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Evaluation of three methods of artificial colony division in honeybee, *Apis mellifera adansonii* (Hymenoptera: Apidae): Initial response of daughter colony

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ABSTRACT

Late colonization of baited hives is a serious problem facing apicultural industry in tropical countries. Towards providing practical solution to this problem, three methods of artificial colony division were experimented in Ogbomoso, Nigeria, using top bar hives. Hives with strong and active colonies (aged $\geq$ 12 months) were used as Mother Colony and were divided into new hives tagged Daughter colony. Method A involved placing Daughter colony at original place of Mother Colony and taking Mother colony to a distance of 30 m away from its original position. Method B involved placing Daughter colony on top of Mother colony, maintaining original position of Mother colony but facing opposite direction. Method C involved placing Daughter colony 30 m away from its Mother colony. In each method, 3 brood combs and 4 honey combs were placed in the Daughter colony hive and the remaining space on the hive was filled with empty top bars. The results indicate that Method A was the best, having no pest infestation or intruder but higher weight gain. At 2, 6 and 8 weeks after colony division, weight gain observed in Method A (3.2, 2.1 and 2.1 kg respectively) was significantly ($p<0.05$) higher than weight gain observed in Methods B (2.2, 0.75 and 0.65 kg) and C (1.61, 0.75 and 1.12 kg) respectively. The pests encountered in Methods B and C were *Aethina tumida*, *Oecophylla longinoda* and *Galleria melonella* while *Brachymeria* species was the only intruder encountered in Method C.

Introduction

Colonization is the means of catching a swarm of bees into a man-made bees' home called hive. Ordinarily, colonization supposes not to be a problem in West Africa, where there are abundant wild colonies. In most cases if an apiary is sited in a virgin land, where there is no established apiary within 3 km radius and appropriate baits are used, colonization can begin within the first day post installation of hives. However, the first author of this paper has observed cases of late colonization in southwestern Nigeria. Ojating and Ojating (2004) and Oyerinde and Ande (2009) also reported cases of late colony establishment rates in different parts of Nigeria. Tesfaye and Tesfaye (2007) and Arse et al. (2010) rated shortage of honey bees colonies as major beekeeping problem in some Ethiopian districts. Several baiting materials have been listed (Segeren et al. 1997; Ojating and Ojating 2004; Lalika and Machangu 2008) with performance based on several factors. Bee wax is considered to be the best bait to attract swarms and the starter strips on the top bar may be enough to do this. Alternatively, smearing bee wax on inner surface of the hive, the top bars and the flight entrance will attract the bees' colony. The baited hive could then be installed on a stand and covered with insulated materials, to provide shade and prevent adverse weather.

Beside late colonization of hives, absconding is another problem of beekeeping in the tropics (Lepetu et al., 2009; Segeren et al., 1997). The cause can be biological, induced by pests like wax moths (*Galleria melonella* and *Achria grisella*) and ants (*Oecophylla* species) or adverse weather condition (Segeren et al., 1997; Ojating and Ojating, 2004; Babarinde et al. 2010, 2011, 2012). Where the primary purpose of beekeeping is profit maximization, these two problems deserve a practical solution which will ensure profit maximization. Swarming being a natural phenomenon which wild bees employ to increase the number of existing colonies offers a possible solution. Artificial division is not commonly done because of the following reasons: It reduces the total yield of the original colony. Second, its technicalities are not known by most beginner beekeepers. At times, such interference (colony division) could lead to a disaster, retarding general output of work or leading to absconding, if not properly done.

Although, Adjare (1984) gave a stepwise procedure of colony division, the major constraints of his method were the

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technicalities involved and space constraints. Artificial feeding and sealing of flight entrance would be technical and thus be difficult for beginner beekeepers. Moving the new hive to a minimum of 3 km away from old hive may also be impracticable for small or medium scale apiculturists who have about an acre fenced apiary. This study was therefore designed with the following objectives: To evaluate the effect of different methods of artificial colony division on daughter colony weight gain and to identify the pest problems associated with the different methods.

Materials and Methods

Experimental site

The research was carried out at the Teaching and Research Apiary of Ladoke Akintola University of Technology (LAUTECH), Ogbomoso (longitude 4^0 10`E latitude $8^0$ 10`E), Nigeria.

Establishment of mother colonies

Hives used for the experiment were constructed using Gregory (2003) top bar model with some modifications, having the following specifications.

Length= 90 cm

Side = 44 x 30 x 19 cm

Floor = 90 cm with 2 cm veranda along the floor length

Entrance= 3 circular entrances (1.0 cm diameter) on the long side

Lid = 56 x 97 cm

The hives had twenty-five top bars each. Fifty hives were baited by smearing 20 g bees wax on inner surface of each hive, its top bars and flight entrance. Thereafter, the baited hives were installed on four-footed iron stand having 60 x 45 cm top-surface area and 55 cm height in October, 2010. Corrugated asbestos were used as roofing materials to prevent adverse weather conditions. The flight entrance of each hive faced the east.

The baited hives were placed under mango (*Mangifera indica*), cashew (*Anarcardium occidentalis*) and locust beans (*Parkia biglobosa*) trees available on the chosen site for the experiment. The predominant weed species on the land were elephant grass (*Pannisetum purpureum*), spear grass (*Impereta cylindrica*), wild sunflower (*Tithonia diversifolia*) and *Tridax procumbens*. The apiary was about 150 m to a stream. During the experimental period, arable farmers around the apiary had maize (*Zea mays*) and cassava (*Manihot* spp), plantain/ banana (*Musa* spp) grown on their plots.

Colony division methodology and experimental design

Colony division methodology was set up in a completely randomized design (CRD). The division experiment took place between January and April when bees had sufficient flora as food source in the ecosystem. After one and half years of hive installation, nine hives were selected from twenty that were naturally colonized (as a result of baiting with bees wax) by honey bees. The selected hives had strong and active colonies. Colony strength and activeness were judged based on both availability and performance of workers (scout/forager) bees at the flight entrance and the percentage of top bars that had brood combs on them. Hives similar in dimensions to those used as Mother colony hives were used for the division experiment. The new hives were tagged Daughter colony hives.

Three division methods were experimented. Method A: Daughter colony hive was placed on the original place of Mother colony hive and Mother colony hive was placed at a distance of 30 metres away from Daughter colony hive. The flight entrance of Daughter colony hive faced the east. Method B: Daughter colony hive was placed on top of Mother colony hive, maintaining the original spot of the Mother colony hive. Flight entrance of daughter colony hive faced the west while that of mother colony hive faced the east. Method C: Daughter colony hive was placed at a distance of 30 meters away from Mother colony hive. Flight entrance of Daughter colony hive faced the east. For each of the division method, seven combs (three brood combs and four honey combs) were taken from Mother colony hives to Daughter colony hives. The remaining space on the top bars hives were filled with empty top bars. Thereafter, corrugated asbestos was used as the roof. For division methods A and C, Daughter colony hives were then installed on metal stands similar to those used for Mother colony hives. Colony division was done within the hour of 7.00 am and 9.00 am. Each division method was replicated thrice.

Data collection and analysis

Weight of Daughter colony hives was determined before the experiment with the aid of a sensitive top loading balance (Camry ®). After colony division, data on weight gain of Daughter colony hive was taken at interval of two weeks for ten weeks using the same sensitive top loading balance (Camry ®). Weight gain was determined as the difference between an incumbent weight and the previous weight. Data were later subjected to analysis of variance (ANOVA) and Least significant difference (LSD) was used to separate significant means at 5% probability level. Data on weight gain were later correlated with mean relative humidity and temperature. Pests encountered during the bi-weekly weight gain determination were collected and preserved. Identification was done at Insect Collection Museum of Crop Protection and Environmental Biology Department, University of Ibadan, Ibadan, Nigeria.

Results

Of the three methods that were experimented, Method A (Daughter colony hive at original position of Mother colony hive) had significantly higher weight gain than the other two methods (B which involved placing Daughter colony hive on top of Mother colony hive, maintaining original position of Mother colony hive and facing opposite direction and C which involved placing Daughter colony hive at a new place, 30 m away from its Mother colony hive) (Fig. 1).

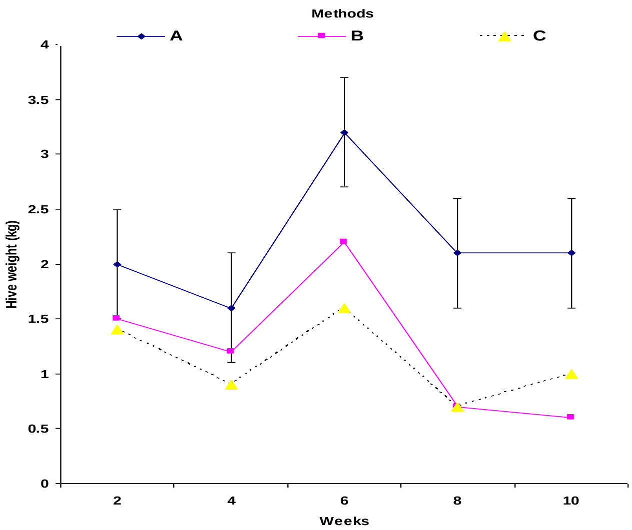

Figure 1. Effect of colony division methods on *Apis mellifera* colony weight gain

Table 1. List of pests and intruder associated with different *Apis mellifera* colony division methods

Pest/intruder identification				Division method		
Name	**Type**	**Family**	**Order**	**A**	**B**	**C**
Oecophylla longinoda	Pest	Formicidae	Hymenoptera	-	+(2)	+(1)
Aethina tumida	Pest	Nitidulidae	Coleoptera	-	+(2)	+(2)
Galleria mellonela	Pest	Pyralidae	Lepidoptera	-	+(2)	+(1)
Brachymeria species	Intruder	Chalcididae	Hymenoptera	-	-	+(1)

+ indicates presence of pest. - indicates absence of pest.
Figures in parentheses are numbers of replicate that was infested by pest.
Method A = Daughter colony hive at original place of Mother Colony hive
Method B = Daughter colony hive on top of Mother Colony hive
Method C = Daughter colony hive at new location.

At 2 weeks after colony division (WACD), there was no significant difference in the observed weight gain for the three division methods. However, at 6, 8 and 10 WACD, weight gain observed in Method A (3.2, 2.1 and 2.1 kg respectively) was significantly ($p<0,05$) higher than weight gain observed in Methods B (2.2, 0.75 and 0.65 kg) and C (1.61, 0.75 and 1.12 kg) respectively. Temperature and relative humidity had no correlation with weight gain (Data, therefore, not shown).

Pests encountered were from three Orders: Hymenoptera, Coleoptera and Lepidoptera. *A. tumida* (small hive beetle) was the most frequent species and was encountered in two replicates of division Methods B and C. This was followed by *O. longinoda* (African weaver ant) and *G. melonella* (Larger wax moth) which were encountered in 2 replicates of Method B and one replicate of division Method C. *Brachymeria* species (Hymenoptera: Chalcididae) was the only encountered intruder and was found in one replicate of Division Method C. Division Method A had no intruder or pest infestation during the experimental period (Table 1).

Discussion

Weight gain in division Method A was due to the fact that forager bees came back to the Daughter colony hive which was the original location of the Mother colony. Though, Adjare (1984) pointed out that in the absence of a queen in colony, workers can develop emergency queen cells on a number of worker cells with young larvae and the Daughter colony should only be inspected for the emergence of a new queen after six weeks. Other studies have indicated that queen can emerge within a period of less than three weeks if a queen-less colony has sufficient active workers (Chambers, 2009; Segeren et al., 1997). Although, in this study, Daughter colonies were not inspected for emergence of new queen, in order not to disturb the young colony, it was logical to point out that Method A succeeded due to timely emergence of a new queen from a queen cell from one of the brood combs. Pests incidence in methods B and C was the reasons for their failure. Babarinde et al. (2010) stated that when a pest infests a colony, it opens the gate for future problem of pests' complexes. Several authors (Adjare, 1984; Segeren et al., 1997, Ojating and Ojating, 2004; El-Sinary and Rizk, 2007; Rajkumar, 2007; Bradbear, 2009; McGregor, 2009; Babarinde et al., 2012) have reported that *G. melonella* can cause absconding of established colony. Various species of ants have been reported as major pests of weak colonies which can cause absconding (Adjare, 1984; Gregory, 2004; Ojating and Ojating, 2004; Segeren et al., 1997, Babarinde et al., 2011). In Cote D'voire, West Africa, ants, lizards and wax moths were reported as principal enemies of honey bees (Palmeri, 2003).

Lepetu et al. (2009) listed ants and wax moths as major problems for Garborone region beekeepers in Botswana. Ellis et al. (2004) reported *A. tumida* as a fast spreading honey bees' pest. Although *A. tumida* could be a nuisance to honey bees, Adjare (1984) reported that it may not be associated with absconding. However, Ojating and Ojating (2004) reported that it caused absconding of three colonies in 2003 in southeastern Nigeria. *Brachymeria* species was occasionally encountered as an intruder that colonized bee hive after absconding in Ogbomoso, Nigeria in 2005. For Method B, though the Daughter colony hive was placed on the Mother colony hive, forager bees maintained supply of food to the Mother colony hive at the expense of the Daughter Colony hive. This was because the presence of the queen and her pheromone-mediated functions in the Mother colony manipulated the activity of the workers. Thus, the abandoned Daughter colony was exposed to pest infestations. Method C which had the Daughter colony hive on another location suffered a similar fate of abandonment by forager bees. Consequently, no queen could be developed and the colony became vulnerable to pests' attack. The complex of the pests was more likely responsible for the failure of the division Methods B and C. The Methods B and C that had pests' problem should be discouraged, since they would predispose the neighboring colonies to pest infestation.

The best method of artificial colony division was method A (Placing the Daughter colony hive at original place of the Mother colony hive). With the modifications of Adjare (1984), local beekeepers can be relieved of the nightmare of late colonization. Colony division can be a gain, especially when it is done prior to swarming. It has double benefits of yield increase and colony maintenance. It is however necessary that colony division be done during the time of floral blossom. This is because seasonal productivity of honey bees' colonies depends on the seasonal availability of nectar and pollen of flowering plants (Ikediobi et al. 1985).

Conclusion

The main contributions of this study to knowledge are the following. Artificial colony division was done within an acre fenced apiary with simple technicalities that are adoptable for beginner apiculturists. This is an improvement on Adjare (1984) who recommended a distance of 3 km between a mother colony and its daughter colony. Also, other methods that cannot work under tropical condition, with associated pest/intruder complexes that were responsible for their failure were discovered.

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