EFFECT OF AGE OF HONEYBEE QUEENS OF *Apis mellifera adansonii* (HYMENOPTERA: APIDAE) ON THE RATE OF BROOD PRODUCTION IN MODERN BEE-HIVES

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Abstract

The effect of age of honeybee queens of *Apis mellifera adansonii* on rate of brood production was studied using Langstroth hives. Brood productivity of young queens (24 days old) and old queens (18 months old) was investigated and compared by extrapolating the brood areas covered as equivalent to the number of eggs laid by the queens in artificial bee-hives within specific experimental period. It was observed that the 24-days-old queens laid 655.3 ± 6.6 eggs per day which was significantly higher ($p < 0.05$) than the 403.0 ± 5.3 eggs laid by the 18-months-old queens. This was probably due to the fact that the physiological state of the body of the old queens diminishes with age coupled with loss of vitality to perform the unique function of continuous laying. The practical implication of this is that the profit-conscious bee farmers are expected to start or establish bee colonies with virile and vibrant young queens. They should also ensure the replacement of the old queens in their colonies with productive, virile young queens at appropriate time. This is to enhance colony productivity by increasing worker bees' population which gathered nectar and pollen during nectar flow period for better yield to the advantage of the bee farmers.

Keywords: honeybee, brood production, queen's age and bee-hives.

Introduction

Honeybees, *Apis mellifera adansonii* (Hymenoptera: Apidae: Apoidea), are members of social insects of the class Insecta and they are referred to as eusocial insects (Frisch, 1966 and Hamel, 1990). There are three castes of bees in a complete colony, a single queen (fertile female), few drones (fertile males) and several thousands of workers (sterile female) (Frisch, 1966 and Ikediobi *et al* 1985). The queen lays all the eggs for new bees and plays a functional role in the colony as the matron. The drone mates the queen, and the workers carry out such other duties as nectar collection, feeding the queen, drone and the broods, ventilating and clearing the hive, building combs, making and storing honey and defending the sovereignty of the colony. After the bees have successfully established themselves in a hive, the worker-bees start extensive foraging activities to gather nectar from variety of flowering plants in the wild (Ikediobi *at al* 1985; Fasasi and Malaka, 2005a and b). Berry and Delaplane (2001) examined the effect of wax comb age on honeybee colony growth and reported that on the average, honeybee colonies with new wax comb produced a greater area (cm^2) of sealed and unsealed broods and a higher weight of individual young bees (mg) than that of the old wax comb. They concluded that new wax combs optimize overall honeybee colony health and reproduction. Despite the differential effects of wax comb age on honeybee colony growth and brood survivorship as identified by Berry and Delaplane (2001), there is another important factor affecting honeybee (colony) productivity which is the age of the queen.

The production of broods and colony strength depend on the quality of the existing queen of *Apis mellifera antoliaca* in the colony (beehive) which in turns dictates

This study was accepted on 20th October 2010.

the output of such colony (Laidlaw, 1992 and Ethem *et al* 2008). The quality of queen is determined by the genetic structure, volume of the spermatheca of the queen, number of the ovarioles in the queen's ovaries (Kaftanoglu *et al* 1988; Laidlaw, 1992 and Ethem *et al.,* 2008). According to Kaftanoglu *et al* (1988), the characteristics of honeybee colonies are determined by the queen and her fecundating drones who is expected to release million of spermatozoa to fertilize the eggs from the queen. Kaftanoglu *et al* (1988) explained that when the number of spermatozoa decreases in a queen's spermatheca as the queen ages, the rate of unfertilized eggs laid increases which in turns encouraged the production of the lazy drones rather than more active worker bees for both domestic and foraging activities.

Colonies with less than one year old queen have been reported to have greater colony population and produce 27-30% more honey yield than colonies with 3-5 years old queen (Woyke, 1984 and Ethem *et al* 2008). It was explained that old queens (3 to 5 years old) lay insufficient eggs to produce enough young workers for winter and over winter activities in Republic of Turkey (Katanoglu, 1987: Genc, 1992; Tarpy *et al* 2000 and Ethem *et al* 2008) which may probably be due to exhaustion and decline in their physiological processes without adequate replacement of new worker bees by the existing aging queen in the colonies which need to be replaced.

In most apiaries or bee farms, bee-keepers lose a lot of bee colonies in winter in Republic of Turkey (Woyke, 1984 and Tarpy *et al* 2000) and in wet and early dry seasons in Nigeria due to lack of replacement of unproductive queens with new virile young queens and poor understanding of the biology of the bees (Fasasi and Malaka, 2005a and b). Most of the 3-10 years old honeybee colonies begin the spring season in Turkey and dry season (honey flow period) in Nigeria with weak population sizes. However, queen's age was mainly identified in advanced countries such as Israel, India, Canada and Britain by apiarists and apicultural researchers as one of the important factors for colony productivity which must be reckoned with for better yield. But in Nigeria this factor has not being considered by bee farmers due to poor level of awareness of the importance of younger queens in bee colonies for better productivity. To emphasize this important factor and create the awareness in the country, this comparative study was conducted to determine the effect of age of honeybee queens of *Apis mellifera adansonii* on rate of brood production.

Materials and methods

Study site

The study was carried out at the Biological Garden, located alongside part of the lagoon front, maintained by Biological Sciences, University of Lagos, Akoka Campus, with an estimated area of about 802 acre of land in Akoka, north-eastern part of Yaba, Lagos State. University of Lagos campus is located between latitudes 6^0 30′ 15′′ and 6^0 31′ 20′′ North of the Equator and Longitudes 3^0 23′ 05′′ and 3^0 24′ 20′′ East of the Greenwich Meridian.

Culture of honeybees

Honeybees were reared and cultured in ten single-chambered artificial bee-hives called Langstroth hives constructed with hardwood (*Terminalia macroptera* – black *Afara*) with iron roofing sheets. Each hive has ten frame bars measured 47.5 cm and 40 cm in length and width respectively with height of 47.5 cm, and were placed on stands measuring 50 cm in height, 40 cm x 40 cm in length and breadth respectively. Honeybee colonies were established by attracting bees into the hives using paste of 70 ml of honey and 35 g of sugar grains enclosed in each perforated Petri-dish placed inside each hive. Within 3 to 24 months the hives became colonized at random, forming what was referred to as bee colonies (culture). Five replicate hives per treatment were similarly set up by dividing five old hives (colonies) into new 10 hives, out of which 5 five hives retained their respective old queens, while the other five hives raised their queens independently.

*The effect of age of honeybee queens (**A. mellifera adansonii**) on the rate of brood production*

In each replicate treatment, the experiment was set up as follows: The broods and honey on seven separate frame bars were removed leaving only empty combs which were returned back to each hive for laying of new progeny. In the same hive, another set of three frame bars with honey-filled combs were left in the hive as food source. Then, 24-days-old and 18-months-queens were selected from established old cultures and placed in each hive on one of the frame bars with empty combs, in order to start fresh progeny. Progeny development was observed at 10 days intervals for a period of 60 days. Each of the two treatments (24-days-old-queens and 18-months-old-queens) was replicated into five. At each observation time, brood production was measured by estimating brood areas using adapted methods of Fresnaye and Lensky, (1961) and Harbo (1993) as described below.

Procedure for estimating brood area in each colonized hive

The brood area in a colony entails the following procedures:

There was a net mesh grid (0.2 cm x 0.2 cm) fixed on a frame bar of same measurements with those in the brood

chamber, with three super-imposed concentric circles of different areas (80, 160 and 590 cm^2 respectively). This net mesh was used to measure the brood area in each frame bar in sequence as follows:

(a) Obtaining brood area per hive:
Brood area of 10 frame bars per hive
$= A_1 + A_2 + A_3 + \text{——} + A_{10} = A\ cm^2$

(b) Obtaining mean number of eggs produced per frame bar:

Mean brood area per frame bar = $(A \div 10)\ cm^2$
Surface area of an hexagonal comb cell = 9 square boxes x 0.2 x 0.2 = 0.36 cm^2 (i.e. one egg laid per hexagonal comb cell = 0.36 cm^2 (after Harbo, 1993)
Mean number of eggs produced per frame bar
$= (A \div 10)\ cm^2 / 0.36\ cm^2$
The data were subjected to analysis of variance (ANOVA) at 5% level of significance.

Results and discussion

On the tenth day of observation, it was observed that 24-days-old-queen laid 2134.6 ± 37.6 eggs which were comparatively low to 2265.9 ± 28.5 eggs laid by the 18-months-old queen (Table 1). But on the twentieth day of observation, the 24-days-old queen produced 5842.9 ± 54.3 eggs which were higher than 3793.0 ± 48.7 eggs produced by the 18-months-old-queen. Thus, from day 20 of observation, the younger 24-day-old queen consistently produced higher numbers of eggs than the 18-months-old-queen on every date of assessment for the rest of the observation period and the rate of brood production by queens of the two different ages increased steadily with time (Figure 1). The 24-days-old-queen laid 655.3 ± 6.6 eggs per day per colony which was 1.6 times higher than that laid by 18-months-old queen. The 655.3 ± 6.6 eggs laid per day by the 24-days-old queens was significantly higher ($p < 0.05$) than the 403.0 ± 5.3 eggs laid by the 18-months-old queen. This shows that the rate of brood production by younger queen was significantly higher than that exhibited by the old queen.

Table 1: Rate of brood production by two different age-groups of bee queens of *A. mellifera adansonii* for 60 days.

Days	24-days-old queen		18-months-old queen	
	Mean brood areas (cm^2)	Mean ± S.D of eggs	Mean brood areas eggs (cm^2)	Mean ± S.D of eggs
10	782	2,134.6 ± 37.6	826	2,265.9 ± 28.5
20	2123	5,842.9 ± 54.3	1383	3,793.0 ± 48.7
30	2484	6,819.4 ± 80.6	1355	3,695.6 ± 68.3
40	2624	7,216.2 ± 72.7	1562	4,282.3 ± 56.6
50	2959	8,150.1 ± 69.3	1660	4,565.6 ± 45.5
60	3325	9,154.6 ± 81.5	2050	5,622.2 ± 72.2

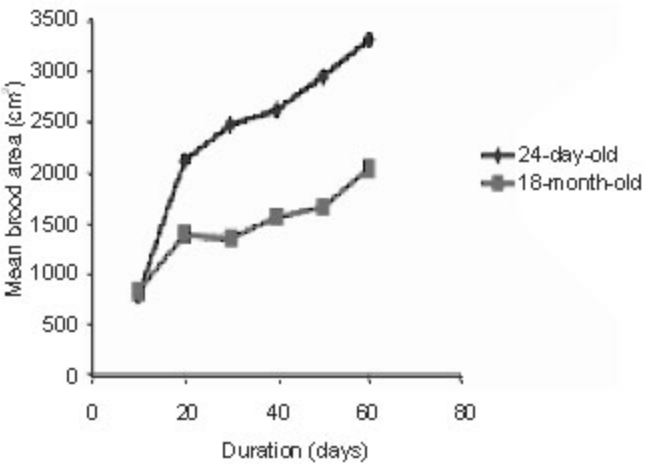

Figure 1: Effect of age of honeybee queens of *Apis mellifera adansonii* on rate of brood production.

This is expected like any other living creature as the physiological state of the body of the old queen diminishes with age coupled with loss of vitality. The bees' species is not exempted from this. This explain the reason why honeybee colonies with old queens have less population as a result of diminishing fecundity experienced by the old queen, hence reducing the progeny productivity of such colony. The results from this study conformed to the observations of Moeller (1958), Seeley (1978) and Ethem *et al* (2008) who reported that new queens lay more number of eggs than old queen above two years old per day per colony. The practical implication of this is that bee farmers should start bee farms with new and vibrant young queens and ensure replacement of old queens in their colonies with young and virile queens since these are responsible for progeny productivity to enhance colony productivity in order to increase colony density with respect to worker bees' (foragers) population in favour of the bee farmers. This type of study on measurement of rate of brood production by bee queen is rare in Nigeria according to literature searches. So, there is need for indepth research to enhance art of bee-keeping as means of economic empowerment in the country.

Acknowledgement

The author appreciates Prof. S. L. O. Malaka, Prof. Kio. N. Don-Pedro (late) and Prof. (Mrs.) W. A. Makanjuola for their scientific contributions and meaningful suggestions. Special thanks to Messers O.O. Oworu and D. Mongbe for their technical assistance on the field.

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Fasasi, K.A.
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Zoological Society of Nigeria.