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EFFECT OF COMB AGE ON BROOD REARING, DRY WEIGHT, NITROGEN CONTENT AND SOME MORPHOMETRICAL CHARACTERISTICS OF WORKER HONEY BEE (*Apis mellifera* L.).

Fathy, H.M.
Econ. Entomol. Dept., Fac. of Agric., Mansoura Univ.

ABSTRACT

Twelve 1st hybrid colonies (Carniolan x Local Egyptian race) were chosen to study the effect of combs age on brood rearing activity, dry weight, nitrogen content and some morphometrical characteristics of emergen worker bees. The colonies were divided into three groups A, B and C, which contained combs of 1, 2 and 4-year-old, respectively.

In relation to brood rearing activity, a highly significant difference was found between group A and group C. There was also a significant difference between group B and group A. The highest mean of dry weight and nitrogen content of head and thorax were recorded in emerging workers of group A, followed by those of group B. The lowest record of dry weight and nitrogen content was exhibited by the emerging workers of group C.

Significant differences also occurred between some morphometrical characteristics namely tongue, flagellum, fore-wing, cubitel index, hind-wing, hooks and basitarsus of emerging workers according to age of combs.

INTRODUCTION

The most important internal and external factors covering the activity and the characteristics of the honey bee are age of the bee, presence of the prolific queen, brood rearing, comb building, comp age, and presence of both nectar and pollen grain sources of favourable environmental conditions.

It is obvious that the characters vary considerably according to the race and the location. Gromisz (1963 and 1965) found that the environmental factors influenced the characters of the bee. He pointed out that the size of brood cells affected the size of the adult workers, while the proportions of the body remained unchanged. El-Dakhakhni (1994) also found a positive relationship between age of the comb and both body weight of the worker and cell size of the comb. The biometrical characteristics of the Carniolan and Egyptian honey bees were investigated by Ruttner and Mackensen (1952), Carlisle (1955), Mohamed *et al*. (1964) and El-Banby (1968).

The amount of both nectar and pollen collected by the colony influences the activities of bees and the amount of reared brood. Mahgoub *et* al. (1990) also found a positive relationship between the growth of the workers and dry weight, nitrogen content and hypopharyngeal glands development. Haydak (1970) and Mahgoub (1971) found relationship between growth of the workers and the amount of pollen grains as the source

of protein. Some biometrical studies were carried out on the Syrian bees by Abdul Halim (1974 and 1979) and Yakoub (1998).

The present study, which continued from September 6 to November 29, 1999 were conducted to find out the relationship between the age of combs and work brood, dry weight and nitrogen content and some carcters of emerging worker bees.

MATERIALS AND METHODS

Twelve 1st hybrid colonies (Carmiolan x Local Egyptian race) were chosen in the Apiary of the Faculty of Agriculture, Mansoura University. The colonies were similar in strength and queens old, stored food and eight of combs covered with bees. They were divided into three groups according to age of the combs in each group.

The first group A colonies contained 1-year-old combs, while group B included 2-year-old combs, and the third group C contained combs of 4-year-old.

I. Estimation of worker brood area:

The number of square inches of sealed worker brood in each colony was recorded once every 12 days according to Clark *et al*. (1971) by using a frame divided into square inches. The area of worker sealed brood was estimated throughout the experimental period from September 6 to November 29, 1999.

II. Dry weight and nitrogen content:

Newly-emerged worker were collected from group A, B and C at the end of each month during Autumn season, 1999. One hundred bees (head and thorax) from each group were monthly weight and dried at 105°C for 24 hours and the average dry weight was then calculated per bee (head and thorax). The dried head and thorax were subjected for nitrogen content determination according to Kjeldahl method of Vogel (1961), at the Central Laboratory Unit, High Institute of Public Health, Alexandria University. The average of three months (September, October and November) of dry weight and nitrogen content (head and thorax) was calculated according to age of combs.

III. Determination of the workers cell size:

At the end of September, October and November, 5 square inches of every tested colony were filled up by water with injection syringe of 10 ml to estimate the worker cell size. So, every colonies group was represented by 20 square inches. The number of worker cells accounted per square inch and average was found to be 25 cell per one square inch. The average of three months (September, October and November) of worker cell size was calculated according to age of combs.

Fig. 1. Morphological measurements of worker honey bee

IV. Morphometrical techniques:

Morphometrical studies were carried out on 100 emerged workers, collected from each group at the end of the experiment under local conditions. The following characters were investigated (Fig. 1).

Tongue length.

Basitarsus length and width.

Fore-wing area and the cubital index evaluated by the ratio between the two veins a and b (a : b) of the right fore-wing.

Area and number of hooks of the right hind-wing.

Flagellum length (10-apidical segments) of the right flagellum.

The specimens were dipped in 10% sodium hydroxide solution for 24 hours, and then washed in distilled water. The dehydration was accomplished by transferring the insects through serial concentrations of ethyl alcohol. The examined parts were mounted in canda blasm on slides. The parts were measured under the stereoscopic binocular microscope using the micrometer eyepiece. The area of the fore-wing or hind-wing was estimated using the formula: Maximum length x Maximum width ÷ 2. The number of hooks was recorded under the bioncular.

RESULTS AND DISCUSSION

I. Worker brood rearing activity:

The results of brood rearing activity during autumn season, 1999, are presented in Table 1 and Fig. 2. The average of the total number of workers sealed brood areas (square inches per colony) of groups A, B and C were 1431, 1260 and 1012 sq. in., respectively. The highest rearing ability showed in group A, which their colonies contained combs of one-year-old and reached to 310 sq. inch in the third week of September. The group C, which their colonies contained combs of 4-year-old recorded the lowest rearing brood area and reached to 50.5 sq. inch in the third week of November, while group B which had combs of 2-year-old occupied a moderate situation between the previous records.

From these results, it was found that the active brood rearing was releated to the colonies containing new combs (1-year-old). The statistical analysis of Table 1 showed a highly significant difference between group A and group C. There was also significant difference between group B and group A.

In general, the brood rearing in honey bee colonies was stimulated as a result of many factors such as the weight and size of the worker body which emerged from new combs (Abdellatif, 1965 and El-Dakhakhni, 1994).

In addition, it is possible that the age of combs affected the brood rearing area and the new combs induced a positive effect on brood rearing ability.

II. Dry weight and nitrogen content of workers:

a. Determination of dry weight:

From the results are given in Table 2 and Fig. 3, the highest means of dry weight of head and thorax (11.14, 10.72, and 10.44 mg) were recorded in

emerged workers of group A in September, October and November, respectively. Meanwhile, the lowest means of dry weight of 10.17, 10.08, and 10.01 mg) were recorded in group C in the same months, successively.

Significance of the mean dry weight of head and thorax is summarized in Table 2.

Table 1. The average of brood area in square inches per colony for the three groups during the period from September 6 to November 29, 1999.

Date	Groups		
	A	B	C
6/9/1999	290.75 b	218.25 b	191.50 b
18/9	310.00 a	285.75 a	252.25 a
30/9	195.50 c	210.00 c	177.00 c
12/10	184.25 d	188.50 d	107.50 d
24/10	156.00 e	109.25 e	97.00 e
5/11	110.75 f	89.50 f	74.50 f
17/11	84.00 h	73.00 h	50.50 h
29/11	99.75 g	85.75 g	61.75 g
Total	1431	1260	1012
$\bar{X} \pm SX$	178.9±1.883	157.5±0.654	126.5±1.320

In a column means followed by a common letter are not significantly different at the 5% level according to Duncan Multiple Range Test.

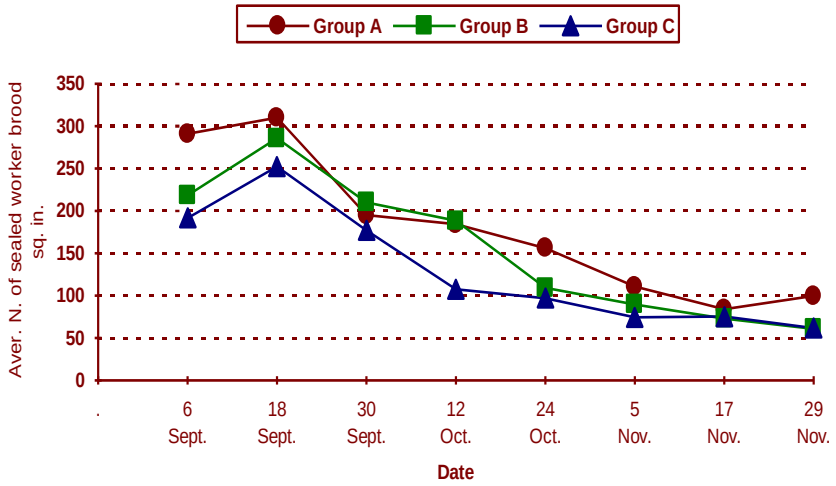

Fig. 2. Worker brood rearing activity according to combs age during experimental period.

Table 2. Significance of dry weight and nitrogen content of head and thorax during experimental months.

	September		October		November	
Groups	**Dry weight (mg)**	**N content (mg)**	**Dry Weight (mg)**	**N content (mg)**	**Dry weight (mg)**	**N content (mg)**
A	11.14 a	1.92 a	10.72 a	1.77 a	10.44 a	1.71 a
B	10.71 b	1.90 a	10.43 ab	1.72 a	10.13 a	1.68 a
C	10.17 c	1.85 a	10.08 b	1.67 a	10.01 a	1.66 a
$\bar{X} \pm SX$	10.67 ± 0.18	1.89 ± 0.815	10.41 ± 0.051	1.72 ± 0.416	10.19 ± 0.315	1.68 ± 0.671

In a column means followed by a common letter are not significantly different at the 5% level according to Duncan Multiple Range Test.

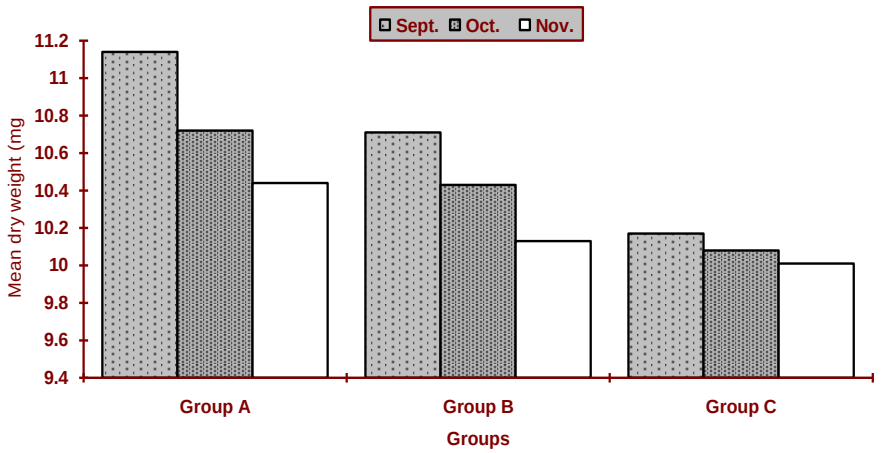

Fig. 3. Dry weight of emerged workers (head and thorax) in group A, B and C during experimental months.

b. Determination of nitrogen content:

The results obtained for the head and thorax are presented in Table 2 and Fig. 4. It may be obvious that the heighest means of nitrogen content of head thorax were 1.92, 1.77 and 1.71 mg in the emerged workers of group A in September, October and November, respectively, The corresponding means were distinctly low in group C, being 1.85, 1.67 and 1.66 mg in the same months, respectively.

Data found in Table 3 indicated that the worker cell size, dry weight and nitrogen content of emerged workers (head and thorax) were decreased gradually according to age of combs from 0.25 ml, 10.77 mg and 1.80 mg in group A to 0.18 ml, 10.09 mg and 1.72 mg in group C, respectively. The present data were in accordance with the results of Buchner (1953), which illustrated that the average weight of the newly emerged workers reared in cells used in 68 generations was 96.1 mg, while the new combs produced worker of 118.1 mg.

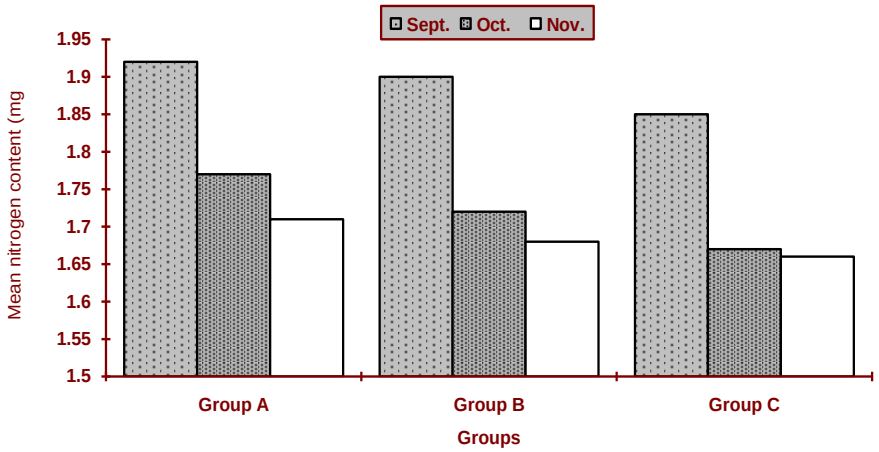

Fig. 4. Nitrogen content of emerged workers (head and thorax) in group A, B and C during experimental months.

Table 3. The average of three months (September, October and November) of worker cell size, dry weight and nitrogen content (head and thorax) according to combs age.

Group	Cells size / sq. in. (ml)	Worker cell size (ml)	Dry weight (mg)	Nitrogen content (mg)
A	6.34	0.25	10.77	1.80
B	5.52	0.22	10.42	1.76
C	4.40	0.18	10.09	1.72

Generally, the obtained results strongly showed that the highest means of dry weight and nitrogen content of head and thorax were recorded in the emerged workers of group A (colonies containing of 1-year-old combs), followed group B (colonies containing of 2-years-old combs). The lowest means of dry weight and nitrogen content were recorded in group C (colonies containing of 4-years-old combs). These results are in agreement with Mahgoub (1971), who found that the dry weight of bee workers follow the same trend of nitrogen content. The present results also indicated that the age of combs had a salient effect on dry weight and nitrogen content of the emerged workers. New combs (group A) gave a positive effect on dry weight and nitrogen content.

III. Morphometric characteristics:

In comparison studies between the three groups, the following characters were examined under local conditions. Table 4 summarizes the obtained results:

1. Tongue length:

The tongue is one of the most important characteristics which has a direct influence on the honey yield. The present results showed that the

average tongue length for the workers of group A was 5.62±0.031 mm, 5.22±0.014 mm for group B, and 5.10±0.022 mm for group C (Table 4) The statistical analysis revealed significant differences among three groups.

These results indicated that group A workers were the most active in nectar collection, among the three groups.

2. Flagellum length:

The antennae are particularly responsive to the stimuli of touch and odour (Sondgrass, 1976). Many investigations illustrated the importance of antennae in both pollination of crops and the honey yield.

The average flagellum length of workers of group A was 2.61±0.002 mm, while group B workers was 2.58±0.003 mm. Those of group C showed an average length of 2.43±0.002 mm (Table 4).

The statistical analysis by using Duncan Multiple Range Test at the level of 1% showed a significant difference in the length of flagellum between workers of group A and group C as well as a similar significant difference between workers of both groups B and C. However, no significant difference occurred between workers of group A and those of group B.

3. The length, width, area of the fore-wing and the cubital index:

a. The length of the fore-wing:

The average length of the fore-wing was 8.64±0.017 mm, 8.26±0.015 mm and 8.13±0.013 mm in the three groups respectively. The statistical analysis using Duncan Multiple Range Test at the level of 1% showed significant differences between the three groups (Table 4).

b. The width of the fore-wing:

The average width of the fore-wing likearse differed significantly among all groups. It was 2.76±0.007, 2.71±0.061 mm and 2.57±0.009 mm, respectively. Statistical analysis indicated significant differences between the tree groups.

The results in Table 4 are clearly similar to those reported by several investigators in Egypt such as Hassanien and El-Banby (1956) who found that the fore-wing mean length and width were 8.64 mm and 2.84 mm, respectively. Wafa *et al*. (1965) also mentioned that the means for the Egyptian bee were 8.36 mm in length and 2.84 mm in width, while the corresponding figures given by El-Banby (1968) for the Egyptian bee were 8.29 mm in length and 2.81 mm in width.

c. Area of the fore-wing:

The average fore-wing area of group A workers was 11.92±0.063 mm^2 while that of group B was 11.19±0.151 mm^2. The workers of group C exhibited an average area 10.45±0.049 mm^2. The statistical analysis in Table 3 proved significant differences between the three groups.

d. The cubital index of the fore-wing:

Table 4 show the average value of cubital index including the range for the three groups. The average figure for the workers of group A was 2.57±0.024. The average for group B was 2.23±0.032, while that for group C was 2.19±0.042. The statistical analysis showed significant differences between the workers of group A and both groups B and C. No significant differences existed between group B and group C.

The ratio of Cubital index is related to wing size. The measurements taken in the present work showed that the size of the fore-wing for the group A was 11.92 mm^2, which was longer than other two groups B and C (11.19, 10.45 mm^2), successively. The results shown by the group A workers are particularly similar to those obtained by Wafa *et al*. (1965), who found that the Cubital index was 2.56.

4. Hind-wing measurements:

Table 4 shows the average hind-wing length with their respective ranges for the three groups. The average length for the workers of group A was 6.37±0.015 mm with a range between 5.98 to 6.67 mm. The average for the workers of group B is 6.33±0.022 mm with a range of 5.94 to 6.63 mm. The average for the workers of group C is 6.26±0.032 mm with a range of 5.86 to 6.74 mm. Statistical analysis shows significant differences exist between three groups.

As for the width, its average reached 1.76±0.0005 mm, 1.76±0.0007 mm and 1.65±0.0008 mm among the three groups, respectively. It may be obvious in Table 4 that group A workers differed significantly from group C. No such differences occurred between the workers of both groups A and B. The statistical analysis also showed significant differences in the width of the hind-wing between group B and group C.

The average area of the hind-wind of workers of of group A (Table 4) was 5.93±0.042 mm^2. The corresponding average in group B was 5.79±0.063 mm^2, while that of group C was 5.46±0.054 mm^2, without any significant differences between the three groups.

As for the number of hooks on the hind-wing, it may be clear in Table 4 that the average number in the workers of group A was 21.53±0.138. In group B, the average number was 21.15±0.148, while that of group C reached 20.75±0.163 with significant differences between group A and group B. No significant differences existed between the workers of both groups B and C.

The size of the hind-wing of bee workers is of same importance since it is directly related to the capability of a longer flying time. The number of hooks located on the hind-wing strengthens the binding force between the fore- and hind-wings. The average area of hind-wing in the group A (5.93 mm^2) was larger than both groups B (5.70 mm^2) and C (5.46 mm^2).

The average number of hooks on the hind-wing was higher in group A (21.53) than in both groups B (21.15) and C (20.75) (Table 4).

5. The length and width of basitarsus of hindleg:

Table 4 indicated that the mean length of the basitarsusis was 2.22±0.006 mm in group A and 2.18±0.005 mm in group B. The corresponding average in group C was 2.11±0.003 mm with significant differences between workers of group C and each of group A and group B. No significant difference existed between group A and group B.

The mean width of basitarsus was 1.18±0.005 mm, for group A, 1.15±0.003 mm for group B, and 1.09±0.001 mm for group C (Table 4). Measuring the basitarsus width of the three groups revealed that the average width of the bastitarsus was wider in the workers group A than in the two groups.

In conclusion, it could be mentioned that the workers of group A (colonies contained 1-year-old combs were significantly more superior in their characters than those of the two other, group B and C. This means that comb age had a positive effect on some characteristics or worker bees, combs of old age being the least effective..

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تـأثير عمـر القـرص الشـمعى علـى تربيـة الحضـنة - الـوزن الجـاف - المحتـوى النتروجينى وبعض صفات القياسات المورفولوجية لشغالات نحل العسل0

حسن محمد فتحى

قسم الحشرات الإقتصادية - كلية الزراعة - جامعة المنصورة0

لدراسة تـأثير عمر القرص الشمعى علـى تربيـة الحضـنة - الـوزن الجـاف - المحتوى النتروجينـى وبعض صفات القياسات المورفولوجية لشغالات نحل العسل تم إختيار إثنـى عشر طائفة هجين أول كرينولى متماثلة فى القوة والغذاء المخزن بها وعدد الأقراص فى كل طائفة0 قسمت الطوائف إلـى ثلاثـة مجـاميع تبعـاً لعمر القرص الشمعى (سنه ، سنتين ، 4 سنوات)0 وأظهرت النتائج مايلى:-

أولاً: وجود إختلافات عالية المعنوية فـى تربيـة الحضـنة بين طوائـف المجموعـة الأولـى (أقراصـها عمر سنة) والمجموعـة الثالثـة (أقراصـها عمر 4 سنوات)0 كـذلك وجـود إختلافـات معنويـة بين المجموعـة الأولـى (أقراصـها عمر سنة) والمجموعة الثانية (أقراصـها عمر سنتين)0

ثانياً: أعلى متوسط للـوزن الجـاف والمحتـوى النتروجينـى لـرأس وصـدر الشـغالات حديثـة الإنبثـاق سـجلت من مجموعة الطوائف ذات أقراص عمر سنه يليها مجموعـة الطوائـف ذات الأقراص الشمعية عمر سنتين بينمـا أقل متوسط سـجل مـن مجموعـة الطوائـف ذات عمر 4 سنوات ويرجـع هذا الإخـتلاف إلـى حجم عيون الشغالة0 حيث كان متوسط حجم عيون الشـغالة فـى الأقراص الشمعية ذات عمـر سنة أكبر منهـا فـى الأقراص ذات عمر 4 سنوات0

ثالثاً: وجدت فروق معنوية فى قياسات بعض الصفات المورفولوجية للشغالات حديثة الإنبثـاق وذلك تبعـاً لعمر القرص الشمعى الذى إنبثقت منه الشغالات0

Table 4. The mean, standard error and range of some morphological measurements for workers of the different groups under local conditions.

Character	Measurements	Group A		Group B		Group C		F test
		$\bar{X} \pm SX$	Range	$\bar{X} \pm SX$	Range	$\bar{X} \pm SX$	Range	
Tongue	L. mm.	5.62±0.034	5.24-6.11	5.22±0.014	4.99-5.56	5.10±0.022	4.85-5.45	15.77*
Flagellum	L. mm.	1.61±0.002	2.55-2.70	2.58±0.003	2.29-2.85	2.43±0.002	2.24-2.68	32.39*
Fore-wing	L. mm.	8.64±0.017	8.34-8.96	8.26±0.015	8.12-8.44	8.13±0.013	7.98-8.33	60.07*
	W. mm.	2.76±0.007	2.39-3.15	2.71±0.061	2.24-3.17	2.57±0.009	2.21-2.88	172.86*
Cubital index	ar mm^2.	11.92±0.063	10.66-13.22	11.19±0.151	10.36-12.11	10.45±0.049	10.09-11.10	24.33*
	a : b	2.57±0.024	2.10-3.18	2.23±0.032	1.39-3.10	2.19±0.042	1.35-3.09	29.69*
Hind-wing	L. mm.	6.37±0.015	2.98-6.67	6.33±0.022	5.94-6.63	6.26±0.032	5.86-6.74	34.12*
	W. mm.	1.76±0.0005	1.56-1.99	1.74±0.0007	1.48-1.87	1.65±0.0008	1.36-1.82	44.86*
	ar mm^2.	5.93±0.042	5.68-6.11	5.79±0.063	5.34-6.09	5.46±0.054	5.11-5.89	57.29*
No. of hooks		21.53±0.138	18.0-25.0	21.15±0.148	18.0-25.0	20.75±0.163	17.0-24.0	66.35*
Basitarsus	L. mm.	2.22±0.006	1.92-2.54	2.18±0.005	1.96-2.43	2.11±0.003	1.72-2.51	5.51*
	W. mm.	1.18±0.005	1.09-1.23	1.15±0.003	1.05-1.25	1.09±0.001	1.02-1.19	107.15*

*** Presence of variation at level 1%.**

Group A: Colonies contained 1-year-old combs, group B: colonies containing 2-years-old combs, and group C: colonies containing 4-years-old combs