COMPARISON OF FOOD PLANTS OF *Bombus terrestris* L. AND *Bombus lapidarius* L. BASED ON POLLEN ANALYSIS OF THEIR POLLEN LOADS

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Summary

The objective of the study was to verify if the differences in foraging preferences between *Bombus terrestris* and *B. lapidarius* reported in the literature are related to the differences in the choice of nesting sites or to food predilections of either species. Therefore, in 2001 and in 2005 colonies of *B. terrestris* and *B. lapidarius* from artificial rearing conducted at the Apiculture Division of Research Institute of Pomology and Floriculture in Puławy, were set up side by side at Skoki near the town of Dęblin. On several dates nest-bound workers of both species were intercepted for collection of pollen loads, microscopic preparations were made thereof and palynological analysis was performed. The analysis of 131 preparations showed differences in the specific composition of pollen loads formed by either species even though the nests were in the same location.

Keywords: *Bombus terrestris*, *Bombus lapidarius*, food plants, pollen loads, pollen analysis.

INTRODUCTION

Pollination as a yield-forming factor is of utmost importance in improving crop yields and it also improves the quality of fruits and of seeds. It is estimated that ca. 30% of total food on earth comes from plants pollinated by insects (Heinrich 1979). Among the pollinators the dominating role is obviously played by the honeybee. Bumblebees come as the second most important pollinators which are particularly efficient in pollinating very important fodder crops with flowers the access to which for the honeybee is difficult such as *Trifolium pratense* and *Medicago*, as well as in pollinating crops in greenhouses such as tomatoes, strawberries or kiwi. *Bombus terrestris* is the most frequently artificially reared species to be used to pollinate greenhouse--grown plants as it proved to be the most efficient one (Pinchinat et al. 1979). A very important role in pollination is played by bumblebees in regions of the world with harsh climate e.g. on the Scandinavian peninsula, especially in Norway where during the season of orchard blooming it is still too cold for the honeybee. Instead, New Zealand where bumblebees had not occurred in the wild imported them to be used for pollination of seed production fields of red clover - *Trifolium pratense* (Faegri and van der Pijl 1979).

In Poland, there are 29 bumblebee species (Dylewska 1996). Their importance for crop pollination was confirmed in numerous studies (*inter alia* Ruszkowski and Biliński 1969, Ruszkowski 1970, Ruszkowski and Żak 1974). The results of those studies performed nationwide and on a large scale gave evidence of a particularly high contribution made by those insects in

Journal of Apicultural Science

pollination of the seed plantations of fodder legumes. In the years 1964 - 1967 Anasiewicz and Warakomska (1977) in order to determine the pollen food of bumblebees caught those insects on flowers occurring at different locations throughout the Lublin region and they also subjected the pollen loads for palynological analysis. Comparative studies of food plants for several bumblebee species in western Scotland, based on pollen collected, were conducted by Brian (1951, 1957). In turn, food preferences of several bumblebee species based on the observation of foraging on the flowers of plants growing in the vicinity of the nests were investigated in north-eastern Scotland by Brodie (1996). Teper (2004) investigated the specific composition of pollen loads brought to the colony nests of *Bombus terrestris* derived from artificial rearing at the Apiculture Division of Research Institute of Pomology and Floriculture in Puławy. The analysis of literature data indicates certain differences in the specific composition of plants visited by bumblebee species under investigation.

Bombus terrestris and *B. lapidarius*, apart from morphological differences, differ also in the choice of nesting sites. *B. terrestris* described as an open-steppe species establishes its nests most of the times in abandoned mouse nests or mole burrows. *Bombus lapidarius* which occurs in wood clearings and in open spaces makes its nests among rocks or in wall fissures (Dylewska 1996, Biliński 1997, Biliński 2002). The study's objective was to find out if the specific composition of pollen harvested by workers of both species is different when bumblebee colonies established in hives are placed side by side.

MATERIAL AND METHODS

In 2001 and 2005, in a home garden at Skoki near Dęblin two hives settled by the colonies of *Bombus terrestris* and *B. lapidarius* reared at the Apiculture Division of Research Institute of Pomology and Floriculture in Puławy, were placed side by side. In July, on several dates nest-bound workers with pollen loads were caught using an entomological net and by using a preparation needle pollen loads were gently removed and the workers released. The collected pollen loads were put into separate labeled bottles. In the first study year a total of 62 pollen samples was collected on 7 dates. In the second year a total of 69 samples on 5 dates was collected. From the material collected 131 glycerol-gelatin microscope preparations were made and the preparations were subjected to palynological analysis.

RESULTS AND DISCUSSION

In both study years a total of 33 types of pollen grains were identified in the pollen loads of *Bombus terrestris* and *B. lapidarius* (Table 1). In the pollen loads removed from the workers of *B. terrestris* 30 types of pollen were identified of which 16 in the samples collected in 2001, and 24 in those collected in 2005. In the pollen loads of *B. lapidarius* in both study years 28 types of pollen grains were identified of which 18 in samples collected in 2001, and 22 in those collected in 2005.

As the main forage crops - suppliers of pollen to bumblebees were recognized those from which workers formed homogeneous pollen loads. In 2001, such pollen loads were formed by bumblebees from 8 plant species (marked "+++" in the table) in the second year they were formed from 11 species (Table 1). The main forage crops for *B. terrestris* were: *Centaurea cyanus*, *Fagopyrum*, *Filipendula ulmaria*,

Table 1.

Specific composition of the pollen found in examined pollen loads.

Pollen		2001		2005	
		B. terrestris	*B. lapidarius*	*B. terrestris*	*B. lapidarius*
1.	*Allium*	-	-	+	+++
2.	*Anthriscus* type	+	+	-	+
3.	*Aster* type	-	-	+	++
4.	*Brassicaceae*	+	+++	+	+
5.	*Caryophyllaceae*	-	-	-	+
6.	*Centaurea cyanus*	-	+++	+++	+++
7.	*Centaurea jacea*	-	+++	+	+++
8.	*Chenopodium*	-	-	+	-
9.	*Cichorium* type	+	+	-	-
10.	*Cirsium* type	+	+	+	+
11.	*Echium*	-	-	++	++
12.	*Fagopyrum*	-	-	+++	-
13.	*Filipendula ulmaria*	+	-	+++	+
14.	*Geranium pratense*	+	-	-	-
15.	*Gramineae*	+	-	-	+
16.	*Helianthus* type	+	+	+	-
17.	*Hypericum*	+++	+	++	+
18.	*Jasione montana*	-	-	++	-
19.	*Lamium* type	++	-	-	-
20.	*Lotus*	+	+++	+++	+++
21.	*Lythrum*	-	-	++	+
22.	*Melilotus*	-	+	+	-
23.	*Polygonum persicaria* type	-	+	-	-
24.	*Plantago*	+++	+	++	+
25.	*Rosaceae*	-	-	+++	+++
26.	*Rubus* type	++	+	++	-
27.	*Salvia*	-	-	-	+++
28.	*Senecio*	+	+	-	-
29.	*Solidago* type	-	-	+	+
30.	*Tilia*	+	+	+++	+
31.	*Trifolium pratense*	+++	+	+++	+
32.	*Trifolium repens* type	+++	+	+++	+++
33.	*Vicia* type	-	+	+	-

+++ pollen forming entire pollen loads
++ pollen occurring fairly abundantly in pollen loads
+ pollen occurring as single grains
– no pollen in pollen loads

Table 2.

The feeding-band of *Bombus terrestris* in July of 2001 (Teper 2004)

Pollen		Dates of pollen load sampling						
		10.07	12.07	14.07	16.07	20.07	25.07	30.07
1.	*Filipendula*	■						
2.	*Tilia*	■						
3.	*Plantago*	■	■					
4.	*Rubus* type	■	■					
5.	*Hypericum*	■	■	■	■			
6.	*Helianthus* type	■	→	→	■			
7.	*Brassicaceae*	→	■					
8.	*Trifolium repens*	■	■	■	→	■	■	
9.	*Cichorium*			■				
10.	*Cirsium* type			■				
11.	*Geranium pratense*			■	→	→	→	■
12.	*Anthriscus* type				■			
13.	*Gramineae*				■	→	→	■
14.	*Lamium* type							■
15.	*Lotus*							■
16.	*Trifolium pratense*							■

→ probable flow continuity

Table 3.

The feeding-band of *Bombus lapidarius* in July of 2001

Pollen		Dates of pollen load sampling						
		10.07	12.07	14.07	16.07	20.07	25.07	30.07
1.	*Tilia*	■						
2.	*Hypericum*	■	■					
3.	*Trifolium repens*	■	■					
4.	*Centaurea cyanus*	■	■	→	■			
5.	*Melilotus*	■	■	→	→	→	→	■
6.	*Trifolium pratense*	■	■	→	→	→	■	■
7.	*Lotus*	■	■	■	■	■	→	■
8.	*Centaurea jacea*		■	→	■	■	→	■
9.	*Cirsium* type		■	→	■	→	→	■
10.	*Rubus* type		■	→	■			
11.	*Vicia*		■	→	■	→	→	■
12.	*Anthriscus* type				■	→	→	■
13.	*Helianthus* type				■	→	→	■
14.	*Brassicaceae*		■					
15.	*Cichorium*		■					
16.	*Senecio*		■					
17.	*Polygonum persicaria* type				■			
18.	*Plantago*				■			

→ probable flow continuity

Table 4.

The feeding-band of *Bombus terrestris* based on the pollen analysis of the pollen loads sampled in July of 2005

Pollen		Dates of pollen load sampling				
		9.07	15.07	21.07	26.07	31.07
1.	*Tilia*	■				
2.	*Centaurea cyanus*	■				
3.	*Brassicaceae*	■				
4.	*Lotus*	■	■			
5.	*Hypericum*	■	■	■		
6.	*Filipendula*	■	■	■	■	
7.	*Trifolium repens* type	■	■	■	■	■
8.	*Trifolium pratense*		■			
9.	*Melilotus*		■			
10.	*Vicia*		■			
11.	*Cirsium*		■			
12.	*Echium*		■			
13.	*Asteraceae*		■			
14.	*Plantago*		■	■		
15.	*Jasione montana*		■	➔	■	
16.	*Rubus* type		■	■	■	
17.	*Centaurea jacea*		■	➔	■	■
18.	*Rosaceae*		■	■	■	■
19.	*Lythrum*			■	■	
20.	*Fagopyrum*			■	■	
21.	*Helianthus* type			■	➔	■
22.	*Allium*				■	
23.	*Solidago* type				■	■
24.	*Chenopodium*				■	■

➔ probable flow continuity

Hypericum, *Lotus*, *Plantago*, *Rosaceae*, *Tilia*, *Trifolium pratense* and *T. repens*. The workers of *B. lapidarius* formed such loads from the pollen of *Allium*, *Brassicaceae*, *Centaurea cyanus*, *Centaurea jacea*, *Lotus*, *Rosaceae*, *Salvia* i *Trifolium repens*. There can be seen certain differences in food preferences between the studied bumblebee species. No pollen of *Caryophyllaceae*, *Polygonum persicaria* type or *Salvia*, of which *B. lapidarius* formed homogeneous pollen loads, was found in the pollen loads of *B. terrestris* in none of the study years. Instead, in the pollen loads of *B. lapidarius* no pollen was found belonging to *Chenopodium*, *Geranium*, *Jasione montana* or *Lamium* type, nor that of *Fagopyrum* of which *B. terrestris* formed homogeneous pollen loads. Likewise, the analysis of the research results by Anasiewicz and Warakomska (1977) show that there are distinct differences in specific pollen makeup between the pollen loads of *B. terrestris* and those of *B. lapidarius*. In that study like in mine the pollen of *Jasione montana* and *Chenopodiaceae* was collected solely by the workers of

Table 5.

The feeding-band of *Bombus lapidarius* based on the pollen analysis of the pollen loads sampled in July of 2005

Pollen		Dates of pollen load sampling				
		9.07	15.07	21.07	26.07	31.07
1.	*Salvia*	■				
2.	*Trifolium repens* type	■	■	→	■	
3.	*Asteraceae*	■	■	→	■	
4.	*Centaurea jacea*	■	■	■	■	
5.	*Lotus*	■	■	■	■	■
6.	*Brassicaceae*	■	→	→	→	■
7.	*Echium*		■			
8.	*Cirsium* type		■	■	■	
9.	*Allium*		■	■	■	■
10.	*Hypericum*		■	→	■	■
11.	*Trifolium pratense*			■	→	■
12.	*Anthriscus* type			■	→	■
13.	*Centaurea cyanus*			■		
14.	*Rosaceae*				■	■
15.	*Filipendula*				■	■
16.	*Lythrum*				■	■
17.	*Plantago*				■	■
18.	*Tilia*				■	
19.	*Gramineae*					■
20.	*Caryophyllaceae*					■
21.	*Solidago*					■
22.	*Rosaceae*					■

→ probable flow continuity

B. terrestris, and the pollen of *Caryophyllaceae* was found only in the pollen loads of *B. lapidarius*. In 2005 homogeneous pollen loads from the pollen of *Allium* were formed by workers of *B. lapidarius*. The particular predilection of that species for the plants of the genus *Allium* was pointed to by Ruszkowski (1970) and Brodie (1996). The latter investigator compared the food preferences of 5 bumblebee species (*Bombus lucorum*, *B. lapidarius*, *B. pratorum*, *B. hortorum*, *B. pascuorum*) and, based on the observations of their foraging, found that the length of their tongue is particular importance in the choice of the plants visited by particular species of those insects. However, the species investigated in this study differ but slightly for their tongue length: *Bombus terrestris* - 7.4 mm; *B. lapidarius* - 7.0 mm (Banaszak 1993). Besides, the study had as it objective to identify plant species visited by bumblebees to harvest pollen from, and in this particular case the length of the tongue does not matter.

Based on the data obtained in individual years of the study a feeding-band was compiled for both bumblebee species (Tables 2, 3, 4, 5).

CONCLUSIONS

1. The results of the study showed differences in the specific composition of the pollen collected by *Bombus terrestris* and *B. lapidarius*, which gives evidence of their dissimilar food preferences also when the colonies of both species live side by side.
2. The palynological analysis of 131 microscopic preparations made of pollen loads allowed the identification of 33 types of pollen derived from the species visited by *Bombus terrestris* and *B. lapidarius*.
3. The following plants were recognized as the major pollen suppliers for *Bombus terrestris: Centaurea cyanus*, *Fagopyrum*, *Filipendula ulmaria*, *Hypericum*, *Lotus*, *Plantago*, *Rosaceae*, *Tilia*, *Trifolium pratense*, *T. repens*.
4. The following plants were recognized as the major pollen suppliers for *Bombus lapidarius*: *Allium*, *Brassicaceae*, *Centaurea cyanus*, *Centaurea jacea*, *Lotus*, *Rosaceae*, *Salvia*, *Trifolium repens*.
5. It was found in the study that *Bombus lapidarius* showed particular predilection for the flowers of *Allium* to be harvested for pollen and therefore that species can be recommended for the pollination of the seed plantations of garlic, onions as well as ornamental species of garlic.

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PORÓWNANIE ROŚLIN POKARMOWYCH TRZMIELA ZIEMNEGO *Bombus terrestris* L. I TRZMIELA KAMIENNIKA *Bombus lapidarius* L. NA PODSTAWIE ANALIZY PYŁKOWEJ FORMOWANYCH PRZEZ NIE OBNÓŻY

Teper D.

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

Dane literaturowe donoszą o różnicach w preferencjach pokarmowych między różnymi gatunkami trzmieli. W celu sprawdzenia czy różnice te wynikają z izolacji przestrzennej pomiędzy naturalnymi gniazdami trzmiela ziemnego (*Bombus terrestris*) i trzmiela kamiennika (*B. lapidarius*) w Skokach koło Dęblina w lipcu 2001 i 2005 roku ustawiono obok siebie uliki zasiedlone przez rodziny tych gatunków wyhodowane w Oddziale Pszczelnictwa ISK w Puławach. W kilku terminach powracającym do gniazd z ładunkami pyłku robotnicom obu gatunków odbierano obnóża pyłkowe, z których następnie wykonano glicero-żelatynowe preparaty mikroskopowe i przeprowadzono ich analizę pyłkową. W obu latach od obu gatunków odebrano łącznie 131 ładunków pyłku. Oznaczono w nich 33 typy ziaren pyłku (Tab. 1). Za główne rośliny dostarczające trzmielom pyłku uznano te, z których formowały one jednorodne obnóża. Trzmiel ziemny takie obnóża formował z: *Centaurea cyanus*, *Fagopyrum*, *Filipendula ulmaria*, *Hypericum*, *Lotus*, *Plantago*, *Rosaceae*, *Tilia*, *Trifolium pratense*, *T. repens.* Trzmiel kamiennik natomiast jednorodne obnóża formował z: *Allium*, *Brassicaceae*, *Centaurea cyanus*, *Centaurea jacea*, *Lotus*, *Rosaceae*, *Salvia*, *Trifolium repens.*

Przeprowadzone badania wykazały różnice w preferencjach pokarmowych pomiędzy trzmielem ziemnym i trzmielem kamiennikiem. Stwierdzono również, że trzmiel kamiennik szczególnie chętnie oblatywał rośliny należące do rodzaju *Allium*, można więc przypuszczać, że ten gatunek trzmiela mógłby być dobrym zapylaczem np. upraw nasiennych czosnku, cebuli czy czosnków ozdobnych.

Słowa kluczowe: *Bombus terrestris*, *Bombus lapidarius*, rośliny pokarmowe, obnóża pyłkowe, analiza pyłkowa.