

Phacelia campanularia A. Gray – A SOURCE OF POLLEN FLOW FOR INSECT POLLINATORS

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S u m m a r y

The objective of the study was *Phacelia campanularia*, an annual species of Hydrophyllaceae family. During 2003 – 2005 seasons, the investigations of flowering period and pollen efficiency were carried out under climatic conditions of the Lublin area. Weight of pollen was estimated by Warakomska's modified ether method (1972), pollen grains were measured according to the recommendations by Andrejev (1926).

The results showed that the blooming of *Phacelia campanularia* started in first decade of June and lasted till the third decade of July (37 – 45 days). The mean number of flowers developed per one plant during the vegetation season reached from 388.7 in 2004, to 423.3 in 2003 and 437.8 in 2005.

The flower of *Phacelia* has five stamens, the anthers of which start dehiscing and releasing pollen at morning hours. Pollen grains are round-flattened with furrows and smooth exine. Their dimensions ranged between 18.88 – 19.63 μm in polar view and 21.32 – 22.15 μm in equatorial view.

The mean pollen weight produced by one flower reached 1.05 mg in 2003, 1.42 mg in 2004 and 1.35 mg in 2005, i.e. 444.25 mg, 552.92 mg and 592.34 mg per one plant respectively. A square meter of a phacelia plot may supply 4.22 – 5.63 g of pollen.

Keywords: *Phacelia campanularia*, flowering, pollen flow.

INTRODUCTION

The genus *Phacelia* Juss. (the family Hydrophyllaceae) comprises several dozen plant species widespread in North America (Howes 1979, Krejča and Klimo 1984, Podbielkowski 1987). Among the few species that are grown under Poland's conditions the most common is lacy phacelia often seeded as excellent bee pasture as well as green manure and cattle fodder (Lipiński 1976, Howes 1979, Jabłoński and Skowronek 1983). Among the ornamentals a species of note is desert bluebell (*Phacelia campanularia*) - grown in rock gardens and on flower beds.

The flowers of phacelia are intensively visited both by honeybees and by other pollinators which forage on the flowerheads all day gathering nectar and

pollen. The number of insects reaches its peak in the afternoon hours (Demianowicz 1953, Howes 1979, Jabłoński 1997). Apart from *Phacelia tanacetifolia* among other species cited by Howes (1979) as attractive to honeybees are *Ph. viscida*, *Ph. congesta* and *Ph. campanularia*.

The presence of phacelia pollen in honeys, bee bread and pollen loads was demonstrated by various investigators dealing with pollen analysis of bee products (Demianowicz 1962, Warakomska 1997, 1999, Sawyer 1988, Wróblewska 2002, Wróblewska and Stawiarz 2004). In addition, Anasiewicz and Warakomska (1969, 1977) recorded phacelia pollen grains in pollen loads of bumblebees.

This study had as its objective to investigate the date and abundance of blooming of *Phacelia campanularia* and to determine the attraction of its pollen to insect pollinators. The species has not been studied yet with this regard.

MATERIAL AND METHODS

The experiment was conducted on the plots of the Department of Botany, Agricultural University in Lublin in the years 2003 – 2005 on a brown soil of loess origin. The study object was *Phacelia campanularia*, the seeds of which were sown each year to the ground in the second half of April.

The flowering records of the taxon were taken as soon as the first buds appeared and were continued until the last flowers ceased to bloom. Blooming abundance of the species was examined by determining the number of flowers per plant per season and plant density per unit area. Those records were taken in six replications in all years of the study.

In order to investigate the attraction of the pollen to the pollinating insects pollen efficiency of phacelia flowers was determined by using the modified ether method by Warakomska (1972). Those tests were run twice in each of the growing seasons on different dates. Pollen output per plant was assayed based on the weight of pollen from 10 flowers and from

1 square meter. In glycerol-gelatin microscope preparations the lengths of polar and equatorial axes of the pollen grains were determined following the recommendations by Andrejev (1926).

The data on blooming abundance per plant and pollen efficiency of flowers of the species under investigation were statistically analyzed using ANOVA. The differences among means were examined for significance using Tukey's test at significance level of $\alpha=0.05$.

RESULTS

In each of the growing seasons the blooming of the taxon commenced in mid-June and lasted for 5 to more than 6 weeks (37 – 45 days). The blooming period was the longest in the third, and the shortest in the second year of study (Table 1). One plant produced on average 388.7 to 437.8 flowers during the season. The number of plants per 1 m² stayed almost the same over the three years of the study and averaged 9.5.

The flowers of desert bluebell are arranged in cymes and their petals are brilliant blue. At the entrance to the corolla tube there are 5 bright creamy spots which serve as indicators to insects. The stamens of bright creamy heads are between the petals and are contrasting with them. As soon as the corolla starts to open the arcuate stamen filaments begin slowly to unbend until

Table 1.
Duration and abundance of desert bluebell (*Phacelia campanularia*) flowering.

Year	Flowering		Number of flowers per 1 plant	
	period	number of days	from – to	mean
2003	11.06-23.07	43	319-576	423.3 a
2004	10.06-16.07	37	247-603	388.7 a
2005	06.06-21.07	45	336-599	437.8 a
mean	09.06-20.07	41.7	300.7-592.7	416.6

Mean values followed by the same letter are not significantly different.

Table 2.
Size of pollen grains of desert bluebell (*Phacelia campanularia*).

Year	Length (μm)				P/E
	polar axis - P		equatorial axis - E		
	mean	from – to	mean	from – to	
2003	19.63	18.11-21.27	22.15	20.47-23.26	0.89
2004	19.50	17.34-20.84	21.32	20.11-22.73	0.91
2005	18.88	17.33-20.42	21.56	19.79-23.42	0.87
mean	19.34	17.59-20.84	21.68	20.12-23.14	0.89

Table 3.
Pollen flow of desert bluebell (*Phacelia campanularia*).

Year	Day and month	Weight of pollen per/		
		10 flowers (mg)	1 plant (mg)	1 m ² area (g)
2003	03.07	11.22 a	474.94	4.51
	14.07	9.77 a	413.56	3.93
	mean	10.49 A	444.25	4.22
2004	25.06	17.38 b	675.56	6.42
	21.07	11.07 a	430.29	4.09
	mean	14.22 B	552.92	5.25
2005	29.06	15.81 b	692.16	6.57
	13.07	11.25 a	492.52	4.68
	mean	13.53 B	592.34	5.63
years mean		12.75	529.84	5.03

Mean values followed by the same letter are not significantly different

they reach a vertical position, then anthers dehisce and pollen is released thus becoming available to insects. When the species was in bloom honeybees with creamy pollen loads were frequently observed.

The pollen grains of desert bluebell are flattened spherical in shape, 6-colpate, with smooth exine (P/E = 0.87 – 0.91). The average length of the polar axis came within 18.88 – 19.63 μm , and that of the equatorial axis within 21.32 – 22.15 μm (Table 2).

The average weight of pollen produced by 10 flowers varied from year to year averaging 10.49 mg in 2003, 14.22 mg in 2004 and 13.53 mg in 2005 (Table 3). The

highest average pollen efficiency per plant was obtained in the growing season of 2005 (592.34 mg). The weight of pollen per plant was mainly the outcome of pollen efficiency per 10 flowers (Table 2) and of blooming abundance (Table 1) over the years of the study. The average pollen efficiency per 1 m² was the highest in 2005 (5.63 g) (Table 3).

DISCUSSION

Over the three years of the study the blooming of *Ph. campanularia* started in the first half of June, in 2005 the plants having started to bloom a few days earlier.

Data on the dates and duration of blooming recorded in the three growing seasons are similar to those cited by Krejča and Klimo (1984) whereas Krause et al. (2004) report the species to start blooming only towards the end of June and to bloom for a shorter time (3 – 4 weeks).

The pollen grains of desert bluebell as opposed to those of lacy phacelia are creamy in colour. According to Erdtman's classification (1954) they are rated as small since their dimensions come within 10 – 25 µm. While in full bloom, the plants were numerous visited by honeybees which gathered pollen forming pollen loads creamy in colour. A similar colour of the pollen loads from that taxon was observed by Hodges (1952).

In literature there no data available on blooming abundance and pollen efficiency of desert bluebell. In the successive growing seasons one plant produced on average 388.7 to 437.8 flowers on numerous racemes. The average pollen weight from 10 flowers did not vary over the years of the study (10.49 – 14.22 mg) which was undoubtedly the result of the weather conditions prevailing during stamen formation and maturing. In all three years the flowers gave larger pollen weight on the first observation date which coincided with the initial stage of blooming. The estimated pollen efficiency of desert bluebell averaged 529.84 mg per plant and 5.03 g per 1 m² of the area under crop. The results can only be compared with those of Warakomska (1972) concerning lacy phacelia the pollen output of which was slightly higher than that reported for this species.

CONCLUSIONS

The blooming of desert bluebell under the conditions of the Lublin area starts in the first or in the second decade of June and lasts from 5 to 6 weeks.

Pollen efficiency per unit area is closely positively correlated with pollen output of individual flowers, blooming abundance and plant density.

The plants of *Ph. campanularia* may provide a valuable supplementary source of pollen flow for insect pollinators in late spring and early summer. Pollen loads from the taxon under investigation are creamy in colour.

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***Phacelia campanularia* A. Gray. ŹRÓDŁEM POŻYTKU PYŁKOWEGO ENTOMOFAUNY ZAPYLĄJACEJ**

W r ó b l e w s k a A .

S t r e s z c z e n i e

Obiektem trzyletnich badań była facelia dzwonekowata (*Phacelia campanularia* A. Gray), gatunek jednoroczny z rodziny Hydrophyllaceae. W sezonach 2003 – 2005 prowadzono obserwacje przebiegu i obfitości kwitnienia oraz szacowano pożytek pyłkowy wspomnianego taksonu w warunkach Lublina. Wydajność pyłkową badano metodą eterowo-wagową Warakomskiej (1972) z zastosowaniem modyfikacji polegającej na dodatkowym wypłukiwaniu pyłku alkoholem. Wymiary ziaren pyłku określono w mikroskopowych preparatach glicerożelatynowych według Andrejewa (1926).

Przeprowadzone badania wykazały, że kwitnienie *Phacelia campanularia* w warunkach Lublina rozpoczynało się w pierwszej dekadzie czerwca i trwało do trzeciej dekady lipca (37 – 45 dni). Liczba kwiatów wytworzona przez jedną roślinę w sezonie wegetacyjnym wyniosła średnio od 388,7 w roku 2004, do 423,3 w 2003 i 437,8 w roku 2005.

Kwiat facelii dzwonekowej zawiera pięć pręcików o jaskrawo kremowych główkach. Pęknięcie pylników i uwalnianie pyłku rozpoczyna się w godzinach przedpołudniowych i trwa kilka godzin. Kulisto-splaszczone ziarna pyłku, charakteryzują się gładką egzyną i obecnością bruzd. Ich średnie wymiary wahają się w granicach 18,88 – 19,63 μm w rzucie biegunowym i 21,32 – 22,15 μm w rzucie równikowym.

Średnia masa pyłku z jednego kwiatu wynosiła 1,05 mg w roku 2003, 1,42 mg w 2004 i 1,35 mg w 2005, co w przeliczeniu na jedną roślinę wyniosło odpowiednio: 444,25 mg, 552,92 mg i 592,34 mg. Z powierzchni 1 m² facelii dzwonekowej można uzyskać 4,22 – 5,63 g pyłku.

Słowa kluczowe: *Phacelia campanularia*, kwitnienie, pożytek pyłkowy.