POLLEN YIELD AND POLLEN GRAIN DIMENSIONS OF SOME LATE-SUMMER PLANT SPECIES OF THE LAMIACEAE FAMILY

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S u m m a r y

The aim of this study was to determine pollen yield and pollen grain dimensions of several late-summer Lamiaceae family species: *Physostegia virginiana* (L.) Benth., *Mentha rotundifolia* (L.) Huds., *M. longifolia* (L.) Huds., *Pycnanthemum californicum* Torr. ex Durand, *Elsholtzia cristata* Willd., *Satureja hortensis* L., *Leonurus sibiricus* L. The study was conducted at the Institute of Pomology and Floriculture, Apiculture Division, Puławy, Poland in the years 1995 – 1997. The mean weight of pollen per 100 flowers of the species under investigation covered a broad range from 0.34 mg to 21.23 mg. The yield of pollen varied from 10 kg·ha^{-1} to 131 kg·ha^{-1}. Honeybee pollen loads of the investigated species were usually small. It was only on the *Elsholtzia cristata* flowers that the bees had larger pollen loads. The pollen grains of the studied species can be classified as medium-sized (P = 26.33 - 47.55 μm, E = 20.5 - 44.48 μm).

Keywords: Lamiaceae, pollen production, attractiveness to bees.

INTRODUCTION

Many plant species from the Lamiaceae family occur in the wild but they are also grown as medicinal herbs, spices, essential oil-yielding plants, and ornamentals. Nearly all of them supply insects with food such as nectar or often pollen. (Jabłoński 1986, 1990, 1993, Jabłoński and Kołtowski 2000, 2001, Chwil 2003). They bloom abundantly and for a long time. For this reason they can provide a continuous food supply to both wild insect pollinators and honeybees. The absence of detailed data concerning the pollen yield from these plants is the reason we decided to measure the flower-pollen output of some late-summer Lamiaceae species. The size of pollen grain was also measured.

MATERIAL AND METHODS

The study was conducted at the Research Institute of Pomology and Floriculture, Apiculture Division, Puławy, Poland in the years 1995 – 1997. Seven species grown in the collection of melliferous species were researched: from perennials: round-leaved mint (*Mentha rotundifolia* (L.) Huds.), horse mint (*M. longifolia* (L.) Huds.), obedient plant (*Physostegia virginiana* (L.) Benth.), mountain mint (*Pycnanthemum californicum* Torr. ex Durand); from biennials: Chinese motherwort (*Leonurus sibiricus* L.); from annuals: crested late-summer mint (*Elsholtzia cristata* Willd.) and summer savory (*Satureja hortensis* L.).

Abundance of pollen production was measured using the either method by Warakomska (1972) as modified by Szklanowska (Szklanowska and Pluta 1984, Szklanowska 1995). During the growing season 4 samples were collected, three times. The sample consisted of 100 to 400 pollen heads depending on anther size of a given species. The dimensions of pollen grains were measured in semi-permanent

glycerol-gelatin preparation made in 1996 and 1997. Shape and size of pollen grains were classified according to the paper of Erdtman (1956).

The data were analyzed statistically by one-way ANOVA. The significance of differences was tested using Duncan's test at α=0.05.

RESULTS

The investigated species bloomed from mid-July to the end of September (Table 1). The shortest blooming period was observed for: late-summer mint, Chinese motherwort, obedient plant and summer savory (from 4 to 6 weeks). Horse mint and round-leaved mint had the longest blooming period (7 - 8 weeks). Of the tested species, Chinese motherwort gave the latest flow of pollen as it bloomed from the second half of August to the end of September.

In successive years, substantial differences for blooming abundance were observed among the tested species. Obedient plant produced the fewest flowers per 1m^2, the average being 20,800 (Table 1). The remaining species had much smaller flowers and thus produced many more flowers per 1m^2 (from 108,600 for

Table 1

Period, abundance of blooming and pollen efficiency of some species from the Lamiaceae. family

Species	Year	Blooming period	Number of		Weight of pollen per 100 flowers (mg)*	Pollen efficiency kg·ha^{-1}
			sprouts·m^{-2}	flowers·m^{-2} (thousands)		
Physostegia virginiana (L.) Benth.	1995	13.07-29.08	174.0	20.5	24.20^{b}	49.7
	1996	18.07-30.08	142.0	16.2	16.80^{a}	27.2
	1997	14.07-04.09	211.0	25.6	22.70^{b}	58.2
	mean:		175.7	20.8	21.23	45.0
Mentha rotundifolia (L.) Huds.	1995	23.07-17.09	39.0	209.4	0.35^{a}	7.3
	1996	05.08-23.09	42.0	199.3	0.36^{a}	7.2
	1997	26.07-24.09	58.0	487.5	0.32^{a}	15.6
	mean:		46.3	298.7	0.34	10.0
Mentha longifolia (L.) Huds.	1995	26.07-15.09	122.0	105.8	1.96^{b}	20.7
	1996	30.07-20.09	150.0	164.0	1.20^{a}	19.7
	1997	20.07-15.09	98.0	71.1	1.76^{b}	12.5
	mean:		123.3	113.6	1.64	17.6
Pycnanthemum californicum Torr. ex Durand	1995	24.07-05.09	64.0	297.6	4.10^{a}	122.0
	1996	29.07-11.09	51.3	319.3	3.80^{a}	121.3
	1997	28.07-15.09	86.6	402.7	3.72^{a}	149.8
	mean:		67.3	339.9	3.87	131.0
Elsholtzia cristata Willd.	1995	27.07-01.09	204.0	178.6	0.72^{a}	12.9
	1996	05.08-04.09	192.0	150.6	0.95^{b}	14.3
	1997	15.08-12.09	298.0	429.6	0.77^{b}	33.0
	mean:		231.3	252.9	0.81	20.1
Satureja hortensis L.	1995	30.07-12.09	123.0	162.9	2.30^{a}	37.5
	1996	01.08-14.09	134.0	114.8	2.12^{a}	24.3
	1997	04.08-15.09	176.0	192.1	3.14^{b}	60.3
	mean:		144.3	156.6	2.52	40.7
Leonurus sibiricus L.	1995	26.08-30.09	93.0	107.5	10.60^{b}	114.0
	1996	24.08-28.09	105.0	134.8	8.80^{a}	118.6
	1997	14.08-20.09	85.0	83.6	10.12^{ab}	84.6
	mean:		94.3	108.6	9.84	105.7

*means followed by the same letters, are not significantly different at α=0.05.

Chinese motherwort to 339,900 for mountain mint).

The process of pollen release in the protandrous flowers of the tested species commences right after the corolla is opened. When the weather was sunny and dry, the anthers were void of pollen after 2-3 hours. Each year, the least pollen was obtained from round-leaved mint - 0.34 mg/100 flowers on average, and from late-summer mint - 0.81mg/100 flowers on average. The greatest amount of pollen was produced by the obedient plant (21.23 mg/100 flowers) (Table 1). Pollen production rate for the remaining species averaged 1.64 mg/100 flowers for horse mint, 2.52 mg/100 flowers for summer savory, 3.87 mg/flowers for mountain mint, 9.84 mg/100 flowers for Chinese motherwort. In the successive years, no significant difference was found in the pollen production rate between round-leaved mint and mountain mint. The variation for that trait among the remaining species was statistically significant.

Pollen production rate per unit area varies with number of flowers per unit area, and pollen abundance. The amount of pollen flow varied greatly both, from year to year and from species to species (Table 1). The least pollen yield, 10.0 $kg \cdot ha^{-1}$, was obtained from round-leaved mint. For the remaining species the pollen production rates were: from 15 to 20 kg of pollen per 1ha for crested late-summer mint and horse mint; from 40 to 45 $kg \cdot ha^{-1}$ for summer savory and obedient plant; and from 100 to 130 $kg \cdot ha^{-1}$ for Chinese motherwort and mountain mint. The pollen loads from the pollen of the tested species were usually small, with the exception of late-summer mint. On late-summer mint worker bees with clearly larger pollen loads were observed.

Morphologically, the pollen grains were tricolpate in obedient plant and in Chinese motherwort, or hexacolpate in horse mint and round-leaved mint, mountain mint and

Table 2

Pollen grain size for some species from the Lamiaceae family.

Species	Year	Length of axis (μm)				P/E
		polar (P)		equatorial (E)		
		min-max	Mean	min-max	Mean	
Physostegia virginiana (L.) Benth.	1996	45-51	48.00	42-51	44.85	1.07
	1997	42-54	47.10	42-48	44.10	1.06
	mean:		47.55		44.48	1.07
Mentha rotundifolia (L.) Huds.	1996	24-28	27.00	15-21	20.00	1.35
	1997	24-27	26.10	16-24	21.00	1.24
	mean:		26.55		20.50	1.29
Mentha longifolia (L.) Huds.	1996	24-30	26.55	24-30	26.85	0.99
	1997	24-27	26.10	21-30	26.10	1.00
	mean:		26.33		26.48	0.99
Pycnanthemum californicum Torr. ex Durand	1996	33-39	36.00	30-42	36.75	0.98
	1997	33-39	34.65	30-39	35.55	0.97
	mean:		35.33		36.15	0.98
Elsholtzia cristata Willd.	1996	27-33	29.25	21-30	24.90	1.17
	1997	27-30	29.25	24-30	26.40	1.11
	mean:		29.25		25.65	1.14
Satureja hortensis L.	1996	27-33	29.10	27-33	29.70	0.98
	1997	24-30	27.90	24-33	28.10	0.99
	mean:		28.50		28.90	0.99
Leonurus sibiricus L.	1996	24-30	26.55	18-21	20.85	1.27
	1997	24-27	26.10	18-24	20.25	1.28
	mean:		26.33		20.55	1.28

late-summer mint. In the slides from summer savory 6-, 7-, and 8-colpate grains were observed. Among the Lamiaceae plants investigated, obedient plant by far had the largest pollen grains (P=47.55 μm, E=44.48 μm). The smallest grains were recorded for round-leaved mint (P=26.55 μm, E=20.50 μm) and Chinese motherwort (P=26.33 μm, E=20.55 μm) (Table 2). The P/E ratio shows that only Chinese motherwort and round-leaved mint have subprolate pollen or prolate grains. The remaining species have spheroidal sporomorphs. Oblate spheroidal grains were observed in horse mint, mountain mint and summer savory. Prolate spheroidal grains were found in the obedient plant. The pollen grains of late-summer mint had a slightly longer equatorial axis in the 1996 samples. That is why in 1996 they were classified as subprolate. In the subsequent year, and in general, they were classified as prolate spheroidal.

DISCUSSION AND CONCLUSIONS

In the case of the mint family, two main types of pollen grains are distinguished: hexacolpate and tricolpate (Zander 1935, Erdtman 1956). Species with a variable number of colpi found are exceptional (Zander 1935). In the present study a variable number of colpi were found in summer savory. The data for sporomorph size come within the limits reported in the literature (Claude et al. 1992, Abu-Asab and Cantino 1994). The pollen grains with the dimension of the polar axis (P) from 26.33 do 47.55 μm and of the equatorial axis from 20.50-44.48 μm can be classified according to Erdtman (1956) as medium sized.

The Lamiaceae family plants are mainly known as melliferous but very often bee-like insects gather pollen from their flowers as well (Ricciardelli 1983, Tanacs and Gulyas 1986, Herrera 1990, Jabłoński 1993, Warakomska 1999, Bożek 2003a,c). The average pollen-yield weight of the investigated 100 flowers, comes within a broad range, from 0.34 to 21.25 mg. Generally, larger flowers (with larger anthers) produced more pollen. The pollen yield ranged from 10 to 131 kg·ha^{-1}. From those tested taxa, bees formed small-sized pollen loads. They were much larger only from late-summer mint, which was the species with poor nectar output (Kołtowski 2006). The lowest pollen yield (10.0 – 17.6 kg·ha^{-1}) was assessed for the species of the *Mentha* genus. As reported in the literature they are most frequently visited by honeybee workers only for nectar (Maurizio and Grafl 1969, Mountain et al. 1981, Jabłoński 1993, Bożek 2003b, Kołtowski 2006).

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POŻYTEK PYŁKOWY I WYMIARY ZIAREN PYŁKU KILKU PÓŹNOLETNICH GATUNKÓW ROŚLIN Z RODZINY LAMIACEAE

Bożek M.

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

Celem niniejszej pracy było określenie wydajności pyłkowej i wielkości ziaren pyłku kilku późnoletnich gatunków roślin z rodziny Lamiaceae: *Physostegia virginiana* (L.) Benth., *Mentha rotundifolia* (L.) Huds., *M. longifolia* (L.) Huds., *Pycnanthemum californicum* Torr., *Elsholtzia cristata* Willd., *Satureja hortensis* L., *Leonurus sibiricus* L. Badania prowadzono w latach 1995-1997 w ISK Oddział Pszczelnictwa w Puławach, w kolekcji roślin miododajnych. Średnia masa pyłku ze 100 kwiatów badanych gatunków mieściła się w szerokich granicach od 0.34 mg do 21,23 mg, a wydajność pyłkowa wahała się od 10 kg·ha^{-1} do 131 kg·ha^{-1}. Obnóża formowane przez pszczoły miodne z pyłku badanych roślin były z reguły małe. Z większymi obnóżami spotykano jedynie robotnice pszczoły miodnej na kwiatach marzymięty grzebieniastej. Ziarna pyłku badanych gatunków można zakwalifikować do średniej wielkości (P = 26,33 – 47,55 μm, E = 20,5-44,48 μm).

Słowa kluczowe: Lamiaceae, pylenie, wydajność pyłkowa.