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Seasonal Availability and Floral Calendar of *Apis mellifera* Nectar and Pollen forage in Eastern Mau

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***Abstract*: Non-involvement of communities along the Eastern Mau in forest conservation has been implicated for the severe degradation of Eastern Mau. Although the Mau Forest task force has recommended synergy between traditional and scientific knowledge in forest management, conservation of threatened species, participatory forest management livelihood support for the local communities e.g. the Ogieks, extensional , technological support and a floral calendar still lacks. A floral calendar is a timetable that indicates the approximate date and duration of blossoming period of the important honey and pollen plants in the area. The extensive knowledge of type, density and quality of bee flora in a region are prerequisites for successful beekeeping. Beekeeper Ogieks in Eastern Mau lack the floral calendars documenting the bee flora and their flowering phonologies for maximum sustainable use of melliferous species. This study has constructed floral calendars which will form a basis for future studies on any possible effects of climate change and the intentional use of beekeeping as a basis for conservation of local flora. The Mariashoni, Nessuit and Kamkembu areas inhabited by Ogieks were randomly sampled as the strata; belt transects were established as per standard procedures. Bee plants were determined through observation of their foraging activities while the flowering period for the bee plants were delimited and recorded every month as per established methods. Plants were identified based on herbarium sheets and flora of tropical East Africa keys. Most bee plants foraged for one season >2months or two seasons with very few flowering for 1 season less than 2 months. Climbers formed the largest proportion (37.50%) of bee plants foraged for one season less than 2 months. There was observed a steady trend of reduction of availability of bee plants towards the dry periods of November and December that coincided with drought.Eastern Mau can support bee keeping year round as bee forage is available throughout the year, with bee plants flowering for at least a month to whole year. The peak availability of forage is in April and May (nectar flow period, 59.30%) while the Dearth period with limited bee forage is in December (10 bee plants flowering, 11.63%): *Pupalia lappacea*, *Aloe secundiflora*, *Leucaena leucocephala*, *Malvaviscus arboreus*, *Acacia brevispica*, *Vernonia auculifera*, *Acacia tortilis*, *Combretum molle*, *Eucalyptus resinifera*, *Olea europea.* The seven *Acacia* spp provide successive bloom mosaic year round.**

***Keywords:* Eastern Mau, Floral calendar, bee plants, dearth, honey flow.**

I. INTRODUCTION

The Mau forest complex is under severe threat of degradation from the forest dwellers and adjacent communities. This has been attributed to non-involvement of communities along the Eastern Mau in forest conservation. Although the Mau Forest task force (2009) has recommended synergy between traditional and scientific knowledge in forest management, conservation of threatened species, participatory forest management livelihood support for the local communities e.g. the Ogieks, extensional , technological support and a floral calendar still lacks. A floral calendar is a timetable that indicates the approximate date and duration of blossoming period of the important honey and pollen plants in the area. Although apiculture has the potential to improve livelihoods to local communities and incentivize them to participate in the conservation of its vital forests., The extensive knowledge of type, density and quality of bee flora in a region are prerequisites for successful beekeeping. Beekeeper Ogieks in Eastern Mau lack the floral calendars documenting the bee

flora and their flowering phonologies for maximum sustainable use of melliferous species in order to synergize traditional and scientific knowledge. Bee keepers rely heavily on natural regeneration of bee plants than on taking deliberate steps towards its conservation, especially of undergrowth. As vegetation faces increasing demands from rising human and livestock populations, a decline of forage trees has been reported that is not matched by a change of attitude towards conservation. To tackle this situation will not be easy because of the complex land, forest and tree tenure issues that are involved. Since conservation of natural resources might not appeal to local residents as a desirable goal in its own right, it stays important to identify a target audience for the message. Bee keepers who believe more could be done to bee plants could initially be receptive to such a message and could act as a link between partners in environmental conservation and local communities (Vlek et al., 2014).

Beekeepers knowledge of plants associated with bees have in certain instances matched well with what occurred in the study during the main flowering period, at the end of the dry period and start of the short rains. The knowledge beekeepers have of flowering appears therefore to be of general nature and prompts use of floral calendar for gathering specific data about flowering outside the normal range (Vlek et al., 2014)

Every region has its own honey flow and floral dearth periods of short and long duration. Such knowledge of bee flora help in the effective management of bee colonies during such periods. Sound information on duration and blooming time is essential for proper beekeeping management. The existence of knowledge on type, density and quality of bee flora in a region are prerequisites for enhancing the efficiency of beekeeping industry and successful beekeeping. Such information enables the beekeepers to utilize bee flora and manage bee colonies effectively (Kumar et al., 2013) it guides prospective beekeepers in the choice of suitable sites for locating apiaries, and identification of crops that may benefit from pollination by honeybees (Dukku , 2013).

For a full understanding of the potential of beekeeping as a sustainable livelihood for the local people, knowledge about flowering phenology of plants and trees potentially foraged by the bees is indispensable. The honeybee plants provide pollen and nectar as main food sources for honeybees, on the other hand flowering plants depend on bees for pollination and subsequent sexual reproduction. This mutual interaction is particularly important in tropical ecosystems. Success in beekeeping is development is dependent first and foremost on the type and quantity of flora available (Admasu, 2007). The identification and registration of honeybee flora in different agroeceological zones and their potential for honey production creates awareness in the maintenace of existing bee flora and multiplication of plant species is important for its sustainability (Wubie et al., 2014). Flowering sequence can be anticipated and hives moved about, where possible , to exploit nectar flows. The floral calendar of an area however usually varies from year to year since flowering depends on the weather. It serves the most useful purpose of showing the sequence of flowering of various plants in a given area thereby helping to identify the main flowering and dearth periods so that eventually suitable plants could be grown to bridge flowering gaps (Kumar et al., 2013).

A floral calendar has been established by (Okoth, 2010) on locally available flora of the Arabuko Sokoke Forest in Northern part of Kenyan Coast and has supported/generated knowledge beekeeping in a community that does not traditionally do beekeeping. Floral calendars could form basis for future studies on any possible effects of climate change and the intentional use of beekeeping as a basis for conservation of local fauna. Vlek et al., (2014) has published floral calendar for 20 bee plants in Marigat parish, Baringo county and also revealed that although beekeepers could be having knowledge of bee plants but specific information has been limited. Flowering calendar have also revealed flowering gaps in December and January in Baringo, which is a dry hot period in the lowlands and coincides with the period when bees migrate to other areas. Carroll (2006) publish floral calendar of nine floral species but only six species flowering periods for Kirinyaga; four bee plants in Kakamega without their flowering periods; twelve species and their flowering periods in Molo, and eleven bee plants and eight flowering periods documented for Nandi Hills. Drawing up a calendar can help identify when the high and low seasons for forage are, species planted to fill gaps and provide forage year round (MaMaSe , 2016).

Some studies designating plants used by honeybees as pollen or nectar sources have helped the development of floral calendars (Terrab et al., 2005; Silici and Gokceoglu, 2007). The studies by Bilisik et al., 2008 has also documented the few plants that honeybee foragers concentrate on and a pollen calendar which has aided the bee keepers in the Bursa Lowland Region of North-west Turkey (Bilisik et al., 2008). The honey flow period and dearth period varies from one location to another and with altitudes. The flowering plants of several plant families blossom at different time interval of

the year. A floral calendar for bee keeping is a timetable that indicates the approximate date and duration of blossoming period of the important honey and pollen plants in the area. The economically important bee plants provide substantial quantity of pollen and nectar for bees during different months of the year. (Waykar et al., 2014).

The developed floral calendar will serve the most useful purpose of showing the sequence of flowering of various plants in Eastern Mau thereby helping to identify the main flowering and dearth periods so that eventually suitable plants could be grown to bridge flowering gaps (Kumar et al., 2013). The knowledge about flowering phenology of plants and trees potentially foraged by the bees will offer a full understanding of the potential of beekeeping as a sustainable livelihood for the Ogiek bee keepers. Floral calendars will form a basis for future studies on any possible effects of climate change and the intentional use of beekeeping as a basis for conservation of local flora. Based on the above background this study was intended to construct a floral calendar of melliferous plant species in Eastern Mau from January to December document the blooming periods and patterns.

II. METHOD

Study site: The study site is located about 50 Km south of Nakuru Town. The altitude ranges from 1200 and 2600 m. It is approximately 280 km2 with the highest number of indigenous forest dwellers dominantly belonging to the Ogiek community. East Mau forest is an important watershed within the Mau Forest Complex, feeding major rivers and streams that make up the hydrological systems of Lake Victoria and inland Lakes of Nakuru, Baringo and Natron. It hosts endangered mammals (Sang, 2001). The forest ecosystem is therefore an important resource base for the local communities, national and international community. The total forest area has gone down by more than one half due to excision for human settlement in 2001(UNEP et al., 2006). The remaining area consists high forest, grassland and planted forest mainly of Cypress and Pines (KFS, 2012). Eastern Mau area terrain ranges from escarpments, hills, rolling land to plains with slopes ranging from 2% above 30% in the foothills. The soil is composed of quaternary and tertiary volcanic deposits. The adjoining settlements have gentle slopes with deep-fertile-volcanic soils suitable for maize, wheat, potatoes, horticultural crops and livestock keeping (Jaetzold and Schmidt, 1982). The area receives trimodal precipitation pattern with the long and intense rains from April to June; short rains in August; and shorter, less intense rains from November to December. Mean monthly rainfall ranges between 30 mm to 120 mm and total annual precipitation of 1200 mm (Kundu, 2007; Okello, 2008). The mean annual temperatures are in the range of 12 -16°C (Kundu, 2007).

***Reconnaissance*:** survey was employed to become familiar with the area, to get an insight on the vegetation distribution in the landscape, to observe and locate the possible traverse during the actual study. Stratified random sampling procedure was followed to select the representative sites based on the strata made prior to the survey.

***Strata and* sampling:**Three forest strata units were purposively sampled in consultation with local administrative officials using two main criteria: ethnic composition, presence of indigenous Ogiek community. The following administrative locations were selected: Mariashoni representing an old settlement predominantly occupied by Ogiek indigenous community (65%), Kapkembu – representing a recent settlement with a homogenous community of the Kipsigis and Ogiek (7.5%) , Nessuit – representing a recent settlement with a heterogeneous population of indigenous (Ogiek, 50%) and immigrant ethnic groups (Langat et al., 2015)

***Data collection and recording*:** Three transects measuring 5m x 50m were laid out in selected sites representative of the main land uses in the study area and every 120 degrees of an identified hive. In order to retain accuracy, a smaller transect measuring 5mx10m was laid out then replicated 5 times. Plants were categorized as trees when they exceeded 3 m in height, as shrubs when they attained a total height of 1-3m. Plants that grew below 1m in height were taken to be undergrowth layer or herbs in the transects and studied in nested quadrats of 1-2m squared (Vlek et al., 2014). This was replicated in Mariashoni, Kapkembu, and Nessuit in Eastern Mau.

Field data was collected through regular monthly visits to the study sites. Each study visit served as pseudo replicates for the site and all observations were made between 0700-1800hrs (winter) and 0700-1830hrs (Summer) . Primary data was collected through direct identification of bee flora in the region mainly by observing the bee visitation. The flower species was identified as bee plant only after visual confirmation and collection of food by honey bees (Sivaram, 2014). The observation on nectar and pollen source was based on activities performed by honey bees on different flowers. Honey bees with their activity of extending their proboscis into the flowers are considered a nectar source and bees carrying pollen on their hind legs were determined as pollen source. Bees with activities of extending proboscis and carrying

pollen are recorded as both pollen and nectar source. Their foraging behavior was observed for period of 10 minutes. If the success of any foraging attempt was ascertained, the plant was scored as bee foraging species after at least 3 honeybees visited the flowers simultaneously or within observation period of 10 minutes (Okoth, 2010).

Floral calendar:Flowering period was delimited as period that extends from the beginning of flowering (5% of open flowers) until the end of lowering. Based on availability of different plants along with their flowering time , a bee floral calendar was developed.

Plant identification: Plants visited by the honey bees were identified in the field to species level by the Flora of East Africa. Samples of plants that could not be identified in the field were collected and saved in Herbarium sheets, and subsequently identified in the Department of Botany, Maseno University by taxonomists after comparing with material held in Maseno University Herbarium as well as published reports. Subsequent identification was aided by Flora of Tropical East Africa (FTEA, 2010).

III. RESULTS

Table 1. Floral calendar for melliferous plant taxa in Eastern Mau

Family	Species	Reward	Form	Months in bloom	Duration	Seasons
Acanthaceae	*Acanthus pubescens* (Thomp ex Oliv.)	N	Herb	April-May, September-October	4	C
Acanthaceae	*Asystasia gangetica* (L.)	N	Herb	January-June	6	B
Acanthaceae	*Justicia exigua* S.Moore	NP	Herb	July-September	3	B
Acanthaceae	*Justicia flava* (Vahl.) Vahl.	NP	Herb	April-May, July-September	5	C
Acanthaceae	*Odontonema strictum* Kuntze	N	Shrub	February-March, July-August	4	C
Agavaceae	*Agave sisaliana* Perrine ex Engelm.	N	Shrub	January, September-November	4	C
Amaranthaceae	*Achyranthes aspera* L.	N	Herb	February-June,	5	B
Amaranthaceae	*Pupalia lappacea* (L.)A.Juss.	N	Herb	March-May, August, November-December	6	D
Anacardiaceae	*Mangifera indica* L.	NP	Tree	January, June-September	5	B
Anacardiaceae	*Rhus nataliensis* Bernh.	NP	Tree	March-May	3	B
Araliaceae	*Polyscias fulva*J.R. Forst. &G.Forst.	NP	Tree	April-May, September-October	4	C
Asphodelaceae	*Aloe secundiflora* Engl.	N	Herb	January, May, October-December	5	C
Asteraceae	*Aspilia mossambicensis*(OLiv.) Wild	P	Herb	May-July	3	B
Asteraceae	*Bothriocline fusca* (S.Moore) M.G.Gilbert	P	Herb	April-June	3	B
Asteraceae	*Hellianthus Annuus* L.	P	Herb	May-July	3	B
Asteraceae	Tithonia diversifolia Hemsl.	P	Shrub	April-May, July	3	C
Asteraceae	Vernonia auriculifera Hern	NP	Shrub	January-April, October-December	7	C
Astercaeae	*Solanecio mannii* (Hook.f.)	P	Shrub	March-May	3	B
Bignoniaceae	*Jacaranda mimosifolia* D.Don	P	Tree	May-September	5	B
Boraginaceae	*Cordia abyssinica* R.Br. ex A.Rich.	NP	Tree	January-March, May-August	7	C
Cactaceae	*Opuntia ficus-indica* (L.)Mill.	P	Shrub	April-May	2	A
Capparaceae	*Maerua triphylla* A.Rich.	N	Shrub	April-June, October	4	C
Caricaceae	*Carica papaya* (L.)	NP	Tree	May-July,	3	B
Combretaceae	*Combretum molle* R.Br.ex G.Don.	N	Tree	February-July, October-December	9	C
Combretaceae	*Terminalia brownii* Fresen.	P	Tree	April	1	A

Convolvulaceae	*Ipomoea batatas* (L.)Lam	N	Climber	May-June, August	5	C
Curcubitaceae	*Cucurbita pepo* L.	NP	Climber	March-May	3	B
Curcubitaceae	*Mormadica foetida* Schumach	P	Climber	April-June,	3	B
Euphorbiaceae	*Croton macrostachyus*	NP	Tree	March-May	3	B
Euphorbiaceae	*Croton megalocarpus*	NP	Tree	July-November	5	B
Eurphobiaceae	*Euphorbia hirta*	NP	Tree	March-May, July-August	5	C
Fabaceae	*Albizia coriaria* Welw. ex Oliv.	NP	Tree	January-May	5	B
Fabaceae	*Acacia brevispica* (Harms) Seigler & Ebinger	NP	Tree	January-December	12	E
Fabaceae	*Acacia elatior* Brenan.	NP	Tree	February-May, September-October	6	C
Fabaceae	*Acacia mellifera* (M. Vahl.)	NP	Tree	January-March	3	B
Fabaceae	Acacia polyacantha (Willd)	NP	Tree	January, April-May,	3	C
Fabaceae	*Acacia senegal*(L.)Willd.	NP	Tree	February-April, July-September, November	7	C
Fabaceae	*Acacia tortilis* (Forssk.)	NP	Tree	August-December	5	B
Fabaceae	*Acacia xanthophlea*(Benth.)	NP	Tree	May-June, September-November	5	C
Fabaceae	*Crotalaria brevidens* L.	P	Herb	May-July	3	B
Fabaceae	*Delonix regia* (Bojer ex Hook.)	NP	Tree	January, May-July	4	B
Fabaceae	*Erythrina abyssinica* Lam. ex DC	NP	Tree	January-February	2	A
Fabaceae	*Glircidia sepium* (Jacq.)Kunth ex Walp.	N	Tree	January-February	2	A
Fabaceae	*Leucaena Leucocephala* (Lam.)de Wit	N	Shrub	January-December	12	E
Fabaceae	*Mimosa invisa*	NP	Shrub	April-October	7	B
Fabaceae	*Pentaclethra macrophylla* Benth.	N	Tree	March-April, June-July	5	D
Fabaceae	*Phaseolus vulgaris* L.	N	Herb	April-May, August-September	4	C
Fabaceae	*Sesbania sesban (L.)Merr.*	N	Shrub	March-May, August-September	5	C
Fabaceae	*Tamaridus indica* L.	NP	Tree	March-June,	4	B
Fabaceae	*Tephrosia vogelii* Hook.f.	P	Shrub	April	1	A
Fabaceae	*Trifolium repens* L.	NP	Herb	March-July	5	B
Fabaceae	*Tylosema fassoglensis* Schweinf.	P	Climber	March	1	A
Graminae	*Pennisitem purpureum* Schumach.	N	Herb	February-April, August-September	5	C
Gramineae	*Cynodon dactylon* L.	P	Herb	January-February	2	A
Gramineae	*Sorghum bicolor* (L.)Moench	P	Herb	April-June	3	B
Gramineae	*Zea mays* L.	P	Herb	April-June	3	B
Lamiaceae	*Leucas deflexa* Hook.f.	N	Herb	July-October	4	B
Lamiaceae	*Ocimum gratissimum* L.	NP	Shrub	January, May	2	C
Lauraceae	*Persea americana* Mill.	N	Climber	April-June, August-September	5	C
Malvaceae	*Hibiscus rosa-sinensis* L.	NP	Shrub	February-April, August, October-November	6	D
Malvaceae	*Malvaviscus arboreus* Cav.	N	Shrub	January-December	12	E
Malvaceae	*Sida acuta* Burm f.	NP	Herb	March-May	3	B
Meliaceae	*Melia azedarach* L.	NP	Tree	June-October	5	B

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Moraceae	*Morus mesozygia* Stapf.	P	Shrub	March-May	3	B
Moringaceae	*Moringa oleifera* Lam	N	Tree	January, June-August	4	B
Musaceae	*Musa acuminata* Colla	N	Herb	May-July	3	B
Myrtaceae	*Callistemon citrinus* (Curtis)	NP	Tree	June-August	3	B
Myrtaceae	*E.grandis* (W.Hill)	N	Tree	May-July	3	B
Myrtaceae	*E.resinifera* (Smith)	NP	Tree	January-December	12	E
Myrtaceae	*Psidium Guajava* L.	NP	Shrub	March-July	5	B
Oleaceae	*Jasminum fluminense* L.	N	Climber	April-May	2	A
Oleaceae	*Olea europaea* ssp *Africana* L.	P	Tree	April-June, November-December	5	C
Passifloraceae	*Passiflora edulis* Sims.	NP	Climber	May	1	A
Proteaceae	*Grevillea robusta* A.Cunn.ex R. Br.	NP	Tree	January-May, August-September	7	C
Rhamnaceae	*Zizyphus mucronata* Willd	P	Tree	August-September	2	A
Rosaceae	*Eriobotrya japonica* (Thunb.)Lindl.	P	Tree	January-February, November	3	C
Rosaceae	*Prunus africana(*Hok.f.)Kalkman	NP	Tree	January-April, August-September	6	C
Rutaceae	*Citrus limon* (L.)	NP	Tree	January-February, June-August	5	C
Rutaceae	*Teclea nobilis*	NP	Tree	May	1	A
Sterculaceae	*Dombeya torrida* (J.F.Gmel)	NP	Shrub	May, August-October	4	C
Tiliaceae	*Grewia bicolor* Juss.	N	Shrub	January-April	4	B
Ulmaceae	*Trema orientalis* L	NP	Shrub	June-August	3	B
Verbenaceae	*Lantana camara* L.	P	Shrub	January,March-May, July	5	D
Verbenaceae	*Stachytarpheta jamaicensis* (L.)Vahl.	N	Herb	April-May, September-October	4	C
Vitaceae	*Cissus rotundiflora* Vahl.	P	Climber	Feb-March, July	3	C
Zygophyllaceae	*Tribulis terrestris* L	P	Herb	March-May,September-November	6	C

N= Nectar,P= Pollen, NP=Nectar; A- 1 season less than 2 months, B- 1 season more than 2 months, C-Two seasons, season, D- Three seasons, E-Year round. The flowering pattern ranged from one season (1month) to year round (12 months). There was availability of bee forage in bloom. THe flowering months varied alongside the changing precipitation levels. The variations in flowering were observed within Genus as well as between various Genera.

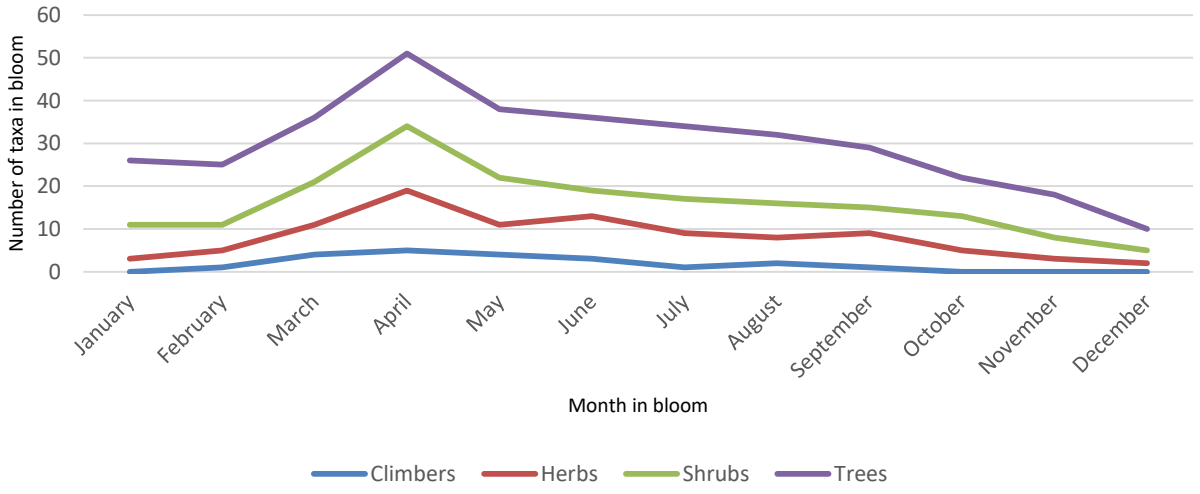

Figure 1. Plant in bloom in the months of the year.

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Trees had the highest number of foragers throughout the year followed by the shrubs, herbs and climbers respectively. There were only 10 plant species that flowered in December and 51 plant species flowering in April. Highest proportion of bloom of bee plants was observed during the rain season. There was observed a steady trend of reduction of availability of bee plants towards the dry periods of November and December that coincided with drought.

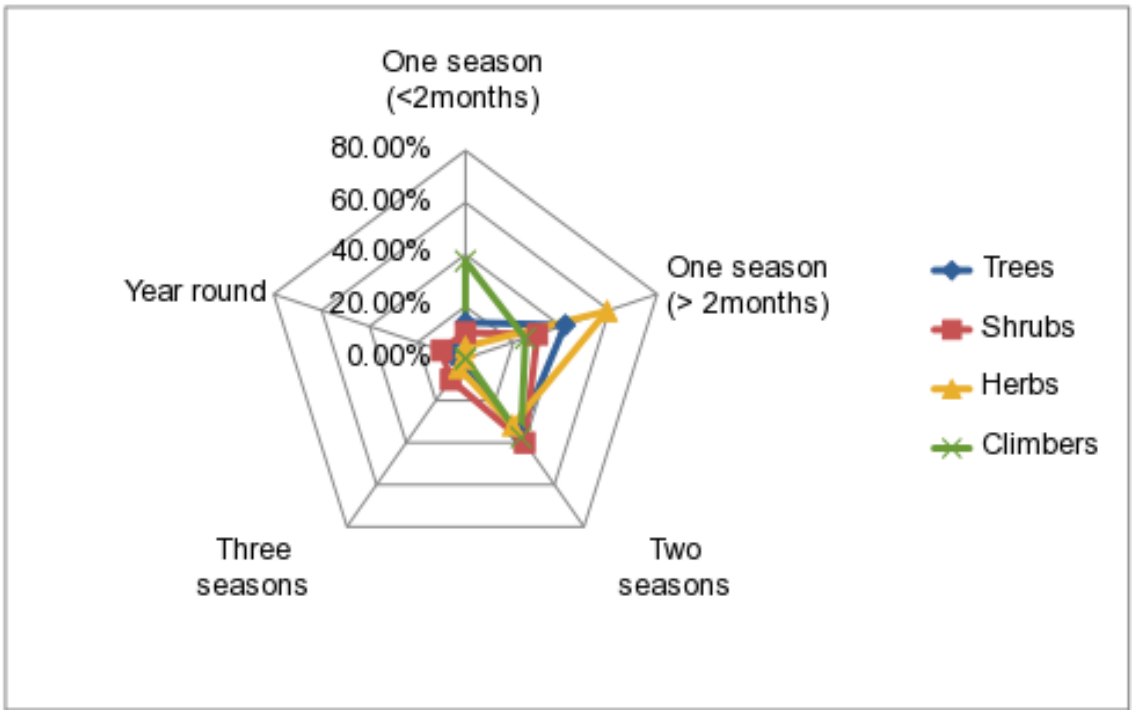

Figure 2. Flowering patterns for different plant forms.

There are very limited proportion of bee plants that bloom year round. Most bee plants foraged for one season >2months or two seasons with very few flowering for 1 season less than 2 months. Climbers formed the largest proportion (37.50%) of bee plants foraged for one season less than 2 months.No climbers was foraged for three seasons or year round. 10% of the shrubs flowered year round. Its only shrubs and trees that flowered year round. Most of the bee plants flowered for two seasons and for one season greater than 2 months. Three season flowering pattern was observed in trees, shrubs and herbs.

IV. DISCUSSION

Highest proportion of bee plants were observed to flower in April (59.3%) May (44.81%) and June (41.86%). Eastern Mau is characterized by a trimodial rain pattern with the long and intense rains from April to June; Short rains in August; and short less intense rains from November to December (Langat et al., 2015). The peak flowering in the number of bee plants therefore coincided with periods of high precipitation. The number of flowering species were lowest in December (11.63%) characterized by less intense rainfall. This agrees with studies in Baringo (Vlek et al., 2014) where most bee plants bloomed with April/May rains and showers in August. In December , the least proportion of bee plants flowered, similar results were observed in Baringo by (Vlek et al., 2014) where only one species flowered out of the 20 bee plants recorded. There is a general scarcity of flowering during the hot, dry months of December to January while flowering of undergrowth plants eg *Pupalia lappacea* that beekeepers reported supplies bees with nectar when there is sufficiently heavy rainfall (Vlek et al., 2014). Less than average rainfall at the beginning of the year have been reported to reduce the number of plants that flower as well as the floral abundance (Dukku, 2013; Akunne et al, 2016). Most of the plants flowering during this time are reported to be perennial trees in similar studies in Arabuko Sokoke forest, Kenya. (Okoth, 2010).

The flowering time is determined by an interraction of genetic and environmental factors. Variation in water stress results in some local variation in flowering phenology, there is however not always a straightforward relationship between moisture and flowering as many other factors may come into play. More abundant flowering of insect pollinated speceis has been obserevd during the wet season in Indian dry tropical forest. This trend has also been observed with studies in

Costa Rica , where small trees and shrubs flowered mainly during the wet season. Need to avoid competition and to synchronise flowering with the availability of pollinators could be attributed to flowering during the dry season (Okoth, 2010). Waykar and Baviskar (2015) in studying bee plants in Nasik District India reported very few plants flowering during the summer period characterised with low precipitation and high temperatures as high as 35^0C. Similar trends were also reported by Dukku (2013) where 59% of the plants flower during the nectar flow period and 41% during the dearth period.

Pupalia lappacea, *Aloe secundiflora*, *Leucaena leucocephala*, *Malvaviscus arboreus*, *Acacia_brevispica*, *Vernonia auculifera*, *Acacia tortilis*, *Combretum molle*, *Eucalyptus resinifera*, *Olea europea* flowered during the month of December characterised by less precipitation and high temperatures as reported by Langat et al., (2015).*Acacia brevispica* and *A.tortilis* always have individuals in a right physiological state to flower about every second month whenever light showers fall by chance outside the regular rainy seasons of the year. *A.tortilis* is considered an important pollen plant in lowlands. Beekeepers in Baringo have considered *A. brevispica* and *A. senegal* as important bee plants, possibly based on frequent flowering (Vlek et al., 2014). Plants like *A.tortilis* have been observed to flower during dry season, in leafless stages and secrete considerable amount of nectar from stored carbohydrates of the previous season. Short and intermittent flowering patterns have also been observed by Nuru et al., (2017). The high preferences of honey bees towards *A.tortilis* may be attributed to infloresence which consists of relatively dense flowers and longer florets which may reduce the honey bee access to its nectar. The preference of honeybees towards different plant species has been attributed to the floral morphology and chemistry of nectar (Nuru et al., 2017). *Acacia* spp. flower even during the dearth period , the bloooms overlap and provide forage throughout the year. This is further even enhanced by its abundance (Dukku, 2013).

This study reported intermittent flowering in three seasons observed in 4 species :*Pupalia lappaceae*, *Hibiscus rosa-sinensis*, *Lantana camara* and *Pentaclethra mycrophylla*. Predominat flowering pattern (sub annual) was also observed with flowering occurrying more than once a year, often irregularly. Bee flora have in similar studies shown intermittent flowering eg four seasons for *Amaranthus hybridus* and some with flowering period as short as 2 weeks eg *Oldenlandria* spp (Okoth, 2010). 54.65% of the plants flowered for 1 season, 36.05% for 2 seasons, 4.65% 3 seasons, 4.65% for the whole year. These results are comparable to Waykar et al., (2014) where Flowering was observed up to period of 12 months. In this study 82 plant species (95.34%) flowered for at least 2 months. This is In agreement with studies of Arabuko sokoke by Okoth (2010) reporting up to 82 plant species (majority) flowering for a period of at least 2 months while upto 12 species including *Grewia bicolor*, *Lantana camara*, and *Hibiscus* sp flowered for at least 6 months.While Okoth (2010) reported 1 month flowering in *Oldenlandia* sp . , this study recorded upto 4 speceis flowering for only one month and no bee plant flowering for 4 seasons. Variation in seasonal ability has also been observed by Haragude et al., (2016) where *Hibiscus rosasinensis*, *Prosopsis juliflora*, and *Azadirachta indica* flowered throughout the year, in two different seasons and for only one month respectively.

7 *Acacia* speceies were recorded in this study: *A.brevispica*, *A.elatior*, *A.mellifera*, *A.polyacantha*, *A.tortilis*, *A.senegal* and *A.xanthophlea*. Their bloom was throughout the year with varying flowering periods ranginging from 3,5,6,7 to 12 months. This characteristic overlap of *Acacia* species have been reported in the past studies by Dukku (2013) reaffirming their importance in the family Fabaceae. The blooming of the Fabaceae, especially *Acacia* spp overlap providing forage throughout the year.They also flower concurrently but vary in terms of peak flowering within a season. All of these phenomena may be considered as adaptations by species to avoid competition for pollinators and minimise heterospecific pollen transfer among related species (Dukku, 2013). *Acacia mellifera*, *A.tortilis* and *A.brevispica*, among the 20 plants have been reported as important for nectar, pollen, and both nectar and pollen provision (Vlek et al, 2014). *A.brevispica* have been reported in both studies to flower all year round. The results of this study are comparible to results by Waykar and Baviskar (2015) as well as Larinde et al., (2014) reporting *Lantana camara* to have flowered for 5 months intermittently in 3 seasons; *Asystasia gangentica* and *Euphorbia hirta* flowering for relatively long periods (6 and 5 months respectively) and *Citrus lemon* flowering for 2 seasons. Vlek et al (2014) while studying the bee plants of Baringo reported most trees to be flowering between May and November. This is in contrast with the results of this study where at least 13 tree species were in bloom every month from January to September contributing the highest number proportion of bee plants.

In Arabuko sokoke 82 plant seceis were recorded as flowering for a period of at least 2 months. Only 18 species were crop species while the rest were secondary colonisers of the formerly forested regions. In the study it was noted that the farms were not planted regularly or at every possible opportunity so during some growing seasons, some farms were

fallow. This removed the possibility of crops growing and flowering more times during the year. 12 plant species showed resilience for flowering for over 6 months in a year, regardless of dry seasons and honey bees were observed foraging on all of them. Coconut tree the only crop flowering throughout the year. Reduced precipitation at the beginning of the year limits bloom as well as the floral abundance. Most of the plants flowering during this time are perennial trees. (Okoth, 2010). Studies by Larinde et al (2014) have also indentified *Aspilia* sp and *Tridax procumbens* to flower year round with everymonth there are different plant speceis that serve as pollen and nectar sources. Vlek et al (2014) while studying the bee plants of Baringo reported most trees to be flowering between May and November. Three plant speceis : *Euphorbia* sp, *Zizyphus macronata* and boscia sp flowered for only one month, no flowering of bee plants was observed in Januray while only one bee plant flowered in March and Decemeber.

V. CONCLUSION

Eastern Mau can support bee keeping year round as bee forage is available throughout the year, with bee plants flowering for at least a month to whole year. The peak availability of forage is in April and May (nectar flow period, 59.30%) while the Dearth period with limited bee forage is in December (10 bee plants flowering, 11.63%): *Pupalia lappacea*, *Aloe secundiflora*, *Leucaena leucocephala*, *Malvaviscus arboreus*, *Acacia_brevispica*, *Vernonia auculifera*, *Acacia tortilis*, *Combretum molle*, *Eucalyptus resinifera*, *Olea europea*. The seven *Acacia* spp provide successive bloom mosaic year round.Bee keepers should harvest their honey end of May which coincides with the end of honey flow period and also planting programs should be adopted for the plants that flower during the dearth period. The floral calendar should be translated to local plant names for further dissemination of floral calendar to the bee keeper Ogieks.

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