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# Flight Activity of African Honeybee in Response to Changes in Colony Size and Weather Variables during Honey Flow Period in the Northern Guinea Savanna, Nigeria

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## Abstract

This study elucidated the flight activity of honeybee, *Apis mellifera adansonii* in response to changes in colony size and weather variables in Samaru, Northern Guinea Savanna, Nigeria. Numbers of foraging workers entering and leaving the hive were counted at different time of the day for a period of 13 weeks. Results indicated that numbers of foraging workers leaving the hive (33.26 ± 11.40) and the number of foraging workers entering the hive (47.36 ± 24.28) were significantly higher ($P<0.05$) in the morning (8.00 – 9.00 a.m) than at other observation periods. The number of foraging workers leaving the hive was significantly higher than the number of foragers entering the hive. The population of foraging workers entering and leaving the hive was positively correlated ($P<0.05$) with each other and also positively correlated ($P<0.05$) with the strength of the colony. Wind speed and temperature have linear but weak correlation with the flight intensity of honey bee but the correlation between bee flight activity and relative humidity was negative.

**Keywords:** Flight Activity, Foraging Workers, *Apis mellifera adansonii*, Weather Factors, Colony Size

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***Subject:*** *0214-0227*

**Introduction**

Savanna ecological zone of Nigeria is a home of multi-varied species of plants and animals. The plant species include annuals and perennials which over the years have been explored for their economic, ethno-botanical, aesthetic and nutritional values. At specific periods of the year, these savanna floras produce inflorescences which apart from producing fruits and seeds for human use also serve as sources of raw materials for bees to produce honey and other usable products like wax, propolis etc. During these periods, honey bees are very active foraging for pollen, nectar and propolis. The foraging activity of worker bees is influenced by number of factors including both internal and external. Internal factors like higher area under brood in the colony stimulated the foragers to collect more pollen. External factors such as temperature, relative humidity, light, wind velocity, rain, clouds and pasture availability also influenced the pollen foraging activities of bees (Morse and Hopper, 1985; Mirsha, 1995; Towrek, 1995; Singh et al., 2000; Rajinder and Neelima, 2013). Study has shown that wide variation occurs on honeybee flight activities during different hours of the day and on different days of the year (Reddy, 1980). Vergheese and Prasad (1980) found that the foraging activities remarkably increased with the increment of broods in the hive. However, the adverse weather creates unfavorable condition for biological revival of the honeybees and affects the gathering of nectar and pollen (Towrek, 1995).

The pattern of activity in different races of *A. mellifera* studied in different parts of the world showed a lot of variation. In Nigeria, Usman et al., 2013 reported two peaks of flight activity (one just before sunrise and the other just before sunset), separated by a period of very low activity for *A. mellifera adansonii* during the dry season and a high flight activity throughout the day during the rainy season. Similarly, in Ghana, Woyke (1992) reported a single peak (in the morning) and two peaks (one after sunrise and one before sunset) of foraging activity for, *A. mellifera adansonii*, in the rainy and dry seasons respectively. Furthermore, one peak of activity was reported for *A. mellifera scutellata* before sunrise in S Africa (Fletcher (1978) and three peaks (7.00, 14.00 and 16.00 h) of activity for Africanized bees in Brazil (Silva and de Jong, 1990). In USA, Russian and Italian bees had been reported to have similar flight activity at any given colony size, temperature, or time of day (Danka and Beaman (2007).

Because of the abundance of honey bees in the Savanna zones of Nigeria, many farmers are engaged in bee farming in addition to their usual crop and animal farming to boost their income. Many trees produce flowers between December and January in these zones because of the prevailing cold weather favourable for flower initiation. This encourages bees foraging for floral products for honey production. The period between January and March tends to be most conducive for honey production as it marks the time when local bee farmers embark on honey harvest in Savanna zone of Nigeria. However, information on the impacts of climatic factors on flight activities of honey bees at this period is scanty in literature especially in the Northern Guinea Savanna of Nigeria. The objective of this study is to elucidate the influence of colony size and climatic elements on the flight activity of *A. mellifera* in the Northern Guinea Savanna of Nigeria.

**Materials and Methods**

The study was carried out in Samaru, Zaria which is situated on latitude 11° 04' N and longitude 07° 42' E and at an altitude of 550-700 m above sea level. It possesses a tropical continental climate with a pronounced dry season, which last up to seven months (October - May). The rainy season lasts from May to September/ October with long-term annual rainfall of 1040 mm in about 90 rain days. The relatively deep tropical ferruginous soils and climate conditions of Zaria are suitable for a good cover of savanna woodland (Northern Guinea Savanna) with a variety of grasses, woody shrubs and short trees. The experimental locality is also characterized with forest tree species such as *Eucalyptus camaldulensis, Eucalyptus citriodora, Eucalyptus tereticornis, Khaya senegalensis, Azadirachta indica, Cassia auriculiformis, Parkia biglobosa* and fruit tree species which include *Mangifera indica, Citrus* spp. and *Psidium guajava*. Some of these are either grown in the wild, plantation or on farm lands as agroforestry trees. These tree species produce flowers at different times during the year and thus, they are good sources of pollen and nectar to bees and other insects that forage on flowers.

The study was carried out using five honeybee colonies selected randomly from Savanna Forestry Research Station's apiary in Samaru, Zaria between January and March, 2012. The number of worker bees each leaving the hive and returning to the hive within five minutes was counted visually at the hive entrance at three different times (8.00 – 9.00 a.m, 1.00 – 2.00 p.m and 5.00 – 6.00 p.m) of the day. Each observation was repeated five times per colony once a week for 13 weeks. The mean of incoming foragers and outgoing foragers' counts from five colonies at each observation time was used as a measure of flight activity for that period.

Weekly colony population was estimated using ERLS (1995) formula adapted by Babarinde et al., 2010.

$$\text{Bees Population} = \frac{BNFE \times 80 \times 1000}{100}$$

*Where:*

BNFE = Bees number at flight entrance with assumption that every bee at flight entrance represents 1000 bees in the colony and worker were 80% of total colony population. Temperature and relative humidity at each observation time was measured with whirling psychrometer while data on daily wind speed was obtained from Meteorological Station of Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. The data obtained was analyzed using correlation analysis, t-test and analysis of variance (ANOVA).

**Results and Discussion**

There were significant differences in the diurnal flight activity of honey bees throughout the period of study. The mean number of returning worker bees is significantly higher in the morning (47.36 ± 24.28, n = 13) than in the afternoon (30.58 ± 22.35, n = 13) and evening (20.59 ± 14.15, n = 13). The number of returning foragers in the afternoon was also significantly higher than in the evening. The same trend was observed in outgoing foragers with more foragers going out in the morning than afternoon and evening. The ratio of outgoing foragers in the morning, afternoon and evening stood at 3.3:2.6:1 (Table 1). Table 2 showed a t-test analysis of number of foragers that leave and enter the hive. The number of bee foragers entering the hive was significantly higher than the number of foragers leaving the hive. The pattern of flight activities of *A. mellifera* depicted by the number of foragers leaving the hive and number of foragers returning to hive is represented in Fig. 1. The variation in the mean number of incoming and outgoing foragers followed the same pattern throughout the period of study. There was an upward trend in the flight activity from the first week and reached a peak between the 5th and the 6th week. A downward trend in the honeybee flight activity was noted between the 6th and the 9th week and thereafter, there was a sharp increase in the numbers of both incoming and outgoing foragers up to the 12th week before it descended again. The observed numbers of incoming and outgoing worker bees revealed a bimodal pattern of flight activity of *A. mellifera* between January and March in the study location.

There was a positive linear correlation between the numbers of incoming foragers and outgoing foragers of *A. mellifera* as represented by the equation, $Y = 1.9452x-12.913$ and $r = 0.96$ (Figure 2). Similarly, a positive and significant linear relationship was observed between the population of *A. mellifera* colonies and flight activity as represented by the equations, $Y = 0.0017x – 4.9891$; $r = 0.99$ for incoming foragers and $Y = 0.0008x + 4.9891$; $r = 0.98$ for outgoing foragers (Figure 3). The flight activity of *A. mellifera* in each colony was directly depended on the population strength of the colony. There were significant variations in the level of flight activity among the five bee colonies used for this study. It was observed that flight activity of bees in colonies 1, 4 and 5 with high population strengths was higher than colonies 2 and 3 with low population strengths (Figures 4 and 5). There was a linear relationship between the temperature and flight activity of *A. mellifera* as defined by the equation, $Y = 2.2252x – 34.641$ and $r = 0.27$ (Figure 6) while an inverse correlation was observed between relative humidity and flight activity. This is defined by the equation: $Y = -2.6808x + 71.346$ and $r = -0.84$ (Figure 7). However, a weak but positive correlation was observed between wind speed and flight activity of *A. mellifera* in the study site ($Y = 0.0454 + 21.828$ and $r = 0.21$) (Figure 8).

The foraging activity of bees is under the influence of several environmental factors such as temperature, wind speed, light intensity, relative humidity, nectar-sugar concentration and time of the day (Nunez, 1977; Buril and Dietz, 1981, Omoloye and Akinsola, 2006; Usman *et al.*, 2013). It was revealed from this study that the numbers of bee foragers that go out of the hive and come in were significantly high in the morning (8:00 – 9:00 a.m.) than as it were in the afternoon (1:00 – 2:00 p.m.) and evening (5:00 – 6:00 p.m). It could be possible that morning hours are most convenient for A. mellifera to source for nectar from flowers in the study area. There could also be a possibility that most of the flowering plants in the locality produce more nectar during the morning hours. Other studies have equally shown flight and foraging activities of *A. mellifera* is high during the morning hours (Haftom, 2014; Alamu et al., 2013; Neguisse *et al.* 2013). The mean temperature and relative humidity recorded during morning hours within the period of study were 20$^{O}$C (range =17 – 23.8$^{O}$C) and 22.8% (range = 9 – 39%). This is in agreement with an earlier report that a temperature of 16-26°C is optimal for foraging by *A. mellifera* (Roman and Weryszko, 2006). The number of incoming worker bees was significantly higher than the number of outgoing worker bees, indicating that the rate at which nectar and pollen are being collected is high during the period of study.

The weekly increase in the flight activity of *A. mellifera* is not unconnected with the increase in bee population. This study revealed that flight activity of honey bee is significantly correlated with the bee population in different colonies. A research finding has shown that colony size (population of adult bees or brood) is one of the strongest regulators of fight activity in both Russian and Italian bees (Danka and Beaman, 2007). It was also shown in this study that temperature and wind speed are directly related to flight activity of bees. Danka and Beaman, 2007 reported the significance of temperature in the regulation of flight in bees. It has also been suggested that olfactory cues are distributed and spread faster under windy conditions than in other weather factors (Omoloye and Akinsola, 2006). In addition research finding has shown that the most important environmental factor determining honeybee visitation to flower is the wind speed (Benedek et al. 1997). Relative humidity was negatively correlated to flight activity of honeybees indicating that *A. mellifera adansonii* would not tolerate extremes of this weather factor.

**Conclusion and Recommendations**

This study has shown that colony size, wind speed and a temperature range of 17 – 23$^{O}$C are important factors governing the flight activity of *A. mellifera* especially during the period of honey flow in the Northern Guinea Savanna, Nigeria. These factors may as well be considered as important both to bees and beekeepers for honey production.

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**Tables**

Table 1. Diurnal flight activity of honeybee, *A. mellifera* in Samaru – Zaria, Northern Guinea Savanna, Nigeria

| | Number of foraging workers | |
|---|---|---|
| Time of the day | incoming foragers | outgoing foragers |
| 8: 00 – 9: 00 a.m | 47.36±24.28a | 33.26±11.40a |
| 1: 00 – 2: 00 p.m | 30.58±22.35b | 26.34±17.06b |
| 5: 00 – 6: 00 p.m. | 20.59±14.15c | 10.87±5.92c |

Numbers followed with different alphabets in the column are significantly different from each other at p = 0.05 (Tukey HSD)

Table 2: A t-test analysis of number of bee foragers leaving and entering the hive

| Variable | n | df | Mean | Std. Err. | (95% Confidence Interval) |
|---|---|---|---|---|---|
| In-flight | 13 | 12 | 32.88154 | 5.124714 | 21.71575 - 44.04733 |
| Out-flight | 13 | 12 | 23.54308 | 2.541405 | 18.00583 - 29.08032 |

Ho: Mean (in-flight) - Mean (out-flight) = 0
Ha: Mean (in-flight) – Mean (out-flight) ≠ 0
t(tab) = 0.9973 < t(cal) = 3.3885; $p<0.05$
Decision: Reject Ho

**Figures**

**Figure 1:** Changes in weekly flight activity of *A. mellifera*

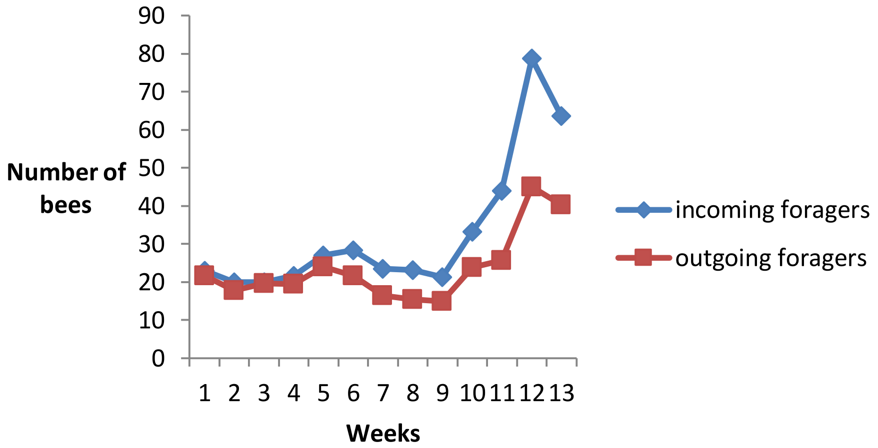

**Figure 2:** Relationship between flight activity of incoming and outgoing foragers of honeybee, *A. mellifera*

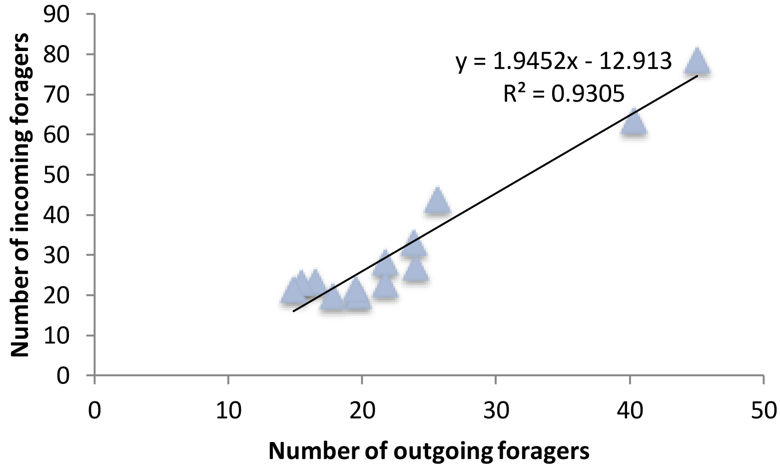


Figure 3: Relationship between flight activity and population of *A. mellifera*

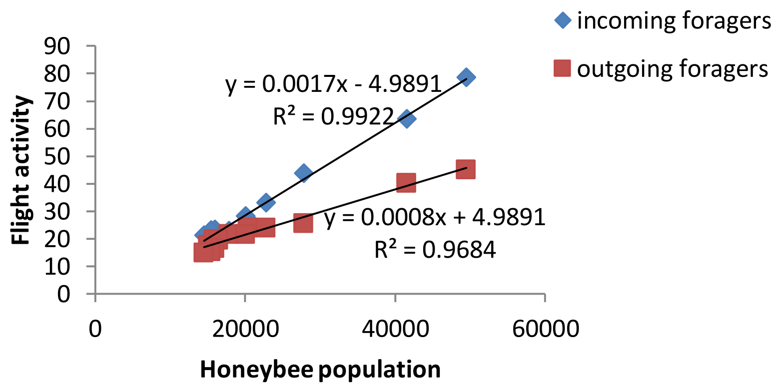


Figure 4: Population of honeybee in different colonies

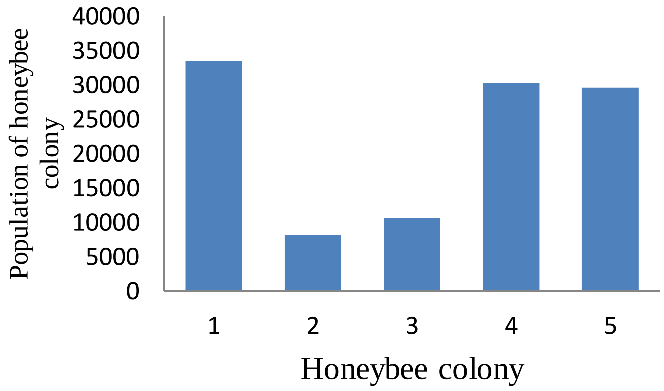

Figure 5: Variations in flight activities of *A. mellifera* among different colonies

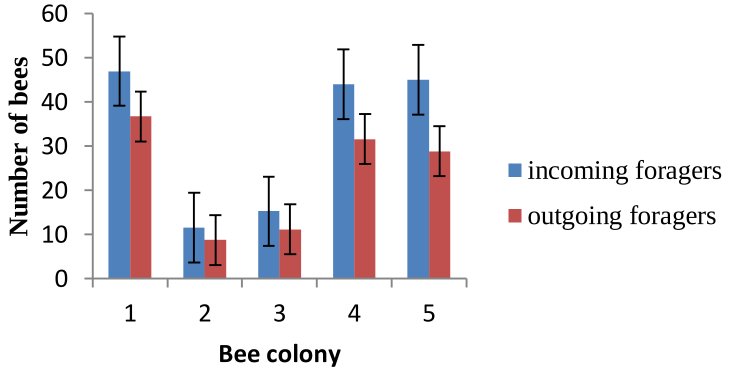


Figure 6. Relationship between temperature and flight activity of honeybee, *A. mellifera*

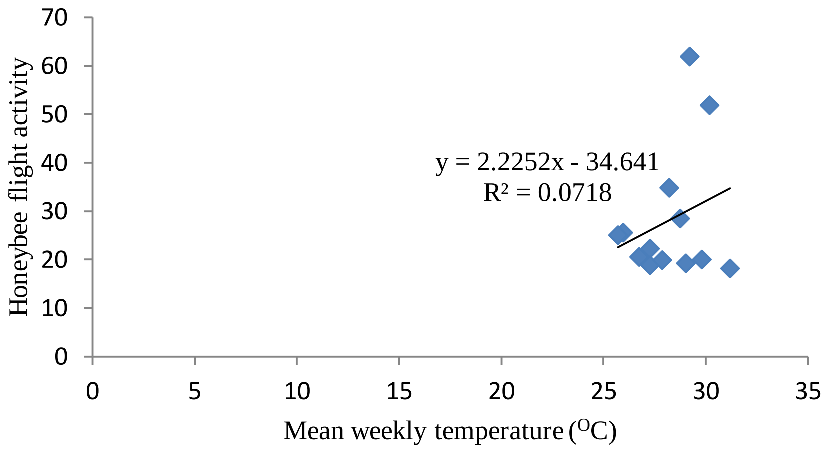


Figure 7. Relationship between relative humidity and flight activity of honeybee, *A. mellifera*

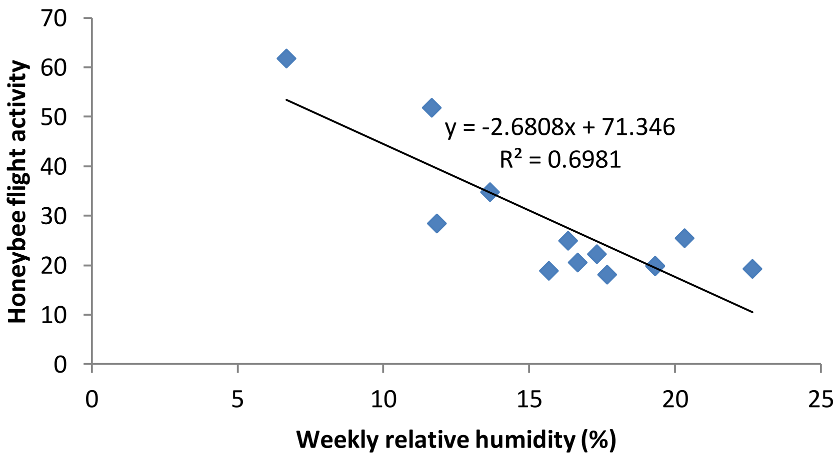

Figure 8. Relationship between wind speed and flight activity of the honeybee, *A. mellifera*