



Assessment of the melliferous potential and floristic diversity in the Tanoé-Ehy Marsh Forest (Southeastern Côte d'Ivoire).

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Abstract

This study aims to inventory and characterize melliferous plant species in the Tanoé-Ehy Marsh Forest (FMTE) and its surrounding to promote beekeeping and biodiversity conservation. The floristic inventory, conducted using plot-based and itinerant surveys, recorded 185 flowering plant species, including 121 melliferous species distributed across 45 families. The most represented families include Fabaceae, Rubiaceae, and Euphorbiaceae. Species richness varies according to vegetation types, with a predominance observed in cultivated fields, which contain 58 species. Melliferous plants are mainly nectar-producing species (45.45%), followed by pollen-producing species (31.40%) and nectar-pollen-producing species (23.14%). Analysis of foraging intensity shows a dominance of moderately visited species (40.50%). In addition, 27 high-value melliferous species were identified, characterized by prolonged flowering periods and strong attractiveness to bees. Woody species dominate the melliferous flora (80.1%), reflecting the forested nature of the ecosystem. These results highlight a high apicultural potential in the area, which could contribute to local socio-economic development as well as forest ecosystem conservation.

Keywords: Modern beekeeping, melliferous plants, forest zone, substantial income.

Introduction

Forests provide resources and services, and generate employment and income for approximately 2.5 billion people worldwide (FAO & UNEP, 2020). Recently, recognition of their importance for food security and nutrition has significantly increased (FAO, 2011; FAO, 2021b). Currently, forests and trees constitute both a foundation and a safety net for the survival of rural communities, while also offering natural resources that help reduce poverty, improve food security and nutrition, and strengthen ecosystem services such as the production of wild fruits, mushrooms, caterpillars, and honey (FAO, 2023). However, the strong pursuit of well-being through agriculture has exerted significant pressure on forest resources. This pressure has led to a drastic reduction in forest cover in favor of cash crops such as cocoa, coffee, rubber, and oil palm. In response, the State of Côte d'Ivoire has implemented several strategies aimed at ensuring the sustainable management of its remaining forest cover. Among these strategies, participatory approaches are increasingly favored due to their effectiveness in sustainable and efficient forest management. Thus, the promotion of alternative income-generating activities, combined with the valorization of natural resources at the local level, represents a strategic lever for sustainable management (Ahouandjinou et al., 2017). Indeed, modern beekeeping appears to be an activity capable of increasing household income, reducing deforestation, and promoting a significant population of pollinators beneficial both to the FMTE forest ecosystem and to surrounding agricultural crops (FAO, 2023; Ahouandjinou et al., 2017; Bradbear, 2010). Beekeeping refers to the set of techniques used for the rearing of bees with the aim of the rational exploitation of hive products such as honey, pollen, wax, propolis, and royal jelly (Nombré, 2003). The development of this apicultural sector requires several key studies, among which the inventory of melliferous plants remains very limited in Africa, and more specifically in Côte d'Ivoire (Iritié et al., 2014a). The few studies conducted on melliferous plants in Côte d'Ivoire to support the promotion of modern beekeeping as a source of sustainable

development include those by Coulibaly (2014), Iritié et al. (2014a), Kouassi et al. (2019), and Kouamé et al. (2020). Most of these studies have been carried out in savanna zones (northern Côte d'Ivoire) and in forest-savanna transition zones (central Côte d'Ivoire). Hence, the importance of the present study, which follows that of Kouamé et al. (2020) in the forest zone of Côte d'Ivoire and represents the first study conducted in the forested and swampy area of the Tanoé-Ehy Marsh Forest (FMTE). Moreover, there is virtually no beekeeping practice in the study area, except for a few traditional amateur beekeepers. This study will therefore provide local populations with essential information on melliferous plant species in the forest zone, while encouraging the adoption of modern beekeeping as a source of income and biodiversity conservation. According to Bradbear (2010), in tropical forests, savannas, mangroves, and temperate deciduous forests, many plant and animal species could not survive without bees.

Apart from a few mission reports on the FMTE (Adou Yao, 2007), as is the case for most swamp forests in Côte d'Ivoire (Kouamé, 2008), this vegetation type remains poorly documented in terms of its flora, and no study on its melliferous potential is known. This study aims to provide new data on melliferous plant species in order to sustainably valorize floral resources for the development of apiculture and biodiversity conservation. Specifically, the objectives are to :

- inventory and characterize melliferous plant species in the Tanoé-Ehy Marsh Forest and its surroundings;
- assess the apicultural potential of these plant species based on the resources they provide.

1. Materials and Methods

1.1 Location, climate, and hydrography of FMTE

Tanoé-Ehy Marsh Forest (FMTE) is located in the southeastern part of Côte d'Ivoire, between latitudes 5°05' and 5°15' North and longitudes 2°45' and 2°53' West. This forest (Voluntary

Nature Reserve) is surrounded by nine villages distributed across several administrative areas, including Noé (Saykro, Ehania-Tanoé, Kongodjan-Tanoé, Kadjakro, Yao-Akakro), Tiapoum (Atchimanou), and Nouamou (Nouamou, Dohouan, Kotoagnan). All the villages are in Tiapoum District (Figure 1). The climate is humid Guinean type, characterized by an average annual temperature of about 26 °C, ranging between 22 °C and 30 °C. Annual rainfall varies between 1,400 and 1,600 mm. The seasonal pattern includes a short dry season from

January to March and a long rainy season extending from April to December (Dibi et al., 2004). FMTE is a swamp forest belonging to the coastal sector, where accessibility is highly limited outside the dry season due to hydromorphic conditions. It is bounded to the west by the Ehy Lagoon and its various branches in the northwest and southwest, and to the east and southeast by the Tanoé River (Hauhouot, 2004). The hydrographic network of the forest consists of numerous channels originating from the Ehy Lagoon and tributaries of the Tanoé River, contributing to the permanently flooded nature of this ecosystem (Dibi et al., 2004).

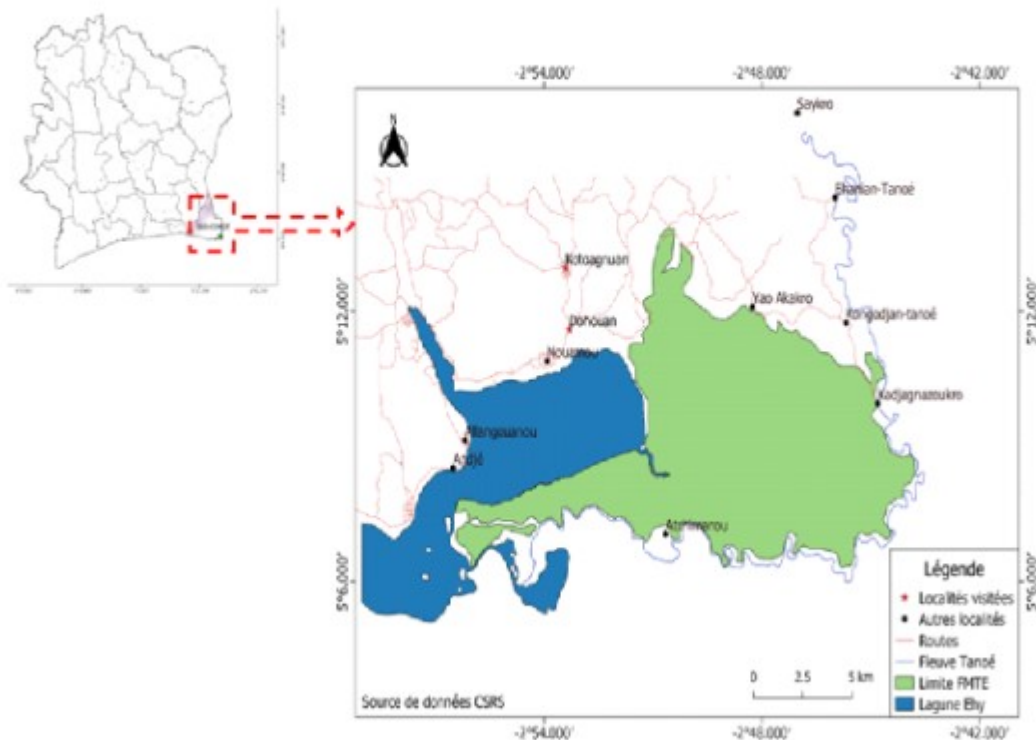


Figure 1: Location of the study area

1.2. Inventory of melliferous plant species

Data collection was carried out through direct field observations. This method, which is both effective and commonly used, allows for the identification of plant species visited by bees

(Nombré, 2003; Yédomonhan, 2009a; Coulibaly, 2014; Kouassi et al., 2019). The inventory was conducted using a combination of plot-based sampling and itinerant surveys. The plot-based method is a floristic inventory technique that consists of recording taxa found within square,

rectangular, or circular sampling areas in order to collect the maximum number of species (Kouamé, 2009). For this study, rectangular plots of 500 m² (20 m × 25 m) were established both at the periphery and inside FMTE. The plots were systematically distributed within an observation zone of 1 km radius around the apiary in order to maximize the recording of melliferous plant species, while maintaining an inter-plot distance of 200 m.

Within each plot, all plants bearing flower buds, open flowers, or senescent flowers visited by bees were identified and recorded. Observations were carried out with the naked eye or, when necessary, using binoculars. The collected data focused on the type of resource collected by foraging bees and the foraging rate of each plant species. Floral resources were identified based on bee foraging behavior. Thus, plants were classified as pollen-producing when bees were observed forming visible pollen loads in their hind leg corbiculae. Conversely, plants were categorized as nectar-producing when foragers were seen inserting their proboscis into the flowers to extract nectar (Yédomonhan, 2009a). Plants were classified as nectar–pollen producing when both behaviors were observed.

Species providing other resources beyond floral products (nectar and pollen), such as sugary sap, resin, or honeydew, were also considered melliferous. In such cases, bees were observed landing on plant organs producing these resources and collecting them directly, as described by Coulibaly (2014).

The melliferous importance of each plant species was assessed through its foraging rate (FR) by bees, which depends on the quality and quantity of resources provided. This rate reflects the foraging preferences of bees (Guinko et al., 1987). It was estimated for each melliferous species as the percentage of flowers visited by foraging bees during a 10-minute observation period, relative to the total number of flowers on the plant, as recommended by Coulibaly (2014). In addition, the itinerant survey consisted of systematically walking through the study area in all directions in

order to record species not captured during plot-based sampling.

1.3. Data analysis

The diversity of melliferous plant species was assessed using species richness (SR). Species richness represents the total count of species identified within a specific area (Aké-Assi, 1984). This measurement includes all species present in each habitat, regardless of their individual numbers, and is analyzed across the species, genus, and family levels. In this study, species richness involves both flowering flora and melliferous flora, following the classification of Cronquist (1981). To accurately evaluate the melliferous potential of the study area, the identified species were categorized based on the specific resources harvested by foragers. Thus, three categories of melliferous plants were distinguished: nectar-producing species (providing only nectar), pollen-producing species (providing only pollen), and nectar–pollen-producing species (providing both nectar and pollen).

According to Janssens et al. (2006), the melliferous potential of a region depends on its richness in nectar-producing plants. Based on the foraging rate (FR) of species, three classes of foraging intensity (FI) were adopted. Following the methodological approach of Yédomonhan (2009a), Coulibaly (2014), and Kouassi et al. (2019) in Benin and Côte d'Ivoire, this classification categorizes species based on bee foraging behavior. These species are grouped into the following classes:

- Class A: weakly visited species ($0 < FR < 5\%$);
- Class B: moderately visited species ($5 \leq FR < 10\%$);
- Class C: highly visited species ($FR \geq 10\%$).

To evaluate species richness across sampled vegetation types, a one-way analysis of variance (ANOVA) followed by Tukey's test was performed. The significance level for all analyses was set at 5% ($p = 0.05$).

2. Results

2.1 Diversity of melliferous flora

Field investigations made it possible to record 185 flowering plant species, among which 121 species were identified as having melliferous potential. These species are distributed across 91 genera and 45 families. The genera with the highest species richness are *Clerodendrum*, *Combretum*, and *Pavetta*, each comprising four (4) species. These are followed by the genera *Dalbergia*, *Ficus*, and *Trichilia*, each represented by three species. At the family level, the most dominant are Fabaceae (15 species), Rubiaceae (12 species), Euphorbiaceae (11 species), and Verbenaceae (8 species). Considering the surveyed vegetation types, melliferous flora richness varies from 30 to 58 species. The highest richness was recorded in cultivated fields, with 58 melliferous plant

species, representing 48% of the total diversity. In contrast, the lowest richness was observed in upland forest areas, with 30 species (25%).

Furthermore, floristic diversity indices indicate moderate diversity at the study site, as evidenced by a Shannon index of 1.14 bits. Across vegetation types, cultivated fields show the highest melliferous diversity ($1.36 \pm 0.37a$). However, analysis of variance revealed a significant difference among the mean Shannon indices of the three vegetation types ($F = 6.4$; $p < 0.01$). Regarding Pielou's evenness index, the value for the entire site (0.82) indicates a good distribution of melliferous individuals among species. The analysis of variance shows no significant difference ($F = 1.12$; $p = 0.33$) among the mean Pielou indices of the different vegetation formations.

Tableau I: Quantitative diversity of melliferous species in the apiary

Vegetation types	Diversity indices	
	Shannon (H)	Pielou (E)
Cultivated fields	1.36 ± 0.37^a	0.87 ± 0.86^a
Flooded forest	1.16 ± 0.54^{ab}	0.79 ± 0.19^a
Upland forest	0.91 ± 0.43^b	0.81 ± 0.30^a
Entire site	1.14	0.82
Statistique test	$F=6.4$; $P < 0.01$	$F=1.12$; $P=0.33$

For the same index, values followed by the same letter are not significantly different at the 5% level (Tukey's test).

2.2. Morphological types of melliferous flora surrounding the apiary

The melliferous flora of the entire study area is dominated by lianas, which account for 30.6% of the total species (Figure 2). They are followed, in decreasing order, by trees (26.4%), shrubs

(23.1%), and herbs (19.9%). At the level of vegetation formations, trees are the most dominant life form in the flooded forest (39.6%) and in the upland forest (43.3%). In cultivated fields, herbs are the dominant form, representing 39% of species, while trees are the least represented, with 10.3%.

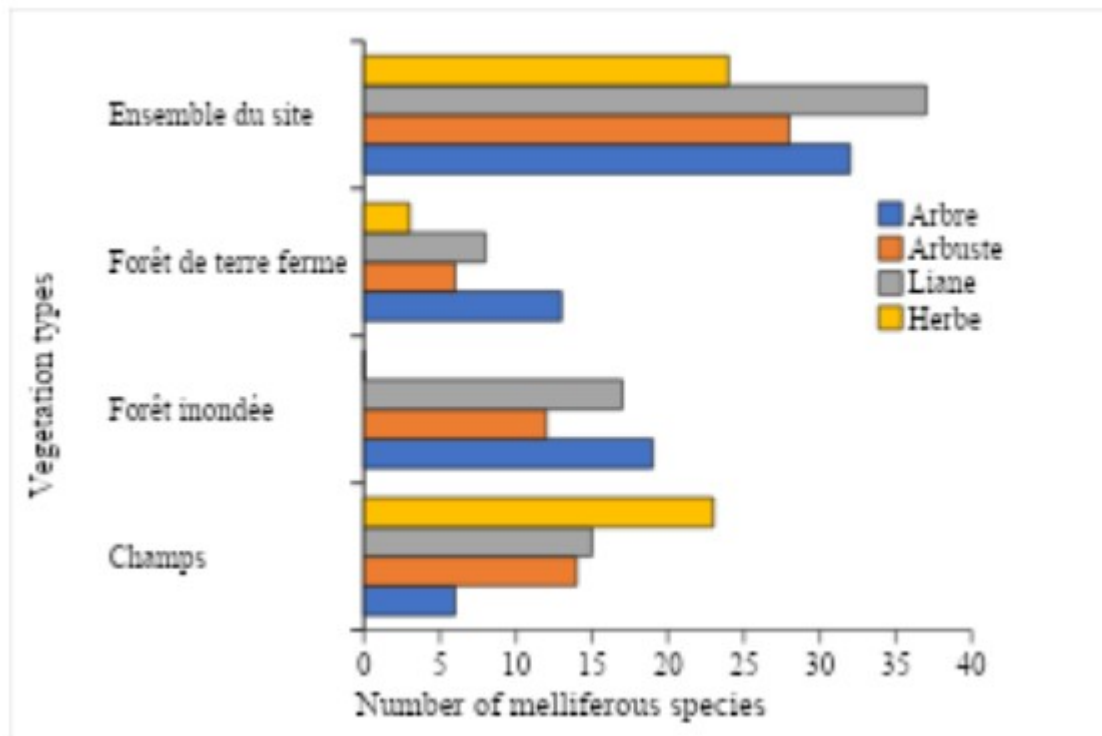


Figure 2 : Distribution of melliferous plant species according to morphological types across vegetation formations (traduire en anglais)

2.3. Floral resources collected by melliferous bees

The floral resources collected by melliferous bees consist mainly of nectar (N), pollen (P), and both nectar and pollen (NP) (Figure 3). Across the study area, bees primarily forage for nectar on 55 species, comprising 45.45% of the total melliferous flora (*Dialium aubrevillei*, *Heisteria parvifolia*, *Landolphia hirsuta*, *Margaritaria discoidea*, *Mondia whitei*, *Ocimum basilicum*, *Rauwolfia vomitoria*, etc.). They also collect

pollen from 38 species (31.40%), including *Ageratum conyzoides*, *Albertisia cordifolia*, *Elaeis guineensis*, *Emilia praetermissa*, *Mimosa invisia*, *Palisota hirsuta*, *Phyllanthus amarus*, *Sida acuta*, *Uapaca paludosa*, *Zea mays*, *Mitracarpus hirtus*, among others. Finally, 28 species (23.14%) provide both nectar and pollen, such as *Anthocleista nobilis*, *Aspilia africana*, *Ludwigia abyssinica*, *Momordica charantia*, *Secamone afzelii*, *Spermacoce latifolia*, *Spermacoce verticillata*, *Talinum triangulare*, and *Trichilia megalantha*.

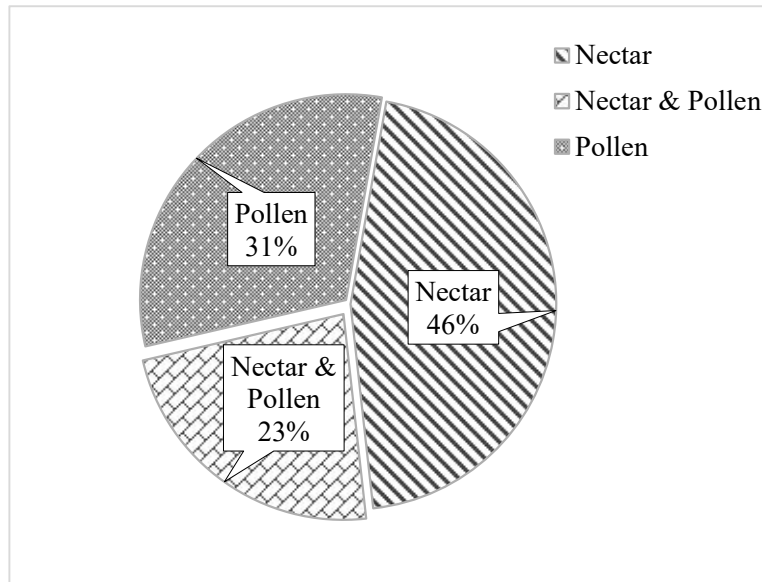


Figure 3 : Distribution of the types of floral resources collected by bees

Analysis by habitat type shows that nectar is the dominant floral resource harvested in cultivated fields (43.10%), flooded forests (50%), and upland forests (50%). Pollen follows as the second most exploited resource, accounting for 34.48% of visits in cultivated fields, 25% in flooded forests,

and 33.33% in upland forests (Figure 4). The combined nectar-pollen resource is the least harvested in cultivated fields (22.41%) and upland forests (16.67%), whereas in flooded forests, its collection frequency equals that of pollen (25%).

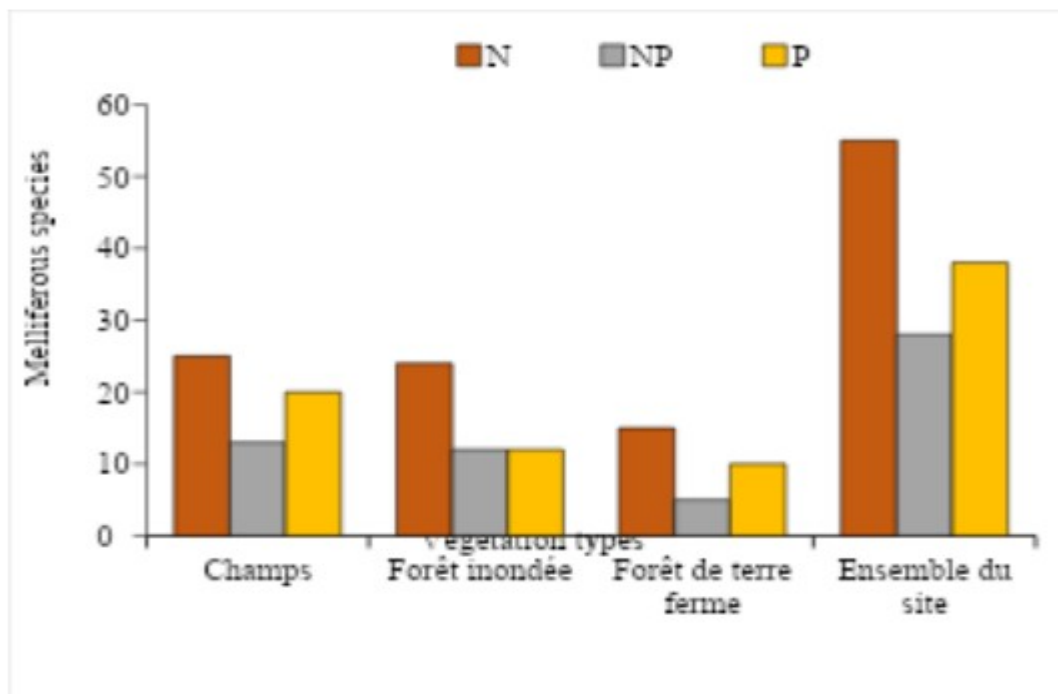


Figure 4 : Distribution of melliferous plants according to the harvested nutrient
N : nectar, P : pollen, NP : nectar-pollen

2.4. Foraging intensity of melliferous species

The melliferous species in the study area were classified according to their foraging intensity by honey bees (Figure 5). Three foraging intensity classes were defined: Class A includes lightly foraged species; Class B consists of moderately foraged species; and Class C comprises highly foraged species. Overall, the melliferous species in the study area are predominantly moderately foraged (Class B), with 49 species, representing 40.50% of all melliferous species recorded. They are followed by lightly foraged species (Class A), with 37 species (30.58%), and highly foraged species (Class C), with 35 species (28.93%). Regarding vegetation formations, moderately and highly foraged species are dominant in cultivated fields, each represented by 22 species (37.93%). In flooded forest areas, lightly foraged species are dominant with 19 species (39.58%), whereas in upland forest, moderately foraged species prevail with 16 species (53.33%). Overall, the study area is dominated by moderately foraged species (Class B).

- Class A melliferous species include *Anthocleista nobilis*, *Berlinia grandiflora*, *Conyza bonariensis*, *Cyperus iria*, *Dialium aubrevillei*, *Grewia barombiensis*, *Mondia whitei*, *Parinari excelsa*, *Ricinodendron heudelotii*, *Tieghemella heckelii*, among others.
- Class B melliferous species include, among others, *Aloe buettneri*, *Chromolaena odorata*, *Dialium guineense*, *Entada abyssinica*, *Erythrophleum ivorense*, *Ficus exasperata*, *Hymenocardia acida*, *Ipomoea mauritiana*, *Dalbergia oblongifolia*, and *Momordica cabrae*.
- Class C melliferous species include *Dracaena ovata*, *Pavetta corymbosa*, *Centrosema pubescens*, *Cocos nucifera*, *Uapaca paludosa*, *Elaeis guineensis*, *Blighia sapida*, *Adenia cissampeloides*, *Combretum racemosum*, *Talinum triangulare*, *Zea mays* (Figure 6), among others.

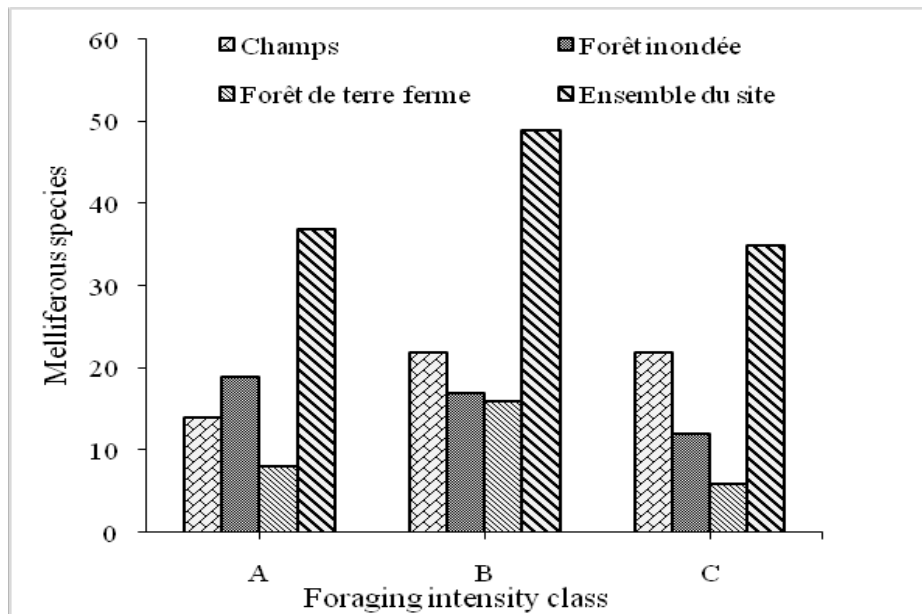


Figure 5 : Distribution of melliferous plants based on foraging intensity (traduire en anglais)
 Class A : lightly foraged, Class B : moderately foraged, Class C : highly foraged.



Figure 6 : View of a bee foraging on *Zea mays*

2.5. Plant species of high melliferous value

Based on the combined criteria of flowering duration and foraging intensity, 27 species (22.31%) of the melliferous flora flower continuously for at least two months and are intensely foraged (Class C). These species constitute the primary floral resources of high apicultural value identified within the apiary's foraging range. In terms of life forms, they consist of phanerophytes (23 species, 46% of the melliferous flora) and therophytes (4 species, 8%). This selection is equally distributed between woody plants (trees and shrubs) and herbaceous plants, with 12 species each, representing 44.44% respectively. These species are identified as follows :

- Twelve (12) exclusively pollen-producing species (22.22%), such as *Zea mays*, *Uapaca paludosa*, *Sida acuta*, *Elaeis guineensis*, *Croton hirtus*, *Cocos nucifera*, *Dracaena ovata*, *Emilia praetermissa*, *Manihot esculenta*, *Mitracarpus hirtus*, *Palisota hirsuta*, and *Sarcocephalus latifolius*;
- Nine (9) exclusively nectar-producing species (33.33%), such as *Asystasia gangetica*, *Blighia sapida*, *Tectona grandis*, *Stachytarpheta cayennensis*, *Blighia welwitschii*, *Combretum comosum*, *Combretum paniculatum*, *Rauvolfia vomitoria*, and *Stachytarpheta jamaicensis*;
- Six (6) nectar-pollen producing species (22.22%), such as *Talinum triangulare*, *Spermacoce verticillata*, *Spermacoce latifolia*, *Ceiba pentandra*, *Adenia cissampeloides*, and *Albizia zygia*.

2.6. Forest melliferous species found in the study area

Among the 121 melliferous species recorded in the study area, 73 are typical forest species. They represent 60.33% of the melliferous flora of the site. These species are primarily foraged for their nectar (25.62%), secondly for both nectar and pollen (20.66%), and lastly for pollen only (14.05%). They are distributed across 36 families and 61 genera. The most represented families are Rubiaceae (8 species), Verbenaceae and Fabaceae (6 species each), Asteraceae and Mimosaceae (4

species each), and Euphorbiaceae, Meliaceae, and Passifloraceae (3 species each). These species include, among others, *Adenia lobata*, *Albertisia cordifolia*, *Baphia nitida*, *Berlinia grandiflora*, *Blighia welwitschii*, *Combretum racemosum*, *Conyza bonariensis*, *Croton hirtus*, *Dalbergia altissima*, *Dalbergia ecastaphyllum*, *Dracaena ovata*, *Elaeis guineensis*, *Sarcocephalus latifolius*, *Secamone afzelii*, *Sida acuta*, *Spermacoce latifolia*, etc.

Discussion

The study area is rich in melliferous potential, with 121 plant species identified as having melliferous value. This number is close to that reported by Fohounfo (2002) in southern Benin (120 species). However, it is considerably higher than the results obtained by Dongock et al. (2004) in the Sudano-Guinean zone of Cameroon (78 species) and Kouamé et al. (2020) in the Guinean zone of Côte d'Ivoire (48 species). Conversely, it remains lower than the findings of Bakenga et al. (2002), who recorded 147 melliferous species in the Bukavu region of South Kivu (Congo). This lower richness may be explained by differences in sampled habitats. Indeed, the inventories conducted by these authors covered a wide range of environments such as crop fields, fallows, home gardens, bushes, and urban shrublands, whereas our study was carried out at the forest edge. Variations in melliferous species richness between studies can be primarily attributed to divergent floristic compositions and phytogeographical regions, as well as discrepancies in honeybee foraging behavior and sampling protocols. Melliferous species in the study area represent 65.41% of the flowering flora. This proportion is higher than the 35.49% and 39.63% reported respectively by Kouassi (2019) and Coulibaly (2014). This high percentage reflects a less selective composition of melliferous species in the study area. Consequently, honeybee activity is strongly influenced by the availability of these plants. According to De Layens & Bonnier (1997), plant selection by bees depends on flower morphology,

phenology, floral composition, and the geographical region concerned. The study site therefore presents strong apicultural potential as well as significant ecological value in terms of ecosystem services provided by the local vegetation. These findings highlight the importance of promoting sustainable apiculture development and conservation of floral resources in the area. The most dominant melliferous plant families are Fabaceae, Rubiaceae, Euphorbiaceae, Verbenaceae, Asteraceae, Apocynaceae, and Combretaceae. The high dominance of Euphorbiaceae and Rubiaceae reflects the characteristic floristic composition of the Guinean zone (Yédomonhan, 2009b). Furthermore, according to Guinko et al. (1992), Fabaceae are among the botanical families with high melliferous value. Therefore, their prevalence in the study area represents a significant floristic advantage for honey production. In addition, the predominance of Asteraceae results from habitat disturbance caused by agricultural practices and bushfires occurring during the dry season. Indeed, Bakenga et al. (2002) and Fohounfo (2002) reported that in agricultural regions, melliferous species are often dominated by Poaceae and Asteraceae families. At the level of vegetation formations, crop fields are the most diverse in melliferous species. The high availability of these species in cultivated areas represents a major advantage for promoting apiculture in the study area, since over 90% of the world's major crops are visited by bees (IPBES, 2016). This situation supports good beekeeping practices around FMTE area due to the abundance of pollinators. According to Yédomonhan (2009a), the open structure of such habitats facilitates bee movement. However, high species diversity in open habitats does not imply exclusive bee pollination, as wind pollination is more pronounced in open environments than in closed formations, where wind movement is reduced (Whitehead, 1969).

The distribution of melliferous plants according to morphological type across the study area shows that woody species (lianas, trees, and shrubs) are the most abundant, accounting for 80.1%. This result is consistent with finds of Ahouandjinou et al. (2021), who reported that the same morphological types represented 55.75% of melliferous species in their study area. However, it differs from the findings of Dongock et al. (2004) in Cameroon, who highlighted the dominance of herbaceous species with 36.5%. The predominance of woody species in the study area is certainly a major advantage for beekeeping activities. Indeed, woody plants generally have a higher melliferous potential than herbaceous species (Coulibaly, 2014), as their flowers produce larger quantities of resources (nectar and pollen). This dominance suggests a primarily perennial melliferous flora, in contrast to herbaceous species, which tend to be annual and more susceptible to seasonal fluctuations. Our study also revealed that melliferous plants in the area are mainly foraged for their nectar (45.45%). This suggests a strong apicultural potential, since, according to Janssens et al. (2006), honey production in a given region depends on the abundance of nectar-producing plants. Our results are also similar to those of Coulibaly et al. (2019) in Côte d'Ivoire and Koudégnan et al. (2024) in Togo, who reported a predominance of nectar-producing species with 45% and 60% of melliferous plants respectively. However, they differ from those of Iritié et al. (2014a), who reported a dominance of nectar–pollen producing species in Yamoussoukro (Côte d'Ivoire). This difference is probably due to environmental influences, as nectar production is highly climate-dependent (De Layens & Bonnier, 1997; Fluri et al., 2001a; 2001b). Thus, a plant species that was once attractive to bees may become less so due to the presence of better alternatives in the environment (Cabannes & Lagacherie, 2003).

The flowering duration of melliferous species is an important aspect in the study of plant resources in an area, as it ensures continuous availability of floral resources, which is essential for the survival

of pollinators as well as for optimizing beekeeping activities. In this study, 78.51% of melliferous species flowered for at least two months. This value is lower than the 99.21% reported by Kouassi (2019). According to this author, this difference may be explained by the frequency of observations. Indeed, the longer the observation interval, the lower the likelihood of recording the flowering of certain species, especially those that are less abundant.

The foraging intensity of a plant helps highlight its importance and attractiveness to bees. In the study area, only 28.93% of species were highly foraged by bees, while 40.50% were moderately foraged. The foraging rate of a nectar-producing species depends on the quality and quantity of nectar it produces (Mokkapati et al., 2025). Regarding quality, bees only forage flowers whose nectar sugar content exceeds 15% (Philippe, 1991). In addition to quality, nectar must also be available in sufficient quantity. According to several authors (Philippe, 1988, 1991; Crane, 1990; O'Toole & Raw, 2004; De Layens & Bonnier, 1997; Fluri et al., 2001a, 2001b), nectar production depends on multiple factors such as climate, soil, altitude, latitude, genetic factors, and the plant's health condition. Foraging activity is also a good indicator of nectar production, as the more nectar is harvested, the more its production is stimulated by the plant (Jean-Prost, 2005; Crane, 1990). Therefore, maintaining strong bee colonies is essential. Nectar production is thus a complex phenomenon influenced both by the plant itself and environmental factors.

Conclusion

The Tanoé-Ehy Marsh Forest (Forêt des Marais Tanoé-Ehy) has exceptional floristic diversity, with several hundred plant species, among which 121 species are identified as having melliferous potential. Considering floral resources, nectar-producing species are the most frequently foraged by bees, accounting for 45.45%. Pollen-producing

species represent the second group, with 31.40%, while plants providing both nectar and pollen simultaneously (23.14%) are the least represented in terms of foraging preference. The overall floristic assemblage is dominated by lianas (30.6%), followed by trees (26.4%), shrubs (23.1%), and herbs (19.9%). Regarding foraging intensity, most melliferous species belong to Class B (moderately foraged), with 49 species, representing 40.50% of the total. Phytogeographical analysis shows that 73 species (60.33%) of the recorded melliferous flora are typical forest species. These species are primarily foraged for nectar only (25.62%), followed by both nectar and pollen (20.66%), and lastly pollen only (14.05%). Overall, the floristic richness combined with habitat diversity (swamp forests, upland forests, and peripheral areas) gives the study area strong apicultural potential, while also playing a key role in the conservation of tropical ecosystems.

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