HONEYBEE COLONY POPULATION IN RELATION TO BROOD REARING AND STORED POLLEN

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Introduction

The egg-laying capacity of queens and the maximum population of a colony of honeybees *(Apis mellifera* L.) are often greatly overestimated. Populations up to 100.000 bees and egg-laying rates up to 1500 eggs per day have been mentioned frequently in literature.

IMDORF et al. (1987) tested the method of estimation of brood rearing and of the number of young worker bees. It was found that there was a very intimate connection between the amount of stores left with a colony of bees and the rate of its brood activity (MERRILL, 1922).

A positive relationship between the amount of stored pollen grains and the colony's size, and the brood rearing in the colony was found by TODD and BISHOP (1940), ALLEN and JEFFREE (1956) and TOWNSEND and SMITH (1969). The importance of pollen grains to the honeybee, resides in the fact that they supply the proteins, fats, vitamins and minerals which are necessary for the normal growth and development of larvae. CALE (1968) showed that the greater the egg-laying, the greater the need for collection of pollen grains to supply the necessary proteins of the colony.

In Egypt, little research work has been done as regards the bee population of a colony, its relationship with the brood activity and the stored pollen grains. Therefore, the purpose of this research is to study these relationships.

Materials and Methods

The present study was carried out at the Experimental Station, in the Faculty of Agriculture, at the Alexandria University. Fifteen colonies of first Carniolan hybrid, bees nearly equal in strength and headed by queens of the same age were selected for this experiment during the seasons of 1994—1995.

I. Estimation of egg production and brood rearing

The number of square inches of sealed worker brood present in each colony was counted every 12 days according to CLARK et al. (1971), by using a frame divided into square inches by means of a nylon thread (FRESNAY and LENSKY, 1961). The square inch of worker brood includes 25 cells on average. The egg number per day was calculated as follows:

$$\text{Eggs / day} = \frac{\text{Number of sq. in. of sealed worker brood x 25}}{12}$$

II. Estimation of nurse bees density

To study the relationship between the bee density and the brood activity, the number of bees was estimated during the brood measurement every 12 days from June 1994 to May 1995. One comb, having bees on one side was taken from each colony and put in a cold chamber (4°C) for one hour. After that, the number of bees were counted. There were six hundred bees on average, and this agreed with IMDORF et al. (1987), who found 1200 bees as the standard bee population on one side of a comb. This means that half of a side in a Langstroth comb includes about 600 bees. According to this estimation, the number of nurse bees in every colony was recorded.

III. Estimation of stored pollen grains

The aim of this research is to study the relationship between the brood rearing and the gathered area of pollen grains. Thus, the same method employed for brood counting was used at 12 days' intervals, to count the number of square inches of pollen grains stored by the field workers. Ten samples of pollen grains were taken at random from the grains stored in the colonies. Each sample (containing 20 cells of pollen) was weighed and the average weight of a pollen cell was estimated. One pollen cell has about 0.66 grams and one square inch of pollen weights about 16.5 grams.

IV. Statistical analysis

The analysis of variance (the F-test) was used for various brood, bees and stored pollen grains and the correlation coefficients between the brood quantity, the colony populations and the amount of stored pollen were also estimated.

Results and Discussion

I. The brood rearing activity and the population of the colony

Brood rearing was studied in fifteen colonies during four seasons. Also the number of nurse bees was estimated in the same period. The data represented graphically in Fig. 1, 2 and 3 illustrated the average number of square inches of sealed

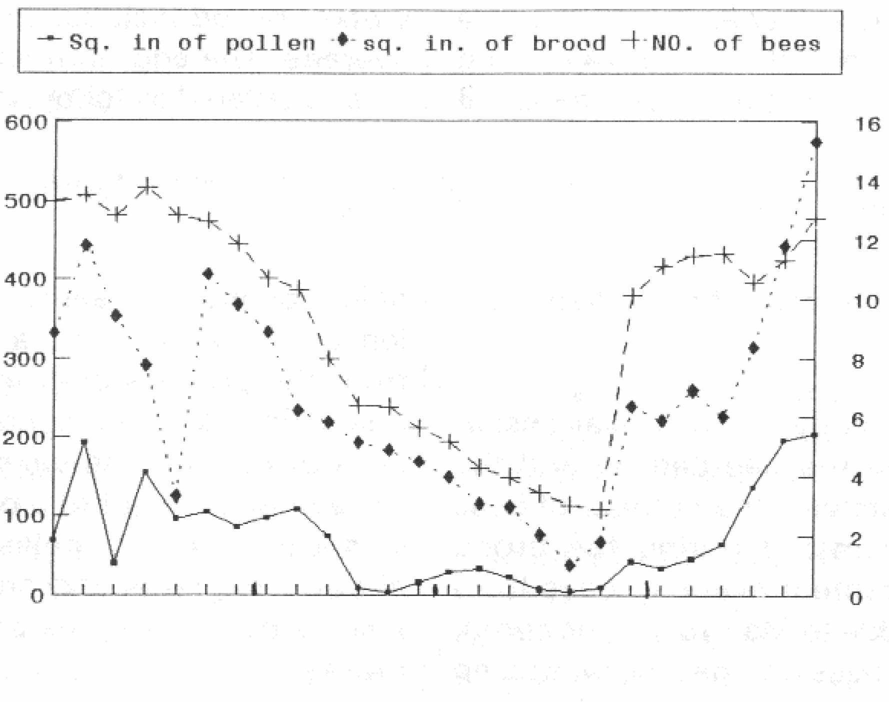

Fig. 1 — Relationship between the amounts of brood, of stored pollen and of nurse bees in various seasons

—■— Sq. in of pollen —◆— sq. in of brood + No. of bees

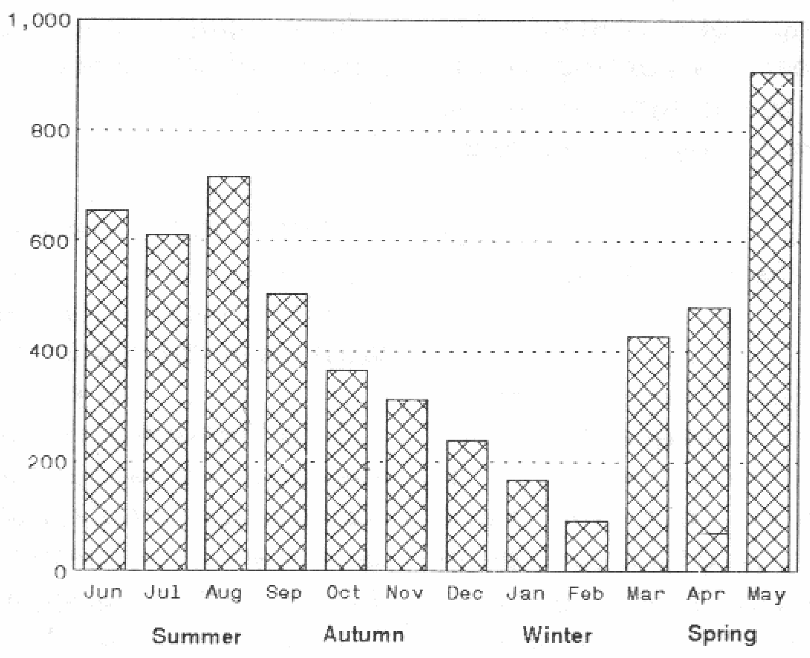

Fig. 2 — Brood rearing activity presented as the number of eggs layed in various seasons

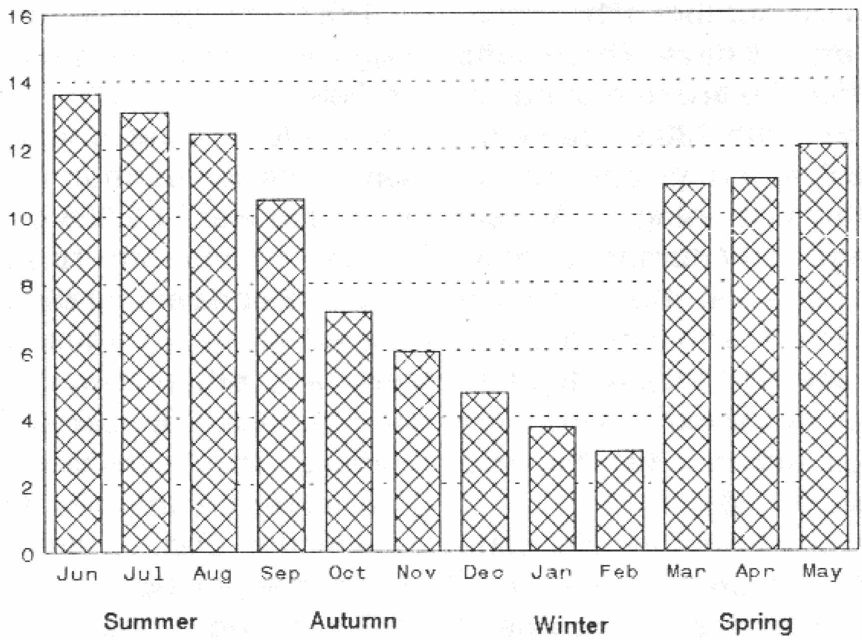

Fig. 3 — Density of bees presented as the number of nurse bees in various seasons

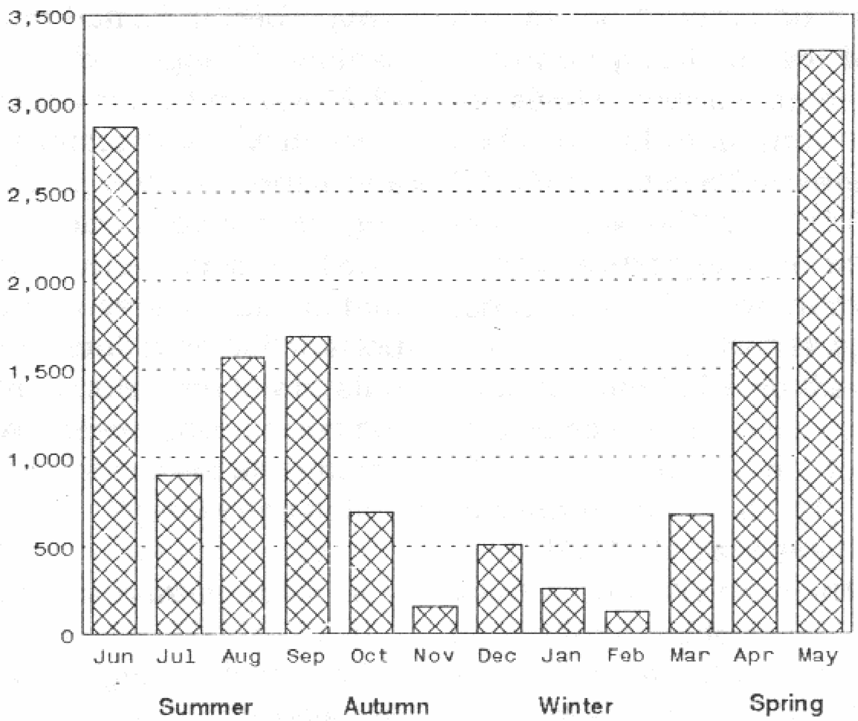

Fig. 4 — Average stored pollen weight in various seasons

brood and the number of bees estimated every 12 days. The results revealed that the brood rearing activity started with 238.9 square inches (426.6 egg/day) and 10,106 bees at the beginning of March. The average daily number of eggs in March was of 427 eggs/day (7.8%) and the number of bees was of 10,891 bees (10.1%). A slight increase was observed in April with 480.9 eggs per day (8.08%) and 11,036 bees (10.2%).

This brood rearing activity coincided with the increase in temperature, as well as with the income of nectar and pollen from some vegetable crops in the experiment area. The egg production and brood rearing activity continued to develop and increase, reaching the highest peak in the third week of May when the major season of clover honey occurs, with 907 eggs as the maximum average amount per month (16.5% of the total egg number), while the large number of bees observed in June and July reached the average of 13,635 bees (12.6%) and of 13,053 (12.1%), respectively. A slight decline occured in the average number of daily eggs: 635.8 eggs. (11.9%).

The lowest peak in brood production occured during the cotton blooming season in August, with 717 eggs/day (13.1%). The number of recorded bees was of 12,425 bees (11.5%). The brood rearing activity and the number of bees continued to decline in October to 365.7 eggs and 7,159 bees, (only 6.7 and 6.6%, respectively) (Fig. 2 and 3).

The average number of daily eggs declined sharply and dropped in February to 93.3 eggs/day, giving the lowest percentage of 1.7%, while the lowest number of bees recorded was of 2,958 bees (2.7%) in the same month. This reduction in the brood rearing level was expected since the main cultivated crop and other sources of nectar and pollen disappeared. This may indicate that available food sources are very important for brood production and for the increase of the bee population.

The brood production in spring (March, April and May) represented 33.1% of the total production and the number of bees represented 31.4%. In summer (June, July and August), the percentages of brood and bees were equal (36.2%). The results obtained in autumn (September, October and November) indicated that the percentage of eggs and of bees were of 21.6% and 21.8%, respectively, while in winter (December, January and February), the percentages of eggs and of bees were of 9.1% and 11.5%, respectively. It is obvious that the queen's fecundity is an important factor influencing the population of the colony, the amount of reared brood, the strength of the colony and the available food (both pollen and honey).

II. Pollen gathering activity

The results in Fig. 1—4 represent the average of a 12 days' estimation of the amount of the stored pollen. A slight reduction in the amount of stored pollen was observed in March (40.83 sq. in./ count: 673.7 grams) (4.69%). The average amount of pollen in April was of about 100 sq. in./count, 1650 grams (11.5%). The highest rate of pollen gathering was observed in May since the figure obtained was of 199.75 sq. in. /count, 3295.9 grams (22.96%). The monthly average amount of stored pollen in June was of 173.75 sq. in./count, 2866.9 grams (19.98%). In July and August, the average amounts of collected pollen grains were of 54.5 sq. in/count, 899.3 grams (6.27%) and 95.0 sq. in./count, 1567.5 grams (10.92%), respectively.

The average amount of stored pollen declined in November, December and January to 9.25 sq. in./ count; 152.6 grams (1.06%), 30.75 sq. in./count, 507.4 (3.54%) and 15.0 sq. in/count, 247.5 grams (1.72%), respectively. The stored pollen amount continued to decline in February and was of 7.25 sq. in./ count, 119.6 grams (0.82%). The lack of pollen occurs only for a short period in autumn and in winter. Pollen is available in colonies during the largest part of the year, and sufficient stored pollen supplies may be observed. This happens because pollen as a food is needed only for short periods of time and the pollen shortage appears when the drones disappear from colonies, as stated by TABER (1978).

The data in Fig. 1 indicate that, in spring, (March, April and May) the amount of stored pollen represented about 39.15% of the annual quantity collected by bees. This percentage was obtained due to the suitability of the ecological conditions for the flowering of various plants and to the fact that the population of foraging bees that could gather the pollen from the blooming plants such as clover, citrus, some ornamental plants and some vegetables, in this period, reached the climax.

The percentage of collected pollen in summer was estimated at 37.17%, while in autumn the percentage of stored pollen was of 17.59%. Most of these pollen grains were collected in September and this agrees with the discoveries of EL-DAKHAKHNI (1981). The lowest amount of stored pollen recorded in winter was of 6.08%, and this was due to the lack of pollen sources and to the decrease of temperature, which greatly affect the foraging activity of bees.

The analysis of variance revealed that there were insignificant differences in the amount of stored pollen during the experimental period and this was due to the small difference (1.98%) between the percentages of collected pollen in spring (39.15%) and in summer (37.17%).

III. The relationship between the brood activity, the bee density and the stored pollen

From the results obtained (Table 1) we may see that, in winter, there

Table 1

Correlation Coefficients between the Amount of Brood, of Stored Pollen and the Number of Bees

Factor	Summer Pollen	Summer Bees	Autumn Pollen	Autumn Bees	Winter Pollen	Winter Bees	Spring Pollen	Spring Bees
Pollen	—	0.545	—	0.945**	—	0.859*	—	0.515
Bees	—	—	—	—	—	—	—	—
Brood	0.234	-0.025	0.752*	0.872*	0.911**	0.949**	0.930**	0.684*

** Significant at the level 0.01; * Significant at the level 0.05

Table 2

Correlation Coefficients for Various Seasons (in Square Inches of Brood, Stored Pollen and Number of Bees)

Factor	Brood Summer	Brood Autumn	Brood Winter	Pollen Summer	Pollen Autumn	Pollen Winter	Bees Summer	Bees Autumn	Bees Winter
Summer	—	0.459	0.629	—	0.697	0.701	—	0.957**	0.851*
Autumn	—	—	0.871*	—	—	0.997**	—	—	0.945**
Winter	—	—	—	—	—	—	—	—	—
Spring	0.040	-0.538	-0.548	-0.282	-0.775*	-0.771*	-0.290	-0.490	-0.508

** Significant at the level 0.01, * Significant at the level 0.05

is a significant positive correlation between the existing amount of brood and the colony's population, as well as between the colony's population and the amount of pollen. This may be due to the semi-dormancy of colonies during this season, for which reason the honeybee colonies depend on stored food (pollen and honey) rather than on foraging.

In spring, the same tendency and the same positive correlations were observed, meaning that the bees still depended on the stored food for brood production. In summer when the foraging activity is obvious, it is likely that the colonies depend on the gathered food (pollen + nectar) for brood production. For this reason, negative correlations were estimated and no correlation was found between the amount of pollen and that of brood.

In autumn, positive correlations started to appear, when the available food became scarce and the colonies depended on the stored food again. Finally, we must mention that, in winter and in spring, colonies largely depend on the stored food and thus, positive correlations exist between the colonies' population and the brood rearing or the pollen amount, while in summer and in autumn, when the foraging activity is higher, the colonies depend on their foragers gathering nectar and pollen and, thus, the correlations are poor.

The analysis of variance revealed that there were more significant differences in the quantity of brood and of bees during the experimental period. The highest percentage of stored pollen (22.96%) and the highest brood rearing activity (16.5%) were observed in May, while the lowest percentages occured in February (0.82 and 1.7%, respectively), and this was due to the strong correlation between the amounts of brood and of stored pollen in spring and in autumn (Table 1).

A positive relationship between the amount of stored pollen, the colony's size and the brood rearing activity in the colony was found (Table 1) and this agrees with the discoveries of TODD and BISHOP (1949), of ALLEN and JEFFREE (1956) and of TOWNSEND and SMITH (1969). Generally, correlations between the brood activity, the bee density and the amount stored pollen were found, especially in autumn and in winter (Table 1).

The results in Table 2 indicate a low correlation between the amount of brood in autumn and that in winter, while no correlation was found between the amount of brood in summer and that in the other seasons. Also, no correlation was found between the amount of brood in spring and that in the other seasons. As regards the amount of stored pollen, a clear correlation was found between the amount of pollen in autumn and the one in winter. Also, a weak correlation was found between the amount of pollen in spring and the one in autumn, as well as between the one in spring and the one in winter.

No correlation was found between the amount of pollen available in summer and the one available in the other seasons. As regards the bee population, a clear correlation was found between the number of bees in summer and the one in autumn, as well as between the number of bees in winter and the one in autumn. A weak correlation was found between the number of bees in winter and the one in summer. No correlation was found between the number of bees in spring and that in the other seasons.

Generally, we found a strong correlation between the bee population in various seasons, a weak correlation between the amounts of pollen and a very weak correlation between the amounts of brood reared in various seasons.

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