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Diversity of the entomological fauna associated with PIG carcasses (*Sus Scrofa domesticus* L.) exposed in the open air in the Sudano-Guinean and Sub-Sudanese zones of Côte d'Ivoire

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Abstract
Necrophagous insects are very important bioindicators in determining the post mortem interval. The objective of this Works was to determine the diversity of Necrophagous insects involved in the décomposition process of a cadaver exposed in the open air in the Sudano-Guinean (Bouaké) and Sub-Sudanese (Korhogo) zones of Côte d'Ivoire.
Twelve pig carcases were used in each agro-ecological zone. Harvesting of adult insects has been done by various traps. Egg samples, larvae and pupae were collected on the corpses then breeded in the laboratory. The necrophagous insects order collected were Beetles and Diptera. In the Diptera, 17 species grouped into six families were collected in each agro-ecological zone. Calliphoridae and Histeridae were the richest in species. Necrophagous insects were collected at various stages of decomposition during all seasons and at both study areas. These could serve as indicators in forensic entomology investigation.

Keywords: Corpses, Diptera, Coleoptera, Sub-Sudanese, Sudano-Guinean, Côte d’Ivoire

1. Introduction
Insects are Very important bioindicateurs in estimating the post mortem interval when a cadaver is found. The discipline that studies these arthropods, forensic entomology, is one of the modern means of investigation, essential for strengthening criminal justice systems [1, 2]. When a body is discovered, investigators need to know the causes and the date of death. The estimation of the short post mortem intervalle (PMI) requires accurate identification of these insects to taxonomic species level.
The bio-geo-climatic zone including habitat, vegetation, soil type and weather conditions where the corpse is discorvered are very important factors in the colonization of it by insects [3, 4]. When an animal dies, it is rapidly colonized by many organisms [5]. The majority of these organisms are arthropods with a clear preponderance of insects. These are usually the first to arrive on the body soon after death [3, 6].
In Côte d'Ivoire, work on the diversity of necrophagous insects has been carried out in Guinean zone by [6, 7]. The literature does not mention any similar study in the Sudano-Guinean and Sub-Sudanese zones of Côte d'Ivoire.
The objective of this work was to determine the diversity of necrophagous insects involved in the decomposition process of a cadaver exposed in the open air in the Sudano-Guinean (Bouaké) and Sub-Sudanese (Korhogo) zones of Côte d'Ivoire.

2. Material and Methods
2.1 Study site
The work was done in the Sudano-Guinean zone (Bouaké) and in the Sub-Sudanese zone (Korhogo).
The site of Bouaké was chosen in the village of Kogondekro of geographical coordinates 7°36'N-5 ° 2'W / altitude 278 m.
In the town of Korhogo, the Botanical Garden of the University Peleforo Gon Coulibaly with geographic coordinates 9°26’N - 5°38' W / altitude 380 m, was chosen.

2.2 Experimental climatic conditions

A thermo - hygrometer brand and model IHM- 172SI was used to measure the temperature and relative humidity. Rain gauge placed on each site allowed measurement rainfall.

In Sudano-Guinean zone, the temperature varied between 27 and 35°C with an average of 33.7 °C during the dry season. The average relative humidity was 59% and the rainfall ranged from 0 to 80 mm. During the rainy season, the average temperature was 32°C, the average relative humidity was 73.6% and the rainfall oscillated between 70 and 732 mm.

In sub-Sudanese zone, temperatures fluctuated between 25 and 36°C with an average of 30.8 ± 3.7°C during the dry season. In the rainy season, it varied from 24.6 to 33.2°C with an average of 26.7°C. The Relative humidity ranged from 12 to 63% with an average of 46.53 ± 15.57 % for the dry season and 68 to 86% with an average of 76.85 % in the rainy season. In the dry season, rainfall oscillated between 0 and 75 mm, while in the rainy season it fluctuated from 46 to 310 mm.

2.3 Capture of insects

The biological material used was whole pig carcasses (*Sus scrofa domesticus* L.). These bodies were used as bait to catch necrophagous insects. To carry out this study, 24 pigs were used for the two agroecological zones (12 pigs per zone). The pigs weighed in average 50 kilograms. Four series of exhibitions were carried out over the twelve months of the year, ie three months for an exhibition.

In each agro - ecological zone, three pigs representing three rehearsals were used for each exhibition series. At each site, the pig carcases were exposed in mesh cages of dimension L = 1.5 m l = 0.80 m and h = 0.70 m [8]. These cages allow to all insects have access to carcasses. However, the fence has prevented vertebrate scavengers to access corpses.

The first series of exhibition started in November 2017 and ended in February 2018. The second series began in March 2018 and ended in May 2018. The third series was conducted between June and mid- August 2018 and the fourth, between mid-August and October 2018.

2.3.1 During these experience, necrophagous insects were collected in five methods

- **Method 1:** Samples of egg have been taken on the corpses at each stage of decomposition. The eggs collected were incubated in the laboratory and the larvae obtained were breeded on pig’s liver or striated muscle until emergence of adults. The emerged flies were killed with ether or carbon dioxide (CO_2) gas, sorted out, identified then counted.
- **Method 2:** Samples of insect larvae found at each stage of decomposition were collected. Diptera pupae were also harvested in / or near the bodies using flexible clamp. Larvae taken were breeded and pupae were directly introduced in to the emergence boxes to obten adult flies in the laboratory.
- **Method 3:** the adult insects were collected with pitfall trap. Six pitfall trap were used, two where in near the stomach, two at the back, one near the head and the last near the anus.
- **Method 4:** Four yellow tanks placed on the ventral and dorsal sides and at the near of the head and the anus, and also containing soap water. These traps allow to harvest certain necrophagous Coleoptera and Diptera.
- **Method 5:** Flying insects were captured with a butterfly net. The captures were executed three times a day: in the morning at 9 o’clock, at 12 o'clock and at 6 o'clock. The insects are caught by pitfall trap and yellow tanks were recorded every day at 18: 30. All insects captured by these different methods were assembled to form a daily sample.

2.4 Preparation and identification of harvested insects

In the laboratory the insects captured by traps and those emerged of pupae and eggs collected on the corpses were bitten and ranged in the entomological boxes. They were identified using a binocular loupe brand and model Optika LAB20 surmounted by a camera MikroCamLab7 version 4.0 and connectable to a computer. The identification keys used were those of [9-17].

2.5 Data Processing

The ecological parameters studied were the following:

- **Total richness:** According [18], the total richness of a biocenose the total number of all species observed during N records.

S = Sp1 + Sp2 +. + Spn

S, being the total number of species observed during N Records, Sp1, Sp2, Spn being the species observed.

2.6 Index of Shannon - Weaver and equitability Index

Shannon - Weaver (H') index

It allows to quantify the heterogeneity of the biodiversity of the study seasons and thus to observe an evolution over time. This index is independent of sample size, but takes into account the relative abundance of each species [19].

- H 'is minimal (= 0) if all individuals in the stand belong to one and the same species.
- It is also minimal if in a stand each species is represented by a single individual, except a species that is represented by a large number of stand individuals.
- The index is maximal when all individuals are equally distributed over all species [20].

$$H' = -\sum_{i=1}^{S} Pi \times log_2 Pi$$

$$Pi = \frac{ni}{N}$$

Where ni is the number of individuals of the species and N is the total number of individuals of all species combined.

2.7 Equitability Index (E)

The equitability index (E) allows to study the regularity of the distribution of species in each season. This index can vary from 0 to 1, it is maximal when the species have identical abundances in the stand and it is minimal when a single species dominates the whole population. Unaffected by species richness, it is very useful for comparing potential dominance between stations or between sampling dates [21].

$$\mathbf{E = \frac{H'}{log2(S)}}$$

H': Shannon's index

S: total richesse

2.8 Similarity index of Jaccard

The similarity index evaluates the similarity between two records by the ratio of species common to both surveys and those specific to each statement. The purpose of this index is to compare the sites or seasons of study.

$$J = \frac{Sc}{(Sx + Sy) - Sc} \times 100$$

Sx, being the number of species from the community x, Sy being the number of species of the community there, and Sc the number of species common to x and y samples

2.9 Statistical treatment

Statistical treatments were performed using the software R 3.0.3 and Statistica version 7.1. The analysis of variance followed by Newman-Keuls test at the 5% level, were used to determine the homogeneity of the different groups. Daily climate data were used to calculate monthly averages of temperature, hygrometry and rainfall.

3. Results

3.1 Entomofauna of corpses

The necrophagous insect species inventoried in the two agroecological zones are given in the table below (Table 1).

Table 1: Entomofauna of corpses collected in Sudano-Guinean and Sub-Sudanese zones

Orders	Families	Species	SGZ	SSZ
Diptera	Calliphoridae	*Calliphora vomitoria* (Linnaeus, 1758)	x	x
		Calliphora vicina (Robineau-Desvoidy, 1830)	x	x
		Chrysomya albiceps (Wiedemann, 1819)	x	x
		Chrysomya marginalis (Wiedemann, 1830)	x	x
		Chrysomya megacephala (Fabricius, 1794)	x	x
		Chrysomya putoria (Wiedemann, 1830)	x	x
		Lucilia ca e sar (Linnaeus, 1758)	x	x
		Lucilia sericata (Meigen, 1826)	x	x
		Protophormia terraenovae (Robineau-Desvoidy, 1830).	x	x
	Sarcophagidae	*Sarcophaga carnaria* (Linnaeus, 1758)	x	x
		Sarcophaga africa (Wiedemann, 1824)	x	x
		Sarcophaga haemorrhoidalis (Fallen, 1817)	x	x
		Wohlfahrtia nuba (Wiedemann, 1830)		x
	fanniidae	*Fannia canicularis* (Linnaeus, 1760)	x	x
	Muscidae	*Musca domestica* (Linnaeus, 1758)	x	x
		Stomoxys calcitrans (Linnaeus, 1758)		x
		Musca sp.	x	
	Stratiomyidae	*Hermetia illucens* (Linnaeus, 1758)	x	x
	piophilidae	*Piophila casei* (Linnaeus, 1758)	x	x
Coleoptera	Cleridae	*Necrobia rufipes* (De Geer, 1775)	x	x
	Histeridae	*Margarinotus brunneus* (Fabricius, 1775)	x	x
		Hister cadaverinus (Hoffmann, 1803)	x	x
		Hister quadrinotatus (Scriba, 1790)	x	x
		Pachylister inaequalis (Olivier, 1789)	x	x
	Dermestidae	*Dermestes maculatus* (De Geer, 1774)	x	x
	Scarabaeidae	*Onthophagus taurus* (Schreber, 1759)	x	x
	Tenebrionidae	*Tenebrio molitor* (Linnaeus, 1758)	x	x
	Trogidae	*Trox cadaverinus*	x	

<u>*Note*</u> : *ZSG : Sudano-Guinean zone ; SSZ : Sub-Sudanese zone* ; x : *Presence*

3.2 Abundance of species of Diptera

3.2.1 Sudano-Guinean zone (Bouake)

Seventeen species of Diptera were collected and grouped into six families. The Newman-Keuls separation test at the 5% threshold revealed that *C. albiceps* was the most abundant species with 2088.06 ± 255.79 individuals (25.21%) and *C. vicina*, the the less abundant species 10.06 ± 4.58 individuals, in the dry season (Series 1) (November-February). Analysis of variance at the 5% threshold (F = 22,5055, ddl = 16; P <0.000 1) revealed a significant difference between the average number of species collected (Table 2). In the beginning of rainy season (series 2) (March-May) the Newman-Keuls separation test at the 5% threshold revealed that *C. albiceps* and *L. caesar* were the most abundant species with respectively 3106.16 ± 231.96 individuals (23.00%) and 2763.46 ± 253.02 individuals (20.47%). Analysis of variance at the 5% threshold (F = 40.7822, ddl = 16; *P*< 0.0001) revealed a significant difference between the mean numbers of species collected (Table 2).

The Newman-Keuls separation test at the threshold 5% showed that in the light of the work carried out in rainy season (series 3) (June - August), *C. albiceps* was the majority species with an average number of 2753,20 ± 319.72 individuals (17.11 %). The variance analysis at the 5% threshold (F = 21.5224; ddl = 16; P < 0.0001) revealed a difference if gnificative between the average number of species collected during this period (Table 2). At the end of the rainy season (series 4) (September-November), the separation test Newman-Keuls at 5% threshold also revealed *C. albiceps* as the most abundant species with an average of 1973 03 ± 205.14 individuals (17.66%). Analysis of variance followed by the 5% threshold (F = 18, 8217; ddl = 16; P < 0.0001) revealed a significant difference between the average number of species collected during this period head (Table 2).

Table 2: Aaverage number of Diptera species harvested in the Sudano-Guinean zone

Families	Species	Dry season: Series 1 (Nov. - Feb.)	Rainy season: Series 2 (Mar. - May)	Series 3 (June- mid-Aug.)	Series 4 (mid-Aug. -Oct.)
Calliphoridae	*Calliphora vicina*	10.06 ± 4.58d	75.73 ± 11.45e	116.26 ± 35.09e	92.56 ± 14.46e
	Calliphora vomitoria	124.10 ± 26.45d	274.86 ± 104.36e	209.16 ± 46.00e	81.50 ± 17.82f
	Chrysomya albiceps	2088.06 ± 255.79a	3106.16 ± 231.96a	2753.20 ± 319.72a	1973.03 ± 205.14a
	Chrysomya marginalis	749.03 ± 153.17c	1069.16 ± 188.00c	1092.00 ± 191.46cd	701.20 ± 112.99de
	Chrysomya megacephala	983.90 ± 245.10c	1077.26 ± 189.07c	1295.43 ± 210.51cd	1567.43 ± 202.63b
	Lucilia sericata	68.50 ± 12.03d	125.46 ± 44.06e	65.86 ± 12.65e	151.40 ± 33.63e
	Chrysomya putoria	201.63 ± 49.56d	321.90 ± 89.18e	494.16 ± 85.05e	405.03 ± 79.94ef
	Protophormia terraenovae	778.20 ± 122.58c	1053.70 ± 198.13c	728.13 ± 162de	733.96 ± 67.62de
	Lucilia caesar	1564.26 ± 293.76b	2763.46 ± 253.02a	2225.80 ± 385.40b	1296.36 ± 220.50b
Fanniidae	*Fannia canicularis*	84.13 ± 24.61d	140.36 ± 35.85e	330.73 ± 75.64e	910.03 ± 192.83cde
Muscidae	*Musca domestica*	948.10 ± 87.49c	1823.03 ± 124.83b	1209.56 ± 236.31cd	1033.30 ± 216.88cd
	Musca sp.	169.13 ± 43.33d	429.03 ± 102.67de	178.93 ± 31.10e	79.60 ± 16.48f
Sarcophagidae	*Sarcophaga carnaria*	308.50 ± 47.74d	817.40 ± 89.03cd	1619.66 ± 182.75c	709.80 ± 84.74de
	Sarcophaga haemorrhoidalis	46.86 ± 11.30c	48.10 ± 7.49e	222.93 ± 43.21e	173.46 ± 43.82f
	Sarcophaga africa	57.50 ± 10.68d	80.06 ± 9.45e	197.43 ± 29.04e	146.76 ± 23.27f
Stratiomyidae	*Hermetia illucens*	48.03 ± 7.54d	190.46 ± 45.14e	1802.00 ± 198.46bc	540.76 ± 23.27def
Piophilidae	*Piophila casei*	53.66 ± 9.47d	105.66 ± 17.69e	1549.56 ± 186.51c	573.73 ± 118.47def
F		22.5055	40.7822	21.5224	18.8217
ddl		16	16	16	16
P-value		0.0001	0.0001	0.0001	0.0001

Note: Numbers followed by the same letter in a column are not significantly different according to the Newman Keuls test at the 5% threshold.

3.3 Abundance of Coleoptera species

3.3.1 Sudano-Guinean zone

At the beginning of the dry season (series 1), eight species were collected. The separation test Newman-Keuls at 5% level showed that among all species collected during this period, *D. maculatus* was the most abundant with an average number of 1131.29 ± 116.30 individuals (45.43%). Analysis of variance at the 5% threshold (F = 67, 4811, ddl = 7; *P*< 0.0001) revealed a significant difference between the average number of species collected (Table 4).

Those carried out at the end of the dry season (series 2), allowed to collect nine species of which *M. brunneus* was revealed by the Newman-Keuls separation test at the 5% threshold as the most abundant with an average number of 996.70 ± 95.49 individuals. Analysis of variance at the 5% threshold (F = 44, 6120, dof = 7; *P*< 0.0001) revealed a significant difference between the average number of species collected (Table 4). In beginning of rainy season (series 3), seven species were captured. The Newman-Keuls separation test at the 5% threshold revealed that *M. brunneus* was the most abundant species with an average of 452.10 ± 56.53 individuals (27.81%). Analysis of variance at the 5% threshold (F = 24, 6854, ddl = 6; *P*< 0.0001) revealed a significant difference between the average number of species collected (Table 4).

In the end of the rainy season (series 4), six species were collected. Of these, the Newman-Keuls separation test at the 5% threshold showed that *D. maculatus* was the most abundant species with an average number of 497.58 ± 43.59 individuals (31.01%). Analysis of variance at the 5% threshold (F = 30, 0063; ddl = 5; P < 0.0001) revealed a significant difference between the average number of species collected (Table 4).

Table 4: Average numbers of Coleoptera species collected in the Sudano-Guinean zone

Families	Species	Dry season: Series 1 (Nov. - Feb.)	Rainy season: Series 2 (Mar. - May)	Series 3 (June- mid-Aug.)	Series 4 (mid-Aug.-Oct.)
Cleridae	*Necrobia rufipes*	338.06 ± 28.07b	738.40 ± 58.11b	239.33 ± 25.47c	255.23 ± 23.24c
Histeridae	*Margarinotus brunneus*	406.06 ± 36.35b	996.70 ± 95.49a	452.10 ± 56.53a	373.36 ± 44.30b
	Hister cadaverinus	164.38 ± 13.25c	485.03 ± 59.05c	217.12 ± 30.44c	227.74 ± 20.27c
	Hister quadrinotatus	2.61 ± 0.69c	1.25 ± 0.43d	-	-
	Pachylister inaequalis	446.63 ± 35.96b	396.40 ± 53.09c	339.76 ± 35.22b	250.26 ± 28.20c
Dermestidae	*Dermestes maculatus*	1131.29 ± 116.30a	738.41 ± 83.55b	375.12 ± 54.39ab	497.58 ± 43.59a
Scarabaeidae	*Onthophagus taurus*	0.23 ± 0.05c	2.61 ± 0.72d	0.81 ± 0.44d	0.77 ± 045d
Trogidae	*Trox cadaverinus*	-	0.93 ± 0.45d	1.25 ± 0.45d	-
Tenebrionidae	*Tenebrio molitor*	0.71 ± 0.45c	0.90 ± 0.41d	-	-
F		67.4811	44.6120	24.6854	30.0063
ddl		7	8	6	5
P-value		0.0001	0.0001	0.0001	0.0001

3.3.2 In Sub-Sudanese zone

In the beginning and end of the dry season (Series 1) seven species of beetle were collect ed. The Newman-Keuls separation test at the 5% threshold revealed that *D. maculatus* was the most abundant species with an average number of 1748.133 ± 179.25 individuals (56.28 %) (F = 59, 4390, ddl =

6; *P*< 0.0001) and *M. brunneus* with 801.06 ± 108.09 (33.43%) at the end of the dry season (series 2) (F = 27, 2629; ddl = 6; *P*< 0.0001). Analysis of variance at 5% level revealed a significant difference between the average number of species collected (Table 5).

At the beginning and at the end of the rainy season (series 3 and 4), seven species have also collected. The separation test Newman-Keuls at 5% level revealed that *D. maculatus, M. brunneus* and *P. inaequalis* were the the most abundant species with respectively average numbers of 208.20 ± 43.96 individuals (27.81%), 171.73 ± 38.18 individuals (22.42%) and 129.06 ± 34.69 individuals (16.85%) (F = 6, 8435, ddl = 6; *P*< 0.0001) (Table 5). Analysis of variance at the 5% threshold revealed a significant difference between the mean numbers of species collected at each experiment (Table 5).

Table 5: Average number of Coleoptera species Collected in the Sub-Sudanese zone

		Dry season		Rainy season	
Families	**Species**	**Series 1 (Nov. - Feb.)**	**Series 2 (Mar. - May)**	**Series 3 (June –mid-Aug.)**	**Series 4 (mid-Aug. - Oct.)**
Cleridae	*Necrobia rufipes*	398.66 ± 50.35[bc]	555.33 ± 70.46[b]	109.43 ± 11.49[ab]	278.86 ± 41.30[b]
Histeridae	*Margarinotus brunneus*	538.33 ± 71.42[b]	801.06 ± 108.09[a]	171.73 ± 38.18[a]	290.43 ± 73.31[b]
	Hister cadaverinus	171.70 ± 35.53[cd]	285.63 ± 39.03[c]	117.63 ± 26.19[ab]	155.76 ± 42.33[bc]
	Hister quadrinotatus	3.73 ± 1.88[c]	9.43 ± 3.34[d]	-	-
	Pachylister inaequalis	239.06 ± 48.87[cd]	203.80 ± 34.08[c]	129.06 ± 34.69[a]	146.06 ± 45.05[bc]
Dermestidae	*Dermestes maculatus*	1748.133 ± 179.25[a]	536.33 ± 61.45[b]	208.20 ± 43.96[a]	458.93 ± 87.01[a]
Scarabaeidae	*Onthophagus taurus*	-	-	3.33 ± 0.83[c]	6.86 ± 2.86[c]
Tenebrionidae	*Tenebrio molitor*	6.76 ± 3.22[c]	4.86 ± 2.66[d]	26.63 ± 8.25[bc]	31.10 ± 11.59[c]
F		59.4390	27.2629	6.8435	8.34495
ddl		6	6	6	6
P -value		0.0001	0.0001	0.0001	0.0001

Note: Numbers followed by the same letter in a column are not significantly different according to the Newman Keuls test at the 5% threshold.

3.4 Ecological Index

3.4.1 Specific richness

In the Sudano-Guinean zone, 25 and 26 species were respectively harvested at the beginning and at the end of the dry season, and 24 and 23 respectively at the beginning and end of the rainy season. E n The beginning of the rainy season (March-May) was the richest in species and the end of the rainy season, the least rich.

In the sub-Sudanese zone, the same number of species (22 species) were collected at the beginning and end of the dry season. The same observation was made at the beginning and end of the rainy season with 24 species. The rainy season experiences were the richest in species.

3.4.2 Shannon Index and Similarity Index

The Shannon index and fairness were higher in the rainy season in both study areas (Table 6). These results show that the individuals were distributed in a more or less equal manner on all the species collected during the two series in the two study areas.

The index of similarity calculated between the two communities (species of the Sudano-Guinean and Sub-Sudanese zones) was higher at the level of the experiment series 4 (88%) (Table 6).

Table 6: Shannon index, equitability index and similarity index in the both zones

	Sudano-Guinean Zone		Sub-Sudanese Zone		
Indices	**H '**	**E**	**H '**	**E**	**J**
Series 1	2.54	0.79	2.23	0.72	80.77%
Series 2	2.61	0.80	2.43	0.78	77.78%
Series 3	2.69	0.82	2.61	0.83	80.77%
Series 4	2.76	0.86	2.65	0.84	88.00%

Note: H': Shannon's index; E: Fairness; J: Jaccard Similarity Index at the Sudano-Guinean and Sub-Sudanese areas

4. Discussion

The study of the diversity of necrophagous insects associated with pigs carcasses exposed at the open-air to the Sudano-Guinean and Sub-Sudanese zones of Côte d'Ivoire has allowed us to harvest mainly Diptera and Coleoptera.

In the Diptera order, the species collected belonged to the families Calliphoridae, Fanniidae, Muscidae, Sarcophagidae, Stratiomyidae and Piophilidae. The presence of these insects on cadavers would be due to their diet and the reproduction. These observations are similar to those of [8, 10, 22].

At the two area's study, family of Calliphoridae was the richest in species. In addition, species belonging to the families Calliphoridae, Sarcophagidae and Muscidae were the first to colonize carcasses. They were collected at the stage of fresh cadaver, swelling and at the beginning of active decomposition. The early colonization of corpses by these families of insects could be explained by the presence at their antennas, the sensors chemical molecules that are able to detect odors in hundreds of meters. These observations are similar to those of [23-25].

In the sub-Sudanese zone, a progressive increase in the number of individuals and the number of species was observed during the transition from the dry season to the rainy season. This finding could be explained by the increase of the relative humidity following the fall of the rains. Thus the increased humidification of the corpse would make it more attractive to the species. This would also promote the reproduction of these. This is similar to that of [6].

In the two study areas, two species were particularly abundant: *C. albiceps* and *L. caesar* at the end of the dry season and at the beginning of the rainy season. The abundance of these species could be explained by an increased egg-laying activity of the females on the one hand, and by the fact that their larvae are predators of the larvae of the other Diptera species on the other hand. This finding is similar to those of [26, 27].

The numbers of most species collected from carcasses between November and February was small. These small numbers would be explained by the drying up of corpses due to the low rates of relative humidity. This led to the mummification of the corpses. These observations are similar to those of [28] and from [8].

Data analysis has identified two categories of families, those which have been present throughout the year and those present during a specific period. The Calliphoridae, Muscidae and Sarcophagidae were present throughout the year with high abundance between February and June. The Stratiomyidae, Piophilidae and Fanniidae were absent in dry season but these families were observed in rainy season; the numbers of individuals increased between July and October. The variation in abundance of species of these families can be explained by the corpses condition. Indeed, during the dry season, the dried cadaver, due to the effect of low relative humidity and high temperatures, is no longer a habitat and a nurturing substrate favorable to the survival and development of larvae. These observations are similar to those of [8, 28, 29].

In the Coleoptera order, the family of Histeridae, the Cleridae and Dermestidae were collected on the third day after death, corresponding to the active decomposition stage. These results are similar to those of [6, 8]. At this stage, Cleridae and Dermestidae species were small while those of the family Histeridae were in large numbers. The presence of individuals of these species at this stage of cadaveric decomposition can be explained by the rancidity of the fat of exposed carcasses. Coleoptera species were generally harvested in large numbers at the active and late stages of decomposition. These results are similar to those of [6, 30]. In addition, these species were more numerous in the dry season than in the rainy season. Their large number observed in the dry season can be due to the effect of the low relative humidity and the high temperatures observed during this period. These two parameters could favor the rancidity of the fats as well as the desiccation of carcasses attracting and providing nutritive debris to the different species of Beetles [31].

The values of the similarity index indicate that there is no difference between the species collected in the two study areas.

5. Conclusion

The study of the diversity of the entomological fauna associated with pig carcasses allowed to inventory necrophagous insects on pig carcasses exposed to the open air in the Sudano-Guinean and Sub-Sudanese zones of Côte d'Ivoire.

Two orders of insects (Coleoptera and Diptera) were collected. Regarding the order of Diptera, 17 species grouped into six families were captured in each agroecological zone.

Throughout the year, in the both agro-ecological zones, the Diptera Calliphoridae, Sarcophagidae and Muscidae were more abundant. These were captured in fresh cadaver stages, swelling and active decomposition during the dry and rainy seasons.

Within the Coleoptera order, nine species grouped into six families were captured. In the sub-Sudanese zone, 5 families were collected. Of these, the Histeridae family was the richest with four species. In the Sudano-Guinean zone, the species Coleoptera harvested have been grouped into 6 families. Five insect families were common to both study areas.

Coleoptera were found on corpses in the active and advanced stages of decomposition.

This study shows that in the context of an entomological expertise to date deaths, experts could find at any time of the year, necrophagous insects on corpses discovered.

6. Declaration of Interests

The authors declare that they have no conflicts of interest in relation to this article.

7. Acknowledgments

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