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INVENTORY OF TERMITES AND BIOGENIC STRUCTURES IN THE FOREST ADJOINING THE "PALM TREES" RESTAURANT OF FELIX HOUPHOUET-BOIGNY UNIVERSITY CAMPUS (*ABIDJAN - SOUTH COTE D'IVOIRE*)

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ABSTRACT

Termites play an important ecological role. Thus, this study was carried out in the forest adjoining restaurant "the palm trees of the university campus of Cocody" to determine the species of termites and their impacts on the trees of this forest. Three transects of 100m long and 2m wide each subdivided into 20 sections and Tropical soil biology and fertility (TSBF) monoliths were developed. Then a systematic excavation was carried out along transects in search of termites. Then the plot containing transects was prospected in order to identify termite mounds and biogenic structures. After inventory, we identified 7 species of termites: *Macrotermes bellicosus*, *Microtermes sp*, *Basidentitermes sp*, *Odontotermes sp*, *Pericapritermes sp*, *Amitermes guineensis* and *Ancistrotermes guineensis*. Wood-feeders, fungus-growers and soil-feeders are the trophic groups found on the site. Fungus-growers were the group with the most species. We recorded a 25% attack rate on the trees from transects. A total of 13 nests were counted including 9 epigeal termite mounds and 4 arboreal nests. The low richness recorded shows that our plot is heavily anthropized. The conservation or maintenance of this site would allow species to recolonize this space.

Contribution/Originality: This review work addresses diversity and impact of termites in an anthropized environment.

1. INTRODUCTION

Termites are one of the major components of tropical ecosystems [1], [2]. They represent almost 65% of the biomass of soil fauna [3]. There are 3106 known living and fossil species worldwide [4] distributed in 12 families [5]. They are widely distributed throughout the world, especially in tropical, subtropical and semi-arid regions [6]. They participate in many ecosystem services, including the decomposition of organic matter and the evolution of the physico-chemical structure of soils [7-9]. They can also serve as biological indicators to estimate the state of

ecosystem degradation. Their sensitivity to habitat disturbance causes changes in their species richness, composition and functional characteristics [10]. However, these social insects are also known for the damage they cause to homes and crops [11]. They are considered the main source of nuisance in tropical regions. In search of food, termites attack worked wood, textiles and paper. Their harmful effects have been demonstrated on plantations and fruit trees [12], [13] on crops [14-16] and on buildings [17]. In Côte d'Ivoire, several works relating to termites have been carried out [18], [19]. At the Félix HOUPHOUËT-BOIGNY University of Cocody, the work of Boga, et al. [20] at the National Floristic Center (NFC) have made it possible to identify several types of termite mounds and species of termites. Thus, it therefore seemed important to see whether, like the NFC which presents numerous termite damage, other forests within the University were not also subject to attacks by predatory insects in particular, those termites. The present study, which is part of the context of biodiversity conservation, has the general objective of studying the diversity of termite species and their evaluation of their attacks on the trees in the forest adjoining the palm tree restaurant of the university campus of Cocody. More specifically, it will be a question of making an inventory of the termites and termite mounds of this forest, then evaluating the damage of termites on certain species present in this biotope.

2. MATERIAL AND METHODS

2.1. Presentation of the Study Site

This study was carried out in the forest sheltering the restaurant "the palm trees", located within Félix Houphouët Boigny University (FHBU) of Abidjan (latitude 5°20 North and longitude 3°59 West). The climate is of the subequatorial type with four seasons [21]. The average annual rain-fall is 1475 mm. The average annual temperature is 26.4°C. The soil is essentially ferralitic. The forest massif of Abidjan belongs to the ombrophile sector of the Guinean Domain where the vegetation is dominated by the dense evergreen humid forest [22].

2.2. Termite Sampling Device

Termites were sampled deep in the soil, in termite mounds and in other biogenic structures. Sampling of termites in the soil was first done by drawing 3 transects 100 meters long and 2 meters wide separated by 45 m. Then a systematic excavation was carried out along the transects subdivided into 20 sections of 10 m² (5m X 2m) each (Figure 1). The sampling of termite mounds on the ground and tree nests was done by systematic excavation on a plot of about 10,000 m². The trunks of trees are prospected up to 1.5 m in height in search of nests in the branches or veneers on the trunks [23], [24]. The sorted termites are stored in labeled pill boxes containing 70% alcohol. On each label is written: the site, the code of the plot, the number of the section and the date of harvest.

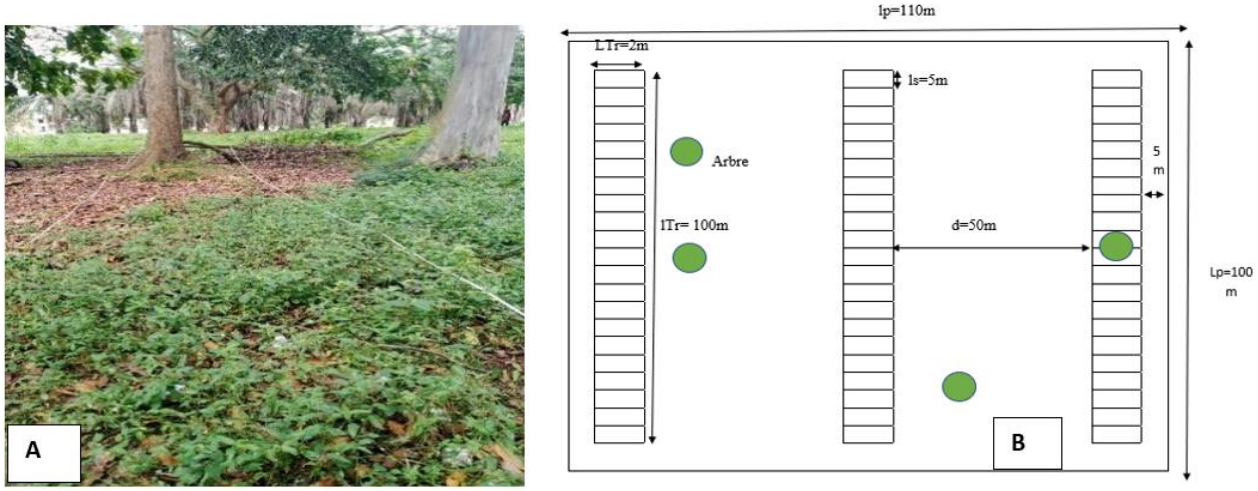

Figure 1. Study site.

Note: A: Forest adjoining the "palm trees" restaurant of Félix Houphouët-Boigny university campus.
B: Experimental device for setting up the transects.
lp: Plot length, Lp: Plot width, ls: Section length, d: Distance between two transects, lTr: Transect length, LTr: Transect width.

2.3. Termite Identification

Using flexible forceps, termites are grouped on the basis of visual or morphological resemblance. Specimens, more specifically soldiers taken at random from each lot, are observed with a brand LEICA of the series EZ4 binocular loupe. The genus and species of each lot is thus determined using the identification keys [25-28].

3. RESULTS

3.1. Termites Identified

All termites sampled belong to the family Termitidae and are divided into 04 subfamilies: Macrotermitinae, Cubitermitinae, Termitinae, Amitermitinae (Table 1). The sampling of termites made it possible to identify seven (7) species which are: *Macrotermes bellicosus*, *Odontotermes sp*, *Ancistrotermes guineensis*, *Microtermes sp*, *Basidentitermes sp*, *Pericapritermes sp* and *Amitermes guineensis* (Figure 2). As for the trophic groups, 3 groups were counted. The fungus-growers are represented by a rate of 57.14% across the entire study site. These are followed by soil-feeders (28.57%) and wood-feeders with 14.29%. The group of fungus-growers is represented by 4 species which are *Macrotermes bellicosus*, *Odontotermes sp*, *Ancistrotermes guineensis* and *Microtermes sp*. The soil-feeders are composed of two species including *Basidentitermes sp* and *Pericapritermes sp*. As for the xylophages, they are represented by only specie *Amitermes guineensis* (Table 1).

Table 1. Species of termites encountered on the study site.

Family	Sub-families	Species	Trophics group
Termitidae	Macrotermitinae	*Macrotermes bellicosus*	Fungus-growers
		Odontotermes sp	Fungus-growers
		Ancistrotermes guineensis	Fungus-growers
		Microtermes sp	Fungus-growers
	Cubitermitinae	*Basidentitermes sp*	Soil-feeders
	Termitinae	*Pericapritermes sp*	Soil-feeders
	Amitermitinae	*Amitermes guineensis*	Wood-feeders
Total	4	7	

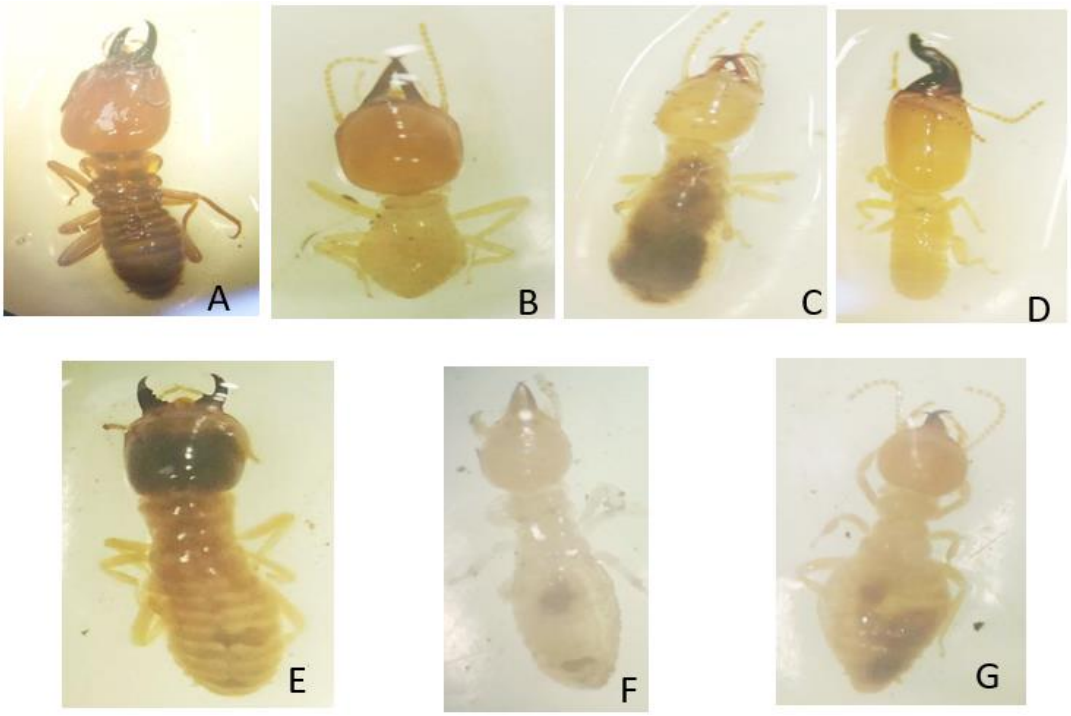

Figure 2. Genus of termites collected.
Note : A : *Macrotermes*, B : *Basidentitermes*, C : *Amitermes*, D : *Pericapritermes*, E : *Odontotermes*, F : *Microtermes*, G : *Ancistrotermes*.

3.2. Impact of Termites on Trees

This study consisted in evaluating the health status of the trees in the study plot. A total of 16 trees were sampled, 12 trees were not attacked but 4 were attacked, i.e. an attack rate of 25%. Among the attacked trees, 3 recorded veneers and harvest galleries (D1) and only 1 tree suffered type 2 attacks (D2) where the tree bark was destroyed by termites. The attack rate differs between species and trees. Thus, *Macrotermes bellicosus* is the only species responsible for attacks on the plant species *Elaeis guineennsis*, i.e. an attack rate of 100%. At the level of *Acacia mangium*, three species of termites namely, *Amitermes guineensis*, *Ancistrotermes guineensis* and *Macrotermes bellicosus* are subservient to this plant, i.e. an attack rate of 33% on this species. No species of termite was encountered on *Eucalyptus grandis* species Table 2. Three (3) species of termites have been identified on trees and are classified into one (1) family and two (2) subfamilies (Macrotermitinae and Amitermitinae). The termites identified belong to two trophic groups: wood-feeders and fungus-growers. The former feed on wood in all its forms, including decaying residues in the litter. They belong to the Amitermitinae subfamily. The second group is made up of fungus-growers who are litter consumers. Qualitative, termite pest species harvested from trees destroy the trees. These attacks start with crop veneers and go as far as destroying the bark of the tree. All species of termites collected from trees are responsible for the damage observed Figure 3. They are responsible for the attacks on the bark and the veneers of the trees. However, *Amitermes guineensis* is the only species responsible for type 2 damage. This termite builds larger galleries and destroys the bark of trees from the outside in.

Table 2. Plant species attacked by termites along transects on the study plot.

Plant species	Number of trees present	Number of trees attacked	Termite species encountered
Elaeis guineennsis	1	1	*Macrotermes bellicosus*
Acacia mangium	9	3	*Macrotermes bellicosus Ancistrotermes guineensis Amitermes guineensis*
Eucalyptus grandis	6	0	-

Figure 3. Termite damage on trees.
Note: A and B: Damage by *Amitermes*, C: Damage by *Macrotermes*, D: Damage by *Ancistrotermes*.

4. DISCUSSION

In this study, 7 species of termites were collected. This low specific richness could be due to the anthropization of the study site because the site is contiguous to a restaurant. Also, this could be due to our study area which is 10,000 m2. These results are different and lower than those of Coulibaly, et al. [29] on the campus of Péléforo Gon Coulibaly University in Korhogo where 12 species of termites have been recorded. This difference could be due to the number of samples. Indeed, these authors considered in addition to ground sampling, the damage caused by termites on campus buildings. Effowe, et al. [30] in Fazao-Malfassa Park, a protected area in central Togo, recorded 58 species and Bakondongama, et al. [31] in the Yoko Forest Reserve (Kisangani, Democratic Republic of Congo) identified 24 species. They justify this diversity by asserting that protected areas are home to a wide variety of species. Indeed, our study site is characterized by the presence of passageways due to the presence of restaurants and a mosque within the forest. The place of worship and the restaurant made it impossible to catch termites in several sections our transects; thus, justifying its low specific richness in termites compared to other authors.

Man considerably modifies the characteristics of natural ecosystems through his activities and termites, being very sensitive to any modification of their biotopes, find it difficult to colonize disturbed environments [32]. As for the study of the trophic diversity of termites, three groups have been identified: fungus-growers, soil-feeders and wood-feeders. Fungus-growers are predominantly represented in the environment studied. This abundance of Fungus-growers in this environment would be linked to their bioecology. The symbiotic relationship they have with *Termitomyces* fungi allows them to digest complex molecules such as cellulose, lignin and tannins, hence their adaptability to their environment [33], [34]. In addition, the minority presence of soil-feeders and wood-feeders was noted on the site. Soil-feeders are related exclusively to decomposing organic particles in the humic fraction of the soil [9] and are the most affected by land degradation. Their presence would be due to that of the organic waste discharged by the restaurants not far from our study site and also by the shade provided by the trees around the restaurant.

Three species are responsible for tree damage. These are *Macrotermes bellicosus*, *Ancistrotermes guineensis* and *Amitermes guineensis*. These species belong to the group of fungus-growers and wood-feeders. This corroborates the results of Anani, et al. [35] on the Lomé campus who also found that the termites responsible for the damage to the 34 trees belong to the group of wood-feeders and fungus-growers. However, only the species *Amitermes guineensis* (wood-feeders) is found on the trees. This is explained by their cellulose-based diet and their need for water [35]. Only 4 trees out of 16 showed termite attacks, i.e. 25% attack. These results are different from those of Coulibaly, et al. [29] on the campus of the Péléforo Gon Coulibaly University in Korhogo (Côte d'Ivoire) who observed 93% and on the campus of the University of Lomé (Togo) which recorded 92.40% attack rate [35]. These results would be due to our sampling site which only took into account the transect trees. Also, termite damage was not observed on the *Eucalyptus grandis* plant species, which is one of the most represented plant species on the plot. According to Isman [36] this plant would have insecticidal properties.

As for the nests, a total of 13 were identified. Four arboreal nests of the species *Amitermes guineensis* and 9 epigeal nests of *Macrotermes bellicosus*, i.e. two types of nests. Our results are different from those of Boga, et al. [20] who inventoried 3 types of termite mounds numbering 165, including 119 aboveground and 46 arboreal at the National Center of Floristic (NCF) on Cocody campus. These authors justify this abundance of biogenic structure by a strong activity of termite colonies, which have gradually restored the NCF forest for 51 years. The low abundance of biogenic structures recorded in this study would be due to the strong anthropization of the study site. Indeed, termites are sensitive to the disturbance of their habitat and termite mounds are subject to destruction when they are near habitats. All these human actions reduce or influence species richness [10].

5. CONCLUSION

Through this study, we were able to record the damage of termites and the different nests of termites in the forest adjoining the palm trees restaurant on the university campus of the Félix HOUPHOUET-BOIGNY University in Cocody. We have identified 7 species of termites: *Ancistrotermes guineensis*, *Macrotermes bellicosus*, *Microtermes sp*, *Odontotermes sp*, *Amitermes guineensis*, *Pericapritermes sp* and *Basidentitermes sp* belonging to the Termitidae family. This forest is home to the group of fungus-growers, soil-feeders and wood-feeders. Fungus-growers are the most represented group on the site with 57.14%. The trees of the study site are attacked with a very low proportion (25%), with *Macrotermes bellicosus* and *Amitermes guineensis* being responsible for this damage. In addition, 13 termite nests including 4 arboreal nests and 9 epigeal nests were identified in this forest. The low diversity of species and the reduced number of termite mounds show that the idea of transformation of this area into a reserve would be an opportunity for the conservation of biodiversity in order to recolonize this anthropized area. It would therefore be necessary to carry out a more exhaustive inventory in order to better study the soil fauna of this site, identify and categorize the types of termite mounds found there.

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