Full Length Research Paper

Identification of plants visited by the honeybee, *Apis mellifera* L. in the Sudan Savanna zone of northeastern Nigeria

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A total of 61 species of savanna plants visited by the honeybee, *Apis mellifera* L. were identified through direct observation of foraging bees. The time of flowering of the plants was also recorded. The largest number of species (26.2%) was recorded for the family Fabaceae. Combretaceae ranked second with 9.8% of the species, while Arecaceae, Lamiaceae, Poaceae Rhamnaceae and Rubiaceae ranked third each with 4.9% of the species. Each of the remaining families had 2 or 1 species. Many of the species are being reported as bee plants for the first time. An overlap of the periods of flowering of the plants, which made forage available to the bees throughout the year, was observed.

Key words: Savanna, bee plants, honeybee plants, bee forage, *Apis mellifera*, Bauchi, Nigeria.

INTRODUCTION

The honeybee, *Apis mellifera*, depends wholly on plants for food. Honeybee workers make thousands of visits to flowers in order to collect nectar and pollen. While doing this they pollinate these flowers, thereby helping to increase fruit and seed-setting both in wild and cultivated plants. The implication of this is that honeybees contribute immensely to the maintenance of ecosystems and agricultural production while they produce important products such as honey. For example, Morse and Calderone (2000) estimated the value of increased yield and quality of crops, due to pollination by honeybees, in the United States of America, for the year 2000, at US\$14.6 billion. The combined production of honey by the top 20 producer-countries for 2011 was estimated at 1.30 million metric tonnes valued at US \$4.62 billion (Anonymous, 2013).

According to Hepburn and Radloff (1998), the plants visited by honeybees can be identified through direct observation of foraging bees (Ayansola and Davies,

2012); palynological analysis of honey (Adekanmbi and Ogundipe, 2009); analysis of pollen loads removed from returning foragers (Köppler et al., 2007); and analysis of pollen stores in nests or hives (Ramanujam and Kalpana, 1992). Experienced beekeepers are also an important, albeit secondary source of information on local floral resources (Teklay, 2011).

Recent studies in various ecological zones of Nigeria have revealed a large diversity of honeybee flora in the country. For example, Ayansola and Davies (2012) reported 49 species from the Tropical Rain Forest and Derived Savanna zones of southwestern Nigeria, while Nnamani and Uguru (2012) identified 56 species from the same ecological zones but in southeastern Nigeria. On the other hand, Ebenezer and Olugbenga (2010) and Mbah and Amao (2009) identified 26 and 28 species, respectively, from the Guinea Savanna zone in north central part of the country while Abdullahi et al. (2011) identified 103 species from the Sudan Savanna zone in

the northeastern part.

The knowledge of plants visited by bees is essential in guiding prospective beekeepers in the choice of suitable sites for locating apiaries. It is also essential in the identification of crops that may benefit from pollination by honeybees. This underscores the relevance of the present study aimed at identifying the honeybee flora of the Savanna, an area that is grossly under-studied (Hepburn and Radloff, 1998).

MATERIALS AND METHODS

The study area

This study was carried out in Bauchi (9°50' E; 10°19' N; 520 m above sea level) from 1999 to 2010. Bauchi is situated in northeastern Nigeria in the Sudan (dry) Savanna, a belt of vegetation that extends from Senegal to Sudan (Hepburn and Radloff, 1998). Observations were made both in the metropolis and in the outskirts of the city in woodlands, fallows and farmland.

Determination and identification of honeybee plants

The determination of a plant as a honeybee plant was done through direct observation of foraging honeybee workers on its flowers. These observations were made during field trips, which lasted from dawn to dusk, organized periodically in all seasons. Only plants on which many foragers sustained foraging for nectar and/or pollen were recorded. Some of the plants were photographed with a digital camera. Unfamiliar plants were identified using botanical field guides (Ghazanfar, 1989; Hopkins and Stanfield, 1966; Keay et al., 1964).

RESULTS

A total of 61 species of plant, grouped into 49 genera and 25 families, were identified as forage plants for *A. mellifera* in the study area (Table 1; Figures 1 to 21). The genus *Acacia* had the largest number of species (9.8%) followed by *Combretum* (6.6%) then *Ziziphus* (4.9%). The other genera, except *Eucalyptus* (3.3%), had one species each. The largest number of species (26.2%) was recorded for the family Fabaceae. Combretaceae ranked second with 9.8% of the species, while Arecaceae, Lamiaceae, Poaceae Rhamnaceae and Rubiaceae ranked third each with 4.9% of the species. Each of the remaining families had 2 or 1 species. The plants were categorized into 41 trees, 6 shrubs and 14 herbs. Seven of the species (*Azadirachta indica*, *Eucalyptus camaldulensis*, *Eucalyptus torelliana*, *Mangifera indica*, *Gmelina arborea*, *Delonix regia* and *Tectona grandis*) were introduced species. While 41.0% of the species flower during the major nectar flow period (March to June), 18.0% flower during the minor one (September to October). On the other hand, while 26.2% of the species flower during the major dearth period (November - February), 14.8% flower during the minor one (July to August).

DISCUSSION

The present study identified 61 species of plants foraged by *A. mellifera*. 32 of these species (*Acacia ataxacantha*, *A. hockii*, *A. senegal*, *A. seyal*, *A. sieberiana*, *Adansonia digitata*, *Annona senegalensis*, *Azadirachta indica*, *Balanites egyptiaca*, *Borassus aetheopum*, *Carissa edulis*, *Daniellia oliveri*, *Delonix regia*, *Faidherbia albida*, *Guiera senegalensis*, *Hymenocardia acida*, *Isobertia doka*, *Khaya senegalensis*, *Kigelia africana*, *Luffa cylindrica*, *Mangifera indica*, *Nauclea latifolia*, *Parkia biglobosa*, *Tectona grandis*, *Tridax procumbens*, *Vernonia amygdalina*, *Vitellaria paradoxa*, *Vitex doniana*, *Ximenia americana*, *Zea mays*, *Ziziphus mauritiana* and *Ziziphus mucronata*) were also identified as bee plants, in various vegetation zones of Nigeria, by other workers (Abdullahi et al., 2011; Adekanmbi and Ogundipe, 2009; Ayansola and Davies, 2012; Ebenezer and Olugbenga 2010; Mbah and Amao 2009; Nnamani and Uguru, 2012).

Of the 49 genera reported here, 25 (*Acacia*, *Adansonia*, *Annona*, *Bombax*, *Borassus*, *Cleome*, *Combretum*, *Daniellia*, *Detarium*, *Feretia*, *Guiera*, *Hymenocardia*, *Isobertia*, *Kigelia*, *Nauclea*, *Parkia*, *Phoenix*, *Pterocarpus*, *Securidaca*, *Stereospermum*, *Tamarindus*, *Terminalia*, *Vitellaria*, *Ximenia* and *Ziziphus*) were also reported by Hepburn and Radloff (1998) as important bee plants in the Sudan (dry) Savanna of Africa, north of the equator.

Although, most of the plants (59%) flower during the nectar flow periods, a large proportion (41%) flowers during the dearth periods. This provides sufficient food to sustain honeybee colonies, making artificial feeding unnecessary. In fact, in some localities substantial harvests are made even during the dearth periods. An important family to note in this regard is Fabaceae: The blooms of its members, especially *Acacia*, overlap providing forage throughout the year. The importance of this family is further enhanced by its abundance in the Savanna ecosystem as reported by this study and Mbah and Amao (2009).

Most of the bee plants reported in this study are of continental importance since they are distributed throughout the Savanna. Since the identified plants have uses other than bee forage, apiculture can benefit from other land-use activities involving these plants. These include agriculture (for example, *Oryza sativa* and *Pennisetum typhoides*), timber plantations (for example, *G. arborea* and *T. grandis*), shelter belts and windbreaks (for example, *A. indica*, *E. camaldulensis* and *E. torelliana*) and agroforestry (for example, *M. indica*).

Other plants, such as *B. aetheopum*, *Detarium microcarpum*, *Hyphaene thebaica*, *V. paradoxa*, *V. doniana* and *X. americana*, are traditionally spared by farmers for their fruit, while clearing the land for agriculture. *Acacia* and *Combretum* are preserved for their gum while *G. senegalensis* is preserved for its medicinal value. Still others are planted on farms, compounds

Table 1. Species of Savanna plants on which *Apis mellifera* L. was observed foraging at Bauchi, Nigeria.

Species	Family	Habit	Bloom*
<i>Acacia ataxacantha</i> DC.	Fabaceae	Shrub	3
<i>Acacia hockii</i> De Willd.	Fabaceae	Shrub	3
<i>Acacia polyacantha</i> Willd.	Fabaceae	Tree	1
<i>Acacia senegal</i> (L.) Willd.	Fabaceae	Tree	1
<i>Acacia seyal</i> Del.	Fabaceae	Tree	4
<i>Acacia sieberiana</i> DC.	Fabaceae	Tree	1
<i>Adansonia digitata</i> L.	Bombacaceae	Tree	1
<i>Annona senegalensis</i> Pers.	Annonaceae	Tree	1
<i>Azaderachta indica</i> A. Juss	Meliaceae	Tree	1
<i>Bombax costatum</i> Pellegr. & Vuill.	Bombacaceae	Tree	4
<i>Borassus aetheopum</i> Mart.	Arecaceae	Tree	4
<i>Cassia tora</i> L.	Fabaceae	Herb	3
<i>Cleome gynandra</i> L.	Capparaceae	Herb	1
<i>Cochlospermum tinctorium</i> A. Rich	Cochlospermaceae	Herb	1
<i>Combretum glutinosum</i> Perr. ex DC.	Combretaceae	Tree	4
<i>Combretum hypopilinum</i> Diels	Combretaceae	Tree	1
<i>Combretum molle</i> R. Br. ex G. Don	Combretaceae	Tree	1
<i>Combretum nigrican</i> Lepr. ex Guill. et Perr.	Combretaceae	Tree	4
<i>Daniellia oliveri</i> (Rolfe) Hutch. & Dalz.	Fabaceae	Tree	4
<i>Delonix regia</i> (Boj. ex Hook.) Raf.	Fabaceae	Tree	1
<i>Detarium microcarpum</i> Guill & Perr.	Fabaceae	Tree	2
<i>Eucalyptus camaldulensis</i> Dehnh.	Myrtaceae	Tree	4
<i>Eucalyptus torelliana</i> F. Muell	Myrtaceae	Tree	4
<i>Faidherbia albida</i> (Delile) A. Chev.	Fabaceae	Tree	4
<i>Feretia apodanthera</i> Del.	Rubiaceae	Shrub	1
<i>Gmelina arborea</i> Roxb.	Verbenaceae	Tree	4
<i>Guiera senegalensis</i> J.F.Gmel	Combretaceae	Shrub	3
<i>Hygrophila auriculata</i> Schumach(Heine)	Acanthaceae	Herb	3
<i>Hymenocardia acida</i> Tul	Euphorbiaceae	Tree	1
<i>Hyphaene thebaica</i> Mart.	Arecaceae	Tree	4
<i>Hyptis spicigera</i> Lamarck	Lamiaceae	Herb	3
<i>Isoblerlinia doka</i> Craib & Stapf	Fabaceae	Tree	3
<i>Khaya senegalensis</i> (Desr) A Juss	Meliaceae	Tree	1
<i>Kigelia Africana</i> Lam.	Bignoniaceae	Tree	4
<i>Luffa cylindrical</i> (L.) Roem.	Cucubitaceae	Herb	3
<i>Mangifera indica</i> L.	Anacardiaceae	Tree	4
<i>Mitracarpus scaber</i> Zucc.	Rubiaceae	Herb	3
<i>Nauclea latifolia</i> Smith	Rubiaceae	Tree	1
<i>Nymphaea lotus</i> L.	Nymphaeaceae	Herb	3
<i>Ormocarpum biracteatum</i> (Hochst. Ex. Rich) Bak	Fabaceae	Shrub	2
<i>Oryza sativa</i> L.	Poaceae	Herb	3
<i>Parkia biglobosa</i> (Jacq) Benth	Fabaceae	Tree	1
<i>Pennisetum typhoides</i> (Burm) Stapf & Hubb.	Poaceae	Herb	2
<i>Phoenix dactylifera</i> L.	Arecaceae	Tree	4
<i>Pterocarpus erinaceus</i> Pior.	Fabaceae	Tree	1
<i>Securidaca longepedunculata</i> Fres.	Polygalaceae	Tree	1
<i>Stereospermum kunthianum</i> Cham.	Bignoniaceae	Tree	1
<i>Tamarindus indica</i> L.	Fabaceae	Tree	1
<i>Tectona grandis</i> L.	Verbenaceae	Tree	2
<i>Terminalia laxiflora</i> Engl.	Combretaceae	Tree	1

Table 1. Contd.

<i>Tridax procumbens</i> L.	Asteraceae	Herb	2
<i>Vernonia amygdalina</i> Del.	Asteraceae	Herb	4
<i>Vitellaria paradoxa</i> Gaertn.	Sapotaceae	Tree	1
<i>Vitex doniana</i> Sweet	Lamiaceae	Tree	1
<i>Vitex simplicifolia</i> Oliv.	Lamiaceae	Tree	1
<i>Waltheria indica</i> L.	Sterculiaceae	Herb	2
<i>Ximenia americana</i> L.	Olacaceae	Shrub	1
<i>Zea mays</i> L.	Poaceae	Herb	2
<i>Ziziphus mauritiana</i> Lamarck	Rhamnaceae	Tree	2
<i>Ziziphus mucronata</i> Willd.	Rhamnaceae	Tree	2
<i>Ziziphus spina-christi</i> (L.) Desf.	Rhamnaceae	Tree	4

*Period during which the plants flower, as defined by Dukku (2003). 1: Major nectar flow period (March to June); 2: Minor dearth period (July to August); 3: Minor nectar flow period (September to October); 4: Major dearth period (November to February).

Figure 1. *Acacia ataxacantha* DC.

or in streets to provide fruit (for example, *Phoenix dactylifera* and *P. biglobosa*), shade (for example, *K. senegalensis*) or as ornamentals (for example, *D. regia*). A notable species with multiple uses is *Adansonia digitata* which yields vegetable, fibre, fruit and traditional herbal medicine, in addition to being an important bee plant.

In conclusion, it is suggested that further studies should be carried out on bee-plant relationships in view of identi-

fying more forage plants for honeybees in the Savanna.

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Figure 2. *Acacia seyal* Del.

Figure 3. *Acacia sieberiana* DC.

Figure 4. *Bombax costatum* Pellegr. & Vuill.

Figure 6. *Cochlospermum tinctorium* A. Rich.

Figure 5. *Borassus aetheopum* Mart.

Figure 7. *Combretum molle* R. Br. ex G. Don.

Figure 8. *Detarium microcarpum* Guill & Perr.

Figure 9. *Feretia apodanthera* Del.

Figure 10. *Guiera senegalensis* J.F.Gmel.

Figure 11. *Hyphaene thebaica* Mart.

Figure 12. *Nauclea latifolia* Smith.

Figure 13. *Nymphaea lotus* L.

Figure 14. *Parkia biglobosa* (Jacq) Benth.

Figure 15. *Securidaca longepedunculata* Fres.

Figure 16. *Stereospermum kunthianum* Cham.

Figure 17. *Tamarindus indica* L.

Figure 18. *Vitellaria paradoxa* Gaertn.

Figure 19. *Vitex doniana* Sweet.

Figure 20. *Waltheria indica* L.

Figure 21. *Ziziphus mauritiana* Lamarck.

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