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Germination potential of the soil seed bank in Yapo-Abbé classified forest, Côte D'ivoire

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This study, conducted in the Yapo-Abbé classified forest in southern Côte d'Ivoire, assessed the potential for natural regeneration from the soil seed bank. A total of 800 plots of 1 m², distributed across different biotopes, were sampled to a depth of 0 to 20 cm, and the soil samples were subsequently germinated under controlled conditions. Ninety-seven species were recorded. High germination densities were observed for pioneer species such as *Cecropia peltata* and *Musanga cecropioides*. Species like *Discoglypremna caloneura* and *Milicia excelsa*, although represented by only three seed trees per hectare, produced 6,927 and 1,929 seedlings per hectare, respectively. Conversely, species such as *Strombosia glaucescens* and *Uapaca esculenta*, despite being well-represented in seed trees, produced no seedlings. The main commercial species (*Milicia excelsa* and *Terminalia ivorensis*) exhibited low regeneration densities from the soil seed bank. Seed dispersal was primarily facilitated by wildlife. These results indicate the existence of an important ecological reservoir ensuring forest resilience, while highlighting potential scarcity risks for certain commercial species. In the context of climate change and anthropogenic pressures, the study recommends conservation, preservation of microhabitats, and regular monitoring of the soil seed bank.

Key words: Côte d'Ivoire, germination, soil seed bank, regeneration, Yapo-Abbé classified forest.

INTRODUCTION

Forest ecosystems cover approximately 4.06 billion hectares, representing about 31% of the land area of world (Food and Agriculture Oraganisation [FAO], 2020). They maintain ecosystems through the provision of a wide range of ecosystem services, such as climate regulation through carbon sequestration, biodiversity consevation, and the supply of natural resources (Bonnesoeur et al., 2019). Regarding tropical forests, they are home to more than 90% of the world's plant biodiversity, making them critical réservoirs of global biodiversity (Lewis et al., 2015). However, these tropical ecosystems are subject to strong anthropogenic pressures. The annual rate of deforestation in the tropics was estimated at 9.3 million hectares between 2025 and 2020, up from 7.8 million between 2010 and 2015 (FAO, 2020).

In West Africa, particularly in Côte d'Ivoire, forest cover degradation is dramatic. The forest area of this country has decreased from approximately 16 million hectares in the 20th century to less than 2.97 million hectares in 2021, a loss of more than 80% (République de Côte d'Ivoire [RCI],

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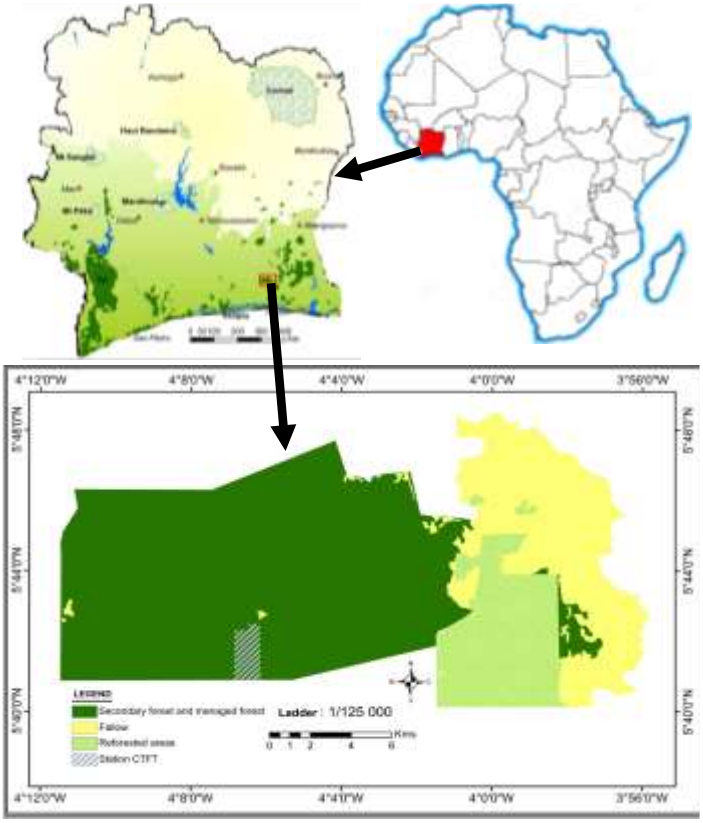

Figure 1. Location of the study site.
Source: SODEFOR (1999).

2024). This deforestation is due to population growth, agricultural expansion, and illegal logging (Kouassi et al., 2021). The southeast and southwest regions, which constituted the densest forest areas in the country, were the most impacted by this deforestation (Koaumé et al., 2020). According to these authors, today, the few remaining forests are mainly contained in classified forests, protected areas and reserves, such as the Yapo-Abbé classified forest. This forest, despite its protected status, has not escaped human pressures. Its proximity to the urban centres of Abidjan and Adzopé, which host several timber industries, has greatly contributed to the intensive exploitation of its timber resources. These activities have led to significant degradation of the natural flora and plant structure, thus compromising the ecological resilience of the Yaopo-Abbé classified forest ecosystem.

In this context of worrying degradation, the reconstitution of natural forests through natural regeneration mechanisms appears to be a sustainable ecological strategy. Thus, the natural regeneration capacity of a forest depends on the bank of viable seeds in the soil and their germination potential (Dalling et al., 2020). The study of this seed bank makes it possible to assess the ecological resilience potential of a degraded forest and to develop appropriate restoration strategies. Accordingly, this study aims to contribute to the knowledge of the natural regeneration potential of the Yapo-Abbé classified forest through the evaluation of the seed bank of native plant species present in its soil. The general objective is to assess the forest's capacity for floristic recolonization through natural germination, thereby supporting the sustainability management of its forest resources. The specific objectives are to:

i) Assess the floristic composition of the forest floor soil seed bank;
ii) Determine the germination potential of this soil seed bank;
iii) Characterize the mode of dissemination of diaspores from the soil seed bank of this classified forest.

MATERIALS AND METHODS

Study area

The Yapo-Abbé classified forest, covering an area of 28,790 ha, is located in the south-eastern Côte d'Ivoire, within the Agboville department, Azaguié sub-prefecture. It lies between latitudes 5°40' and 5°48' north and longitudes 3°95' and 4°15' west (Figure 1). This forest has a remarkable ecological diversity, structured into four main biotopes: secondary forest, managed forest enriched with commercial species, reforested area of timber species, and fallow land. Among these, the secondary forest remains the most

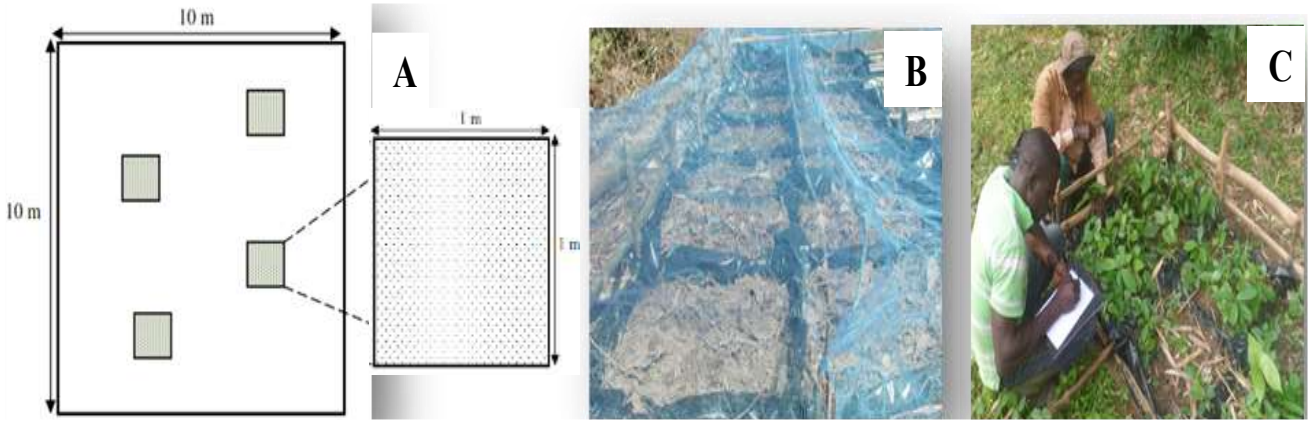

Figure 2. Data collection methods: a) study plots, b) storage of soil samples taken, and c) inventory of germinated species. Source: Konan (2016).

representative in both surface area and floristic richness (Kouamé et al., 2023). The climate is sub-equatorial, characterized by four distinct seasons: a long dry season from December to February, a long rainy season from March to June, a short dry season in July to August, and a short rainy season from September to November. According to Société d'Exploitation et de Développement Aéroportuaire, Aéronautique et Météorologique (SODEXAM, 2024), the mean annual temperature over the period 2010 to 2023 is 27°C, with annual rainfall ranging from 1,200 to 1,800 mm. The relief is moderately undulating, dominated by small hills with gentle and shallow slopes (Société de Développement des Forêts [SODEFOR], 1999). The soils in the Yapo-Abbé classified forest are characterized by a horizon rich in coarse elements, composed particularly of quartz gravels, reflecting ancient pedogenesis on a crystalline basement (Yao et al., 2022).

Approach

Two main approaches are used to assess the germination potential of each soil seed bank. The first is physical extraction of seeds by flotation and sieving, followed by careful direct sorting with a binocular magniflying glass and chemical viability test, such as the tetrazolium test. The second approach is based on the direct germination of seeds from soil samples, protected by a mosquito net to prevent any external introduction of seeds (Shemsedin and Mekuria, 2020). In the present study, due to the lack of adequate equipment for seed viability testing and a seed bank for species identification, the method of direct germination under mosquito nets was adopted. The experimental setup consisted of 200 plots of 100 m², each subdivided into 100 plots of 1 m². Within each plot, four subplots were selected, and soil samples were collected from a depth of up to 20 cm, for a total of 800 soil samples (Figure 2A to C). Each soil sample was placed in a 50 × 50 × 20 cm bag, covered with a 1 mm mesh net to exclude external seed inputs (Padonou et al., 2022).

The bags were maintained in situ under controlled conditions and monitored regularly over a 12 months period. During this period, all germinated seedlings were inventoried and counted immediately upon émergence as well as at later stages. At each sampling, both edaphic and biological parameters potentially influencing germination were recorded. These included soil color (using Munsell's code), soil texture, biotope type (secondary forest, enriched forest, reforested area or fallow), and vegetation canopy (closed, semi-open, open). These factors, long recognized as determinants of plant dynamics, are increasingly being studied for their combined effects on seed germination (Gandía et al., 2022).

Data processing and analysis

Floristic richness of the soil seed bank germination potential

Floristic richness of the soil seed bank was evaluated by counting the number of germinated species. The taxon identification of seedlings was established using a published tropical flora (The Plant List, 2023) and by comparisons with the National Herbarium of Côte d'Ivoire reference collections. The present methodological approach allows to estimate species diversity in the soil seed bank, a fundamental parameter for the understanding of the dynamics of natural regeneration of forest ecosystems (Bossuyt and Hermy, 2001).

Correlations between germinated species and the forest flora

In order to assess the degree of relationship between the germinated species and the existing flora of the Yapo-Abbé classified forest, a linear regression analysis was performed to evaluate the relation level between the germinated species and the flora of Yapo-Abbé classified forest. Regression analysis is a statistical method for modeling and predicting the value of a variable Y from a variable X (Legendre and Legendre, 2012). For the purposes of this study, X is the number of plant species recorded in the classified forest, while the variable Y corresponds to the number of species that germinated from the soil seed bank. This analysis is based on the hypothesis that the floristic composition of the Yapo-Abbé classified forest can be an indicator of the species likely to regenerate from the soil seed bank. However, the reverse is not always valid, as the seed bank may contain species absent from the current vegetation, due to differences in seed phenology, dispersal or persistence (Gioria et al., 2021). The use of simple linear regression was considered appropriate since it allows the assessment of quantitative relationships between two continuous variables.

The resulting regression equation provides a predictive tool to estimate the number of germinated species (Y) from the number of species observed in the forest (X), thereby enabling interpretation and comparison between the standing vegetation and the regeneration potential stored in the soil.

Density of woody seedlings and seed trees in the Yapo-Abbé classified forest

The average density of seedlings derived from sprouted woody

Table 1. List of dissemination modes of species based on Densereaux and Lems (1957).

Method of dissemination	Diaspores types	Characteristics
Zoochory plants (relating to animal dispersal)	Sarcochorous plants	Fleshy indehiscent diaspores
Anemochory plants (related to wind dispersal)	Sclérochorous plants	Relatively lightweight, non-fleshy diaspores
	Ptérochorous plants	Diaspores bearing wing-like appendages
Autochory plants (relating to the mother plant dispersal)	Ballochorous plants	Dry or fleshy diaspores dispersed by the parent plant

species in the soil seed bank was assessed based on the number of seedlings recorded per sampled bag and per inventoried species. The values obtained were then extrapolated to the number per hectare for each biotope. The seedling density was evaluated according to the formula: N = n/s; with N as the average density, expressed in seedlings/ha; n is the total number of seedlings germinated in the biotope and s is the total area sampled in the biotope. This method, commonly used in studies of natural regeneration and stand dynamics (Boubacar et al., 2019), makes it possible to quantitatively assess the potential for in situ regeneration. It also allows comparisons of the spatial distribution of species across different environmental settings.

Modes of dissemination of diaspores of sprouted woody species

The mode of dissemination of the diaspores of species that germinated from the soil seed bank of the Yapo-Abbé classified forest was assessed through the identification and classification of dispersal syndromes. The typology of Dansereau and Lems (1957) was used. This typology distinguishes three dispersal types: anemochory (dispersal by wind), zoochory (dispersal by animals) and autochory (dispersal by the plant itself) (Table 1). The dispersal mode of species provides valuable insights into the presence and spatial distribution of seeds that successfully germinate from the soil seed bank in different forest biotopes.

Influence of environmental parameters on germination of soil seed bank species

The influence of environmental parameters on the germination of soil seed bank species was assessed using Canonical Correspondence Analysis (CCA). Introduced by Ter Braak (1986), CCA is a multivariate statistical method that explores the relationships between floristic composition and environmental variables, allowing the identification of ecological factors driving species distribution within a given ecosystem. In soil seed bank studies, CCA is particularly relevant for highlighting how environmental gradients affect germination patterns. Previous work (Wossar et al., 2022) has successfully applied this approach to evaluate the impact of biotope characteristics, canopy cover, topography, soil texture, and soil color on seed bank species' germination dynamics. This study used CCA to provide a deeper understanding of the complex interactions between plant species and their environment, contributing to improved strategies for ecosystem management and biodiversity conservation.

Statistical tests

The different parameters were analyzed using an analysis of variance (ANOVA) followed by mean comparisons tests, in order to determine whether significant differences existed between the biotopes. The significant level was set at $\alpha = 0.05$. Differences were considered statistically significant for $p < 0.05$ and not significant for $p \geq 0.05$. This analysis was carried out with version 7.1 of the XLSTAT software.

RESULTS

Floristic richness of the soil seed bank germination potential

The analysis of the floristic richness of the soil seed bank in the Yapo-Abbé classified forest revealed a total of 97 plant species, comprising 31 woody species, 32 liana species and 34 herbaceous species. Species distribution between biotopes showed that 70 species were recorded in the secondary forest. Within the managed forest, 60 species were recorded, with a predominance of woody forms. In total, 35 species were invetored, including 17 woody species and 25 species recorded in reforested areas (Table 2). These results indicate that the flora from germinated soil seed bank is more diverse, particularly in terms of woody species representation.

Relationship between germinated species and the flora of the classified forest

The evaluation of the relationship between germinated species from the soil seed bank and the flora of the Yapo-Abbé classified forest, using linear regression (Figure 3), shows no significant fit of the scatter plots to the regression lines, regardless of the biotope. The regression equations obtained were : $y = -38.9x + 2760$; $R^2 = 0.002$ (secondary forest), $y = -300.6x + 4917.7$; $R^2 = 0.0008$ (managed forest), $y = - 289.4x + 6283.6$; $R^2 = 0.02$ (reforested area) and $y = 85.8x + 4100.8$; $R = 0.04$ (fallow). In all cases, the coefficients of determination (R^2) are much lower than 1, indicating an absence of correlation between the number of germinated species and the density of the corresponding seed trees. These results suggest that seed germination from the soil seed bank is largely independent of the current structure of the tree vegetation in this classified forest. In other words, natural regeneration from

Table 2. Species richness of the germinable soil seed bank.

Variable	Total number of species	Number of woody species	Number of liana species	Number of herbaceous species
FC Yapo-Abbé	97	31	32	34
Secondary forest	70	25	19	26
Managed forest	60	23	14	23
Fallow	35	17	8	10
Reforested area	25	9	7	9

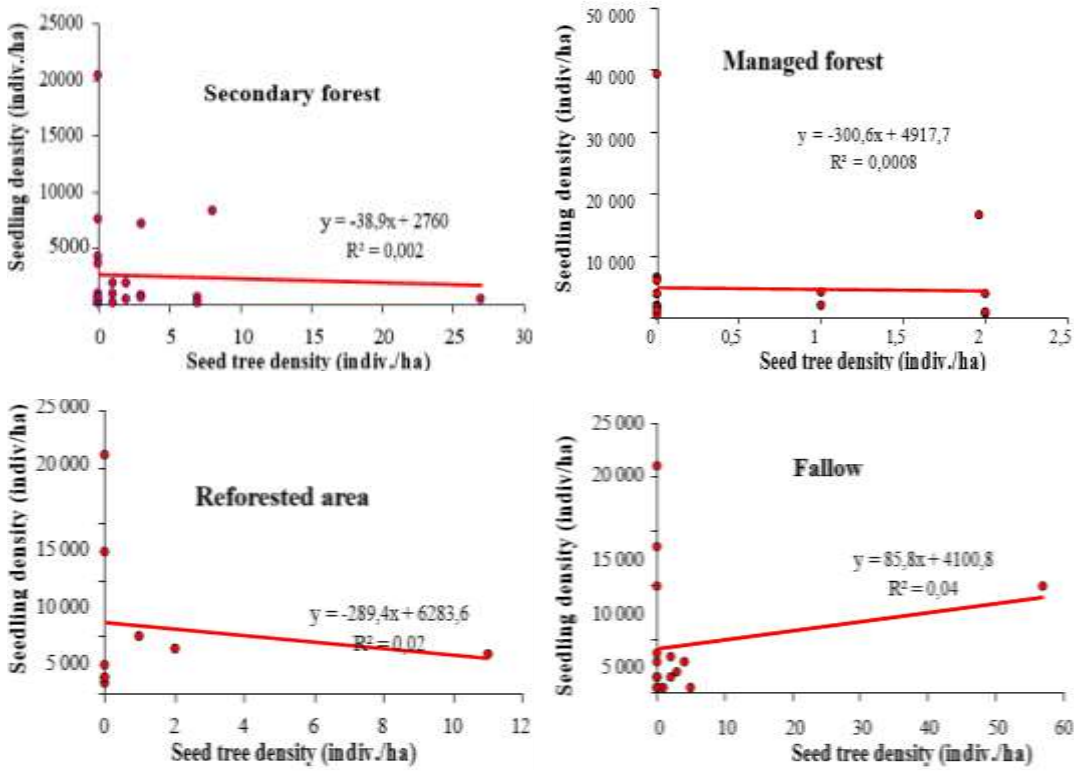

Figure 3. Linear regression plots of the density of germinated species as a function of the categories of their seed trees.

the soil seed bank does not directly reflect the current floristic composition of the classified forest.

Density of woody seedlings and seed trees in the Yapo-Abbé classified forest

The analysis of the densities of the 31 woody species, both from the soil seed bank and seed trees, across the different biotopes of the Yapo-Abbé classified forest reveals a strong dominance of pioneer species. *Cecropia peltata* is the most abundant, with 39,250 seedlings/ha from the soil seed bank in the managed forest biotope, 21,000 seedlings/ha in reforested areas and fallows, and 20,431 seedlings/ha in secondary forest. It is followed by *Musanga cecropioides*, with 15,500 seedlings/ha in the managed forest and 11,224 seedlings/ha in the secondary forest ; and *Macaranga barteri*, with 13,533 seedlings/ha in fallows. Interestingly, some species with low seed tree densities (< 3 trees/ha) nevertheless have high densities of seedlings from the soil seed bank. This is the case of *Discoglypremna caloneura* (6,927 seedlings/ha), *Milicia excelsa* (1,929 seedlings/ha), *Xylopia aethiopica* (1,927 seedlings/ha) and *Canarium schweinfurthii* (877 seedlings/ha) in the secondary forest soils.

A similar trend is observed in the managed forest biotope (Table 3). Conversely, certain species that are well represented in seed trees did not produce any seedlings.

Table 3. Woody seedlings density of germinated species and seed trees (ind./ha).

Species	Secondary forest		Managed forest		Reforested area		Fallow	
	Seedling density	Seed trees density	Seedling density	Seed trees density	Seedling density	Seed trees density	Seedling density	Seed trees density
Strombosia glaucescens	526	27	-	34	-	-	-	1
Musanga cecropioides	11 224	8	15 500	2	4 000	2	9 800	57
Terminalia ivorensis	701	7	6 500	-	-	-	1 400	2
Uapaca esculenta	175	7	-	5	-	1	-	-
Cleistopholis patens	789	3	4 000	1	-	4	-	4
Discoglypremna caloneura	6 927	3	4 000	1	-	2	-	1
Zanthoxylum gilletii	701	3	3 750	2	-	-	467	5
Milicia excelsa	1 929	2	3 750	-	-	4	-	13
Parinari excelsa	526	2	-	1	-	-	-	1
Canarium schweinfurthii	877	1	2 000	-	-	2	467	1
Xylopia aethiopica	1 929	1	2 000	1	-	1	1 867	3
Xylopia villosa	88	1	500	2	-	4	-	2
Anthocleista vogelii	263	-	-	-	-	-	-	8
Antiaris africana	877	-	1 500	-	5 000	1	2 800	-
Baphia nitida	351	-	-	-	-	-	1 400	-
Cecropia peltata	20 431	-	39 250		21 000	-	21 000	-
Elaeis guineensis	-	-	-	-	-	-	3 267	2
Ficus sur	-	-	750	-	-	-	467	-
Harungana madagascariensis	4 209	-	3 750	-	-	-	467	-
Klainedoxa gabonensis	-	-	2 000	1	-	2	-	-
Macaranga barteri	7 541	-	6 250	-	1 000	-	13 533	-
Macaranga spinosa	701	-	250	-	-	-	-	-
Microdesmis keayana	614	-	-	-	1 500	-	1 400	-
Myrianthus libericus	-	-	-	-	1 500	-	1 400	-
Phyllanthus discoideus	175	-	1 750	-	-	-	3 733	-
Piptadeniastrum africanum	-	-	1 500	-	2 500	-	-	-
Rauvolfia vomitoria	263	-	1 250	-	-	-	-	-
Ricinodendron heudelotii	351	-	1 500	-	3 500	11	2 800	4
Trema guineensis	3 683	-	1 000	-	-	-	9 800	-
Trichilia monadelpha	614	-	6 000	-	12 500	-	-	-
Xylopia quintasii	-	-	750	-	-	-	-	-

Notable examples include *Strombosia glaucescens* (34 trees/ha) and *Uapaca esculenta* (5 trees/ha) in the managed forest. Furthermore, species of high commercial value, such as *M. excelsa* and *Terminalia ivorensis*, generally display low seedlings densities in the soil seed bank.

Modes of dissemination of diaspores of sprouted woody species

The analysis of diaspore dissemination modes of sprouted woody species in the soil seed bank of the Yapo-Abbé classified forest reveals three main modes (Figure 4): zoochory (animal-mediated dispersal), anemochory (wind dispersal), and autochory (self-dispersal). Among these, zoochory is by far the most dominant across all studied biotopes, accounting for 82% of the soil seed bank in managed forest, 81% in secondary forest, 80% in fallow land, and 69% in reforested areas. Anemochory is next, with proportions ranging from 33 to 23%. Autochory is the least represented (0 to 8%). These results show that diaspore dispersal in the Yapo-Abbé classified forest is mainly ensured by animals, thus highlighting their crucial rôle in the natural regeneration of woody species.

Influence of environmental parameters on germination of soil seed bank species

CCA was used to assess the influence of environmental parameters on the germination of woody species from the

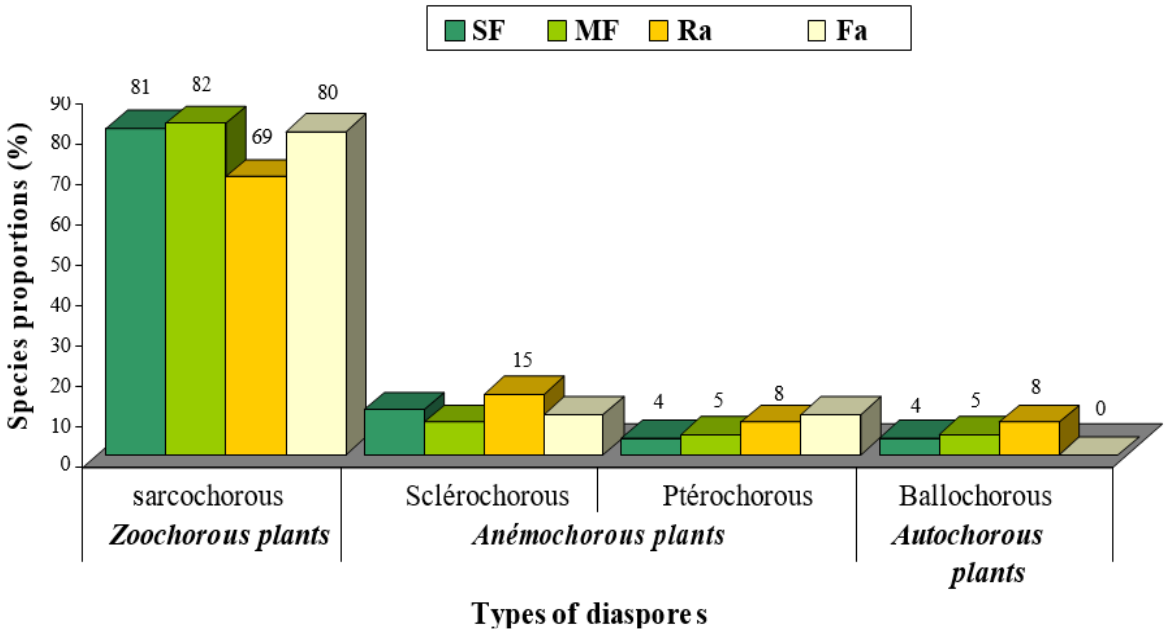

Figure 4. Distribution of the different types of diaspores of germinated species according to the mode of dissemination. SF: Secondary forest; MF: Managed forest; Ra: Refoested area; Fa: Fallow.

soil seed bank of the Yapo-Abbé classified forest. This analysis distinguished four ecological groups of species (Figure 5).

Group 1 consists of species whose germination is favoured by brown soils under closed canopy conditions, typical of secondary forests. This group includes *S. glaucescens*, *C. schweinfurthii*, *U. esculenta*, *Oxyanthus racemosus*, *Klainedoxa gabonensis*, *Parinari excelsa*, *Microdesmis kaeyana*, *Xylopia quintasii*, *X. aethiopica* and *Piptadeniastrum africana*.

Group 2 includes species whose germination is conditioned by loose, reddish soils under slightly open canopies, as in the managed forests biotope. These include, for exemple, *Anthocleista vogelii*, *Phyllanthus discoideus*, *Zanthoxylum gilletii*, *M. barteri*, *Bridelia micrantha*, *Rauvolfia vomitoria*, *Ficus sur*, *Xylopia villosa*, *M. excelsa*, *Antiaris africana*, *T. ivorensis* and *Ricinodendron heudelotii*.

Group 3 includes species whose germination is linked to open habitats, particularly fallows and reforested areas. These are *C. peltata*, *M. cecropioides*, *Myrianthus libericus* and *Cleistopholis patens*.

Group 4 includes species whose germination is associated with gravelly soils; namely, *Trema guineensis*, *Harungana madagascariensis*, *Trichilia monadelpha*, *Baphia nitida* and *D. caloneura*.

These results indicate that soil texture and colour, vegetation cover (canopy) and biotope type are the main determining factors of germination success for woody species from soil seed bank in the Yapo-Abbé classified forest.

DISCUSSION

The evaluation of the germination potential of the soil seed bank in the Yapo-Abbé classified forest revealed 97 germinated plant species, comprising woody, liana, and herbaceous forms. This diversity is comparable findings from other West African natural forests, such as the Kadé and Neun forests in Ghana, which contained 96 and 147 species in their soil seed banks, respectively (Hall and Swaine, 1980). Such floristic richness appears to be closely linked to the ecological conditions of secondary and managed forest biotopes, where favorable climatic and edaphic factors enhance both the persistence and germination of seeds throughout much of the year (Bitignon et al., 2020). Although the soil seed bank has a rich flora, the floristic similarity between the germinated species and the vegetation of the Yapo-Abbé classified forest remains low. This result is consistent with the work of Li et al. (2017), who reported that a soil seed bank rarely accurately reflects the composition of the surface aboveground vegetation. Data from Huang et al. (2020) also highlight that the structure and composition of soil seed bank are strongly influenced by the ecological circumstances and history of anthropogenic actions of the environment.

Observation of seedlings density from the soil seed bank and seed trees highlights that some species, such as *D. caloneura*, *M. excelsa*, *C. schweinfurthii*, *A. africana* and *T. ivorensis*, contain high seedling densities despite the low presence of their seed trees. This pattern may be explained by the persistence of old, dormant seeds within

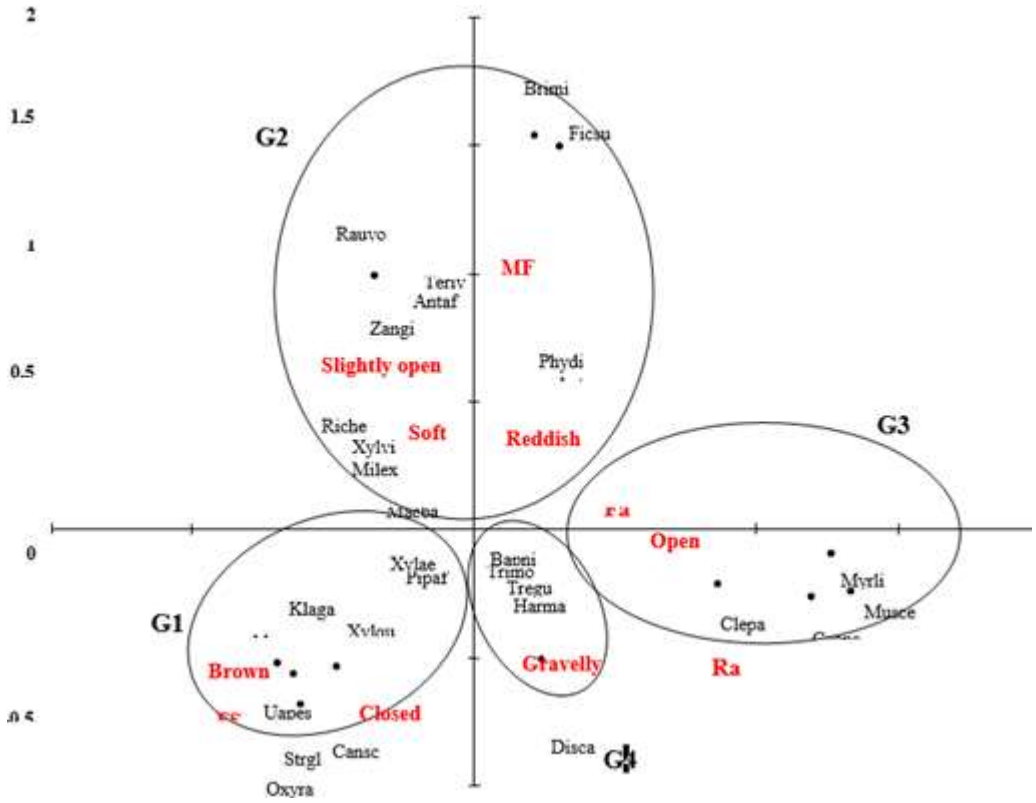

Figure 5. CCA analysis highlighting the influence of environmental parameters on the germination of species in the soil seed bank. G: Group; MF: Managed forest; Fa: Fallow; Ra: Refosted area; Closed: canopy of vegetation closed; Slightly open: slightly open canopy of vegetation; Open: open canopy of vegetation; Soft: Soft soil; Reddish: Reddish soil; Brown: Brown soil; Gravelly: Gravelly soil; Plant species = Brimi: *Bridelia micrantha*; Fiscu: *Ficus sur*; Rauvo: *Rauvolfia vomitoria*; Teriv: *Terminalia ivorensis*; Antaf: *Antiaris africana*; Zangi: *Zanthoxylum gilletii*; Phydi: *Phyllanthus discoideus*; Riche: *Ricinodendron heudelotii*; Strgl*: Strombosia glaucescens*; Cansc: *Canarium schweinfurthii*; Uapes: *Uapaca esculenta;* Oxyra*: Oxyanthus racemosus;* Klaga*: Klainedoxa gabonensis;* Parex*: Parinari excelsa;* Micka*: Microdesmis kaeyana;* Xylqu*: Xylopia quintasii ;* Xylae*: Xylopia aethiopica;* Pipaf*: Piptadeniastrum africana*; Antvo: *Anthocleista vogelii*; Macba: *Macaranga barteri*; Xylvi: *Xylopia villosa*; Milex: *Milicia excelsa*; Cecpe: *Cecropia peltata;* Musce: *Musanga cecropioides*; Myrli: Myrianthus *libericus*; Clepa: *Cleistopholis paten*; Tregu: *Trema guineensis;* Harma: *Harungana madagascariensis*; Trimo: *Trichilia monadelpha*; Bapni: *Baphia nitida*; Disca: *Discoglypremna caloneura.*

the soil, awaiting favorable conditions for germination (Bauma et al., 2025). Recent syntheses confirm the major role of soil seed banks as true "reservoirs of biodiversity", often only weakly correlated with the standing vegetation in place (Carta et al., 2022).

Conversely, some species, such as *S. glaucescens* and *U. esculenta*, well represented among seed trees, are absent from the germinated seed banks. Their shade-tolerant, sciaphile character could explain this absence. Germination tests carried out in open environments do not reproduce the low-light conditions necessary to trigger their germination (Kupers et al., 2019). Studies conducted in Central Africa forests further confirm that the regeneration of shade-tolerant species is strongly dependent on reduced light availability beneath the canopy (Luambua et al., 2024). In addition, the relatively short duration of the experiment (12 months) (Nadarajan et al., 2023) as well as seed predation by insects and rodents (Williams et al., 2021), may also have contributed to this weak representation of these species among those that germinated in the soil seed bank.

The analysis of seed dispersal modes revealed a clear dominance of zoochory (> 69%) across all biotopes. This preponderance underscores the central role of animals in the natural regeneration of the Yapo-Abbé classified forest; particularly in secondary and managed forest biotopes, where habitats remain favourable for frugivores and granivores (Konan, 2016). Some zoochorous species are able to break seed dormancy and initiate germination only after passing through the digestive tract of animals (Pascal, 2008). According to Beaune et al. (2013) zoochory facilitates the long-distance dispersal of 60 to 90% of tropical forest species, highlighting its key role in local plant dynamics. CCA showed that the germination of

soil seed bank species is strongly influenced by environmental factors, such as biotope type, soil properties, and vegetation structure. Brown soils under closed canopy favored sciophilous species, such as *S. glaucescens*, *C. schweinfurthii*, and *X. aethiopica*; while open environments (e.g., fallows, reforested areas) were favorable for the germination of pioneer species of *C. peltata* and *M. cecropioides*. These results are consistent with the observations of Jakovac et al. (2021), indicating the importance of soil microconditions, associated microflora, land-use history, and soil seed bank.

Conclusions

The assessment of the germinative potential of the soil seed bank of the Yapo-Abbé classified forest indicates an important reservoir of biodiversity that could support the natural regeneration of this classified forest. Although some pioneer species have high seedling densities and actively contribute to plant dynamics, commercially valuable species, such as *M. excelsa* and *T. ivorensis*, show limited natural regeneration, which represents a potential risk for for the sustainability of these species. Therefore, strategies necessary for their conservation must be adopted. The study showed that the soil seed bank constitutes an important ecological reservoir for maintaining both biodiversity, and resilience mechanisms to forest disturbances. This indicates the importance of preserving microhabitats, protecting soils and maintaining interaction between animal and plant species to ensure the long-term ecological resilience of this classified forest. This study can be further developed in future research to include perspectves oriented towards germination strategies of shade-tolerant and extented dormancy species, as well as the influence of biotic interactions on seed viability and dispersal. Continuous monitoring of the soil seed bank, particularly in the curent context of climate change and strong anthropogenic pressures, is necessary to guide effective restoration programs and sustainable management of the biodiversity of yhe Yapo-Abbé classified forest.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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