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Co-existence and interactions of pest with bee-wax baited *Gmelina arborea* (Roxb.) woodhives in Abeokuta, Nigeria

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Abstract: *Wooden hives set for honeybees' colonization are often attractive to pests. However, little is known about the interaction among these pests with the hives and more so, impacts of baiting materials on the attractiveness of these pests other than honeybees. Therefore, the interaction of other insects and colonization response of native honeybees to Gmelina arborea wood made hives baited with honey-wax and non-baited hives were investigated for comparison. Paired choice test of baited and non-baited hives with six replicates were strategically placed within four hectares of matured secondary forest between January and December, 2014 in Abeokuta, Nigeria. Two categories of pests were recognized; cavity nesting and cavity destroying organisms. There were remarkable differences in the pest species composition and their impacts. The use of bait influenced the attraction of honeybees' enemy pests first, and has negative impacts on colonization rate and economy of the hives. The study revealed October as the best colonization month with 7 hives colonized (58%), followed by December with 2 hives (16%), and February and March with 1 hive colonized (8%) in each month. Non-baited hives recorded faster and complete colonization than the baited hives. This study has demonstrated the non-usefulness of bait in modern beekeeping in South-western Nigeria.*

Keywords: *Appealing, cavity nesting fauna, Nigeria, October, wood*

I. Introduction

Cavities in woody plants are known as important component of forest ecosystem, providing habitats for many diversified organisms including rodents, snails and honeybees. Modern beekeeping employed man-made wooden cavities (hives), and these hives are also attractive to other organisms termed "pests".However, the depths of interactions between and or among these pests with hives have not been fully explored. While hive colonization can be influenced by a wide variety of interacting factors, it is widely accepted that hive cavity characteristics determine colonization by honeybees [1-7]. In natural habitat [2,4,5,7], an understanding of the selectivity specification in cavity colonization is imperative. As honeybees are being selective, therefore, the man-made cavities are usually constructed to meet their required characteristics in terms of volume in an enclosed system. However, many other cavity nesting/destroying organisms find hives made for beekeeping conservation and studies appealing. Their colonization and interactions appeared to have negative impacts both on the hives and genetic honeybees' economies. Reducing these impacts require in-depth understanding of underlying factors which determine the attraction of the pests for developing preventive management strategies.

The influence of pest infestations to colonization and absconding is usually confounded by the interactions between pests which influence high rate of absconding occasioned by competition between pests and honeybees. Despite the reported low colonization rate and high incidence of pre-colonization pests in modern beekeeping in Nigeria, few studies have linked low colonization with the utilisation of bait materials. Native honeybees are often specialized in colonizing specific wood species cavities such as *Vitex doniana, Gmelina arborea, Adansonia digitata, Ficus mucuso, Lophira lanceolata* etc. in the wild without any bait placement or inclusion. This specialization has reflected in efficient stable colonization, high fecundity and appreciable yield of modern beekeeping using *Gmelina arborea* wood [8]. Low colonization has been linked with variety of divergent factors, but the root cause has not been linked with the inclusion of bait materials used. Therefore, the attraction of other insects and colonization response of native honeybees to *Gmelina arborea* wood made hives baited with honey-wax, and non-baited hives were investigated for comparison between January and December, 2014 in Abeokuta, Ogun State, Nigeria.

II. Materials And Methods

The study area

The study was conducted in Ereke village (Latitude $7^0 10^{'} 14.59^{"}$ and $7^0 10^{'} 15.09^{"}$N and Longitude $3^0 28'37.69"$ and $3^0 28^{'} 41.89"$ E) via Federal College of Education, Osiele, Abeokuta from January to December, 2014. The climate follows a tropical pattern with the raining season starting about March and ending in November, followed by dry season. The mean annual rainfall was estimated to be about 1600mm. The mean annual temperature was estimated to be 26.6°C while mean monthly temperature ranged between 25.7°C in July

to 30.2°C in February [9]. The area was a matured secondary forest which falls in the rain forest belt having diversified peculiar tropical dominant native tree species with agricultural tree crops like *Theobroma cacao, Citrus sineensis* and *Elaeis guineensis*.

Hives construction

Gmelina arborea sawn wood of 1x12x12 and 2x6x12 sizes were purchased from Bodija Sawmill/lumber market in Ibadan and used to construct twelve Kenyan Top Bar Hives (KTBH) using reference [8] model specifications. The covers were reinforced with waterproof material to reduce weathering and degradation.

Paired choice setting of baited versus non-baited hives

Paired choice setting of baited and non-baited hives with six replicates were strategically juxtaposed on iron chairs within four hectares of matured secondary forest between January and December, 2014 in Ereke village Abeokuta, Ogun State, Nigeria. A total number of twelve hives were used of which six were baited with honey-wax placed centrally while the remaining six were not baited. Observations were recorded from the monthly inspections of the set experiments right from January to December ending when the experiment was terminated.

III. Results

Influence of bait on pest infestationsand their interactions.

Two major classes of pests were recognized based on their interactions with the hives, viz; cavity nesting (CN) and cavity destroying (CD) organisms as indicated in table 1. The cavity nesting (CN) included spiders, wasp and wild cockroach. They were principally pre-colonization pests utilizing hives as refuge in day time. They were not found in the colonized hives and their interaction had no negative impact on the hives and probably honeybees too. These were likely due to their solitary/pairing mate, feeding habit, and nocturnal behaviors. During inspections, spiders being nocturnal pest were always alerted and observed scurry away when lifting hives' covers from all hives before being colonized, while the diurnal pest such as small ants and termites remained. Cob webbing activity of the spiders that could have been trapping honeybees and preventing colonization was not a cavity activity of the spiders found in the hives. The cavity destroying (CD) pests were mainly small ants and termites. They were generally pre-colonization and post-colonization diurnal social insect's pest, destroying hives through their staining and feeding habits. Their infestations were annoying and damaging (Fig 1 and 2).

Table 1: Frequency of hives occupancy by pests

Pests	Baited hives (%)	Non-baited hives (%)
Small black ants (CD)	6 (100%)	0 (0%)
Termites (CD)	2 (33%)	1 (17%)
Spider(CN)	6 (100%)	6 (100%)
Wasp (CN)	1 (17%)	0 (0%)
Wild cockroach (CN)	1 (17%)	0 (0%)

Source: Authors Field Work, 2014

Fig. 1: Hive co-infested by small black ants and termites

Fig. 2: Hive completely attacked by two species of termites

The activities of CN pests did not show any negative impacts on the wooden hive and probably on the colonization rate unlike CD insect pests. The CD insects; especially small black ants'appearance were annoying and their activities have excreta-like staining impact on the wood while the termites were both wood destructive and had soil staining impact on the wood.

Colonization months

Monthly colonization rate between baited and non-baited was presented in percentage.The non-baited hives were first colonized and all occupied by honeybees while baited hives colonized later and five out of six eventually colonized before the one year expiration of the experiment. The wax used to bait the hives apparently affected the colonization rate and bees showedstrongest colonization preference for October month followed by December, February and March as indicated in table 2.

Table 2: Frequency/rate of colonization rate within the year

Months	Baited hives	Non-baited hives	Total (%)
January	0	0	0 (0%)
February	0	1	1 (8%)
March	0	1	1 (8%)
April to September	0	0	0 (0%)
October	3	4	7 (58%)
November	0	-	0 (0%)
December	2	-	2 (16%)
Total	**5**	**6**	**11 (92%)**

Source: Authors Field Work, 2014

IV. Discussion

Protection of hives against colonization by organisms other than honeybees is of paramount importance. It was observed that baited hives appealed to pests and have negative impacts on colonization directly or indirectly. The native honeybees showed a stronger colonization preference for non-baited hives than baited ones. The small black ants were observed aggregating at the centre of hives where baits were placed. In advanced stage, they colonized the bars assemblage flat top under the covers. Infestation of only baited hives by the gregarious small black ants was apparently due to the wax used as bait which served as good diet. The positions and activities of spiders did not suggest any link with bait attractions. Termites attack was ratio 2:1 for baited and non baited hives. The baited hives attacked were not colonized earlier and attacks were extended to the whole hives including covers while non-baited colonized hive was attacked at the periphery/ back. These

varied severities of attack were likely as a result of indirect influence of the wax used. The incidences of wasp and wild cockroach were minimal but also found only on baited hives. The use of wax as bait contributed remarkably to higher incidences of pest and relatively lower colonization rate. This result of lower colonization rate was in congruity to those of [10], who documented that wax-baited hives were less colonized than propolis-baited hives in Uganda.

There were remarkable differences in the pest species composition and their impacts. Their impacts varied remarkably on both the hives and honeybee colonization ranging from staining of the hives to eating of hives. The staining characteristic exhibited by the small black ants could likely be attributed to defecation activity or secretions of which were repellent to honeybees. The ants' colony infestation was previously reported as pre-colonization pest situation in Southern Nigeria [11] but found in weak colony bars assemblage under the cover in this study. However, the pest was reported as post-colonization insect that caused 29% absconding rate in Central Uganda [12] without reporting its impact on the wood. Severe wood destructionswere observed on 2 baited-hives and less in non-baited hive by *Amitermes evuncifer* Silvestri and *Macrotermes bellicosus* Smeathman co-attacking the hives concurrently. This result was in agreement to those of [13], who reported that hives infestation was higher and caused destruction to wood and grass woven hives in Kwara State, Nigeria, and [14], who documented that termites attacked 46.67% of colonized hives at periphery in Port Harcourt, Nigeria. Soil staining impact also accompanied the infestations of the hives by the termites. This was likely due to the utilization of soil for tunneling, and inter-phase interaction of termites between soil and wood. Termites' attacks were severely more on both colonized and non-colonized hives in the rainy season that concise with non colonization period by honeybees. This result was in tandem with the reported findings of [14] in Port Harcourt, Southern Nigeria.

Native honeybees showed highest preference for colonizing hives in the month of October. This was probably due to the fact that month October was the reproductive swarming month for honeybees in the ecological zone. This result is strikingly similar to those of [11], who opined that swarming of honeybees in the month of October have some strong association with setting and fruiting of some crops like *Anacardium occidentale* (Cashew), *Mangifera indica* (Mango), *Theobroma cacao* (Cocoa), *Citrus* sp.(Oranges), *Azadirachta indica* (Neem), Irvingia sp. (Bush Mango), etc. which provided nectars and pollens for honeybees' nutrition. It was safe to submit that, bees have chosen this month in preparation for on-season of food flow to prepare and store food against off-season [11]. However, colonization of habitat was not limited to the month of October but chances of colonization in other dry season months were relatively low.Low preference for other dry season months and no colonization in the rainy season months are further confirmation of previous report that seasons greatly influence habitat colonization by honeybees in Nigeria.Colonization in other dry season months was within the range of the months reported by [15,16,17,8]. Considering the place of wood in beekeeping industry, the use of bait materials that will cause low colonization and economic loss of hives should be discouraged.

V. Conclusion

Infestations of the hives by the pestswere influenced, albeit to a remarkable degree, by the utilization of honeybee wax as bait. Relationship of the pests with the hives, in particular cavity destroying (CD) pest had destructive and staining impacts on the wood and apparently exhibited strong repellent phenomenon against honeybees. The low colonization of the hives by honeybees that accompanied the small black ants and termites infestations resulted in destruction of the hives but more abundant of the pest species. This study has demonstrated the non-usefulness of bait in modern beekeeping in Nigeria. Also, the study revealed October as the best colonization month of achieving at least 50% colonization rate in south western Nigeria. Considering the role wax played in the quick invitation of the honeybees antagonistic pests, the use of bait generally should be discouraged or in extreme cases, propolis should be used. The sustainable management of native genetic honeybee's resource among other things must aim to:

- decrease the damage made by pests on the wood resources used for beekeeping,
- sustain beekeeping and production of sufficient quality honey and other products in the face of high domestic and foreign demand,
- conserve the biological and genetic diversity of important natural resources useful to honeybees,
- improve the economic value of genetic honeybee's resource by offering only high quality produce/product for export, and
- enhance the living standards of forest villagers through employment in production areas.

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