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Inventory of arboreal entomofauna of Nambékaha observatory in northern Ivory Coast

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Abstract
The role of insects is very crucial from an ecological point, because they contribute to the natural ecosystems balance. However, their high diversity and variability from one ecosystem to another does not always facilitate their good knowledge. For the first time, this study aimed to survey the arboreal entomofauna of Nambékaha Observatory in order to protect and conserve it. The insects were captured in tree and shrub savannas using three methods (aerial traps, beating and capture by stratification). The first two methods were used to determine the overall diversity of insects. As for the capture by stratification, it was used to determine the diversity of insects at different strata of trees and shrubs. The diversity parameters such as taxonomic richness, abundance, and frequencies of occurrence, were calculated. A total of 529 specimens of insects belonging to 42 families were captured. The taxonomic richness of insects (34 families) was higher in tree savanna while their abundance was higher in shrub savanna (310 specimens). The frequencies of occurrence analysis showed that the family Formicidae (Fo = 66.66%) was the most frequent in both types of savannas. Regarding the different strata, 16 families were recorded in the stratum 1 against 15 families in each of strata 2 and 3. Formicidae was the most frequent family in all strata.

Keywords: Insect, tree, shrub, stratum, Nambékaha, Korhogo

Introduction
Most terrestrial ecosystems have already suffered a significant loss of biodiversity over the last 30 years, negatively impacting ecosystem services (IPBES, 2018a) [5]. The set of factors that affect biodiversity are essentially climate change, habitat loss, overexploitation, pollution, invasive alien species, illegal wildlife trade, but above all, climate change. The latter currently constitutes one of the major threats to biodiversity, as species that cannot adapt or move will risk extinction (Carvalho *et al*., 2010) [1]. Forests worldwide are facing alarming declines due to climate change (Homet *et al*., 2019) [4]. Several studies have linked extreme weather events, including drought, heat waves and increased defoliation rates with tree mortality (Sangüesa-Barreda *et al*., 2015) [12]. Insects, main component of our study, are not spared by this decline of biodiversity. Climate change impacts species and their distribution, but also their composition (IPBES, 2018b) [6]. They are among the animal groups with the highest diversity but sometimes appear harmful because some can sting, transmit diseases or ravage crops. However, without the meticulous work of insects, our world would collapse. They work in cleaning nature by feeding on animal and plant debris, in the production of fruit through pollination, in the recycling of organic elements and in the enrichment of soils. Some, like predators, provide valuable assistance to agriculture. Others, on the other hand, are considered harmful to agriculture. However, it is clear that there is a massive decline in insects in our ecosystems. Indeed, the world of insects is deteriorating at a frightening speed. However, different insect groups are not affected in the same way (Pounds *et al*., 2006; Miller-Rushing *et al*., 2008) [8, 10]. For flying insects, it is estimated that up to 40% of species are endangered (Pro-Natura, 2019) [11]. Concerned about the loss of biodiversity, several measures have been taken, including the creation of protected areas and recently, Nambékaha Observatory to observe, monitor and conserve biodiversity. It is thus presented as a scientific, technical and institutional system set up to ensure the proper management of biodiversity. The general objective of this study is to take stock of the entomofauna of Nambékaha Observatory in order to provide the scientific communities concerned in Côte d'Ivoire and the rest of the world with a set of data and information. That will make possible to carry out studies to better understand the functioning of ecosystems in northern Côte d'Ivoire in a global changes context. Specifically, it involves (ii) to determine the diversity of arboreal insects in the Observatory, (ii) to assess the spatial heterogeneity of arboreal insects and (iii) to analyze the vertical distribution of insects according to defined strata.

Materials and methods
Study sites
The study was conducted in the Observatory of Nambékaha (9°29'10.048'' N; 5°68'69.288'' W) located in the department of Korhogo. It was created as part of the research capacity building. Built on an area of 11 ha, the vegetation consists of tree savanna and shrub savanna. On the outskirts of the Observatory, there are plots developed for agriculture. Since its creation, no entomological study has been conducted within it by researchers, which explains the choice of the site.

Description of sampling plots
The sampling plots were chosen according to the morphological type of plants that compose them. Thus, two savannas (approximately 1 ha, each), one of which is composed mainly of trees and the other of shrubs, were delimited for the study. Inside the Observatory, there is a research building and a climate station. Around these infrastructures, runs the shrub savanna. The tree vegetation is found at the ends of the Observatory.

Capture of insects
The insects (Figure 1) were captured using three techniques: aerial traps, beating and stratification.

- The aerial traps were made from plastic bottles. Cut in two, the upper part of the bottle is buried in its lower part. The traps are hung on tree branches using tape following transects. Each transect is made up of six trees. In total, five transects were carried out in each savanna (30 traps per savanna). On the same transect, the traps were 50 m apart from each other. Traps filled with salt water to a quarter of their volume and detergent (liquid soap) were placed only once during the study. Insects were harvested 72 hours after the traps were set (Yodé *et al*., 2020) [13].
- The beating technique was applied to thirty trees per savanna following the same transects used to place the aerial traps. It consists of vigorously shaking the branches of trees and shrubs so as to make the insects fall onto a white sheet placed under the trees and shrubs (Nageleisen *et al*., 2020) [9].
- Regarding the strata methods, insects were captured using blue glasses containing soapy water and salt. This technique was used to identify insects present at different strata on 30 trees per plot. The traps made of rubber glasses were placed vertically on the trees at different levels. The first level was chosen at one meter from the ground (stratum 1), the second level at 3 m from the ground (stratum 2) and the third level at 5 m from the ground (Yodé *et al*., 2020) [13] (Figure 2).

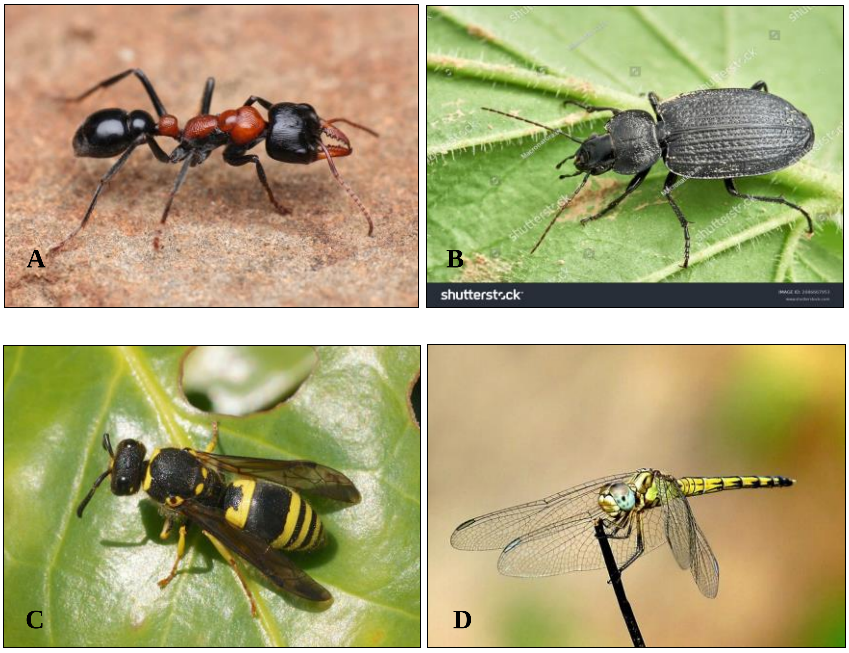

Fig 1: Representative of some insect families (A: Formicidae; B: Carabidae; C: Vespidae; D: Libellulidae

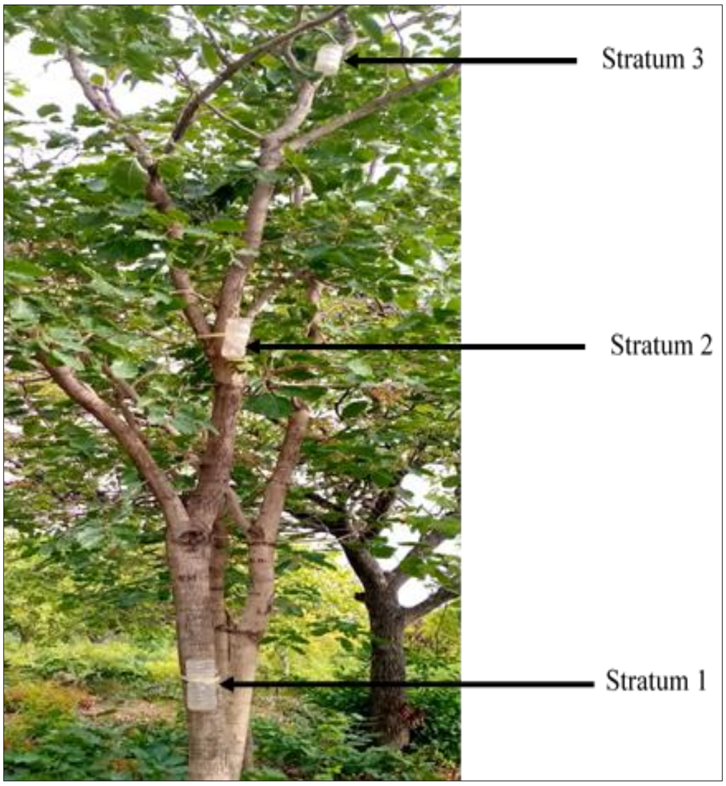

Fig 2: Traps placed by stratum

Data analysis
The taxonomic richness and abundance of bees were assessed. The data were analyzed using Statistica software version 7.1. The comparison of mean abundances between plots was carried out using ANOVA 1 test, followed by Kruskal Wallis Post-Hoc test. Biological diversity indices such as Shannon Index and Pielou's evenness were calculated to assess bee diversity. To compare the taxonomic composition, frequency of occurrence (Fo) was calculated based on the presence of orders according to the formula Fo = (Si/St) × 100 (Si = number of records where order i was present; St = total number of records) (Djakou and Thanon, 1988) [2].

Results
Taxonomic diversity
A total of 42 families of insects were captured during the study. The tree savanna, with 34 families, recorded the highest taxonomic richness. The Shannon index (H' = 2.01) and Pielou's evenness (E = 0.57) were higher in the tree savanna. Regarding the abundance of insects, 529 specimens were captured in the two savannas, including 310 specimens in the shrub savanna and 219 specimens in the tree savanna. The analysis revealed no significant difference between the mean abundance of the specimens captured in the two savannas (F = 1.04; P = 0.31).
Regarding the strata, 18 families of insects were identified in the three strata. The stratum 1 recorded 16 families. The strata 2 and 3 recorded 15 families, each. Concerning the abundance, 2419 specimens of insects were captured in the three strata on tree and shrub in each savanna. The highest number of specimens (937 specimens) was recorded on the stratum 1, followed by the stratum 3 (910 specimens). The stratum 2 recorded the lowest number of specimens (572 specimens). However, the statistical analysis revealed no significant difference between the mean abundance of insects in the three strata (F = 1.052 and P = 0.21).

Taxonomic composition
Insects were diversely distributed in the two savannas. Some families were common to the both savannas and others were specific to each savanna. Indeed, 14 families of insects were captured in the both savannas, 20 families were captured only in the tree savanna and 8 families were captured only in the shrub savanna (Table 1).

Table 1: Composition of insect families in the savannas (+: present/-: absent)

Families	Tree savanna	Shrub savanna	Families	Tree savanna	Shrub savanna
Acrididae	-	+	Lyctidae	+	-
Anthicidae	+	+	Mantidae	-	+
Aphelinidae	+	+	Melonthinae	+	-
Attelabidae	+	+	Mordellidae	+	+
Bethylidae	+	-	Mydidae	+	+
Bibionidae	+	+	Ochtetidae	+	-
Blattidae	+	+	Ormyridae	+	-
Bostrichidae	+	-	Passalidae	+	-
Bruchidae	+	+	Pentatomidae	+	-
Buprestidae	+	+	Phalacridae	+	-
Carabidae	-	+	Pteromalidae	+	-
Cetoniinae	+	-	Pyralidae	+	-
Cicadidae	+	-	Pyrrhocoridae	+	-
Dinidoridae	+	+	Scarabaedae	+	+
Elateridae	+	-	Sylphidae	+	+
Encyrtidae	+	-	Silvanidae	+	+
Ensifera	+	-	Syrphidae	+	-
Eurytomidae	+	-	Tabanidae	-	+
Formicidae	+	+	Termitidae	+	-
Histeridae	-	+	Tessaratomidae	-	+
Libellulidae	-	+	Vespidae	-	+

Occurrence frequency of insect families
Insects were categorized into three groups according to their occurrence frequency. In the tree savanna, the first category consisting of Formicidae was the most frequent family (Fo = 66.66%). The other insects with an occurrence frequency less than or equal to 20% were accidental families. In the shrub savanna, Formicidae (Fo = 66.66%) were the most frequent family. Aphelinidae (Fo = 33.33%) were an accessory family. The other insects with an occurrence frequency less than or equal to 20% were accidental families (Table 2).

Table 2: Occurrence frequencies of insect families in the three strata

Occurrence frequency (%)					
Families	Tree savanna	Shrub savanna	Families	Tree savanna	Shrub savanna
Acrididae	0	6.66	Lyctidae	13.33	0
Anthicidae	3.33	3.33	Mantidae	0	3.33
Aphelinidae	16.66	33.33	Melonthinae	3.33	0
Attelabidae	10	0	Mordellidae	10	20
Bethylidae	3.33	0	Mydidae	3.33	3.33
Bibionidae	6.66	13.33	Ochtetidae	6.66	0
Blattidae	20	10	Ormyridae	3.33	0

Bostrichidae	3.33	0	Passalidae	3.33	0
Bruchidae	10	3.33	Pentatomidae	3.33	0
Buprestidae	3.33	20	Phalacridae	3.33	0
Carabidae	0	10	Pteromalidae	3.33	0
Cetoniinae	3.33	0	Pyralidae	3.33	20
Cicadidae	3.33	0	Pyrrhocoridae	3.33	0
Dinidoridae	6.66	3.33	Scarabaedae	6.66	16.66
Elateridae	13.33	0	Sylphidae	16.66	3.33
Encyrtidae	3.33	0	Silvanidae	3.33	3.33
Ensifera	3.33	0	Syrphidae	20	0
Eurytomidae	3.33	0	Tabanidae	0	3.33
Formicidae	66.66	66.66	Termitidae	3.33	0
Histeridae	0	3.33	Tessaratomidae	0	3.33
Libellulidae	0	3.33	Vespidae	0	3.33

Concerning the strata, the analysis of the occurrence frequencies at the two savannas level made it possible to categorize the families of insects. In the stratum 1, Formicidae (Fo = 73.33%) were more frequents. Culicidae (Fo = 33.33%) and Buprestidae (Fo = 23.33%) were accessory families. The other families were accidental. In the stratum 2, Formicidae (Fo = 60%) were also the most frequents. The accessory families were Culicidae (Fo = 36.66%), Mordellidae (Fo = 26.66%), Anthomyidae (21.66%) and Buprestidae (Fo = 21.66%). The other families were accidental. In the stratum 3, Formicidae (Fo = 63.33%) were still the most frequents. Mordellidae (Fo = 53.33%) and Culicidae (Fo = 45%) were fairly common families. Buprestidae (Fo = 31.66%) were accessory families. The other families were accidental (Table 3).

Table 3: Occurrence frequencies of insect families in the three strata

Occurrence frequency (%)			
Families	**Stratum 1**	**Stratum 2**	**Stratum 3**
Anthomyidae	15	21.66	25
Aphelinidae	1.66	0	6.66
Apidae	1.66	1.66	6.66
Buprestidae	23.33	21.66	31.66
Culicidae	33.33	36.66	45
Cydnidae	11.66	6.66	15
Elateridae	5	11.66	13.33
Formicidae	73.33	60	63.33
Mantidae	6.66	3.33	1.66
Micropezidae	16.66	15	20
Mordellidae	13.33	26.66	53.33
pentatomidae	3.33	3.33	0
Ptermalidae	3.33	0	1.66
Pyrrhocoridae	0	1.66	0
Scarabeidae	6.66	10	26.66
Tephritidae	6.66	6.66	1.66
Vespidae	8.33	15	16.66

Discussion

This study is one of the first to focus on the diversity of arboreal insects in the Observatory of Nambékaha. It made possible to establish a database on the insects of the Observatory of Nambékaha. The high number of insect specimens in the shrub savanna may be due to a dietary or reproductive requirement of insects that only growing plants can satisfy (Dominique, 1969) [3]. Indeed, the shrub savanna is composed of young plants that flower abundantly, produce enough sap and attract more insects, unlike the tree savanna whose trees are aging and attract fewer insects. The taxonomic richness of insects is higher in the tree savanna due to its heterogeneity in floral species compared to the shrub savanna. These results are consistent with those of Jeanneret *et al*., (2003) [7] who showed that heterogeneous environments are rich in food, and therefore favorable to insects. This heterogeneity provides several nesting possibilities compared to simple or homogeneous habitats which are unsuitable for a large number of species. In the three strata, Formicidae are the most abundant family. Their abundance could be explained by the fact that they are ecologically present in most terrestrial ecosystems. As for the family Mordellidae, it is quite frequent only in the stratum 3. The frequency of Mordellidae in this stratum is linked to their diets. According to Delvare *et al*., (1989), Mordellidae are floricolous hence their strong presence in the stratum 3, in search of flowers. This family is followed by Culicidae which is also quite frequent in the stratum 3 unlike the other two strata. Indeed, Culicidae are nectarivorous hence their strong presence in the stratum 3 in search of nectar from flowering plants. Another family frequent in the stratum 3 is Buprestidae which, according to Delvare *et al*., (1989) are xylophagous. Indeed, in the stratum 3, trees have more dry (dead) branches, which attracts xylophagous insects. Scarabaeidae have a diversified diet, they can be detritivorous or phytophagous (Delvare *et al*., 1989). Their strong presence in the stratum 3 compared to the stratum 2 and the stratum 1, could be explained by the fact that most of the leaves of trees and shrubs are found high up.

Conclusion

This study made it possible for the first time to establish the diversity of arboreal insects of the Observatory of

Nambékaha. It showed that insect diversity can vary from one habitat to another depending on their floral compositions. In the same habitat, insect diversity can also vary at different levels of a tree or shrub. Further studies will make it possible to study insect diversity according to the seasonal variation and to monitor the species present in the environment.

Author contributions

DC and MK designed the study. DC and YK collected data in the field and determined insect specimens and their traits. DC and YK analyzed and plotted output data. DC wrote the first draft of the manuscript. YT, MK and SK contributed to improve the draft. All authors contributed substantially to revisions.

Data availability

Data of this study are available upon request from the corresponding author. The data are not publicly available due to privacy restrictions.

Conflict of interest

All authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Carvalho SB, Brito JC, Crespo EJ, Possingham HP. From climate change predictions to actions - Conserving vulnerable animal groups in hotspots at a regional scale. Global Change Biology,2010:16(12):3257-3270.
2. Djakou R, Thanon SY. Écologie Afrique intertropicale. Édition Bordas, Paris, 1988, 191.
3. Dominique D. Recherche écologique dans la savane de Lamto (Cote d'Ivoire): l'entomocoenose de *Vernonia guineensis benth*, 1969.
4. Homet P, González M, Matías L, Godoy O, Pérez-Ramos IM, García LV, *et al*. Exploring interactive effects of climate change and exotic pathogens on Quercus suber performance: Damage caused by *Phytophthora cinnamomi* varies across contrasting scenarios of soil moisture. Agricultural and Forest Meteorology,2019:107605:276–277.
5. IPBES. The regional assessment report on biodiversity and ecosystem services for Africa. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2018a, 494.
6. IPBES. The regional assessment report on biodiversity and ecosystem services for Europe and Central Asia. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2018b, 894.
7. Jeanneret P, Schüpbach B, Luka H. Quantifying the impact of landscape and habitat features on biodiversity in cultivated landscapes. Agriculture, Ecosystems and Environment,2003:98:311-320.
8. Miller-Rushing AJ, Lloyd-Evans TL, Primack RB, Satzinger P. Bird migration times, climate change, and changing population sizes. Global Change Biology,2008:14(9):1959-1972.
9. Nageleisen LM, Bouget C. L'étude des insectes en forêt : méthodes et techniques, éléments essentiels pour une standardisation. Synthèse des réflexions menées par le groupe de travail " Inventaires Entomologiques en Forêt " (Inv.Ent.For.), 2020.
10. Pounds JA, Bustamante MR, Coloma LA, Consuegra JA, Fogden MPL, Foster PN, *et al*. Widespread amphibian extinctions from epidemic disease driven by global warming. Nature,2006:439(7073):161–167.
11. Pro-Natura. Éducation à l'environnement Pro Natura • Dossier pédagogique : Les quatre saisons des insectes, 2019.
12. Sangüesa-Barreda G, Camarero JJ, Oliva J, Montes F, Gazol A. Past logging, drought and pathogens interact and contribute to forest dieback. Agricultural and Forest Meteorology,2015:208:85–94.
13. Yodé CD, Dosso K, Kouakou LMM, Yeo K, Dekoninck W, Konate S, *et al*. Evaluating Efficiency of Different Sampling Methods for Arboreal Ants (Hymenoptera: Formicidae) in A West African Forest-Savanna Mosaic, 2020.