in 2018 the flowers of *P. grandis* on the Vörös Hill and Csatár Hill were mainly visited by hoverflies (*Brachypalpus laphriformis* (Fallén, 1816), *Brachypalpus valgus* (Panzer, 1798), *Chrysotoxum elegans* Loew, 1841, *Criorhina asilica* (Fallén, 1816), *Eristalis tenax* (Linnaeus, 1758), *Eupeodes luniger* (Meigen, 1822), *Scaeva pyrastris* (Linnaeus, 1758), *Scaeva selenitica* (Meigen, 1822), *Sphaerophoria scripta* (Linnaeus, 1758)), but representatives of Calliphoridae (*Calliphora vicina* Robineau-Desvoidy, 1830, *Pollenia vespilo* (Fabricius, 1786), *Pollenia rudis* (Fabricius, 1786)), Stratiomyidae (*Nemotelus pantherinus* (Linnaeus, 1758)) Tachinidae (*Blondelia nigripes* (Fallén, 1810), *Germaria ruficeps* (Fallén, 1820)) were collected too.

All hoverfly species collected in our study had already been reported from the Bakony Mts (Tóth, 2001), but no hoverflies have been observed on *Pulsatilla grandis* flowers in that region so far. So our former study recorded 9 new hoverfly visitors of that species in the Bakony Mts (Mészáros and Tóth 2020).

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

The study area can be found on the Csatár Hill near Veszprém city (Hungary). The 0.6 ha study site lies at 328–335 m a.s.l.. Its vegetation can be classified as *Chrysopogono-Caricetum humilis* Zólyomi (1950) 1958 association. According to our former studies this is a diverse dry grassland with high nature conservation value, we have recorded 9 protected plant species on the area: *Anacamptis pyramidalis* (L.) Rich., *Erysimum odoratum* Ehrh., *Jurinea mollis* (L.) Rchb., *Linum tenuifolium* L., *Orchis morio* L., *Plantago argentea* Chaix in Vill., *Polygala major* Jacq., *Pulsatilla grandis* Wender., *Stipa pennata* L. (Mészáros et al., 2018).

Diptera were collected in a 24 hours long period between 14-29 March 2020. We collected the Diptera visitors of every flowering plant species. Only *Pulsatilla grandis* Wender was flowering on the first and second study days, later the following species were flowering too: *Alyssum montanum* L., *Muscari neglectum* Guss. ex Ten. s. l., *Potentilla arenaria* Borkh. and *Pulsatilla nigricans* Störck. 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, which is suitable for Diptera collecting. The site was scanned continuously.

The species have been identified by Sándor Tóth according to Mihályi (1979; 1986) and Tóth (1977; 2017).

We used our data from 2019 (Mészáros and Tóth 2020) to compare the number of Diptera visitors of *Pulsatilla grandis* in two consecutive years. Mean daily temperature and precipitation data was shared by the Hungarian Meteorological Service.

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

135 individuals were collected, 46% of them were female and 54% male. Although 5 early-spring species were flowering on the study area (*Alyssum montanum*, *Muscari neglectum*,

*Potentilla arenaria*, *Pulsatilla grandis*, *Pulsatilla nigricans*), flies were collected only from 3 species (*Muscari neglectum*, *Potentilla arenaria*, *Pulsatilla grandis*) (Table 1).

Table 1. Diptera visitors collected on the Csátár Hill

Species	<i>Potentilla arenaria</i>			<i>Muscari neglectum</i>			<i>Pulsatilla grandis</i>		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
<i>Bombylius discolor</i> Mikan, 1796	4	3	7	23	15	38		1	1
<i>Bombylius major</i> Linnaeus, 1758	30	27	57	10	5	15			0
<i>Bombylius medius</i> Linnaeus, 1758		1	1	1	3	4			0
<i>Brachypalpus laphriformis</i> (Fallén, 1816)		1	1			0			0
<i>Brachypalpus valgus</i> (Panzer, 1798)	1		1			0			0
<i>Calliphora vicina</i> Robineau-Desvoidy, 1830		1	1			0			0
<i>Gonia divisa</i> Meigen, 1826		1	1			0			0
<i>Gonia ornata</i> Meigen, 1826	1	1	2			0			0
<i>Melanostoma mellinum</i> (Linnaeus, 1758)						0		1	1
<i>Meriania puparum</i> (Fabricius, 1794)	1	2	3			0			0
<i>Tachina lurida</i> (Fabricius, 1781)	2		2			0			0
Total:	39	37	76	34	23	57	0	2	2

The highest number of *Brachycera* individuals occurred on *Potentilla arenaria* (76) and *Muscari neglectum* (57). Only 2 individuals were collected from *Pulsatilla grandis*. The ratio of males and females was various: *Potentilla arenaria* and *Muscari neglectum* had more male visitors, while only females were collected from *Pulsatilla grandis*. 53% of all individuals (135) were *Bombylius major*, and 34% were *Bombylius discolor*. *Bombylius major* was the most frequent visitor of *Potentilla arenaria* (57), *B. discolor* had the second highest number with significantly less individuals (7). Their frequency was different in the case of *Muscari neglectum*, 38 *Bombylius discolor* and 15 *B. major* were collected. From the 11 visitors only *Bombylius discolor* was collected on all the 3 plant species. *B. major* and *B. medius* visited 2 plant species, the other species were only collected on *Potentilla arenaria*. 91% of the collected

individuals represented the Bombyliidae family, rest of the individuals were member of Tachinidae (6%), Syrphidae (2%) and Calliphoridae (1%) families (Table 2).

Table 2. Diptera families collected on the Csatár Hill

Family	<i>Potentilla arenaria</i>			<i>Muscari neglectum</i>			<i>Pulsatilla grandis</i>		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Bombyliidae	34	31	65	34	23	57	1	1	2
Calliphoridae		1	1			0			0
Syrphidae	1	1	2			0	1	1	2
Tachinidae	4	4	8			0			0
Total:	39	37	76	34	23	57	0	2	2

Bombyliidae are medium-sized, usually hairy flies with long proboscis. Some species hover in the air over the flowers and use their proboscis to reach the nectar (Tóth, 1977). Panov (2007) studied the gut content of Bombyliidae species and observed that females consumed much more pollen than males. They found no difference in the pollen consumption of long-proboscid and short-proboscid species. Both sexes are capable of pollen digestion. According to our observations they touched the flowers of *Pulsatilla grandis* with their proboscis only for moments, whereas they spent more time on *Potentilla* and *Muscari* plants. They reach the nectar with their long proboscis (without mowing in the flower), therefore their role in pollination is negligible. Adult Syrphidae (hoverflies) mainly feed on nectar, honeydew and pollen, thus can play important role in pollination (Tóth, 1977). Adult *Tachinidae* live in forests and bushy habitats, feeding on nectar and sugar containing sap. Among Diptera *Tachinidae* have the highest importance in forest ecology, therefore they belong to families with great economic value. They help pest control in forestry (Tóth, 2014). Their occurrence on the study site can be expected as the grassland is bordered by forest on two sides.

All hoverfly species collected in our study had already been reported from the Bakony Mts (Tóth, 2001), on different plant species. Our study reports one new hoverfly visitor (*Melanostoma mellinum*) of *Pulsatilla grandis* in the Bakony Mts. On *Pulsatilla grandis* we did not record the occurrence of *Platycheirus fulviventris* and *Rhingia campestris*, which were observed on *Pulsatilla nigricans* Störck in the Bakony Mts in a former study (Tóth, 2001). Neither *Brachypalpus laphriformis* nor *Brachypalpus valgus* had not been observed before on *Potentilla arenaria* in the Bakony Mts, so these are 2 new records for the Bakony Mts too. No hoverflies were found on *Muscari neglectum* flowers, former studies in the Bakony Mts have recorded also only 4 hoverfly species on *Muscari racemosum*.

The yellow flowers of *Potentilla arenaria* attracted the most visitors, thus we can conclude that colour is more important than the size of flower for Brachycera species in flower selection. *Potentilla* was abundant in the whole grassland, so the little groups of blue *Muscari* flowers were not so conspicuous, not to mention the solitary, purple flowers of *Pulsatilla*. It is also probable that the length of the stem play a role in flower selection as well. Flies can safely visit the *Potentilla* flowers on short stems even in stronger airflow. *Muscari* has longer stem so its flowers are not so stable in windy conditions. The huge, bell shaped flowers of *Pulsatilla* sway in the wind.

The results of the two study years show that the number of Diptera visitors of *Pulsatilla grandis* has considerably decreased. In 2019 15 individuals were collected from the same *Pulsatilla grandis* population between 16-24 March (Mészáros and Tóth 2020). Although the length of our study was nearly the same in 2020, only 2 individuals were collected. According to the data of the Hungarian Meteorological Service (Table 1) the average of mean daily temperature decreased in the second year (7.52 and 5.30 °C). Mean daily temperature values were 2.9–13.5 °C in the first year, and -4.1–13.4 °C in the second. The mean of daily total

precipitation values was significantly higher in the first year compared to the second (0.28 and 0.05 mm).

The decrease of mean daily temperature in the study period is interesting because *Pulsatilla* flowers were in the same phenological stage in both years. Buds were gradually opening, than slowly wilting after full blossoming. So pollinators could visit flowers in the same phenological stages in both years. In early spring insects limitedly visit flowers due to unfavourable weather (Kratochwil, 1988), thus lower temperature could also cause the decrease of *Pulsatilla* visitors in the second year. The overlap of phenological stages of plants and insects was less optimal in 2020. In 2020 mean daily temperature values fluctuated widely (Figure 1). The difference between the lowest and highest mean daily temperature was 10.6 °C in 2019 and 17.5 °C in 2020 (moreover the mean daily temperature was under 0 °C on some days in this year). The fluctuation between nights and days was considerable too, which also could have unfavourable effects on the visiting activity of flies.

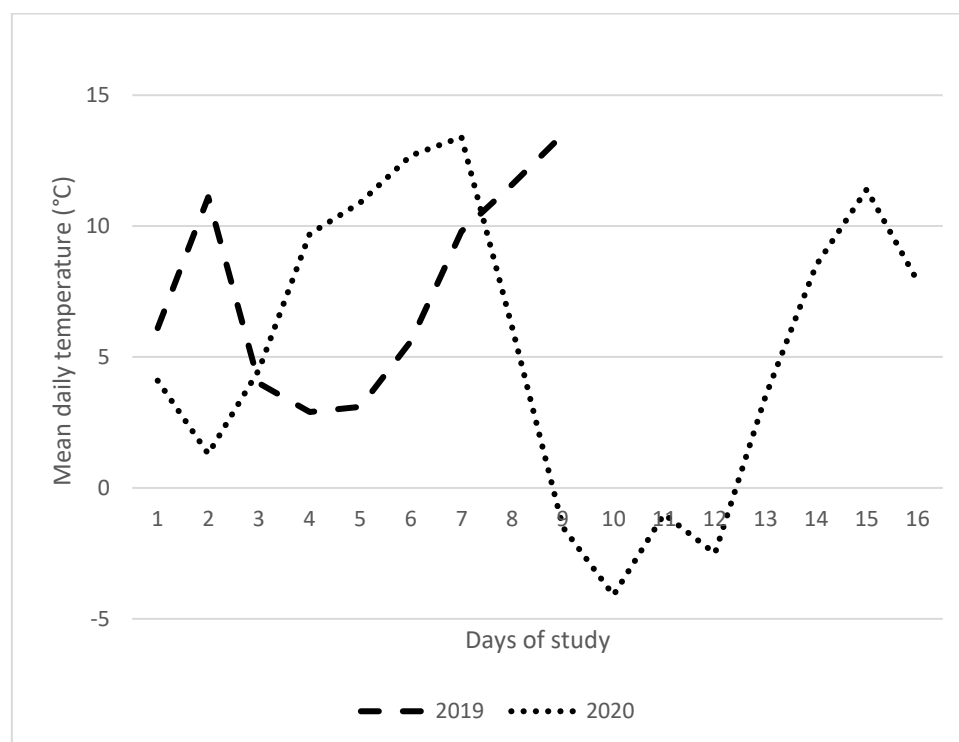


Figure 1. Mean daily temperature values during the study period (Kab Hill) according to the data of the Hungarian Meteorological Service



Mean precipitation values correlate with the number of collected flies, the lack of precipitation also has negative effects on the presence of Brachycera individuals.

The population of *Pulsatilla* decreased significantly in the two years of the study because of game damage. In the second year we observed that the number of damaged plants increased every day. Sauberer and Panrok (2015) found in their study in Lower Austria and Vienna that some *P. grandis* individuals were damaged by red deer or European hare. The results of Kerekes (2013) also confirm that roe deers consume the shoots of *P. grandis* in early spring. We found in our former study that 61% of game damage happened when flowers were in buds (Mészáros and Galambos 2017). When the achenes have formed, we did not recorded new game damage. This can be the result of appearance of other, more preferred plants. Although every part of the plant is poisonous game species often feed the *Pulsatilla grandis* shoots with buds and flowers, and preferred the former phenological stage. Despite the above mentioned game damage the number of *Pulsatilla* flowers were still high, thus the lower number of flowers could not be the main reason of the decrease of Brachycera individuals in the second year.

Flies are mainly not studied as pollinators but they role in plant-insect relations is indisputable. These relations are very complex and diversified, deep and detailed knowledge is needed for their better understanding. The aim of our study was to improve this knowledge.

### *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.

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