EFFECT OF POLLEN LOAD SIZE ON THE WEIGHT OF POLLEN HARVESTED FROM HONEYBEE COLONIES (*Apis mellifera* L.)[1]

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Summary

The objective of this study was to demonstrate whether and to what extent the size of pollen loads formed by foragers affects the weight of pollen collected from honeybee colonies. The study comprised 19 colonies and was conducted from May to the end of August in the years 2004 and 2005. Pollen was collected in the form of pollen loads using a pollen capturing device with a 5 mm mesh plate. By using the electron scanning microscope shape of pollen grains was determined to make the taxonomic identification of plant species and families foraged on by the bees. The average daily harvest of pollen loads from 1 honeybee colony was 17.62 g in 2004 and 19.40 g in 2005. Pollen yield per colony in the fist study year was from 4.50 g/day (colony no. 10) to 68.19 g/day (colony no. 21). In the second study year substantially lower values were recorded: from 4.30 g/day (colony no. 6) do 38.25 g/day (colony no. 9). The weight of single pollen loads recovered from honeybee foragers averaged 6.54 mg/load in 2004 and 6.80 mg/load in 2005. The largest pollen loads recovered weighed 7.44 mg/load in 2004 (colony no. 12) and 8.33 mg/load in 2005 (colony no. 9). The relationship between the weight of single pollen loads recovered from incoming foragers and the pollen yield was demonstrated for single honeybee colonies whereas the repeatability of that trait at a similar level occurred in 1 colony in the first study year and in 6 colonies in the second study year - in both successive years the relationship was not repeated in any colony.

Keywords: Honeybee colony, pollen loads, pollen efficiency, pollen-capturing devices.

INTRODUCTION

Pollen is the sole protein food of a honeybee colony harvested by bee foragers in their natural environment. In order to satisfy its needs a honeybee colony uses from ca. a dozen to more than 35 kg of pollen [Hodowla pszczół 1983]. The presence of pollen in the nest is a prerequisite for normal colony development and, first of all, for regular growth and development of the brood. The rich amino acid composition of the pollen protein and other valuable pollen constituents (fats, enzymes, vitamins, phytohormones, mineral compounds) made pollen one of products recovered from the bees harvested by man so it is often referred to as bee pollen (Bratkowski and Wilde 1996; Bratkowski and Wilde 2002; Wilde, Grabowski and Siuda 1998; Wilde and Wilde 2002).

Valuable dietary, prophylactic and even curative properties of pollen caused the demand for the product to be on the increase so more and more attention has been paid to pollen recovery from bees. Capture of pollen and pollen sales also contribute to the payability of honey farming. Conse-

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quently, it is important to get an understanding of all the factors which have an impact on the pollen efficiency of bee colonies and of how the factors relate to one another.

Pollen can be collected from bees in two forms: as pollen loads – granules fromed by the bees from fresh pollen and as bee bread – a product of milk fermentation processed by the bees in the combs.

Foragers working outside the beehive are usually specialized to harvest particular materials in order to increase their work efficiency. It was demonstrated that 60% of them are nectar foragers, 25% are busy collecting pollen and ca. 15% bring the two materials at the same time and also act as deliverers of water and propolis raw materials. However, worker bees have been observed to be highly adaptable to current conditions and colony requirements which manifests itself as a change in the proportion of nectar vs. pollen foragers (Free 1960).

The objective of this study was to demonstrate if and to what extent the size of pollen loads formed by foragers affects the weight of pollen collected from honeybee colonies.

MATERIAL AND METHODS

The study was conducted over two consecutive foraging seasons of 2004 and 2005 and comprised 19 Carniolan honeybee colonies kept at a stationary apiary at the village of Szydłowice (central-eastern part of the province of Opole). Experimental colonies were settled in extended Warsaw-type hives (nest frame of 300 x 435 mm). In the first week of pollen capturing the bees covered completely 12 – 13 combs including 5 – 6 combs with capped brood and 2 – 3 combs with uncapped brood.

Pollen was recovered as pollen loads using a pollen-capturing device with a 5 mm mesh shake-off plate. Pollen was captured from mid-May to the end of August in both study years throughout the day (shake-off plates were lowered from 4:30 to 20:30 once in every three days on average. The pollen-capturing season was divided into two periods: early summer (from mid-May through the first week of July) and late summer (starting with the second week of July to the end of Agust). In each year pollen loads there were 28 pollen load sampling events (14 in each period) which made a total of 1064 samples in both study years. Each portion of the captured pollen was weighed and dried at a temperature of 42°C in a drier. The pollen loads in each sample were counted. Subsequently, based on the previously determined fresh weight of the sample and on the number of pollen loads the mean weight of single pollen load was calculated. Subsequently, the pollen loads were viewed in daylight and segregated according to their colour into selected samples using colour standards. From each of the samples (visually homogeneous pollen loads) portions of 0.1 g each were taken, placed in labelled test tubes and solved in distilled water. Several drops of the solutions were placed onto a slide and re-dried in an incubator. Pollen was scraped off the slides, small portions were transferred onto microscope patrons and fixed using the hypotension method in an Edwards-Pirani 50 duster.

Subsequently, shapes of pollen grains were determined and saved to a CD using a LEO 435 VP scanning microscope. Based on the pollen shapes, the taxonomy of the plants visited by the bees (families and species) were identified (Warakomska 1972, Faegri and Iversen 1978, Warakomska and Muszyńska 2000, Ziembińska-Tworzydło and Kohlman-Adamska 2003).

On the pollen-capturing days measurements were made and weather records were taken: degree of cloud cover (from 0 to 10 points), wind velocity (km/h), rainfall (mm) and air temperature (°C) at 7:00, 13:00 and 19:00. Based on those records a weather assessment scale was developed with scores from 0 to 18 – Table 5. Weather parameters were developed based on the author's own observations and measurements made in the apiary using the the digital weatherman WM - 918 manufactured by Huger Electronics GmbH (Tables 5 and 6).

The data were analyzed statistically using Statistica ver. 6.1 software (SN licence no. AXXP503B482831AR) by computing arithmetical means, standard deviations, correlations and significant differences.

RESULTS

The study showed that the amounts of pollen gathered and stored in the hive differred from colony to colony so the daily amounts of pollen recovered from colonies varied greatly.

The average daily recovery of pollen loads from 1 bee colony in the season of 2004 was 17.62 g/day, the harvest being lower in the early-summer period averaging 14.05 g/day and higher in late summer averaging 21.20 g/day. In the season of 2005 the average yield was 19.40 g/day in early summer and 18.01 g/day in late summer (Tables 1, 2, 3). It has to be noted that

Table 1

Weight of fresh pollen recovered from experiment colonies in two study years.

Colony no.	Pollen weight (g/day)					
	Year 2004			Year 2005		
	min	max	$\bar{x}$ ± SD	min	max	$\bar{x}$ ± SD
1	0.18	31.93	8.20A±7.69	0.22	62.85	24.17B±15.99
2	0.75	25.16	6.41A±6.69	0.73	68.55	18.23B±15.62
3	0.10	45.68	17.40±12.81	0.67	82.42	22.02±18.63
4	1.32	137.52	21.93±34.85	0.08	107.6	17.86±19.88
5	2.81	57.87	24.68±15.38	0.17	84.26	14.87±21.28
6	0.79	21.54	10.65A±5.59	0.00	56.43	4.30B±10.59
7	5.87	83.15	40.91A±22.88	0.07	81.10	23.60B±20.37
8	0.10	56.21	8.13A±12.84	0.05	185.70	32.61B±37.15
9	0.03	18.54	4.66A±5.41	0.13	200.20	38.25B±38.50
10	0.64	14.85	4.48±3.86	0.04	39.08	7.27±9.31
11	0.82	49.54	17.27A±14.26	0.13	31.94	5.84B±8.69
12	1.33	35.72	15.94±12.10	0.10	63.16	15.64±15.28
13	1.88	26.16	12.07±6.56	0.59	84.07	15.14±15.94
14	1.52	40.21	12.61±9.71	0.03	50.64	13.22±13.30
15	0.10	25.05	10.10±8.27	0.03	32.88	10.00±8.66
16	1.08	81.25	27.35±24.85	0.04	100.3	27.40±22.55
17	0.13	24.35	8.79a±6.58	0.39	97.46	19.36b±20.26
18	0.58	36.44	15.08±10.76	0.03	174.10	27.80±32.44
21	11.83	149.32	68.19A±40.85	0.49	68.94	30.94B±18.07
±	2.71	32.88	**17.62**±15.19	0.26	56.44	**19.40**±12.67

A-B – statistical differences highly significant for year-to-year comparisons at $p \leq 0.01$
a-b – statistical differences significant for year-to-year comparisons at $p \leq 0.05$.

Table 2

Average pollen weights and single pollen load weights as recovered from honey bee colonies in 2004.

Colony no.	Early summer period		Late summer period		Entire season ($\bar{x}$ ± SD)	
	Pollen weight (g/day)	Single pollen load weight (mg/load)	Pollen weight (g/day)	Single pollen load weight (mg/load)	Pollen weight (g/day)	Single pollen load weight (mg/load)
1	8.44**	5.96**	7.96	7.82	8.20±7.69	6.89±1.92
2	3.12^{A}	6.23	9.69^{B*}	6.73*	6.41±6.69	6.48±1.55
3	20.79	5.10	14.01	6.25	17.40±12.81	5.68±1.28
4	5.07^{A}	5.88	38.79^{B**}	7.14**	21.93±34.85	6.51±2.27
5	28.45	6.05	20.91	6.09	24.68±15.38	6.07±1.11
6	8.96*	5.50*	12.34	6.96	10.65±5.59	6.23±1.35
7	30.62^{a}	5.76	51.19^{b}	7.17	40.91±22.88	6.46±1.83
8	3.34^{A*}	5.33*	12.92^{B**}	6.27**	8.13±12.84	5.80±1.59
9	1.30^{A}	5.59	8.03B	8.37	4.66±5.41	6.98±2.64
10	5.83	6.31	3.13	6.56	4.48±3.86	6.43±1.81
11	7.77	6.24	26.76*	7.37*	17.27±14.26	6.80±2.12
12	11.62	7.38	20.25	7.50	15.94±12.10	7.44±1.94
13	12.78	6.40	11.35	6.69	12.07±6.56	6.55±1.64
14	11.81	6.46	13.41	6.51	12.61±9.71	6.49±0.98
15	7.07	4.66	13.13	7.29	10.10±8.27	5.98±1.86
16	19.68	6.41	35.02	8.10	27.35±24.85	7.26±1.51
17	10.52	6.18	7.06	8.40	8.79±6.58	7.29±2.34
18	16.43	6.31	13.73	6.02	15.08±10.76	6.16±1.63
21	53.30a	5.60	83.07^{b}	7.83	68.19±40.85	6.71±1.83
$\bar{x}$	**14.05**	**5.97**^{A}	**21.20**	**7.11**^{B}	**17.62**±15.19	**6.54**±1.13
SCMP	738	x	1112	x	1850	x

SCMP – estimated total pollen weight for the study period (g)
** – correlation coefficient value between amount of pollen recovered and weight of single pollen load highly significant at $p \leq 0.01$
* – correlation coefficient value between amount of pollen recovered and weight of single pollen load significant at $p \leq 0.05$
A-B – differences in pollen amounts highly significant at $p \leq 0.01$ for period-to-period comparisons
a-b – differences in pollen amounts significant at $p \leq 0.05$ for period-to-period comparisons.

no statistically valid difference was demonstrated among those amounts. However, the scatter of weight values for pollen recovered from individual colonies was much higher. In the first study year average daily yields came within a range from 4.48 g/day (colony no. 10) to 68.19 g/day (colony no. 21). In the second study year, the higher average across colonies notwithstanding, much lower extreme values were recorded since the lowest average yield was 4.30 g/day of pollen (colony no. 6) and the

Table 3

Average pollen weights and single pollen load weights recovered from bee colonies in 2005.

Colony no.	Early summer period		Late summer period		Entire season ($\bar{x}$ ± SD)	
	Pollen weight (g/day)	Single pollen load weight (mg/load)	Pollen weight (g/day)	Single pollen load weight (mg/load)	Pollen weight (g/day)	Single pollen load weight (mg/load)
1	26.02*	7.82*	22.17*	6.79*	24.17±15.99	7.34±1.62
2	22.44	7.69	13.75**	5.7**	18.23±15.62	6.76±1.59
3	23.94*	6.65*	19.99*	5.49*	22.02±18.63	6.10±1.81
4	23.04*	7.04*	12.36	5.72	17.86±19.88	6.42±1.71
5	12.5*	6.58*	17.39**	5.84**	14.87±21.28	6.24±1.64
6	8.04[a]**	6.69**	0.32[b]	6.07	4.30±10.59	6.40±1.52
7	29.24	7.53	17.6*	7.09*	23.60±20.37	7.33±1.67
8	32.84	8.6	43.99**	8.03**	32.61±37.15	6.94±2.33
9	8.99*	7.71*	5.45	5.83	38.25±38.50	8.33±2.27
10	5.19*	6.26*	6.53**	5.31**	7.27±9.31	6.83±1.89
11	9.33[a]	7.48	22.36[b]*	7.35*	5.84±8.69	5.82±1.50
12	10.54	7.59	16.07**	7.47**	15.64±15.28	7.42±1.39
13	13.09[a]	6.67	6.71[b]	4.75	15.14±15.94	6.39±1.47
14	32.63	6.43	21.85*	5.93*	13.22±13.30	7.53±1.57
15	27.94[a]*	8.52*	10.23[b]	6.45	10.00±8.66	5.77±1.58
16	14.47[a]	7.85	41.96[b]*	7.71*	27.40±22.55	6.20±1.25
17	42.11*	7.32*	22.52**	6.5**	19.36±20.26	7.55±1.93
18	20.11*	6.98*	9.84	5.71	27.80±32.44	7.79±1.79
21	31.04*	6.28*	30.83**	5.7**	30.94±18.07	6.01±1.42
$\bar{x}$	**20.71**	**7.34**[A]	**18.01**	**6.26**[B]	**19.40**±12.67	**6.80**±1.19
SCMP	1091	x	949	x	2040	x

For designations see Table 2

highest - 38.25 g/day (colony no. 9) – Table 1.

With regard to the weight of pollen loads recovered from individual bee colonies over successive days of the study it was found that the lowest amount was 0.03 g/day in the first year (colony no. 9) and 0.00 g/day in the second or there were days on which no pollen loads were recovered (colony no. 6). The highest weights of pollen recovered were 149.32 g/day in 2004 (colony no. 21) and 200.20 g/day in 2005 (colony no. 9) – Tables 1 and 2. There were highly significant differences ($p \leq 0.01$) from 8 honeybee colonies and significant differences ($p \leq 0,05$) for 1 colony in pollen efficiency between study years (Table 1).

The study showed that the amounts of pollen recovered in 8 colonies stayed at a similar level for over the two years (±30%) – Table 3.

The weight of single pollen loads made by the foraging bees averaged from 6.54 mg/load in 2004 and 6.80 mg/load in

Table 4

Single pollen load weights obtained in the study (mg/load).

Colony no.	Year 2004			Year 2005		
	min	max	x̄ ± SD	min	max	x̄ ± SD
1	3.60	9.92	6.89±1.92	3.67	10.38	7.34±1.62
2	4.36	10.66	6.48±1.55	4.39	10.16	6.76±1.59
3	3.88	9.58	5.68±1.28	2.79	10.86	6.10±1.81
4	3.84	12.50	6.51±2.27	2.32	11.27	6.42±1.71
5	4.32	8.70	6.07±1.11	0.89	10.18	6.24±1.64
6	3.51	9.02	6.23±1.35	3.33	10.20	6.40±1.52
7	3.01	10.33	6.46±1.83	3.50	10.79	7.33±1.67
8	3.33	10.13	5.80a±1.59	1.67	11.70	6.94b±2.33
9	3.00	11.87	6.98a±2.64	4.33	12.61	8.33b±2.27
10	4.19	11.38	6.43±1.81	4.00	12.41	6.83±1.89
11	3.60	12.22	6.80±2.12	2.20	9.83	5.82±1.50
12	4.91	10.46	7.44±1.94	5.00	11.68	7.42±1.39
13	3.73	10.62	6.55±1.64	4.04	10.18	6.39±1.47
14	5.11	8.38	6.49A±0.98	5.09	11.46	7.53B±1.57
15	4.05	10.27	5.98±1.86	2.20	8.77	5.77±1.58
16	4.39	10.72	7.26A±1.51	2.00	9.35	6.20B±1.25
17	4.19	11.79	7.29±2.34	4.79	10.98	7.55±1.93
18	4.14	10.91	6.16A±1.63	4.25	12.72	7.79B±1.79
21	4.66	10.94	6.71±1.83	3.00	10.26	6.01±1.42
±	4.86	9.55	**6.54**±1.13	5.00	10.00	**6.80**±1.19

A-B – statistical differences highly significant for year-to-year comparisons at $p \leq 0.01$
a-b – statistical differences significant for year-to-year comparisons at $p \leq 0.05$.

2005. However, when analyzed over the successive periods of the two seasons weights of single pollen loads varied much more substantially. In the early summer period of 2004 the average weight of a single pollen load was 5.97 mg/load whereas in late summer it was 7.11 mg/load (a statistically significant difference at $p \leq 0.01$). The respective values for early and late summer periods of 2005 were 7.34 and 6.26 mg/load (also a highly significant difference) – Tables 2 and 3). In 2004 the largest pollen loads averaging 7.44 mg/load were made by worker bees of colony no. 12. In 2005, the largest pollen loads, averaging 8.33 mg/load were made by foragers of colony no. 9. Furthermore, in 2004 the smallest pollen loads were made by workers of colony no. 3, averaging 5.68 mg/load and in 2005 by workers of colony no. 14, 5.77 mg/load on average. In 2004 the largest pollen loads recovered weighed 12.50 mg/load (colony no. 4) and in 2005 12.72 mg/load (colony no. 18) the difference in weight between them being extremely small. It is only in five colonies that significant ($p \leq 0.05$) or highly significant ($p \leq 0.01$) differences were found for single pollen load weight between the study years (Table 4). In 9 bee colonies bee foragers made pollen loads of very similar weight over the two years (±10%). It allows the conclusion that over the study years the weight of pollen loads was a more

Table 5

Weather evaluation score scale.

Weather	Weather evaluation scale (points)		
	no wind	weak wind	high wind
Sunny cloudless	18	17	16
Slightly overcast	15	14	13
Partly overcast	12	11	10
Fully overcast	9	8	7
Intermittent showers	6	5	4
Rainfall	3	2	1
Storm	0	0	0

Table 6

Average weather conditions on pollen sampling days.

Year	Period	Mean values of weather conditions			
		Air temperature (°C)	Wind velocity km/h	Cloud cover score (points)	Weather score (points)
2004	early summer	23.3	6.92	4.4	12.2
	late summer	19.1	13.37	3.5	11.6
2005	early summer	18.7	11.75	3.5	13.1
	late summer	17.4	18.78	7.6	8.5

stable character of bee foragers than the weight of pollen recovered from colonies (Tables 2, 3 and 4).

The analysis of the data obtained does not give unequivocal evidence of weight of single pollen loads being related to weight of pollen recovered from bee colonies. In 2004 such a relationship was demonstrated for 3 colonies only in the early summer period and for 4 colonies in late summer. However, averaged over the periods the relationship was true of one colony only (Table 2). In 2005, significant ($p \leq 0.05$) or highly significant ($p \leq 0.01$) correlations in this respect were demonstrated for 11 colonies in the early summer period and for 13 colonies for the late summer period. The repeatability of that tendency for both periods of the 2005 season was shown for 6 colonies (Table 3). It can be generally stated that it is only in occasional colonies that the weight of single pollen loads was related to weight of pollen recovered.

DISCUSSION

Average amount of pollen loads harvested in Poland's apiaries is 3 kg per colony per season. Under Poland's climatic conditions pollen capturing is done most frequently in May and June. The pollen efficiency of honeybee colonies may be higher and rise to 8 kg per colony but only when advanced apiary managment is applied (Bratkowski and Wilde 2002). In countries where the climate is warmer and the growing season is longer than that in Poland up to 13 kg of pollen can be recovered from bees without resorting to special management practices (Nelson, McKenna and Zumwalt 1987). However, even under Poland's conditions up to 20 kg of pollen loads can be recovered from a strong bee colony given favourable weather and honey flow patterns that allow successive foraging on winter oilseed rape, faba beans and buckwheat (Bratkowski and Wilde 1996).

The author's investigations demonstrated that the foragers of individual colonies gathered different amounts of pollen. In the first study year the average pollen yield of 17.62 g/day was obtained or 1.85 kg for the whole pollen capturing season (from mid-May to the end of August). In the second year the yield was 19.40 g/day which translates into the season's total of 2.04 kg (Tables 2 and 3), the year-to-year difference being insignificant. The amounts are comparable to those obtained by the author in earlier studies carried out in 2002 and 2003, the respective values being 19.0 and 23.4 g/day (Roman 2004b). Given an average pollen efficiency of the bee colony in Poland of 3 kg of pollen loads per season the daily efficiency can be put at 50 g (Wilde and Bratkowski 1997). The value is much higher than the averages obtained in this study for either year (Table 1). Grabowski, Wilde and Siuda (2002) report in their study that using a pollen-capturing device they recovered from 0.50 kg to 2 kg of pollen loads over 10 days so their daily efficiency was from 50 to 200 g of pollen loads. Wilde and Bratkowski (1966) recovered an average of 7.4 kg of pollen loads over the period from the beginning of winter rape blooming to the end of July, which translated into a daily efficiency of 90 – 100 g. In both years of this study pollen yields of more than 100 g/day were obtained from some colonies, in 2004 the highest pollen efficiency being 149.32 g/day (Table 1). In 2005, the highest weight of pollen loads recovered per colony was 200.20 g/day (Table 2). Hellmich, Kulincević and Rothenbuhler (1985) as well as Grabowski and Siuda (2002) emphasize that, along with environment-related factors, the amount of pollen is also affected by the genetic traits of a bee colony which, among other things, control the amount of bee bread stored by the colony. Another factor that affects daily harvest of pollen is colony development stage and its biological condition. At the height of the season, in May and in June, the colonies can store as much as 500 g of pollen loads per day (Warakomska 1962). Those amounts are imposingly high when compared to those obtained in this study (Table 1). The least average daily efficiency (2005) was shown by colony no. 6 (4.30 g/day) in which problems with queen performance occurred: queen supersedure occurred three times without any apparent reason and the absence of the queen was recorded in that colony towards the end of the study period. However, colony no. 11 which performed regularly during the season also showed a very low pollen efficiency of 5.84 g/day. Likewise, in 2004 from colonies no. 9 and 10 equally small amounts of pollen were recovered, 4.66 and 4.48 g/day, respectively even though the colonies showed regular functions throughout the season (Tables 1, 2, and 3).

Pollen harvest is also affected by the level of daily nectar increment which is stressed by Poliščuk (1984). That investigator showed that an incoming abundant nectar flow resulting in weight increases of 3 – 4.5 kg caused substantial decline of pollen harvest and the reduction of pollen brought in by the foragers, sometimes down to several grams per day. Instead, when the increment of nectar harvest dropped to 0.1 – 0.2 kg/day the bees would bring in pollen loads more intensively up to 190 – 236 g per colony per day.

Pollen loads are collected from bees by means of pollen-capturing devices of various types. By using pollen capturing devices ca. 30% of pollen loads brought in by the bees can be recovered. The remaining larger part of pollen is usually passed by the bees through the mesh of the device and brought into the nest. Such a situation is beneficial for the honeybee colony since if the bees' ability to gather pollen in the nest is severely restricted by capturing too large amounts of it colony development is negatively affected which may result in a reduction of honey efficiency by as much as 60% (Gansier 1984). Bieńkowska and Pohorecka (1996) showed that the amount of pollen loads recovered from a bee colony is also related to the diameter of the openings in the plate of the pollen capturing device. Owing to the plate with openings 5.0 mm in diameter the investigators obtained an average daily pollen harvest of 17.2 to 24.4 g. Those amounts were comparable to those obtained in both years of this study (17.62 and 19.40 g/day – Table 1).

The weight of single pollen loads obtained in this study came within a range from 3.00 to 12.50 mg (6.54 mg/load on average) in the first study year and from 0.89 to 12.72 (6.60 mg/load on average) in the second year (Tables 3 and 4). Free (1960) maintains that the maximum weight of a pair of pollen loads made by foragers may reach 30 mg from which it follows that a single pollen load may weigh up to 15 mg thus having a weight comparable to maximum values obtained in this study (Table 4). Pidek (1988) demonstrated in his study that pollen loads recovered from bees varied in weight ranging from 3.9 to 17.4 mg/load following desiccation. Grabowski, Wilde and Siuda (2002) report that the size of captured pollen loads is related to the lineage of the bees involved. Those investigators (Grabowski, Wilde and Siuda 2002) demonstrated in their study that the foragers of selected “high-pollen” lines made pollen loads which averaged 10.2 mg in weight and those of non-selected lines made pollen loads that averaged 9.8 mg. In his earlier study Roman (2004a) captured pollen loads of average weight from 5.68 to 7.89 mg/load. In the present study average weights of single pollen loads came within a range from 5.68 to 7.44 mg/load in 2004 and from 5.77 to 8.33 mg/load in 2005 (Table 4).

In this study pollen loads recovered from individual honeybee colonies and compared over different study years and over successive sampling events were demonstrated to vary in weight (Tables 2 and 3). However, in 9 colonies average weights of single pollen loads made by worker bees in the seasons of 2004 and 2005 were very similar and the year-to-year differences were less than 10%. It indicates that the impact of the variable weather conditions prevailing during the study on the worker bees and the weight of pollen loads made by them varied from colony to colony (Tables 5 and 6).

The study indicates that pollen efficiency was higher in those colonies in which foragers made pollen loads of higher weight. However, in his earlier study the author (Roman 2004a) showed that the largest pollen loads were made by foragers of the lowest pollen efficiency. In other honeybee colonies the author failed to demonstrate any relationships in this regard nor did he show any close dependence of the weight of pollen recovered from the colony on the size of pollen loads brought to the hive (Roman 2004a). Therefore, based on the results of this study it should be stated that the relationships found in individual colonies between the weight of a single pollen load and the weight of pollen recovered from it is not a stable trait. The repeatability of that relationship was obtained only for 1 colony (no. 8) in 2004 and for 6 colonies in 2005. However, in none of the colonies did the relationship occur over the two successive seasons (Tables 2 and 3). Hence pollen efficiency of honeybee colonies can not be judged based on the weight of single pollen loads.

CONCLUSIONS

1. Pollen efficiency of honeybee colonies varied over successive study periods.
2. Weight of single pollen loads recovered from incoming foragers varied, among other things, over different periods of the foraging season.
3. The weight of single pollen loads made by the bees of individual honeybee colonies was a more stable character over the two seasons than the amounts of pollen recovered from those colonies.
4. Relationships between single pollen load weights as measured for incoming foragers and pollen efficiency were demonstrated for several honeybee colonies. The repeatability of a similar level of that trait occurred in 1 colony in the first study year and in 6 colonies in the second study year - in both consecutive study years the relationship was never repeated in any colony.

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WPŁYW WIELKOŚCI OBNÓŻY PYŁKOWYCH NA MASĘ PYŁKU KWIATOWEGO POZYSKIWANEGO OD RODZIN PSZCZOŁY MIODNEJ (*Apis mellifera* L.)

Roman A.

Streszczenie

Przeprowadzone badania miały na celu wykazanie, czy i w jakim stopniu wielkość formowanych przez zbieraczki obnóży wpływa na masę pyłku kwiatowego pozyskiwanego od rodzin pszczelich. Badania przeprowadzono w okresie od połowy maja do końca sierpnia w latach 2004 i 2005, na 19-tu rodzinach pszczelich. Pyłek kwiatowy pozyskiwano w postaci obnóży przy pomocy poławiacza typu wylotkowego z płytką strącającą z oczkami o średnicy 5,00 mm. Wykorzystując mikroskop skaningowy określono kształty ziaren pyłku, a na ich podstawie rodziny systematyczne i gatunki roślin, z których korzystały pszczoły. Średni dzienny zbiór obnóży pyłkowych od jednej rodziny pszczelej wynosił 17,62 g w 2004 roku i 19,40 g w 2005 r. Wydajność pyłkowa poszczególnych rodzin pszczelich w pierwszym roku badań kształtowała się na poziomie od 4,50 g/dzień (pień nr 10) do 68,19 g/dzień (pień nr 21). W drugim roku badań odnotowano znacznie niższe wartości od 4,30 g/dzień (rodzina nr 6) do 38,25 g/dzień (rodzina nr 9). Masa pojedynczych obnóży formowanych przez pszczoły zbieraczki wynosiła średnio 6,54 mg/szt. w 2004 roku i 6,80 mg/szt. w 2005 roku. Największe obnóża zebrane w 2004 roku posiadały średnią masę 7,44 mg/szt. (rodzina nr 12), natomiast w 2005 roku - 8,33 mg/szt. (rodzina nr 9). Zależność między masą pojedynczych obnóży przynoszonych przez zbieraczki do ula a wydajnością pyłkową wykazano u pojedynczych rodzin pszczelich, a powtarzalność tej cechy na zbliżonym poziomie wystąpiła u 1 rodziny w pierwszym roku i 6 rodzin w drugim roku badań - w obu kolejnych latach badań zależność ta nie powtórzyła się u żadnej rodziny.

Słowa kluczowe: Rodzina pszczela, obnóża pyłkowe, wydajność pyłkowa, poławiacze pyłku.