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Research Paper

Honey bee abundance, flora species composition and diversity for urban apiculture development opportunities in Dambi Dollo Town, Western Ethiopia

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Abstract

Urban apiculture is widely regarded as one of the finest methods for combating bee population loss, poverty, food insecurity and unemployment. A longitudinal field survey was used to assess honey bee abundance and flora diversity during peak honey bee flora blossoming time in Biftu, Dollo, Lafto and Yabelo sites of Dambi Dollo town. Field observation and targeted sweep netting methods were used to collect foraging honey bees. Managed honey bee colonies were sampled by apiary inspection and wild honey bee colonies were also recorded by colony census in all available and accessible nesting sites. For the honey bee flora, a 200 m long and 1 m wide transect plot was established and all trees, shrubs and herbs species found in the plot were recorded. The bees were observed while foraging on a total of 20 honey bee floral species. Totally, 2369 managed honey bee colony positive hives were observed in all sites with a relative abundance of 66.1%. Nine wild honey bee colonies were recorded with the highest abundance at Biftu (55.5%) followed by Dollo (33.3%). A total of 49 bee flora species belonging to 32 families were identified in the study area. The numbers of flora species were similar and generally evenly distributed among the local sites. In conclusion, Dambi Dollo town has an abundant bee fauna, floristic composition, and diversity for urban apiculture development. Further studies on mellissopalynology from pollen load and honey pollen analysis are recommended to establish floral calendar and monofloral honey in the area.

1. Introduction

Ethiopia has a huge apiculture development potential because of its endowment with diversity in climate and vegetation resources. The country has about 7,000 plant species which support foraging bees and other pollinators (Addisu et al., 2017). Ethiopia has the highest honeybee population in Africa which is estimated to be about 10 million bee colonies, out of which about 5 to 7.5 million are estimated to be hived while the remaining exists in the wild (Addisu et al., 2017; Kiros and Tekleberhan, 2017). Regardless of the high potentiality of the country for apiculture development, apiculture research conducted in the country so far has relied on rural areas and not managed to characterize and document the apicultural resources and associated constraints of the sector for its proper intervention and utilization in urban areas.

Urban apiculture is gaining popularity around the world and in Ethiopia as well. Urban settings have got attention for refuging apiculture resources (Sponsler and Bratman, 2021) because of landscape uniformity, habitat loss, and excessive pesticide usage in rural areas which diminish floral resource diversity; thus, rural regions are no longer ideal habitats for pollinators including honey bees (Montagnana and de Oliveira., 2020). Urban beekeeping is widely regarded as one of the best methods for combating the global bee

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population loss and beekeeping in cities is supporting appropriate development plans and laws; it is a key component of a long-term urban economy (Horst et al., 2017). Urban beekeepers may play an important role in supporting honey bee health through early detection of pests and pathogens and by preventing their spread by adhering to proper best management practices (Bolshakova and Nino, 2018). Apiculture development increases crop yield and maintains biodiversity and people want to live in environmentally friendly and sustainable environments where nature is fully incorporated with contemporary city infrastructure (Stevenson et al., 2020).

In Ethiopia, like in other developing countries, beekeeping is practiced to minimize urban and rural poverty and to help insuring food security. Most of the research done in the country focused on rural apiculture practices and honey production systems. For example, Haftu (2015) reported that even if the government of Ethiopia has given due attention to apiculture development as a means of poverty reduction and national exports diversification strategies, research couldn't address all possible aspects and areas to describe and document apiculture resources and associated constraints for proper intervention and utilization. Moreover, there has never been any scientific research or documentation to determine honey bee abundance and flora diversity in Dambi Dollo town. Honey bee abundance and bee flora diversity are very critical for the establishment of an apiary sites in apiculture development and honey production systems. Therefore, the present study intended to assess the honey bee abundance and flora diversity for urban apiculture development opportunities in Dambi Dollo town.

2. Materials and Methods

2.1. Description of the study area

The study was conducted in Oromia Regional State, Kellem Wollega Zone, Dambi Dollo Town, which is located at about 642 km from the Ethiopian capital, Addis Ababa. The town is the capital center for Kellem Wollega zone. It is geographically located between 8° 30' 07" and 8° 46' 24" N and 34° 46' 06" to 34° 50' 00" E. Dambi Dollo town is bounded by different rivers namely Laga Mexi in north, Laga Hidda in the East, Laga Lome in the south and Laga Borta in the west. These water bodies make Dambi Dollo town potential area for apiculture development. The town is comprised of four urban kebeles (the lowest administrative units) and all the kebeles, namely Biftu, Dollo, Lafto, and Yabelo, were considered for the study.

2.2. Study design and period

A longitudinal field survey was used from June to October 2022 during wet and peak honey bee flora blossoming time for assessing the abundance of foraging honey bee, managed and wild honey bee colonies and for estimation of bee flora abundance and diversity as well. The field survey for assessing relative abundance of foraging honey bees and its associated flora was conducted during peak flowering time of September and October 2022. This period was selected because the majority of honey bee flora species of the area flower during this period (Amsalu et al., 2020; Ofijan and Etenesh, 2023). Whereas sampling of managed honey bee (contained and owned by beekeepers in their apiaries in different hive technologies such as traditional, transitional and frame hives) and wild honey bee (freely available in the area) colonies via field survey from beekeepers' apiary, and wild bee nesting habitats were done every month during the wet season.

2.3. Sampling of foraging honey bees and managed and wild honey bee colonies

Field observation and targeted sweep netting method was used to collect foraging honey bees and for their forage inventory. Homemade sweeping net with standard size was used. The net was composed of a steel wire ring of 30 cm diameter and 140 cm long wooden handle and 48 cm long nylon cloth bag (ARS, 1986). Observations and targeted sweep netting were conducted for three hours, from 10 a.m. to 1 p.m., because the honey bees are active during these hours of the day. Targeted sweep netting and timed observations were conducted by a single collector using active search and net approaches. A transect length of 200 m and a width of 1 m were used. Four transect lines were randomly placed in each study site (kebele). A total of 16 transect lines of the same length and width were used. The distance between each transect was 100 m to avoid

double counting. The surveyor walked at slow speed and counted bees during an observational period of 45 min per transect line (Westphal et al., 2008). Since bees are flying animals, they were collected, counted, recorded and then the live bees were released after accomplishing the entire work per site. The standard field collection procedure of bees and other pollinator insects by transect line was applied.

At each study site, the forager bees and plants visited by the honeybees were observed simultaneously during flowering period of major bee forages in September and October 2022. During the field observations, the types of plants and their growth forms and the behavior of the honeybees, while collecting nectar and pollen, were noted. Foraging bee activities were observed including insertion of the proboscis to the corolla of flowers and the "pumping" movement of the abdomen when they are sucking nectar (Dema, 2022).

Sampling of managed honey bee colonies were done by observation of a sample of beekeepers' apiary, and recording colony status as positive and negative hives by hive types (traditional, transitional and frame hive). Sampling of local beekeepers was described in details elsewhere (Habtamu and Oljira, 2023). Whereas for wild colonies, colony census was conducted in all wild honey bee nesting habitats in each study site across the town. Wild honey bee colony nesting sources such as under house eaves, tree cavities and electric pools were surveyed by availability and convenient sampling methods.

2.4. Honey bee flora inventory and species diversity

Before starting bee flora field survey, a week-long reconnaissance survey of selected honey bee flora was conducted in all urban kebeles to obtain first-hand information about the study area. For the honey bee flora species composition and diversity estimation, a 200 m long and 1 m wide transect was established as described earlier. All trees, shrubs and herbs species found in the transect line were recorded with local names, and samples were collected, pressed, dried and brought to Dambi Dollo College of Teacher's Education, Biology Department herbarium for taxonomic identification. Moreover, life forms of the plants (trees, shrubs and herbs) were recorded, as when the height of plants exceeds 3 m considered as trees, as shrubs when they attained a total height of 1-3 m and plants below 1 m were considered as undergrowth or herbs in transects (Dema, 2022). The plant specimens were identified using the Flora of Ethiopia and Eritrea and the experts.

The Shannon-Wiener diversity index (*H'*) was used to calculate the species diversity and evenness of the honey bee flora in the study area. The index was calculated for each kebele by using the formula:

$$H' = -P_i(\ln P_i)$$

where *H'* is the Shannon-Wiener diversity index, P_i is the percentage of the total population of the ith species and ln is natural logarism.

Then, Shannon equitability index (E_H) was determined by:

$$E_H = \frac{H'}{H_{max}} = \frac{H'}{\ln S}$$

where *S* = observed number of species. Equitability assumes a value between 0 and 1 with 1 being complete evenness.

2.5. Data analysis

Statistical Package for Social Sciences (SPSS) version 21 was used for the analysis of quantitative data. Relative abundance of foraging honey bee was calculated by dividing the total number of bees observed visiting a single plant species divided by the total number of bees observed on all plant species multiplied by 100. To get relative abundance of managed honey bee colonies, total bee colony positive hives was divided by total hive observed for each hive type. Both qualitative and quantitative results were interpreted by descriptive statistics.

3. Results

3.1. Relative abundance of foraging honey bees

Forager bees, which are outdoor working sterile female bees (workers) that collect pollen and nectar, were observed while they were visiting flowers. A total of 13,176 foraging honey bees were collected by field observation and targeted sweep netting over the study period (Table 1). The honey bees were observed while

actively foraging on a total of 20 floral species, of which *Guizotias cabrascabra* (18.61 %) was the most frequently visited flora species by the foraging bees, followed by *Ocimum santum* (11.09 %). However *Carissa spindrum* was the least frequently visited flora species by the bees in the study setting. In Table 1, local names are provided because the end users are local beekeepers who know and use vernacular names of the plants and to rich the wider local community of the nation, other local names of the plants in English are added.

3.2. Relative and monthly abundance of managed honey bee colonies

Managed bee colonies, which are the entire castes (a queen, hundreds of drones and thousands of workers and their broods) per hive, were inspected in apiaries. Table 2 shows the relative abundance of managed honey bee colonies by hive type and location. Totally, 2369 honey bee colony positive hives were observed in all sites over the study period with a total relative abundance of 66.1 % and the rest 33.9 % were honey bee colony negative hives. Bee colonies in traditional hives were most abundantly observed from Yabalo (79.2 %), followed by Biftu (64.6 %), Lafto (55.3 %) and Dollo (51.3 %) in that order. Likewise, bee colonies in transitional hives were also most abundantly observed from Yabalo (75.7), followed by Lafto (70.0), Dollo (56.7 %) and Biftu (55.5 %). However, the bee colonies contained in frame hives were most abundantly observed from Biftu (65.6 %), followed by Dollo, Yaballo and Lafto, in that order.

Table 1: Relative abundance of foraging honey bees by their flora species

Vernacular Name	Local Name	Scientific Name	Growth form	Abundance (N)	Relative Abundance (%)
Hadaa	*Meche*	*Guizotias cabrascabra*	Herb	2,452	18.61
Mossobila	*Sikakibe*	*Ocimum santum*	Herb	1,461	11.09
Keelloo	Adeyabeba	*Bidens pachyloma*	Herb	1,456	11.05
Tuufoo	Meche	*Guzotia scabra.*	Herb	1,326	10.06
Baggee	*Kotign Hargi*	*Combretum paniculatum*	Shrub	1,320	10.02
Luusiniyaa	*Fosolia*	*Louisiana irises*	Herb	892	6.77
Baaqelaa	*Bakela*	*Vicia faba*	Herb	726	5.51
Atara	*Ater*	*Pisum sativum*	Herb	642	4.87
Cilaaddama	*Tenadam*	*Satureja paradoxa*	Herb	542	4.11
Nuugii	*Nug*	*Guitozia abyssinica*	Herb	467	3.54
Dinnicha	*Dinich*	*Solanum tuberosum*	Herb	462	3.51
Bakkaniisa	*Bisana*	*Croton macrostachyus*	Tree	362	2.75
Harangamaa	*kotign*	*Pterolobium stellatum*	Shrub	245	1.86
Raafuu	*Gomen*	*Brassica carinata*	Herb	243	1.84
Suufii	*Suf*	*Helianthus annus*	Herb	148	1.12
Kosorruu	*Sokoru*	*Acanthus sennii*	Shrub	125	0.95
Dabaaqula	*Duba*	*Cucuerbita pepo*	Herb	115	0.87
Dhummugaa	*Sensel*	*Justicia schimperiana*	Shrub	85	0.65
Zayituunaa	*Zeyituna*	*Psidium guijava*	Tree	82	0.62
Hagamsa	*Agem*	*Carissa spindrum*	Shrub	25	0.19

Table 2: Relative abundance of managed honey bee colonies by hive types and local site

Site	Hive type	Colony (n)		Relative abundance (%)
		Positive	negative	
Biftu	Traditional	475	260	64.6
	Transitional	61	49	55.5
	Frame	538	282	65.6
Dollo	Traditional	264	251	51.3
	Transitional	51	39	56.7
	Frame hive	210	200	48.8
Lafto	Traditional	119	96	55.3
	Transitional	112	48	70.0
	Frame	104	46	69.3
Yabalo	Traditional	210	55	79.2
	Transitional	106	34	75.7
	Frame	119	61	66.1
Total		2369	1411	62.7

Monthly abundance of managed honey bee colonies owned by the beekeepers is presented in Figure 1. The beekeepers owned more number of bee colonies in tradition hive from Biftu kebele followed by Dollo, Yabalo and Lafto, respectively (Figure 1(a)). However higher number of managed bee colonies were possessed by beekeepers in transitional hive from Lafto, followed by Yabalo, Biftu and Dollo (Figure 1(b)). With regard to possession of colony positive frame hive, higher number of bee colonies were owned by the beekeepers from Biftu, followed byDollo, Yabalo and Lafto during the study period respectively (Figure 1(c)).

3.3. Wild honeybee colony abundance

Wild honey bee colonies were observed at all sites, except Lafto (Table 3). Accordingly, the highest number (5) of wild honey bee colonies was observed at Biftu, followed by Dollo (3) and Yabalo (1). The wild honey bee colony nesting habitats were found to be underside of eave, electric pool, and tree cavities (Figure 2). To avoid the risk in counting, instead of collecting wild bees, census only was carried out; the wild bee colonies were searched for and counted.

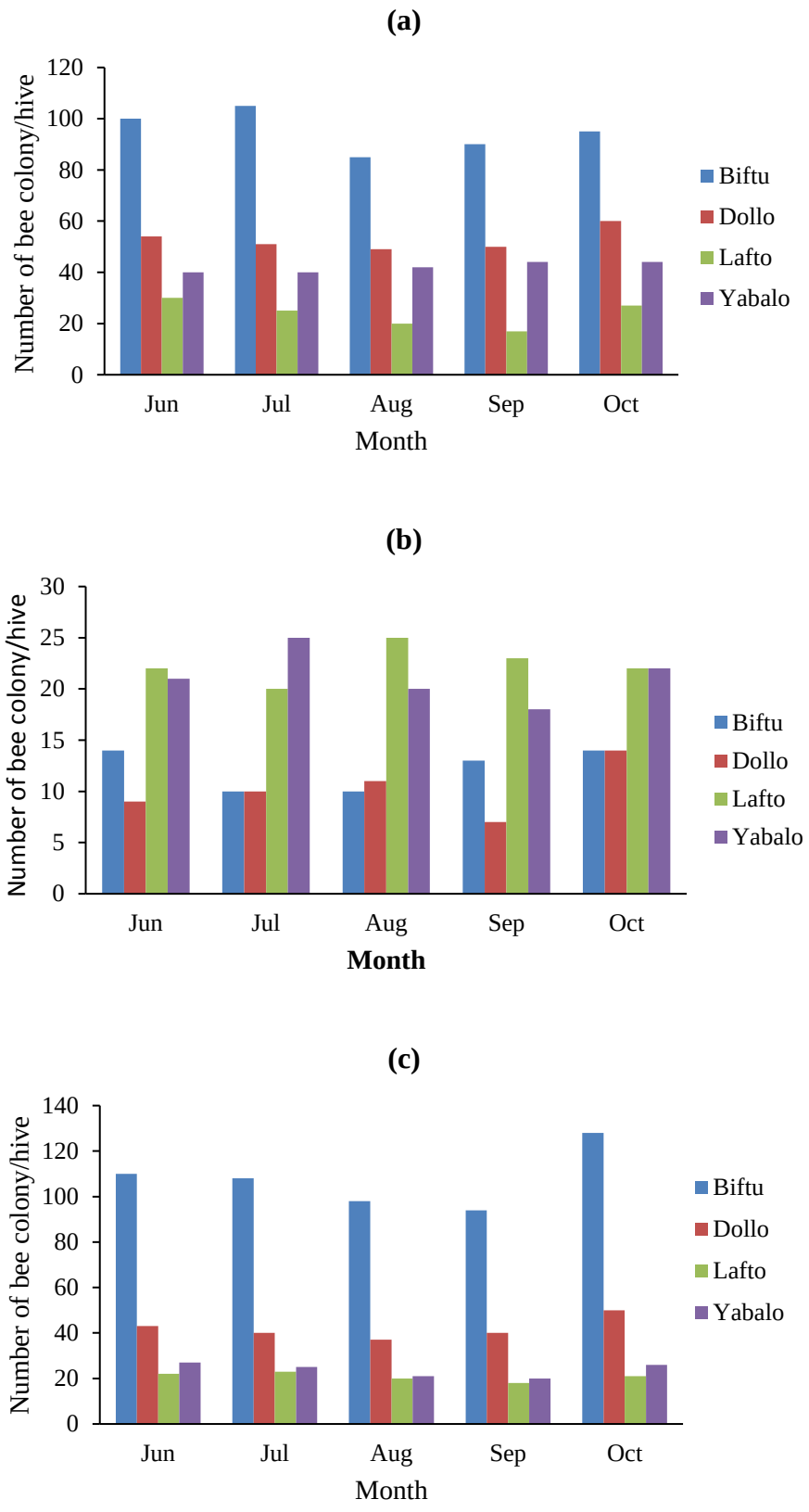

Figure 1: Monthly abundance of managed honey bee colonies in the four localities for (a) traditional hive, (b) transitional hive and (c) frame hive

Table 3: Number of wild honeybee colonies by study site

Site	Nesting site			Total bee colony
	Under eaves	Electric pool	Tree cavity	
Biftu	2	1	2	5
Dollo	1	0	2	3
Lafto	-	-	-	-
Yabelo	-	-	1	1

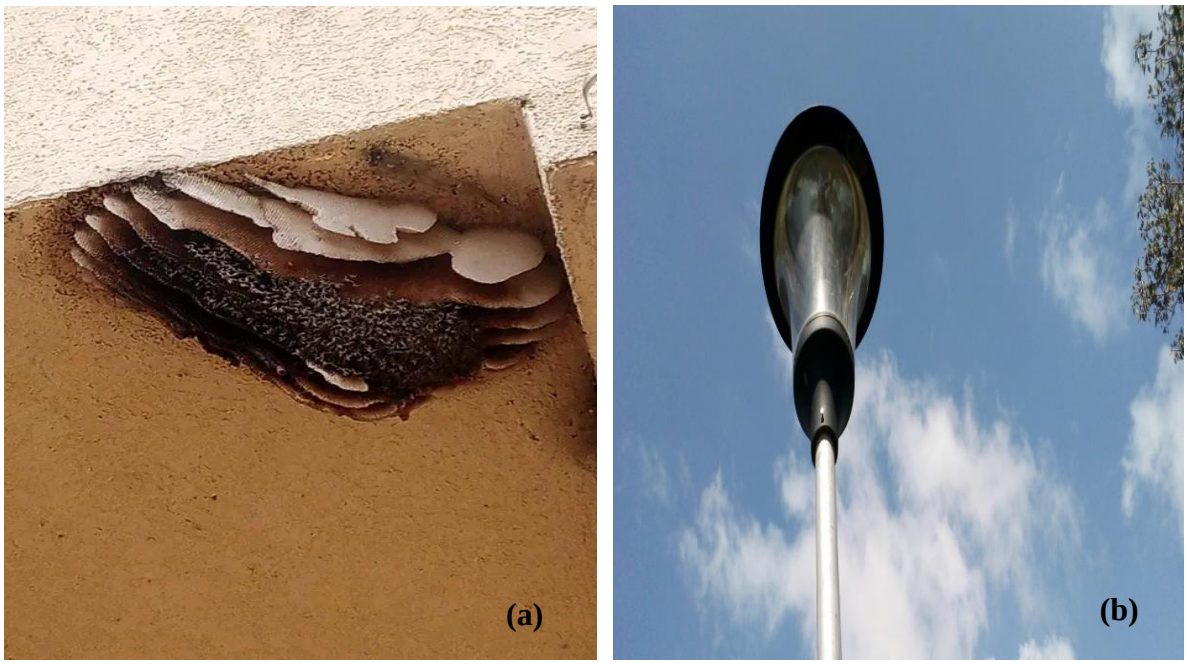

Figure 2: Typical wild honeybee colonies nesting under eave (a) and on an electric pool (b)

3.4. Honey bee flora species composition and diversity

From the field survey results via transect line and from respondents (beekeepers) via questionnaire, a total of 49 commonly grown bee flora species belonging to 32 families were identified and recorded from the study setting (Table 4). The leading families with 6 species each were *Fabaceae* and *Asteraceae*, followed by *Lamiaceae* with 4 species and *Acanthaceae*, *Meliaceae*, *Moraceae*, *Myrataceae*, and *Poaceae* each having 2 species in the study area.

3.5. Life forms of bee plants

The life forms of bee flora recorded by field observation from September to October showed that herbs represented the highest number of floristic composition, 65.0 %, followed by shrubs (25.0 %) and trees (10.0 %) (Figure 3(a)). However, the growth forms of the bee flora obtained from field inventory and respondents revealed that trees represented the highest number of floristic composition, 40.8%, followed by herbs (34.7 %) and shrubs (24.5 %) (Figure 3(b)).

3.6. Honey bee flora diversity

Table 5 shows the Shannon diversity indices for the bee flora species in Dambi Dollo town. Bee flora species diversity at Dollo site (3.268) was relatively higher than Biftu (3.258), followed by Lafto (3.221) and Yabalo (3.214), in that order. The number of species observed in the local sites were similar. However, the flora species were generally evenly distributed among the local sites.

Table 4: List of honey bee flora species in the study area

Vernacular Name	Local Name	Scientific Name	Family Name	Plant Habit	Flowering Season
Laaftoo	Nech Girar	*Acacia abyssinica*	*Fabaceae*	Tree	Mar-May
Sondii	Vachellia	*Vachellia labia*	Fabaceae	Tree	June-Aug
Kosorruu	Sokoru	*Acanthus sennii*	*Acanthaceae*	Shrub	Sep-Nov
Muka arbaa	Albizia	*Albizia gummifera*	*Fabaceae*	Tree	Mar-May
Odaa	Oda	*Apodytes Dimidiate*	*Metteniusaceae*	Tree	Sep-Dec
Niimii	Nim	*Azadirachta indica*	*Meliaceae*	Tree	Dec-Jan
Lolchisa	Bersama	*Bersama abyssinica*	*Francoaceae*	Tree	Nov-Dec
Keelloo	Adeyabeba	*Bidens pachyloma*	*Asteraceae*	Herb	Oct-Nov
Raafuu	Gomen	*Brassica Carinata*	*Brassicaceae*	Herb	Jun-Nov
Pappayyaa	Papaya	*Carica papaya*	*Caricaceae*	Tree	Sep-Nov
Hagamsa	Agam	*Carissaspindrum*	*Apocynaceae*	Shrub	Dec-Feb
Burtukaana	Birtukan	*Citrus aurantifalia*	*Rutaceae*	Tree	Sep-Dec
Buna	Buna	*Coffee Arabica*	*Rubiaceae*	Tree	Mar-May
Baggee	Areg	*Combretumpaniculatum*	*Combretaceae*	Shrub	Sep-Nov
Waddeessa	Wanza	*Cordial Africana*	*Boraginaceae*	Tree	Jun-Nov
Bakkaniisa	Bisana	*Croton macrostachyus*	*Euphorbiaceae*	Tree	Jun-Aug
Dabaaqula	Duba	*Cucuerbita pepo*	*Cucurbitaceae*	Herb	Sep-Nov
Somboo	Ekebergia	*Ekebergia capensis*	*Meliaceae*	Tree	Sep-Nov
Baargamoo	Bahirzaf	*Eucalyptus camaldulensi*	*Myrataceae*	Tree	Mar-Apr
Arbuu	Shola	*Ficus sur*	*Moraceae*	Tree	Sep-Dec
Qilxuu	Shola	*Ficus vasta*	*Moraceae*	Tree	Sep-Dec
Nuugii	Nug	*Guitozia abyssinica*	*Asteraceae*	Herb	Sep-Nov
Hadaa	Dawa	*Guizotias cabrascabra*	*Asteraceae*	Herb	Sep-Nov
Tuufoo	Dawa	*Guzotia sp.*	*Asteraceae*	Herb	Nov-Dec
Suufii	Suf	*Helianthus annus*	*Asteraceae*	Herb	Sep-Nov
Dhummugaa	Sensel	*Justicia schimperiana*	*Acanthaceae*	Shrub	Sep-Nov
Luusiniyaa	Lusona	*Louisiana irises*	*Iridaceae*	Shrub	May-Jun
Mango	Mango	*Mangifera indica*	*Anacardiaceous.*	Tree	Sep-Dec
Muuzii	Muz	*Musa paradisca*	*Musaceae*	Shrub	Sep-Oct
Mossobila	Mosobila	*Ocimum Santum*	*Lamiaceae*	Herb	Sep-Nov
Ejersa	Weyira	*Olea africana)*	*Oleaceae*	Tree	Apr-May
Avokaadoo	Avokado	*Persea Americana*	*Lauraceae*	Tree	Sep-Dec
Andoodee	Endod	*Phytolacca dodocandra*	*Phytolaccaceae*	Shrub	Sep-Nov
Atara	Ater	*Pisum sativum*	*Fabaceae*	Herb	Aug-Oct
Birbirsa	Birbirsa	*Podocarpus falcatus*	*Podocarpaceae.*	Tree	Sep-Dec
Urgessaa	Premna	*Premna schimperi*	*Lamiaceae*	Shrub	Jan-Mar
Zayituunaa	Zeyituna	*Psidium guijava*	*Myrtle*	Shrub	Mar-Apr
Harangamaa	Pterolobia	*Pterolobium stellatum*	*Fabaceae*	Shrub	Sep-Dec
Geeshoo	Gesho	*Rhamnus prinoides*	*Rhamnaceae*	Tree	Sep-Nov
Goraa	Enjori	*Rubus apetalus*	*Rosaceae*	Shrub	Sep-Nov
Cilaaddama	Tenadam	*Satureja paradoxa*	*Lamiaceae*	Herb	Sep-Oct
Saspaaniyaa	Saspaniya	*Sesbania*	*Fabaceae*	Tree	Jun-Aug
Dinnicha	Dinich	*Solanum tuberosum*	*Solanaceae*	Herb	Mar-Jun
Misingaa	Mashela	*Sorghum bicolor*	*Poaceae*	Herb	Sep-Dec
Baddeessaa	Dokima	*Syzygium guineense*	*Myrtaceae*	Tree	Aug-Dec
Reejjii	Verna	*Vernoia auriculifera*	*Compositae*	Shrub	Dec-Jan
Ebicha	Gorawa	*Vernonia amygedalina*	*Asteraceae*	Tree	Dec-Feb
Baaqelaa	Bakela	*Vicia faba*	*Papilionnoideae*	Herb	Aug-Nov
Boqqolloo	Bekolo	*Zea mays*	*Poaceae*	Herb	Jul-Oct

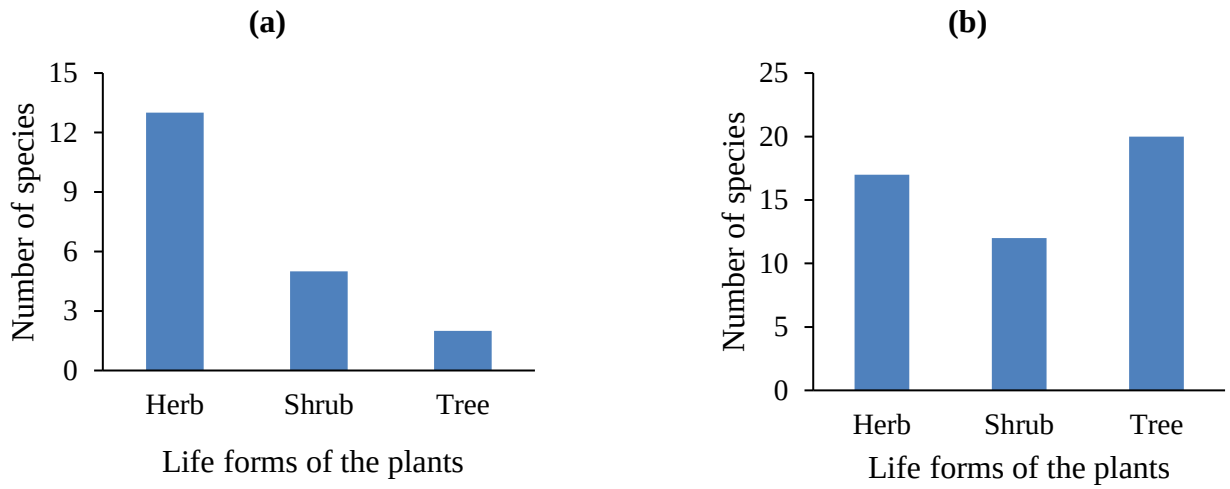

Figure 3: Life forms of bee plants obtained by (a) field observation of foraging honey bees in Sep. and Oct. and (b) conducting plant census via respondents from June to Aug.

Table 5: Shannon diversity index for bee flora species in Dambi Dollo town

Bee flora species diversity index	Site			
	Biftu	Dollo	Lafto	Yabelo
Number of individual plant (N)	14,791	9,592	6,932	9,969
Observed number of species (S)	49	49	47	49
Shannon diversity (H')	3.258	3.268	3.221	3.214
Shannon equitability (evenness) (E_H)	0.837	0.840	0.837	0.826

4. Discussions

A total of 13,176 honey bees were observed while foraging on a total of 20 floral species of which, *Guizotias cabrascabra* (18.61 %) was the most frequently visited flora species by the bees followed by *Ocimum santum* (11.09 %) in Dambi Dollo town. These findings are in line with the recent study by Ofijan and Etenesh (2023) who observed that herbaceous plants that flowered in the first season of the year from September to November were abundant bee forage resources in Kellem and West Wollega zones. The same authors also reported that *Asteraceae* and *Euphorbiaceae* to be the major pollen source plant families visited by foraging bees which were identified by pollen analysis in midland areas of Kellem and West Wollega zones, similar to the present findings. Unlike the previous study, the present study did not conduct pollen analysis from Dambi Dollo town and warrant further studies. The results of the study show that Dambi Dollo town hosts abundant foraging honey bee fauna especially during the major bee plant flowering season from September to October for urban beekeeping opportunities.

Greater relative abundance of managed bee colony positive hives was observed in the town as compared to colony negative hives. These would be expected because the apiary inspection survey was conducted during the wet season of the year (June to October) including bee flora flowering season. The colony negative hives observed in the town might be due to bee colony absconding (Yaregal and Oljira, 2020; Asrat et al., 2023). Managed honey bee colony decline and absconding is caused by colony management related and natural factors (Asrat et al. 2023). It was observed that during the summer season (June-August) some hives were empty. However, starting from the blossoming time of honey bee flora in September, the hives became positive and filled with honey bees. Although Dambi Dollo town owned abundant managed bee colonies during the study period, year round bee colony possession of local beekeepers and causes of honey bee colony decline and absconding need further studies.

Relative abundance of honey bee colonies contained in traditional, transitional and frame hives varied by location sites in the town. These results would be explained by local variations in environmental factors such as vegetation cover, availability of water bodies and other factors that positively and negatively affect honey bee fauna and flora. The results imply that the major apiary resource bases specifically flora and bee fauna are locally and focally distributed in the town and will determine apiary site selection.

A total of 49 bee flora species belonging to 32 families were identified and recorded, of which *Fabaceae* and *Asteraceae* were the most abundant bee forage resources in the study setting. These results are comparable with the works of Dema (2022), who recorded 48 plant species belonging to 33 families, of which *Fabaceae*, *Roseaceae* and *Asteraceae* were composed of higher number of bee forages in Gemechis Forest of West Hararge Zone in Ethiopia. Likewise, the present results are also comparable with a bee forage records of Tariku and Zerihun (2019) that reported a total of 47 bee flora species belonging to 30 families from Wondo Genet Forest in Southern Ethiopia. The comparative results of the present and previous studies evident that Dambi Dollo town alone has immense bee flora species comparable to the protected forest (Gemechis Forest) in western Hararge Zone and Wondo Genet Forest in Southern Ethiopia. Moreover, the number of bee flora species recorded in the present study is greater than the number of bee flora species identified from Guji Zone (Tura and Admassu, 2018) and North Wollo (Wubshet and Mebratu, 2024), but less than the number of bee flora species recorded from Gera forest of Jimma Zone (Tura and Admassu, 2019), East and Horo Guduru Wollega Zones (Amsalu et al, 2020; Amsalu and Tusa, 2023) and Southwest Jimma Zone (Tesfa and Hayat, 2023).

The life forms of bee flora recorded from September to October showed that herbs represented the highest number of floristic composition followed by shrubs, and trees. These results would be expected because this period is the major flowering season in Ethiopia when a higher number of flowering herbaceous plant species are observed due to the availability of moisture following the main rainy season, which lasts from June to August (Tariku and Zerihun, 2019; Tura and Admassu, 2019; Tesfa and Hayat, 2023). The dominance of herbaceous flora during September to October was also recorded in previous studies elsewhere in Ethiopia (Tura and Admassu, 2019; Amsalu et al., 2020; Asrat et al. 2023; Tesfa and Hayat, 2023; Wubshet and Mebratu, 2024).

However, the growth forms of the bee flora obtained from field inventory and the respondents revealed that trees represented the highest number of floristic composition, followed by herbs, and shrubs. In line with these results, previous reports indicate that trees were the most important source of bee forages, followed by herbs and shrubs (Amsalu et al. 2020; Amsalu and Tusa, 2023). The dominancy of trees is due to the protection and conservation of trees in home gardens for shade, horticulture, ornaments, hanging beehives for traditional beekeeping which might have contributed to the availability of a higher number of trees in urban Dambi Dollo areas.

Bee flora species diversity at Dollo site was relatively higher compared to the other sites but the flora species were evenly distributed among the local sites. This could be attributed to similarity of urban agro-ecology, urban landscape and plant species composition.

5. Conclusions and Recommendations

Abundant number of honey bees were observed while foraging on 20 floral species of which, *Guizotias cabrascabra* and *Ocimum santum* were the most frequently visited flora species in Dambi Dollo town in September and October. Higher number of managed bee colony positive hives was also observed in the town as compared to colony negative hives. Forty-nine bee flora species belonging to 32 families were identified and recorded of which *Fabaceae* and *Asteraceae* were the most abundant bee forage resources in the study setting. Generally, Dambi Dollo town has abundant foraging, managed and wild bee fauna and floristic composition and diversity for urban apiculture development.

Bee forage plant identification was based on field observation and beekeepers' experience and not on pollen analysis (Melissopalynology). Melissopalynology deals with the study of the botanical and geographical origin of honey by analyzing honey sediments such as pollen, spores and other fungal spores contained in honey samples (Dema, 2022). Thus, further

studies on mellissopalynology from pollen load and honey pollen analysis is recommended to establish floral calendar and monofloral honey in the urban area.

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