Univ. j. zool. Rajshahi. Univ. Vol. 32, 2013, pp. 67-71
http://journals.sfu.ca/bd/index.php/UJZRU
ISSN 1023-6104

Influence of Temperature on the Pollen Gathering Behavior of Honeybee *Apis mellifera*

Mosharrof Hossain* and Mahtab Ali
Department of Zoology, Rajshahi University, Rajshahi-6205, Bangladesh

Abstract: The experimentation involved twenty five colonies of *Apis mellifera* placed in the Litchi Orchard (*Litchi chinensis*) at Bongram in Rajshahi District. The foraging behavior, as studied showed that the highest number of bees carries pollen from 10.30 to 11.30 am (21.86 bees/min) and lowest number of bee foraged from 2.30 to 5.00 pm (1.24 bees/min). However, during the experimental period the highest and lowest number of brood was found 5.29 and 1.71 frames in the Naka-1 and D-8 hives respectively. This study focuses that there is a positive correlation between the number of brood and the foraging behavior of honeybees on pollen gathering.

Keywords: *Apis mellifera*, Honeybee, Pollen, Temperature

Introduction

Pollen is an extremely important resource that honeybee colonies must collect. It provides them with their only natural source of protein, which is needed for larval development, and fulfils other dietary requirements for lipids, sterols, vitamins, and minerals (Herbert, 1992). Nectar is the major energy source of the colony, providing the raw fuel for the activities of all colony members. Not only are nectar and pollen utilized differently by honeybee colonies, but each is collected in a unique way. Colonies typically recruit more foragers to the task of nectar collection than pollen collection, and only a small percentage of foragers collect both resources simultaneously (Parker, 1926; Free, 1960; Visscher & Seeley, 1982). Behaviors of nectar and pollen foragers also differ; nectar foragers lap nectar from flowers and store it internally, whereas pollen foragers collect pollen externally by grooming it from their bodies and pressing it into their corbiculae (Hodges, 1984). Akratanakul (1988) has made a description of several bee species and has indicated honey bee a social insect. Every honey bee colony is a family and it consists of a single fertile female, a large number of infertile females and several hundred of male taken together, these three categories are referred to as castes.

All the activities of the colony are controlled by the queen who is the mother of the colony (Prost, 1994). Queen mates with drones and take part in the reproduction and lays egg in the comb. The workers perform all kinds of activities comb building, brood rearing, food collection, ventilation, cleaning of hives etc except reproduction.

In colonies honeybees also store more nectar than pollen. It was estimated that a generalized temperate honeybee colony collects about 120 kg of nectar per year, 70 kg of which is directly consumed during the summer, with the remaining 50 kg being converted to honey and accumulating as a reserve (Rosov, 1944). In contrast, a similar colony will collect only 15-30 kg of pollen, almost all of which is consumed, with a reserve of about 1 kg kept in the colony at any one time (Winston, 1987). The small reserve of pollen in honeybee colonies makes them quite susceptible to sudden fluctuations in the environmental supply of pollen. Because the production of brood and bees, and hence the overall fitness of the colony (Schmid-Hempel *et al*., 1993), is dependent on protein intake, honeybees must tightly regulate their collection of pollen to meet their protein requirements. The regulation of pollen collection is therefore an inherently different process than nectar collection, and should be very sensitive to the flow of protein in the colony.

Previous studies have shown that honeybee colonies regulate their collection of pollen in response to changing demands for protein. However, relatively little is known about whether individual bees or colonies respond to the protein content of the pollen they are collecting. Therefore, in this experiment it was investigated to know the influence of environmental temperature on the pollen gathering behavior of *Apis mellifera*.

*Corresponding author: mshzool@yahoo.com

Material and Methods

The following materials were used to complete the experiment; (i) Stop watch, (ii) Pollen trapper, (iii) Plastic containers, (iv) Electric balance, (v) Note books, (vi) Alcohol thermometer and (vii) Hives with live bees.

Methodology

Among the 25 hives, five hives were randomly selected for the observation and experimentation in Litchi Orchard in Rajshahi District (Fig. 1A). Each of the colonies having twelve frames with all caste of bees at least five brood frames. The foragers carrying pollen loads were identified to see the pollen loads in pollen baskets on their metathoracic legs (Fig. 1C). The pollen deposition data were recorded from 7.30 am to 6.30 pm during the experimental periods. In this way the pollen gathering observations were continued and recorded six times, three times in the morning and three times in the afternoon every day for six weeks from 14 March 2009 to 24 April 2009 because of Litchi sprouting season.

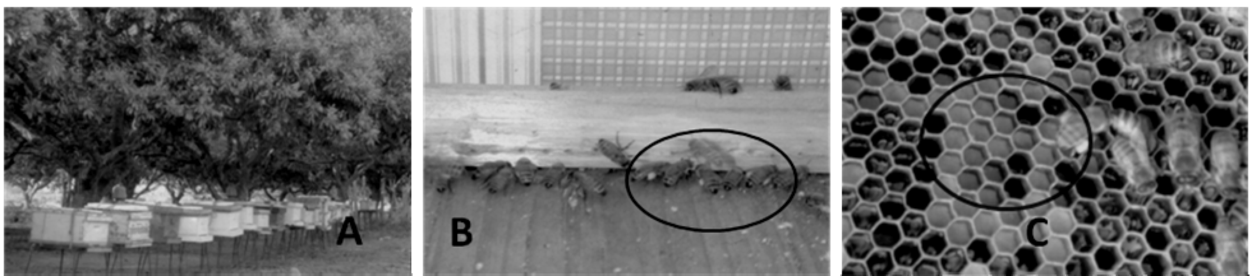

Fig. 1. Pollen gathering of honeybee *Apis mellifera*. A, Bee hives in Litchi Orchard (Flowering trees); B, bees with pollen(black circle); C, deposited pollen in the comb (black circle).

Results and Discussion

The pollen gathering activity of *Apis mellifera* is influenced by the requirement of pollen in the hive. The availability of pollen yielding flower and the surrounding climatic conditions such as environmental temperature, solar radiation, relative humidity and wind speeds. In the present study, the pollen gathering activity of *Apis mellifera* varies from time to time of the day, such as the temperature in the morning of the day remains low and with sufficient solar radiation, the pollen gathering activity remains higher (Fig. 2). It increases with time of day and solar radiation. But in the afternoon when the temperature and solar radiation decreases gradually the pollen collection activity slows down also gradually. Abrol & Kapil (1986) described that the daily activity starts at low temperature to higher solar radiation was similar to this experiment. Any variation in the amount of brood within colonies may results in corresponding adjustments to pollen foraging activity, to match pollen supply with demand has been studied many researcher (Filmer, 1932; Free, 1967, 1979; Cale, 1968; Todd & Reed, 1970; Al-Tikrity *et al.*, 1972; Eckert *et al.*, 1994; Pankiw *et al.,* 1998; Dreller *et al.,* 1999).

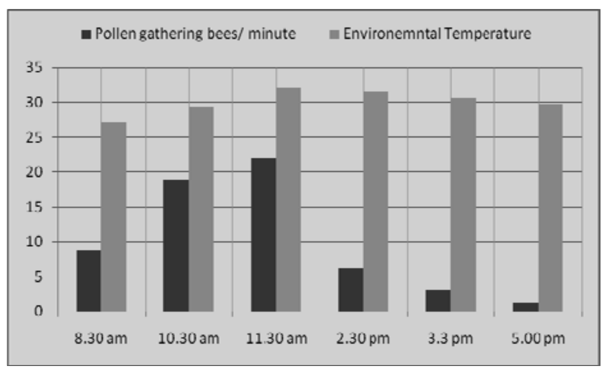

Fig. 2. Showing pollen gathering behavior of honeybee (*Apis mellifera*) in relation with environmental temperature.

Colonies are also capable of responding to sudden decreases in protein intake resulting from the use of pollen traps. Here the highest number of bees were carrying pollen at 11.30 am (21.86 bees/min) and lowest in the 5.00 pm (1.24 bees/min) (Table 1) during the study periods. These results imply that the pollen collection activity initiation is controlled by environmental temperature (Butler, 1941). However, the pollen collected by bee's termination is determined either by a decline in light intensity or possibly by a decline in pollen availability. The present investigation revealed that inexperienced foragers exerted more effort by collecting heavier pollen loads and also returned a greater diversity to their colonies (Fig. 1B). Honeybee colonies may respond to changes in the quantity and quality of pollen stored in their colony by adjusting the numbers of inexperienced to experienced foragers in their work force. Future work in this area should document changes in the recruitment of these foraging cohorts.

This experiment continues six weeks, the recorded pollen gathering activity of *Apis mellifera* showed significant relation with the environmental temperatures (Butler, 1941). Therefore, a long study period is required to assess the effect of environmental temperature on the pollen collection of the honeybees in definite way. Evidence from this study demonstrates that honeybee colonies match protein intake with protein need, suggesting that pollen collection is tightly regulated and sensitive to pollen quality in the hive. However, the mechanisms and feedback influencing the behavior of individual pollen foragers are likely to contrast greatly with those that influence nectar foragers.

Table 1. *Apis mellifera* pollen gathering behavior per minute per hive at different time of a day

Sampling date	Week	Hives No.	Morning			Average	Afternoon			Average
			8.30 Am	10.30 Am	11.30 Am	Average	2.30Pm	3.30 Pm	5.00 Pm	Average
14/3/09-20/3/09	1st	Naka-1	7.63	18.06	22.63	16.11	11.69	7.49	2.11	7.10
		D-8	5.89	17.29	20.69	14.62	9.91	8.23	3.94	7.36
		H-5	6.71	17.91	21.26	15.29	11.14	7.17	5.86	8.06
		H-10	5.23	16.11	23.51	14.95	9.77	7.2	3.14	6.70
		H-11	6.69	8.57	22.34	12.53	9.46	7.29	5.37	7.37
21/3/09-27/3/09	2nd	Naka-1	14.51	29.2	35.83	26.51	7.91	3.91	0.71	4.18
		D-8	12.69	36.46	36.26	28.47	7.86	2.23	0.51	3.53
		H-5	12.29	34.29	37	27.86	6.37	1.89	0.69	2.98
		H-10	9.6	30.17	33.09	24.29	6.4	1.66	0.43	2.83
		H-11	13.6	33.43	35.94	27.66	10.06	2.51	1.23	4.60
28/3/09-3/4/09	3rd	Naka-1	12.8	23.89	20.6	19.10	5.54	1.51	0.51	2.52
		D-8	11.31	18.08	14.43	14.61	4.71	1.57	0.4	2.23
		H-5	11.83	24.51	25.57	20.64	6.54	2.74	0.66	3.31
		H-10	11.77	21.63	22.71	18.70	5.23	2.34	0.6	2.72
		H-11	13.91	29.2	17.71	20.27	3.6	1.43	0.47	1.83
4/4/09-10/4/09	4th	Naka-1	5.91	14.6	22.09	14.20	4	1.23	0.54	1.92
		D-8	6.86	14.91	12.51	11.43	3.74	0.83	0.54	1.70
		H-5	7.54	16.06	21.31	14.97	4.23	1.63	0.69	2.18
		H-10	7.11	14.46	12.66	11.41	4	2.01	0.46	2.16
		H-11	4	9.66	10.97	8.21	2.83	1.03	0.4	1.42
11/4/09-17/4/09	5th	Naka-1	6.46	13.49	17.31	12.42	4.54	1.66	0.77	2.32
		D-8	4.26	11.46	15.23	10.32	4.69	1.46	0.37	2.17
		H-5	6.26	12.34	18.46	12.35	6.34	2.97	0.86	3.39
		H-10	6.26	12.23	17.17	11.89	6.29	2.4	0.62	3.10
		H-11	6.46	12.23	19.83	12.84	4.49	1.74	0.66	2.30
18/4/09-24/4/09	6th	Naka-1	9.97	21.6	28.31	19.96	4.37	1.6	0.6	2.19
		D-8	9.94	13.09	15.74	12.92	5.94	2.46	0.94	3.11
		H-5	8.4	15	20.26	14.55	3.86	1.89	0.42	2.06
		H-10	9.26	13.4	16.14	12.93	5.77	3.17	1.26	3.40
		H-11	10.46	22.71	18.2	17.12	4.97	3.37	1.34	3.23

Although Waddington *et al. (*1998) concluded that pollen foragers modulate their threshold of dancing and their dance rate in relation to the quality of a pollen source; present investigation of pollen gathering behavior showed that other non-nutritional factors may explain these observations (Pernal & Currie, 2001). Furthermore, many researchers stated that colonies show compensatory responses after direct manipulations of the quantity of stored pollen by changing the numbers of pollen foragers and their rate of pollen collection (Barker, 1971; Free & Williams 1971; Fewell & Winston 1992; Camazine, 1993; Dogterom & Winston, 1999; Dreller *et al.,* 1999; Fewell & Bertram, 1999). The present experiment conclusively demonstrated that honeybee colonies respond to changes in the nutritional value of their stored pollen reserve and this response is similar to that seen for changes in the size of the pollen reserve in the brood (Fig. 3). However, the foraging behaviors of inexperienced and experienced foragers were discovered to be considerably different. In conclusion, this experiment has examined several facets of honeybee foraging that were hitherto unexplored.

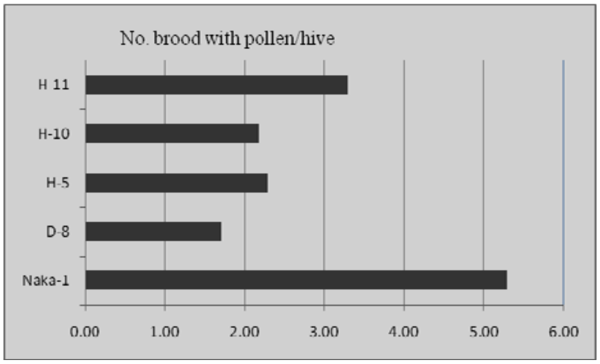

Fig. 3. Six week average number of brood/colony in different type hives performed by *Apis mellifera* during the experimental period.

Acknowledgement

The authors are grateful to the Chairman, Department of Zoology, University of Rajshahi for providing laboratory facilities and Mr. Jarzid for kindly handling the honey bees in the field.

References

Abrol, D.P. & Kapil, R.P. 1986. Factors affecting pollination activity of *Megachile lanata* Lepel. *Proceeding of Indian Academy of Science* (*Animal Sciences*), **95:** 757-769.

Akratanakul, P. 1988. *Beekeeping in Asia*. FAO, Agriculture Service Bulletin, **68(4):** 1-12.

Al-Tikrity, W.S., Benton, A.W., Hillman, R.C. & Clarke, W.W. Jr. 1972. The relationship between the amount of unsealed brood in honeybee colonies and their pollen collection. *J. Apic. Res*. **11:** 9-12.

Barker, R.J. 1971. The influence of food inside the hive on pollen collection by a honeybee colony. *J. Apic. Res*. **10:** 23-26

Butler, C.G. 1941. A study of the frequency with which honeybees visit red clover (*Trifolium pratense)*, together with an examination of the environmental conditions. *Ann. Appl. Biol.* **28:** 125-34.

Cale, G.H. Jr. 1968. Pollen-gathering relationships to honey collection and egg-laying in honeybees. *Am. Bee. J.* **108:** 8-9.

Camazine, S., Crailsheim, K., Hrassnigg, N., Robinson, G.E., Leonhard, B. &, Kropiunigg, H. 1998. Protein trophallaxis and the regulation of pollen foraging by honey bees (*Apis mellifera* L.). *Apidologie* **29:** 113-126.

Dogterom, M.H. & Winston. M.L. 1999. Pollen storage and foraging by honey bees (Hymenoptera: Apidae) in highbush blueberries (Ericaceae), cultivar Bluecrop. *Can. Entomol.* **131:** 757-768.

Dreller, C., Page, R.E. Jr, & Fondrk, M.K. 1999. Regulation of pollen foraging in honeybee colonies: effects of young brood, stored pollen, and empty space. *Behav. Ecol. Sociobiol.* **45:** 227-233.

Eckert, C.D., Winston, M.L. & Ydenberg, R.C. 1994. The relationship between population size, amount of brood, and individual foraging behaviour in the honey bee, *Apis mellifera* L. *Oecologia* **97:** 248-255

Fewell, J.H. & Bertram, S.M. 1999. Division of labor in a dynamic environment: response of honeybees (*Apis mellifera*) to graded changes in colony pollen stores. *Behav. Ecol. Sociobiol.* **46:** 171-179.

Fewell, J. H. & Winston, M. L. 1992. Colony state and regulation of pollen foraging in the honeybees, *Apis mellifera* L. *Behav. Ecol. Sociobiol.* **30:** 387-393.

Filmer, R.S. 1932. Brood area and colony size as factors in activity of pollination units. *J. Econ. Entomol*. **25:** 336-343

Free, J.B. & Williams, I.H. 1971. The effect of giving pollen and pollen supplement to honeybee colonies on the amount of pollen collected. *J. Apicul. Res.* **10:** 87-90.

Free, J.B. 1979. Managing honeybee colonies to enhance the pollengathering stimulus from brood pheromones. *Appl. Anim. Ethol*. **5:** 173-178.

Free, J.B. 1960. The pollination of fruit trees. *Bee World* **41:** 141-151.

Free, J.B. 1967. Factors determining the collection of pollen by honeybee foragers. *Anim. Behav.* **15:** 134-144

Herbert, E.W. Jr. 1992. Honey bee nutrition. In*: The Hive and Honey Bee* (Graham, E.W. Eds). Hamilton, II, pp. 197-224.

Hodges, D.1984. *The pollen loads of the honeybee*: A guide to their identification by colour and form, 1st edn. International Bee Research Association, London.

Pankiw, T., Page, R.E. Jr & Fondrk, M. K. 1998. Brood pheromone stimulates pollen foraging in honey bees (*Apis mellifera*). *Behav. Ecol. Sociobiol.* **44:** 193-198.

Parker, R.L. 1926. 'The collection and utilization of pollen by the honeybee. Mem. Cornell Agric. Exp. Sta. **98:** 1-55.

Pernal, S.F. & Currie, R.W. 2001. Discrimination and preferences for pollen-based factors by foraging honey bees (*Apis mellifera* L.) pollen collected*. J. Apic. Res.* **10:** 87-90.

Prost, P.L. 1994. *Apiculture.* 6th edition. Oxford & BHI publishing, Calcutta.

Rosov, S.A. 1944. Food consumption by bees. *Bee World* **25:** 94-95.

Schmid-Hempel, P, Winston, M.L. & Ydenberg, R.C.1993. Foraging of individual workers in relation to colony state in the social Hymenoptera. *Can. Entomol.* **125:** 129-160.

Todd, F.E. & Reed, C.B. 1970. Brood measurement as a valid index to the value of honey bees as pollinators. *J. Econ. Entomol.* **63:** 148-149.

Visscher, P.K. & Seeley, T.D. 1982. Foraging strategy of honeybee colonies in a temperate deciduous forest. *Ecology* **63:** 1790-1801.

Waddington, K.D., Nelson, C.M. & Page, R.E. Jr 1998. Effects of pollen quality and genotype on the dance of foraging honey bees. *Animal Behavior* **56**: 35-39.

Winston, M.L. 1987. The biology of the honey bee. Harvard University Press, Cambridge, p. 281.

Manuscript received on 05.06.2013, Accepted on 04.12.2013