



ABUNDANCE AND DIVERSITY OF STAPHYLINIDAE IN CATTLE FARMS IN THREE CITIES IN IVORY COAST

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ABSTRACT

Beetles of Staphylinidae family are predators of animal disease vectors and insect pests associated with field crops and greenhouse crops. The objective of this study, which focuses on these beetles, is to determine the abundance and diversity of Staphylinidae in cattle farms. Three sampling sites were selected to conduct an inventory of this taxonomic group: DJERA PRODUCTION farm (Kpouèbo subprefecture), the Cattle Breeding Center (located on Yamoussoukro-Bouaflé highway), and Youssouf Fofana Agropastoral Company (Mankono) site. The dung trap was used to collect Staphylinidae at these sites. It yielded 248 individuals, representing 18 species across six subfamilies. The species *Omalium* sp. was the most abundant (99 individuals), accounting for 39.92% of the total collected population. The largest number of individuals was collected at Kpouèbo site (121 individuals), and the smallest number at Mankono site (44 individuals). Yamoussoukro and Kpouèbo sites recorded the same number of species, namely six (6 species). Kpouèbo site is relatively more diverse, with a Shannon index of $H = 1.628$. The abundance and diversity of Staphylinidae vary significantly from one site to another.

KEYWORDS: Abundance, Staphylinidae beetles, Diversity, Insects, Predator, Cattle farming, Dung trap.

1. INTRODUCTION

Livestock systems occupy approximately 30% of the world's land area.^[1] and constitute a significant global asset worth at least 1,400 billion dollars. Nearly 41.5% of the land in Côte d'Ivoire is used for permanent pastures and rangelands.^[2] Livestock rearing is an important risk-mitigation strategy for vulnerable communities, and livestock are a key source of nutrients and draft power for growing crops in smallholder farming systems. Therefore, managing cattle health is a major challenge for maintaining farm productivity and profitability, as well as the well-being of both animals and farmers.^[3] However, livestock often face disease problems that weaken the animals and, consequently, reduce production. Animal diseases generate a wide range of biophysical and socioeconomic impacts that can be direct or indirect and can vary from a local to a global scale. However, thanks to more effective drugs and vaccines, as well as diagnostic technologies and services, rinderpest has been significantly reduced.^[4] At the same

time, this has led to the misuse of Veterinary Medicinal Products (VMPs). These substances have been widely used, with 194 metric tons of antiparasitic agents produced by the European Union.^[5] VMP compounds such as ivermectin are poorly metabolized by cattle.^[6] and are excreted as unchanged residues in feces.^[7,8] Unfortunately, these residues have been shown to have negative, sublethal, and lethal effects on non-target manure fauna—in particular, manure beetles of the family Staphylinidae—in cattle environments.^[9,10] However, these insects have been reported as predators of animal disease vectors and insect pests associated with field crops and greenhouse crops. By consuming these contaminated bovine disease vectors, these beetles accumulate the pesticide in their bodies and are therefore exposed to a much higher dose of the poison than the vectors themselves.^[11] According to,^[12] the impact of pesticides on non-target organisms depends on several factors, the most important of which are: the dispersion of the products, their non-selectivity, the toxicity of the

active ingredient, the persistence of the active ingredient, and its ability to accumulate in the food chain. It is within this context that this study was initiated to determine the abundance and diversity of Staphylinidae in cattle farms, with the aim of raising awareness among ranchers about the need to conserve these insects in the sustainable management of pastures when using pesticides.

2. MATERIALS AND METHODS

2.1. Equipment

The study equipment consists of a GPS (Global Positioning System) device (Garmin 60 CSx) for collecting geographic data, mapping routes, and marking the various locations where dung traps—consisting of a bucket and dung—were set.

A sieve was used to sift the samples. A binocular stereo microscope (BYO ST-11) with 40x magnification and identification keys by.^[13,14] and.^[15] were used to identify the insects. After identification, these insects were preserved in pill bottles containing 70% alcohol.

2.2. METHODS

2.2.1. Study Site

The Djera Production farm is located 190 km from Abidjan in the Kpouebo subprefecture of the Toumodi department (Bélier Region), and the Cattle Breeding Center is located approximately 24 km from Yamoussoukro on the Yamoussoukro-Bouaflé highway.

These sites are located within an area bounded by longitudes 5°24'W and 5°0'W and latitudes 6°40'N and

7°12'N.^[16] The climate is characterized by an average temperature of 28°C and average annual rainfall ranging from 1,000 to 1,400 mm, most of which falls during two rainy seasons: April through June, considered the major rainy season, and September through October, considered the minor rainy season, separated by two dry seasons.^[17] The Youssouf Fofana Agropastoral Company (SAFY) is located in the Béré region, about 25 km from Mankono. The Béré region has a Sudano-Guinean climate, which includes a wet season and a dry season. The wet season lasts for more than half the year (April through October), with the heaviest rains occurring from July through September; outside of this period, the atmosphere is dry and dominated by the Harmattan. The average annual temperature in Béré is 26.1°C, and average annual precipitation is 899.6 mm. After agriculture, livestock raising has recently become the primary livelihood of the indigenous populations, who own large herds of cattle, sheep, pigs, goats, and poultry.^[18] Le centre et le nord du pays sont les zones où l'élevage est beaucoup plus développé contrairement au Sud où l'élevage est marginal. Ces zones sont favorables au développement de l'élevage, en particulier l'aviculture et la boviniculture. Cette étude a été effectuée sur les sites d'élevage modernes car ils possèdent des pâturages délimités. Le système d'élevage est sédentaire moderne et les applications des protocoles sanitaires sont respectées. Dans chaque localité, un site été choisi pour l'échantillonnage (Fig. 1).

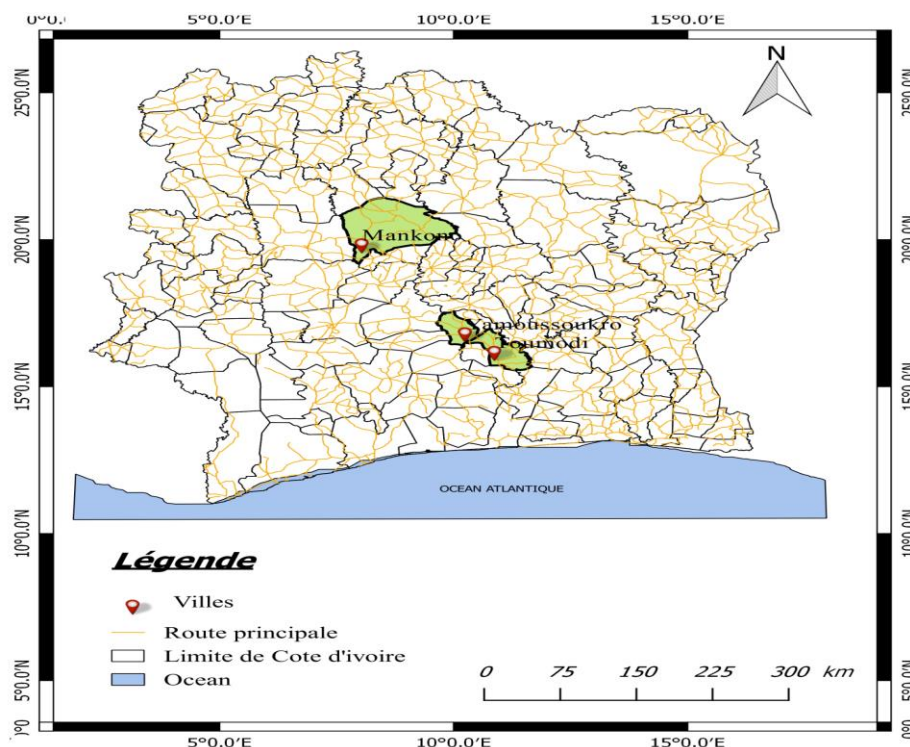


Fig. 1. Map showing the locations of the various study sites.

2.2.2. Insect Sampling

Insect collection took place from May 2019 to October 2019, with one sampling per month. The experimental trap layout covers an area of 7,500 m². Within this layout, three 100-meter transects spaced 25 meters apart were marked out. One trap was placed at the start (0 m) of the first transect, another 50 m from the second, and the last one 100 m from the third (Fig. 2). The bucket is driven into the ground so that its rim is flush with the ground surface. Fresh cow manure, wrapped in cloth, is suspended above the bucket. Dung beetles, attracted by the smell of dung and seeking to use it, fall into a bucket containing a mixture of soapy water and salt and drown (Fig. 3). The dung used is collected in advance from the barns at each site early in the morning at 7:00 a.m., before the traps are set. The same procedure was repeated at all three sites. The insects captured by the

traps were collected 48 hours after the traps were set. Next, fifteen^[15] dung samples were randomly collected at each site using a trowel or a machete and were submerged in a bucket filled halfway with water. Floating insects were collected using a sieve and forceps and then placed in containers filled with 70% alcohol. STATISTICA 7.1 software was used for statistical analyses. One-way analysis of variance (ANOVA) and the Tukey test (post-hoc test) were used to test for statistical significance in the data on the average abundance of Staphylinidae beetles by species across sampling sites. Diversity indices—the Shannon index (H) and evenness (E)—were calculated using the Paleontological Statistics (PAST) 3.11 software. Species richness (S) was obtained by simply counting the number of species at each location.

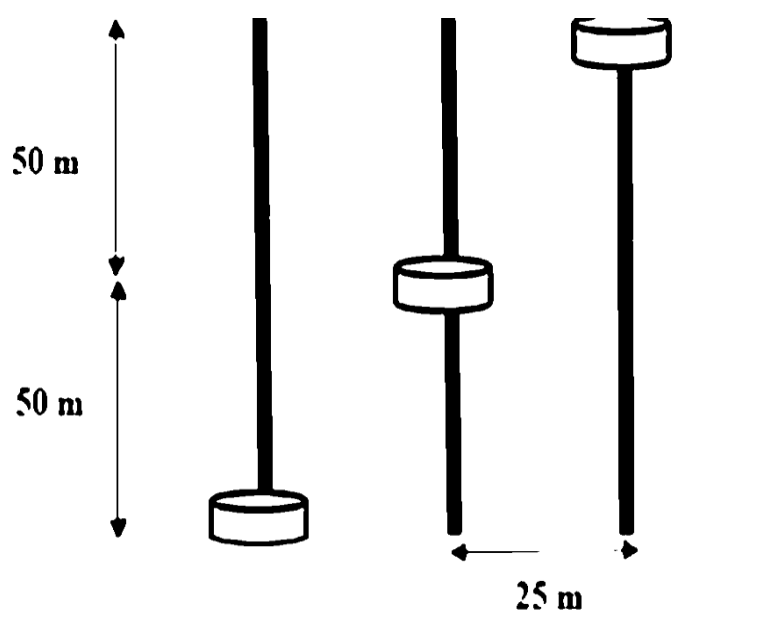


Fig. 2. Sampling device.



Fig. 3. Dung trap in use.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. General taxonomic structure of the Staphylinidae at the three sites

A total of 248 individuals belonging to six subfamilies were collected at the three sites, including 83 individuals in Yamoussoukro, 121 individuals in Kpouèbo, and 44

individuals in Mankono. These Staphylinidae are divided into 17 species. The subfamilies Aleocharinae and Staphylininae have the most species, with six and four species, respectively. The subfamily Omaliinae, with two species, has the highest number of individuals (149) (Table 1).

Table 1: Staphylinidae species collected at the three sites.

Subfamilies	Species	Number
Aleocharinae	<i>Albeta</i> sp.	3
	<i>Anatbeta</i> sp.	2
	<i>Drusilla</i> sp.	10
	<i>Earota</i> sp.	1
	<i>Falagria</i> sp.	5
	<i>Oxypoda</i> sp.	40
Omaliinae	<i>Anthophagus</i> sp.	50
	<i>Omalium</i> sp.	99
Oxytelinae	<i>Anotylus</i> sp.	50
	<i>Bledius</i> sp.	2
Paederinae	<i>Paedorus</i> sp.	1
Staphylininae	<i>Atrechus</i> sp.	2
	<i>Ocypus</i> sp.	5
	<i>Philonthus</i> sp.	2
	<i>Quedius</i> sp.	7
Steninae	<i>Xantholinus</i> sp.	2
	<i>Stenus</i> sp.	1

3.1.2. Staphylinidae abundance

Kpouèbo is the site with the highest number of individuals collected, averaging 15.33 ± 3.31 individuals.

However, statistical analyses show no significant difference ($p = 0.906$) (Fig. 4).

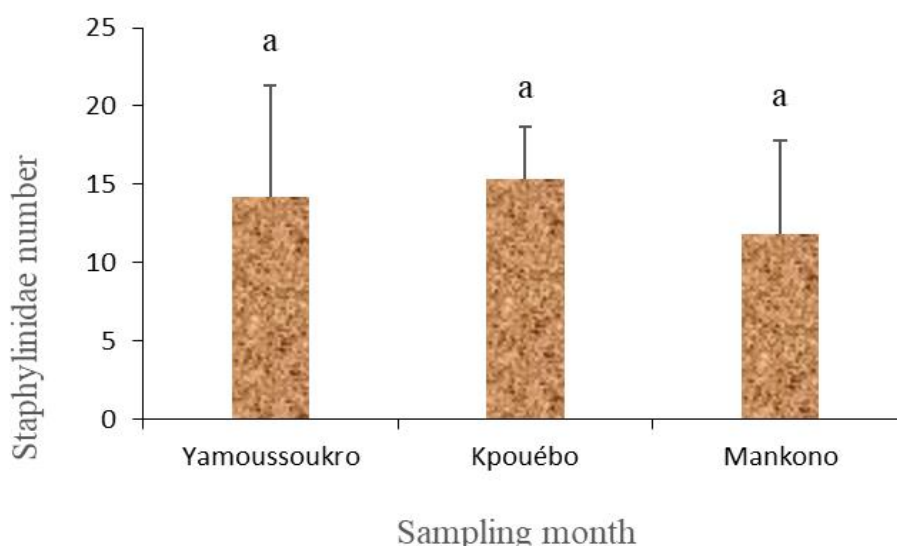


Fig. 4. Comparison of Staphylinidae abundance across sites (mean values $\pm$ standard error; values with the same letter are not significantly different at the 5% significance level).

3.1.2. Staphylinidae fauna in Yamoussoukro

Eighty-three (83) individuals, belonging to five subfamilies and 11 species, were collected. The *Omalium* sp. species accounted for the largest number of individuals (34), representing 41% of the collected

individuals, followed by *Anotylus* sp. (16 individuals), representing 19.28% of the total population (Table 2).

Table 2: Staphylinidae species collected at Yamoussoukro site.

Subfamilies	Species	Number
Aleocharinae	<i>Albeta</i> sp.	2
	<i>Drusilla</i> sp.	3
	<i>Oxypoda</i> sp.	10
Omaliinae	<i>Anthophagus</i> sp.	7
	<i>Omalium</i> sp.	34
Oxytelinae	<i>Anotylus</i> sp.	16
	<i>Bledius</i> sp.	1
Staphylininae	<i>Ocyplus</i> sp.	3
	<i>Philonthus</i> sp.	1
	<i>Quedius</i> sp.	5
Steninae	<i>Sidenus</i> sp.	1

3.1.3. Staphylinidae Fauna in Kpouèbo

A total of 121 individuals were collected. They are grouped into four subfamilies and 13 species. The species *Omalium* sp. was the most abundant, with 45 individuals—accounting for 37.2% of the total

collected—followed by *Anthophagus* sp. (20.66%), *Oxypoda* sp. (19%), and *Anotylus rugosus* (7.43%). The other species account for less than 5% of the population (Table 3).

Table 3: Staphylinidae species collected at Kpouèbo site.

Subfamilies	Species	Number
Aleocharinae	<i>Albeta</i> sp.	2
	<i>Anatbeta</i> sp.	1
	<i>Drusilla</i> sp.	5
	<i>Earotae</i> sp.	1
	<i>Oxypoda</i> sp.	23
	<i>Falagria</i> sp.	4
Omaliinae	<i>Anthophagus</i> sp.	9
	<i>Omalium</i> sp.	45
Oxytelinae	<i>Anotylus</i> sp.	25
Staphylininae	<i>Ocypus</i> sp.	2
	<i>Quedius</i> sp.	2
	<i>Xantholini</i> sp.	1
	<i>Xantholinus</i> sp.	1

3.1.4. Staphylinidae Fauna in Mankono

A total of 44 individuals were collected, grouped into 5 subfamilies and classified into six species. The species *Omalium* sp. was the most abundant in terms of number

of individuals (20), accounting for 45.45% of the total population, followed by *Oxypoda* sp. (11 individuals), accounting for 25% of the collected individuals (Table 4).

Table 4: Staphylinidae species collected at Mankono site.

Subfamilies	Species	Number
Aleocharinae	<i>Oxypoda</i> sp.	11
	<i>Drusilla</i> sp.	2
Omaliinae	<i>Omalium</i> sp.	20
Oxytelinae	<i>Anotylus</i> sp.	9
Staphylininae	<i>Atrechus</i> sp.	1
Paederinae	<i>Paedorus</i> sp.	1

3.1.5. Staphylinidae diversity

Six species were collected at each of the sites in Yamoussoukro and Kpouèbo. Four species were identified at the Mankono site.

Kpouèbo site has the highest Shannon index (1.63), while Mankono site has the lowest diversity index (1.14).

This makes Kpouèbo site the most diverse in terms of Staphylinidae species and Mankono site the least diverse in terms of Staphylinidae species. Furthermore, the equitability indices are also relatively higher at Kpouèbo and Mankono, and lower at Yamoussoukro. A high value indicates a good distribution of species across the surveyed sites (Table 5).

Table 5: Diversity Indices.

	Yamoussoukro	Kpouèbo	Mankono
Shannon Index	1.22	1.63	1.14
Fairness	0.68	0.91	0.83
Specific Wealth	6	6	4

3.1.7. Staphylinidae abundance by Collection Month in Yamoussoukro

A total of 83 Staphylinidae were collected. The highest number of individuals was collected in May, and the

lowest in October. Statistical analyses show a significant difference among the six months of collection ($P = 0.021$) (Fig. 5).

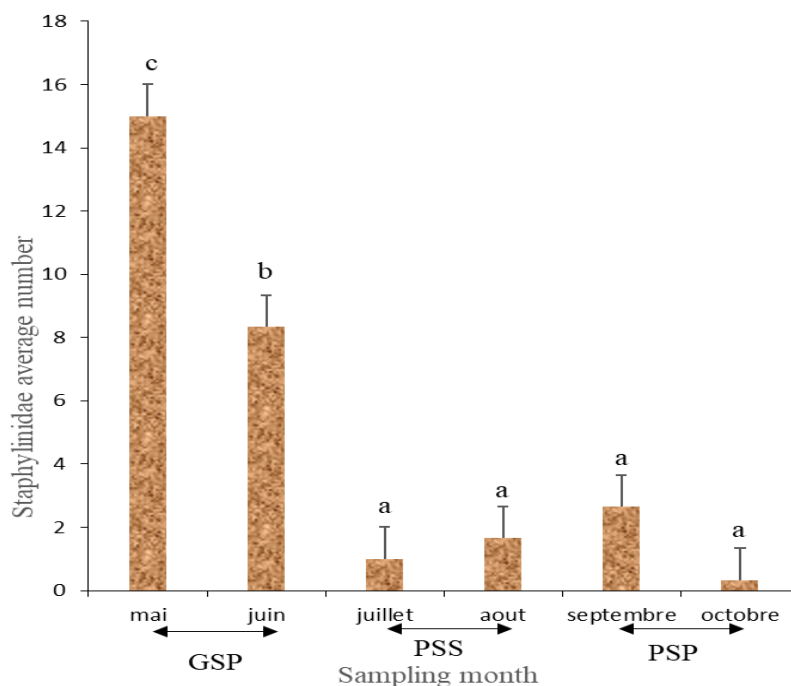


Fig. 5. Abundance of Staphylinidae by month in Yamoussoukro (mean values $\pm$ standard error; values with the same letter are not significantly different at the 5% significance level) ; GSP: long rainy season; PSS: short dry season; PSP: short rainy season.

3.1.8. Staphylinidae abundance by Month in Kpouèbo

At this site, a total of 121 Staphylinidae were collected over a six-month period. September was the month in which the most individuals were collected, and October was the month in which the fewest individuals were

collected. Statistical analyses show a highly significant difference among the six months ($p = 0.001$) (Fig. 6).

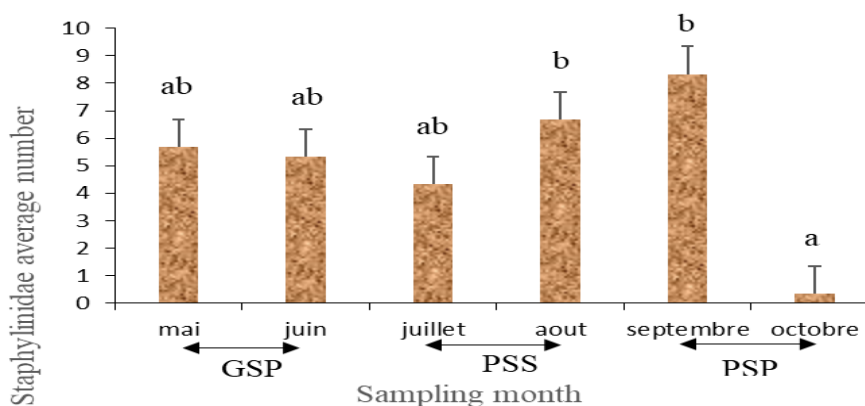


Fig. 6. Abundance of Staphylinidae by month in Kpouèbo (mean values $\pm$ standard error; values with the same letter are not significantly different at the 5% significance level) ; GSP: long rainy season; PSS: short dry season; PSP: short rainy season.

3.1.9. Staphylinidae abundance by Month in Mankono

In Mankono, a total of 44 individuals were collected over the six-month period. May was the month in which the most individuals were collected, while September and

October were the months in which the fewest individuals were collected. Statistical analyses show a significant difference among the six months ($p = 0.03$) (Fig. 7).

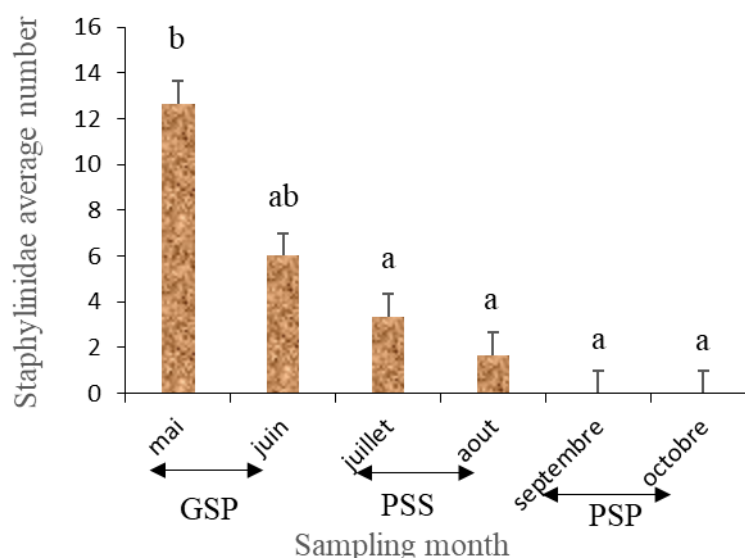


Fig. 7. Abundance of Staphylinidae by month in Mankono (mean values $\pm$ standard error; letters marked with the same symbol are not significantly different at the 5% significance level) ; GSP: major rainy season; PSS: minor dry season; PSP: minor rainy season.

3.2. DISCUSSION

In this study, baited traps using cattle manure were used. More individuals were collected at Kpouèbo and fewer at Mankono. Analysis revealed that the species *Omalium* sp. was the most abundant among all species collected at the three sites. This same species was also the most abundant at each site individually. The abundance of this species may be due to specific environmental requirements that favor it. Indeed, this species can be found in forest environments as well as in grasslands or cultivated areas near hedgerows. It is extremely abundant at all elevations.^[19] The environment at these three sites would therefore be conducive to the development of this insect. According to,^[20] each species occupies a specific ecological niche and requires certain temperature conditions to complete its life cycle (from the larval stage to the reproductive adult stage). In addition to these requirements, whether or not a species can live and reproduce in a particular location is determined by climatic constraints.^[21] The only beetles native to the Palearctic region (the ecological zone comprising Europe, North Africa, and parts of Asia and the Middle East) that have been identified are *Latridius minutus* and *Omalium rivulare*.^[22,23] Regarding species abundance at the study sites, the Kpouèbo (Toumodi) site has more Staphylinidae species than the Mankono and Yamoussoukro sites; fewer species were collected at the Mankono site. The low abundance of Staphylinidae species at the Mankono site could be explained by the fact that anthropogenic impacts are more pronounced there, as herders live on the site with their families, unlike at the Kpouèbo site, where herders do not live on

the pasture. This could lead to a decline in this population. This disruption of the ecological balance can cause stress in the organisms living in these environments.^[24] report that the increased susceptibility of organisms can lead to major and irreversible changes within natural ecosystems when disturbances are severe. Furthermore, hatching larvae are likely to be exposed to predation (by birds, insects, etc.) and competition.^[25] Furthermore, the Kpouèbo and Yamoussoukro sites are more species-diverse than the Mankono site. This may be due to the fact that the pasture at this site is located along a watercourse, which helps maintain constant moisture in the pasture. According to,^[26] Staphylinidae inhabit leaf litter, particularly in terrestrial habitats with moist conditions. The larvae and adults live in moist organic debris along streams. Females lay eggs in areas where water is visible in the soil. During the six-month collection period from May to October, high abundances of Staphylinidae were observed in May at the Yamoussoukro and Mankono sites. In contrast to the Kpouèbo site, where there was a decline in the abundance of these Staphylinidae during May, the highest abundance was observed in September, and the lowest abundance occurred in October. The abundance of Staphylinidae in May at the respective sites (Yamoussoukro and Mankono) could be explained by the fact that during those months there was less disturbance and resources were available. According to,^[27] while a habitat may or may not be open, it is the amount of food resources that determines the abundance, species richness, and biomass of insect communities. At the Kpouèbo site, the decline in the abundance of

Staphylinidae may be attributed to the fact that during that month, due to tick infestation, cattle and pastures were treated with antiparasitic products such as (deltamethrin, alpha-cypermethrin...), which may have had negative impacts not only on the environment but also on this insect community. According to,^[12] and the,^[28] nearly all insecticides used in pest control have a broad spectrum of activity and are therefore not entirely specific to the target pests. According to,^[29] the actual amount of insecticide applied appears to be the dominant factor in determining the severity of a treatment's impact on non-target arthropods, both in terms of immediate effects and the recovery of non-target arthropod populations. The decline in the abundance of Staphylinidae species in October at the Yamoussoukro and Mankono sites could be due to the onset of the major dry season. High temperatures can dry out food sources, rendering them unusable. According to,^[30] during hot and dry periods, dung becomes less available as a food source. In addition to temperature, the harmattan—given climate change—would likely lead to the disappearance of these species in September and October.

CONCLUSION

This study was conducted in Yamoussoukro, Kpouèbo, and Mankono. It focused on the Staphylinidae family of beetles in order to gather information to raise public awareness about the need to conserve these species. More individuals were collected in Kpouèbo, and more species were identified in Yamoussoukro and Kpouèbo. The species *Omlium* sp. was the most common at all sampled sites. The Kpouèbo site also had the greatest diversity of Staphylinidae beetle species, but there was a good distribution of these species across the sites. The abundance of Staphylinidae species varied by sampling month depending on the site.

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