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**Some Observations on the Pollen Foraging Activities
of the Honey Bee, *Apis mellifera* L.
(Preliminary Report)¹⁾**

By

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(With 2 Text-figures)

Recent studies on the division of labour in honey bee colonies showed the validity of pioneer works by Rösch (1925-'30) who asserted that each worker bee gradually altered her social duties according to her age. However these works also proved that the relation between tasks and age is more flexible than believed by Rösch, and that the division of labour within the colony is determined not only by the age of the members but also by the need of colony which alters according to various factors either external or internal to the colony. (Lindauer 1952, Ribbands 1953, Sakagami 1953a, b, 1958).

During the course of the present writer's study on the adjustive behaviour of pollen-foragers in the hives with or without pollen traps, there was noticed a great individual difference in the behaviour of foragers even among the workers of the same age. Leaving a detailed description for an account elsewhere, here will be reported some aspects of the observations as a preliminary note.

Before going further, cordial thanks are expressed to Professor Tohru Uchida and Dr. Shōichi F. Sakagami for their pertinent guidance and valuable suggestions, and to Mr. Kiyoki Moriya for his kind help in this study.

Material and method: The observations were carried out with two moderate colonies of impure Italian race, each inhabited by about 10,000 bees at the start of observation on May 5, 1960.

According to the main aim of the study undertaken, one colony (A) was provided with a single-screened pollen trap in the front of the hive, while the other (B) served as the control without any trap. In each colony, about 100 bees were captured immediately after emergence, individually marked with coloured paint and returned to the colony. This procedure was carried out 5 times approximately every half-month and in total about 500 bees were marked in each colony. Observation was made from June 23 to September 7, about 6 hours per day, usually 9.00 a.m. to 3.00 p.m.; the in-out flying bees were classified into pollen foragers (with pollen loads), non-foragers and presumable nectar foragers (without pollen each trip more than 5 minutes or less than 5 minutes but dusted with pollen).

Simultaneously, the total amount of daily pollen income was calculated.

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from the amount of trapped pollen and trap efficiency. (cf. Moriya 1960).

Results

1) *Change in the amount of incoming pollen according to the need of colony:* Colony A (experimental) evolved a swarming on June 30, and the brood rearing ceased until hatching out on August 2 of the first larvae produced by the new queen.

This lack of broods during more than one month may indicate the low requirement of the colony for pollen, the principal protein source for growing larvae. Total amount of daily pollen income dropped rapidly during this period and again gradually increased in parallel with the brood rearing which recommenced on August 3 (as seen in Fig. 1).

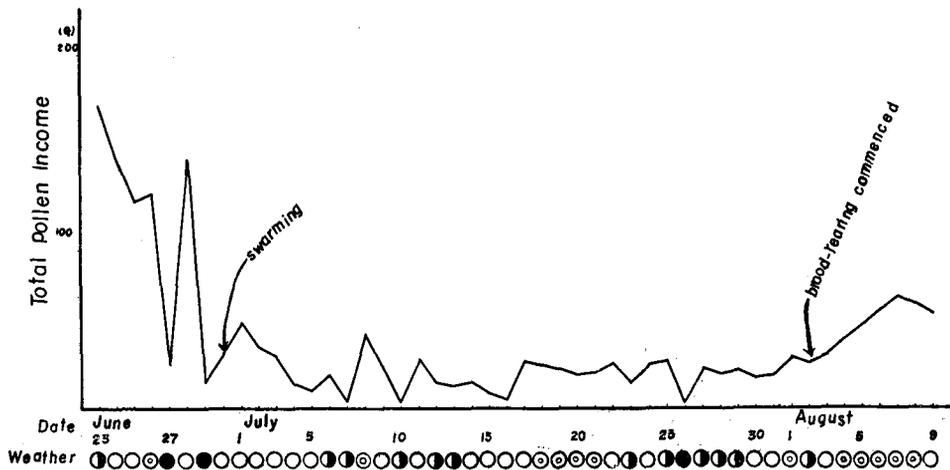


Fig. 1. The daily change the amount of the pollen trapped throughout the observed condition. (the data from Moriya 1960)

Weather condition : ⊙ very fair, ○ fine, ◐ cloudy, ● rainy.

While there was no marked difference of weather conditions during the observation period, this is explained partly by the decrease of workers by swarming (to $\frac{1}{2}$ the number before swarming) but partly also by the decreased requirement of the colony for pollen.

2) *Adjustive response of pollen foragers:* From the comparison of the individual records of marked bees in both colonies A and B, it was assumed that the pollen-foraging activity commenced at a relatively earlier age of workers in the colony provided with the pollen trap, than in the control colony. The distribution of

ages at which the first pollen foraging was observed is shown in Table 1.¹⁾

Table 1. Distribution of first pollen-foraged day in individually marked bees

days after emerging	Marked on June, 6			Marked on August, 4		
	16	18	19	26	30	34
Colony A (with pollen trap)	1	7	12	1	—	7
Colony B (control)	0	0	1	0	5	—

From which there are two conclusions drawn: 1) The age at which pollen foraging commences greatly varies according to the individual (16–35 days after emerging), but 2) bees of the trapped colony foraged pollen at about 2–5 days younger age than those in the control colony. The second fact suggests that, in the colony provided with pollen trap, the pollen requirement of the colony increased, because of the pollen deficiency, which acted on the worker population of pre-foraging age and forced them to engage in pollen foraging earlier than in the unobstructed condition.

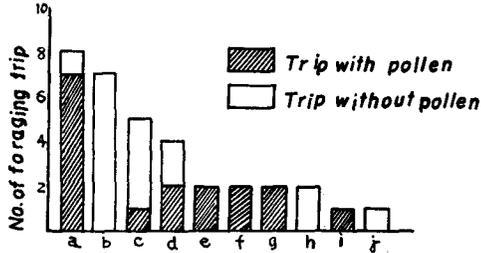
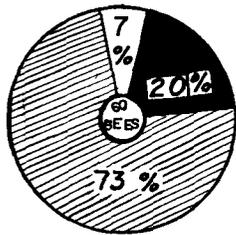
Moreover, the ages at which pollen foraging commenced seem to vary according to season. The distribution of the first pollen foraging days of individually marked bees in each month is shown in Table 1.

From the table it is clear that the bees started their pollen foraging at an earlier age in June, while at a later age in September. This also corresponds to the intensity of brood rearing and suggests another aspect of adjustive mechanism in response to the need of the colony.

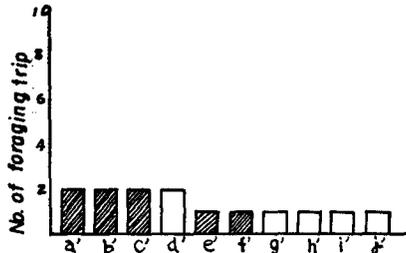
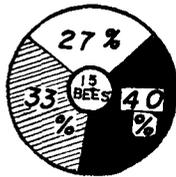
3) *Individual difference among same aged workers*: Although the general trend in the division of labour, the hive duties by younger bees and the field duties by older ones, invariably detected throughout the observation, the performance of each of the marked bees greatly varied from individual to individual, of which two instances are illustrated in Fig. 2. The left pie graphs in the figure show the relative proportion of pollen foragers (black), presumable nectar foragers (hatched) and non-foragers (white) among same aged bees.

On June 24 '60, about 1/5 of the 19 days old bees were pollen foragers, while there are 7% of bees which did not engage in any foraging activities. On September 6, however, the ratio of foragers especially of pollen foragers decreased both in bees aged 35–60 days after emergence.

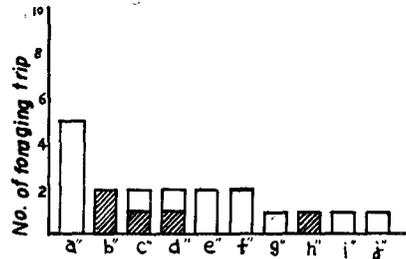
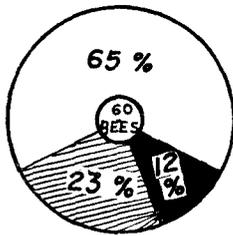
1) The results obtained do not always clearly show the earlier issue of pollen foragers in the experimental colony, caused by the lack of observation on Sep. 2 for an inevitable circumstance.



June 24, 60 bees of 19 days old



September 6, 15 bees of 60 days old



September 6, 60 bees of 35 days old

Fig. 2. Individual difference among same aged bees.

Left: Ratio of pollen foragers (black), presumable nectar foragers (hatched) and non-foragers (white).

Right: Some individual records of foraging activities. Each histogram shows performance of one particular worker individually marked.

Further the individual difference among marked individuals is shown in the right histograms of the figure. While certain individuals such as *a, b, c, d*, performed a great number of foraging trips, there are individuals such as *i, j*, which scarcely foraged at all. The graph shows simultaneously the general higher foraging activity on June 24, than on September 6, again according to the activity in brood-rearing.

Conclusive Remarks

Although the present paper is only a preliminary report of studies on the foraging behaviour of honeybees, a few remarks will be offered here with. As described above, the colony which suffered a pollen deficiency resultant from the installation of the pollen trap behaved adjustively : by increasing the pollen foragers younger than in the control colony. Such adjustment was also described by Lindauer (1952).

Such adjustive increase of pollen foragers, may affect the increase of total pollen income through two ways : either by the increase in the total foraging members or in the foraging activity of each forager. From the data exhibited in Fig. 3, both ways seem to be possible. But these results indicate simultaneously a great individual difference in the response of each bee, as already mentioned by Lindauer, Ribbands and Sakagami. How such individual difference relates to the total increase of pollen income or, in general, how the individual bees response to the common need of the colony, must be further studied as an important problem in honey bee biology.

Summary

The behaviour of pollen foraging bees was observed by using individual marking of bees and pollen traps. The comparatively younger pollen foragers increased in number, perhaps as a response to the pollen deficiency. Such adjustive response is indicated by the different ratio of pollen foragers corresponding to the activity of brood-rearing. A great individual difference was observed even among the same-aged bees. The necessity of further research on the role of such individual difference in the adjustive maintenance of the colony was emphasized.

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