Preliminary Survey of Wood Species Cavities Preferred by Honeybees in Nigeria

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Abstract - Though woods remain the principal nest service provider to *Apis mellifera* Scutellata in Nigeria, a technical information/knowledge gap on the wood species preferred by the bees still remains. Therefore, investigation was carried out on the wood species cavities colonized by honeybees in Nigeria for a period of four years. 24 wood species belonging 15 families were identified. The predominant wood families used for nesting by honeybees were Fabaceae, Malvaceae and Verbenaceae accounted for 11.90%, 19.04% and 26.19% respectively with *Adansonia digitata* (Malvaceae) holding multiple nests. Other families include Anacardiaceae, Apocynaceae, Arecaceae, Combretaceae, Irvingiaceae, Moraceae, Myristicaceae, Ochnaceae, Rubiaceae, Rutaceae, Sapotaceae and Ulmaceae. Among individual tree species; *Gmelina arborea* cavities were most encountered (13.10%), followed by *Vitex doniana* (10.71%), Adansoni adigitata (8.33%) and *Anacardium occidentals* (8.33%).19 species were indigenous forest/savannah woods (trees), 1 exotic forest tree while 4 were agricultural tree crops such as palm. Results showed that honeybees significantly preferred Verbenaceae wood cavities (both living and dead). Families Apocynaceae, Malvaceae and Moraceae were preferred alive while others were preferred in dead state. The study further revealed that Nigeria honeybees have affinity for white and yellow coloured woods which makes them colour specific. Alternative cavities encountered were rock (primary rock), termite mounds and deserted rodent and soldier ants' burrows. This study has therefore provided the crucial information required for the sustainable management of genetic bee's resource. Finally, the availability status of the preferred wood species, ecological significance of honeybees as well as its conservation through the provision of desirable cavities deserves more attention than ever before.

Keywords: Adansonii, *Apis mellifera*, Native, Nigeria, Survey, Vegetation, Wood cavities

1 INTRODUCTION

Apis mellifera Scutellata (formally Adansonii) is native to tropical Africa in not less than 35 countries including; Nigeria, Rwanda, Senegal, Sao Tome and Principe. Africanized bees (*Apismellifera*Scutellata) have been observed as facultative cavities nesters and colonise mostly vertical living or dead woods (trunks) for nesting. They are secondary nesters usually colonising suitable abandoned cavities created and/or used by primary nesters or excavators such as wood peckers, fungi, rodents, mammals and other insects (soldier ants, beetles) in Nigeria.

Woods are one of Nigeria's most important natural resources which provide nests for bees and many other living creatures. Hollows of both living and dead trees (woods) provide unique habitat structures for much wildlife [3; 2; 1]. Africanized bees are highly selective social insects in the choice of cavities and colonization from diverse native to exotic timbers. Diversity of hollow woods presents a unique opportunity in selecting choice of wood species cavities for honeybees nesting.

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The current trend of timber removal from the forests is significantly affecting the honeybees and choice of cavities.

Honeybees may prefer certain tree types with specific characteristics (species, position, size, safety, height, extractives content, colour, etc.) for nesting sites. Detailed study and description of the preferred trees cavities by *Apismellifera* L. in America has been reported since four decade ago [10]. The study documented Oak, Walnut, Elm, Pine, Hickory, Ash, Maple, Basswood Beech, Apple, Hemlock and Cedar as preferred species, although the superficial observations' findings have previously been reported [5; 9; 7; 11; 6].The rationale for surveying the wood species cavities preferred by honeybees in Nigeria is premised on the need to provide necessary technical information gap for conservation and selection of suitable (quality) woods for beekeeping in Nigeria and Africa at large.

Despite the uniqueness in the choice of cavities selection among the diverse timbers and importance of honeybees to our wellbeing, no research study has been reported on the natural woods species cavities preferred by Honeybees in Nigeria. Hence, this study focused on the observation of trees species cavities and other cavities preferred by tropicanized honey bees in Nigeria- a largely savannah vegetation and partly tropical forest

vegetation. Management principles and practices for conservation of the woods' species preferred with the ultimate goal for a sustainable development of beekeeping in Nigeria and Africa at largeare recommended.

2 METHODOLOGY

2.1 Data collection

Moderately vegetation covered States and communities with significant trees and bee hunting activities within the two major vegetation types (Forest and Savannah) in Nigeria were surveyed between 2007 and 2011. Trees' cavities used as nests were observed. Nigeria is located in western part of Africa and covers 923,768 square km land area. It is situated within longitudes 3^{o} and 14^{o}East of the Greenwich meridian and latitudes 4^{o} and 14^{o} North of the Equator. The surveyed area is of three major ecological regions; a humid forest region, a sub-humid region with highland, and a semi-arid region, with an average annual rainfall of about 1610 mm divided by two rainy seasons [4]. The average temperature is about 23^{0}C and average relative humidity is 78%. Sunshine reaches around 1700 hours per year. The natural vegetation is savannah and rain forest.

In forest zone, States and communities with significant trees and bee hunting activities were visited. These States are: Ogun, Ondo and Rivers. World Bank Assisted Forestry Plantations in Ogun and Ondo Sates (Omo Area J4 and Oluwa forestry reserves), enclaves and communities which are bee hunting active within and outside the reserves were surveyed and key informants were interviewed for identification of dead woods colonised in their farm lands. In Rivers State, University of Port Harcourt Biodiversity Conservation Area and other Conservation Agricultural Plots as well as four other communities and private individual Oil Palm farms at Onne where bees foraging activities are prevalent were equally surveyed.

In savannah zone, States and communities with significant trees and bee hunting activities were also visited. These States are: Kano, Kogi and Yobe. Private individuals' tree crops farm lands and free-areas were surveyed in Kano and Kogi States while visits were paid to Potiskum local communities, a major southern part of Yobe State known for bee hunting. Shelterbelt research station in Kano was also assessed.

In general, the study employed a combination of on-site survey; field interviews; physical observation and literature reviews. Field interviews involved the selection and interview of key informants for identifications of dead woods utilised nests vertically and horizontally in their farm lands. While literature reviews helped to elicit and confirm the families' names. Wood samples whose colours are not ascertained were slashed for visual colour assessment.

3 RESULTS

3.1 Identified wood species

Twenty four (24) wood species belonging to fifteen (15) families were identified. Table 1 and 2 showed the distribution of wood species preferred, their families, colours, condition in which the species were colonised, vegetation zones found and tree types. Of the 24 wood species identified, the predominant wood families encountered for nesting were Verbenaceae, Malvaceae and Fabaceae accounted for 26.19%, 19.04% and 11.90% respectively with *Adansonia digitata* holding multiple nests. Verbenaceae are medium density white coloured wood species with no clear distinction between the heartwood and sapwood. Verbenaceae were preferred both in living and dead states. Malvaceae are low density white coloured wood species also with no clear distinction between the heartwood and sapwood but only preferred in living state. Fabaceae are medium/high density yellowish pink coloured wood species with distinctive demarcation between the heartwood and sapwood. They were nearly preferred in dead state. Anacardiaceae accounted for 7.83% representing one species. Light yellow coloured and preferred in dead state. Rutaceae accounted for 8.33% representing two species. Light yellow coloured hardwood and preferred in living dead states. Rubiaceae (5.95%) represented by two species. Yellow coloured wood with distinctive demarcation between the heartwood and sapwood. They were nearly preferred in dead state. Other families include; Apocynaceae (2.38%), Arecaceae(2.38%), Combretaceae (1.19%), Irvingiaceae (1.19%), Moraceae (2.38%), Myristicaceae (3.57%), Ochnaceae (2.38), Sapotaceae (2.38%) and Ulmaceae(2.38%). Among individual tree species, Gmelina *arborea* cavities were most encountered (13.10%), followed by *Vitex doniana* (10.71%), *Adansonia digitata* (8.33%) and *Anacardium occidentals* (8.33%) as shown in table 3. Nineteen (19) species were indigenous forest/savannah woods (trees), one (1) exotic while four (4) were agricultural tree/palm crop as shown in table 1. Tables 4 and 5 showed the wood orientations and other cavities preferred.

TABLE1
Identified Wood Species

S/N	Wood species	Local name (Yoruba, Nigeria)	Families	Colour	Tree Condition	Vegetation type found	Tree type
1	*Adansoniadigitata* L.	Ose	Malvaceae	White	Living	Savannah	IST
2	*Anacardium occidentals* L.	Kaju	Anacardiaceae	Light yellow	dead	Forest/ Savannah	AGTC
3	*Anogeissusleiocarpus* (DC.) Guill. andPerr.	Ayin, Orin dudu	Combretaceae	Dark yellow	dead	Savannah	IST
4	*Bombaxbuonopozense* P. Beauv.	Ponpola	Malvaceae	White	living	Forest/ Savannah	IFST
5	*Ceiba pentandra* (L.) Gaetn.	Araba	Malvaceae	White	living	Forest/ Savannah	IFST
6	*Celtiszenkeri* Engl.	Ita	Ulmaceae	Whitish yellow	dead	Forest/ Savannah	IFST
7	*Citrus paradise* Macf.	Osan grape	Rutaceae	Light yellow	living/dead	Forest/ Savannah	AGTC
8	*Citrus sinensis* (L) Osbeck (pro.sp)	Osandidun	Rutaceae	Light yellow	living/dead	Forest/ Savannah	AGTC
9	*Cocosnucifera* L.	Agbon	Arecaceae	Dark yellow	dead	Forest/ Savannah	AGTC
10	*Daniellaoliveri*(Rolfe) Hutch. &Dioclea	Iya	Fabaceae	Brownish yellow	dead	Savannah	IST
11	*Delonix regia* (Boj.ex Hook.) Raf.	Panseke	Fabaceae	Whitish yellow	living/dead	Forest/ Savannah	INFT
12	*Ficus mucuso*Welw.	Obobo	Moraceae	White	living	Forest	IFT
13	*Gmelinaarborea*Linn. Roxb.	Gmelina	Verbenaceae	White	living/dead	Forest	INFT
14	*Irvingia gabonesis* (Aubry-Lecomte ex O'Rorke) Baill.	Oro	Irvingiaceae	Light yellow	living	Forest/ Savannah	INFT
15	*Lophira lanceolata* Tiegh. ex Keay	Panhan	Ochnaceae	Yellow	living	Savannah	IST
16	*Morindalucida*Benth.	Oruwo	Rubiaceae	Yellow	dead	Forest/ Savannah	IFST
17	*Nauclea diderrichii* (De Wild.) Merrill	Opepe	Rubiaceae	Golden yellow	dead	Forest	IFT
18	*Pterocarpus erinaceous*Poir.	Apepe	Fabaceae	Dark yellow	dead	Forest/ Savannah	IFST
19	*Pycnanthus angolensis* (Welw.) Warb.	Akomu	Myristicaceae	Whitish yellow	Living/dead	Forest/ Savannah	IFST
20	*Rauwolfia vomitoria* Afzel.	Asofeyeje	Apocynaceae	White	living	Savannah	IST
21	*Tamarindus indica* L.	Tamarind	Fabaceae	Whitish pink	living/dead	Savannah	IST
22	*Vitellaria paradoxa* (parkia)	Emi	Sapotaceae	Dark yellow	living/dead	Savannah	IST
23	*Vitex doniana* Sweet	Ori	Verbenaceae	White	living/dead	Savannah	IST
24	*Vitex ferruginea* Schumach & Thonn.	Ori eta	Verbenaceae	White	living/dead	Forest	IFT

AGTC= Agricultural Tree Crop
IFST=Indigenous Forest/Savannah Tree
IFT=Indigenous Forest Tree
INFT=Introduced Forest Tree
IST=Indigenous Savannah Tree

Fig. 1: Honeybee Nest in Dead *Cocos nucifera* L. Palm Trunk in Forest Zone

Fig. 3: Honeybee Nest in living *Ficus mucuso* trunk in Forest Zone

Fig. 2: Honeybee Nest in living *Vitex doniana* S. Trunk in Savannah Zone

Fig. 4: Honeybee Nest in living *Adasonia digitata* L. Branch in Savannah Zone

Fig. 5: Abandoned Honeybee Nest in Termite Mound in Forest Zone

TABLE 2
Occurrence of family wood cavities utilised by Honeybees as nests in Nigeria

S/N	Wood families	Frequency	Relative frequency (%)
1	Anacardiaceae	7	8.33
2	Apocynaceae	2	2.38
3	Arecaceae	2	2.38
4	Combretaceae	1	1.19
5	Fabaceae	10	11.90
6	Irvingiaceae	1	1.19
7	Malvaceae	16	19.04
8	Moraceae	2	2.38
9	Myristicaceae	3	3.57
10	Ochnaceae	2	2.38
11	Rubiaceae	5	5.95
12	Rutaceae	7	8.33
13	Sapotaceae	2	2.38
14	Ulmaceae	2	2.38
15	Verbenaceae	22	26.19
		84	**100**

TABLE 3
Occurrence of species' wood cavities utilised by Honeybees as nests in Nigeria

S/N	Wood species	Frequency	Relative frequency (%)
1	*Adansonia digitata* L.	7	8.33
2	*Anacardium occidentalis* L.	7	8.33
3	*Anogeissus leiocarpus* (DC.) Guill. andPerr.	1	1.19
4	*Bombax buonopozense* P. Beauv.	5	5.95
5	*Ceiba pentandra* (L.) Gaetn.	4	4.76
6	*Celtis zenkeri* Engl.	2	2.38
7	*Citrus paradise*Macf.	2	2.38
8	*Citrus sinensis* (L) Osbeck (pro.sp)	5	5.95
9	*Cocos nucifera* L.	2	2.38
10	*Daniella oliveri* (Rolfe) Hutch. & Dioclea	2	2.38
11	*Delonix regia* (Boj.ex Hook.) Raf.	1	1.19
13	*Ficus mucuso*Welw.	2	2.38
12	*Gmelina arborea*Linn. Roxb.	11	13.10
14	*Irvingia gabonesis* (Aubry-Lecomte ex O'Rorke) Baill.	1	1.19
15	*Lophira lanceolata* Tiegh. ex Keay	2	2.38
16	*Morinda lucida*Benth.	3	3.57
17	*Nauclea diderrichii* (De Wild.) Merrill	3	3.57
18	*Pterocarpus erinaceous* Poir.	2	2.38
19	*Pycnanthus angolensis* (Welw.) Warb.	3	3.57
20	*Rauwolfia vomitoria*Afzel.	2	2.38
21	*Tamarindus indica*L.	5	5.95
22	*Vitellaria paradoxa* (parkia)	2	2.38
23	*Vitex doniana* Sweet	9	10.71
24	*Vitex ferruginea* Schumach&Thonn.	2	2.38
		84	**100**

TABLE 4
: Wood Cavities Orientation

Wood Orientation	Frequency	Relative Frequency
Horizontal	3	3.57
Vertical	81	96.43
	84	**100**

TABLE 5
Wood and other cavities' nests of *Apis mellifera* S.

Cavities Materials	Frequency	Forest	Savannah
Wood (tree trunk)	84	40	44
Termite mounds	12	12	-
Primary rock	2	-	2
Deserted rodent burrow	4	-	4
Deserted Soldier Ant burrow	3	-	3
	105	**52**	**53**

4 DISCUSSION

Results have shown that *Apis mellifera* S. of Nigeria lives on a wide variety of wood and can meet its nesting requirements within the forest and savannah vegetations provided the preferred species are adequate and in the right state (living and/ or dead). The nesting selection of honeybees was not varied from forest to savannah vegetation selecting same family wood members with similar characteristics. Nigeria honeybees have affinity for white and yellow coloured woods over popular brown coloured woods. This is a strong indication to suggest that *A. mellifera* S. native to Nigeria has special preference for certain wood species. Apart from forest/savannah trees cavities which were either white or yellow coloured nested. The honeybees also benefited from agricultural cultivated tree crops' species like cashew, citrus and coconut. These tree crops are yellow coloured woods. There were well observed instances of honeybees hanging on wide variety of tree branches. It was equally observed that bees utilize alternative cavities such as rock (primary rock), termite mounds, deserted rodent and soldier ants' burrows despite the availability and distribution of brown wood cavities. It seemed Nigeria honeybees are avoiding the toxic phyto-compounds (extractives) that are usually associated with brown coloured woods. The attraction to white and yellow coloured species could be attributed to little or no presence of toxic extractives in their woods.

On family member preference, Verbenaceae family, having the highest frequency is the most preferred (both in living and dead states) with three species represented. They are generally white and medium density woods. The highest frequency could also be adduced to its abundance across the vegetation zones. Other families preferred both in living and dead states are Myristicaceae, Rutaceae and Sapotaceae. The family members fall into either non-durable and /or moderately durable wood class which require 5-10yrs and 10-15 yrs respectively to structurally decompose after death. This attribute might have informed the preference in living and dead states. Evidences abound that honeybees also nest only in dead woods' cavities of certain families (Anacardiaceae, Arecaceae, Combretaceae, Fabaceae, Rubiaceae and Ulmaceae). The reason could be due to the chemical reactions producing exudates that might not be friendly with bees when the trees are still living. It was also observed that bees colonised the cavity of dead part and avoided the living part of the same cashew tree. This is an indication that some living trees have insect repellent property. Once such species cease to conduct and respire, the species' cavities become suitable. Some species cavities are however preferred only in living state (Apocynaceae and Moraceae families), this discovery that honeybees are attracted to certain woods in living state only is an important implication for the conservation of the genetic pool of bees' resources. It seemed bees possessed first-hand information on the sacredness of *Adansonia digitata* by human in Nigeria as well as longer life span endowment. *Adansonia digitata* was the only observed species of Malvaceae family that held multiple nests. Up to 5 nests were observed hanging on the branches of the tree with other nests within the cavity. Preference for this multiple nesting could be probably because of tree size and thus protection of nests. For instance, the diameters of the branches of fully grown A. digitata are bigger than mother stems (trunk) diameters of many other trees. The long-standing relationship between honeybees and trees might have caused bees to accept and reject some woods' species as nest providers. Perishability status of these species after death is undesirable characteristic for honeybees nesting.

In wood orientation, horizontal oriented woods accounted for 3.57% while vertical oriented woods used as nests accounted for 96.43%. This is expected probably because of the relative abundance and distribution of both living and dead woods in vertical position. Fallen woods in horizontal position are always attracted by other pest or used by human for energy. Observation from honeybees' nests in termite mounds, rock, and burrows is a further strong indication to suggest that honeybees have special preference for

certain alternative cavities. The selection behaviour of the alternative cavities varied from forest to savannah. Honeybees' inhabit alternative cavities such as termite mounds in the wetter part of the forest zone while deserted rodents' burrows, deserted soldier ant burrows and rock cavities were embraced in the savannah zone. The termite mounds in the wetter part of Nigeria have very wide girth and have height of 4m or more. This characteristic provides suitable cavity for bees nesting in wetter forest environment characterised with nearly constant soil surface moisture saturation as against the drier savannah part of the country where water table is very low. Honeybees in Nigeria utilised variety of materials for nesting ranging from woods (white and yellow coloured), soil and primary rock. Preference for these materials is a pointer to suggest that the materials have common property of attraction. Based on the materials used as cavities, the result is similar to the findings of [8] on hybrid of Africanized Honeybees, *Apis mellifera* L. in Mexico and [12] on stingless bee species, *Trigonacollina* S. in Thailand.

4.1 CLASSIFICATION OF CAVITIES

Based on our observations, we classified the cavities preferred by honeybees as;

a) Most preferred (cavities in white woods)
b) More preferred (cavities in yellow woods)
c) Preferred (cavities in alternative materials such as rock, soil, termite mound)
d) Not preferred (cavities in brown woods)

4.2 STATUS OF THE PREFERRED WOODS SPECIES AND HONEYBEES

Generally, there is a transient population of trees in Nigeria. Surveys on the status of trees cavities preferred by honeybees and honeybee itself in Nigeria are rare. Hunting and habitat loss have led to serious impacts on honeybees nests shifting from their natural habitat to human dwelling houses and schools. However, the effect of hunting on honeybees' populations cannot be easily predicted and assessed. This is because there have not been any scientific approach to conserving genetic honeybees' resources in Nigeria. In many countries where the importance genetic honeybees' resources are understood, bees' trees are always protected with suitable cavities created without depending on fungi and birds (cavities creators) whose activities may not be easily determined. There has been an increasing trend in the use of all trees species amongst both urban and rural dwellers for energy (Charcoal and firewood). This trend has grave consequences on the survival of tree species. This is because of the unsustainable manner in which these species are harvested. Furthermore, the downturn in the economy and inflationary trend has led to the excessive harvesting of trees for various uses. Many of these species are now threatened. Out of the 19 timber trees identified, only *Adansonia digitata* enjoys indigenous preservation. This is because of the sacredness attributed to this species which is nationwide. There is the likelihood that Nigeria may soon emerge as tiny sudan/sahel savannah. There is urgent need to improve the conservation efforts, conserve more areas and propagate wood species preferred by honeybees in Nigeria.

5 CONCLUSION

The study has revealed that honeybees native to Nigeria are facultative social insects requiring diversity of both living and dead woods for nesting. *Apis mellifera* L. is a wood cavity nester but showed special preference for white and yellow coloured wood cavities. Cavities in woods are important structural component of our ecosystem providing habitats (nests) for honeybees and many others wildlife. In both vegetation zones however, the presence of the preferred woods' species was inadequate. Thus honeybees opted for alternative cavities in soil, rock and termite mounds. Verbenaceae comprising *Gmelina arborea, Vitex doniana and Vitex ferruginea* were significantly preferred, accounting for 26.19%. These species provided cavities for bees in living and dead states. Other families in descending order of occurrence are Malvaceae, Fabaceae, Anacardiaceae, Rutaceae, Rubiaceae, Myristicaceae, Apocynaceae, Arecaceae, Moraceae, Sapotaceae, Ulmaceae, Ochnaceae, Irvingiaceae and Combretaceae. The study also revealed that honeybees utilised agricultural tree/palm crops cavities such as cashew, citrus and coconut. Genetic honeybees' resource is still abundant searching for suitable cavities to nest. Deforestation in more recent time for energy and charcoal has encouraged clear felling of nearly all trees' ages and forms. Who will save Nigeria vegetation and provide suitable cavities for the needy honeybees?

6 RECOMMENDATIONS

- Generally Nigerians need serious education and awareness on the importance of genetic honeybees' and trees' resources conservation. More lands need to be strictly conserved and propagate fast growing cavities honeybees' trees.
- Identify and leave cavities honeybees' trees to grow old and die. Alive, they provide structural diversity and a rain of genetically fit seed and fruits; once dead,

they provide cavity nest sites while standing and a new source of large deadwood when they fall.

- Strict law should be made and followed by strict penalty for felling honeybees' cavities preferred wood species.
- Vegetation conservation laws and policies should be uniform and all the tiers of the government and communities should be involved.
- Urgent effort should be made by the government to reduce poverty level and provide alternative cheaper environmental friendly energy for cooking.
- Massive plantations of *Gmelina arborea* and *Vitex doniana* should be encouraged now not only for honeybee's conservation and management but also for many quantifiable and unquantifiable products and services.
- Our cultural conservation strategies should be revived. Our environment is our heritage which should be handed over to posterity without undermining its quality.

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