

# Ants Assemblage Method According to an Age Gradient of Mango Orchards in Korhogo (Côte d'Ivoire)

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## Abstract

This study was conducted in the Korhogo region in an age gradient of mango orchards. The goal was to assess diversity and determine the influence of the environment on the composition of these organisms. Sampling was done using pitfall traps, threshing and manual collection. A total of 82 ant species were sampled on all plots. The cultivated plots are richer in ant species than the natural environment. Of the three (3) sampling methods, the Manual Collection proved to be more efficient (eff = 79.52%), followed by threshing (eff = 75.15%) and finally the least effective trap pit (eff = 73.39%). The number of individuals of the species varies according to the environment. The highest value was obtained in the young plot (485 individuals), followed by the intermediate plot (478 individuals), then the older plot (426 individuals) and finally the control plot (320 individuals). The species *Camponotus acvapimensis* was harvested mainly with 159 individuals. On the other hand, the species *Lepisiota* sp.1; *Camponotus rufigenis*, *Camponotus sericeus* and *Oecophylla longinoda* were specifically harvested in the control, young, intermediate and aged plots, respectively.

## Keywords

Ant, Mango Tree, Age Gradient, Assemblage, Diversity

## 1. Introduction

Native to the Indo-Burman region, the mango tree (*Mangifera indica*) is one of the most cultivated fruit species in the world, Vanniere *et al.*, (2013) [1]. These

fruits are food products with high nutritional and commercial value. They help to limit deficiencies, especially in vitamin A deficiency thanks to its high vitamin A and vitamin C content, Rey *et al.*, (2004) [2]. Mango is grown in many subtropical and tropical countries [3]. Mango occupies a prominent place in the economy of West Africa [4] in general, and in Côte d'Ivoire in particular where it is the third export fruit after banana and pineapple [5]. In 2016, 32.628 tonnes of mangoes are exported from Côte d'Ivoire, making it the leading African producer of mangoes and the third-largest supplier to the European market after Brazil and Peru [6]. Mangrove farming provides employment and contributes to the fight against poverty [7]. However, it is heavily under the threat of pests, especially Tephritid flies that attack fruit, causing huge losses in production, N'dépo *et al.*, (2009) [8].

In fact, the bites of these pests on mangoes create black spots from which the development of larvae begins and the rot of the fruit becomes unfit for consumption [9]. The management of these bio-aggressors in fruit agroecosystems is difficult and does not allow to make a precise choice on an optimal and effective method of control [10]. Pesticide application is one of the methods for controlling these pests when it is inadequate for several reasons. In fact, these phytosanitary products, which are often unapproved and poorly used, cause a modification of the natural ecosystem, leading to a loss of biodiversity, particularly that of ants. Ants provide ecosystem services by playing an important role in soil bioturbation, the regulation of phytophagous insects, and are accidental pollinators of flowers, Diame *et al.*, (2015) [11]. According to [9], the weaver ant is a biological agent for the control of fruit flies, which are pests of several varieties of fruits, including mangos. It is also used to protect fruit trees against certain pests, especially Hemiptera. Unfortunately, the myrmecofauna of mango orchards in Côte d'Ivoire is little known. Therefore, in a context of sustainable development of the mango sector, it is important to know these organisms and the factors favoring their installation. Previous work carried out in Côte d'Ivoire on myrmecofauna focused mainly on the ecology of this species. This is the case of the work of [12] [13] [14] [15] and Yéo *et al.* (2017) [16].

## 2. Materials and Methods

### 2.1. Presentation of the Environment

This study was carried out in the Korhogo department, capital of the Poro region in northern Côte d'Ivoire, 648 km from Abidjan, during December (2017) at February (2018). The commune of Korhogo is at 9°53 north latitude and 6°49 west longitude. The population is estimated at about 243,048 inhabitants [17]. The climate of the Korhogo department is of Sudanese type, marked by alternating dry season (November to April) and rainy season (May to October). Average temperatures vary between 24°C and 32°C. The rainy season extends from May to October with maximum rainfall approaching 200 mm of rain in August.

## 2.2. Choice of the Site

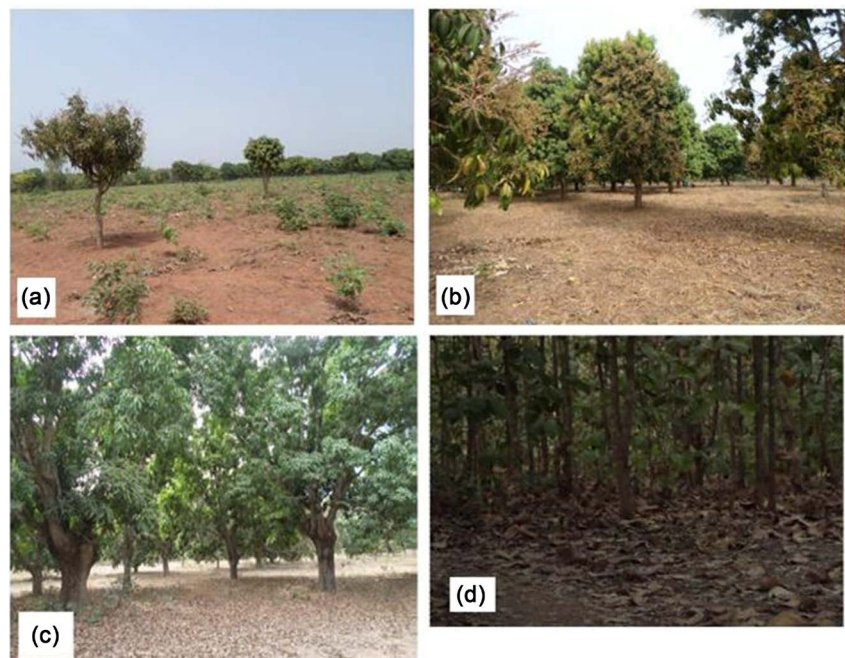
Sampling was done in two types of sites namely the natural environment and the mango orchards. Korhogo was chosen because it is one of the major mango production areas. The natural environment is the botanical garden of Péléforo Gon Coulibaly University. The mango orchards were selected from four villages in Korhogo Department, namely Kpattrakaha, Torgokaha, Lainevogo and Nébremadougou. Orchards have been categorized by age. Three categories were selected: young plots (age between 0 and 5 years), intermediate plots (age between 6 and 15 years) and old plots (age greater than 15 years) (**Figure 1**).

## 2.3. Sampling Methods

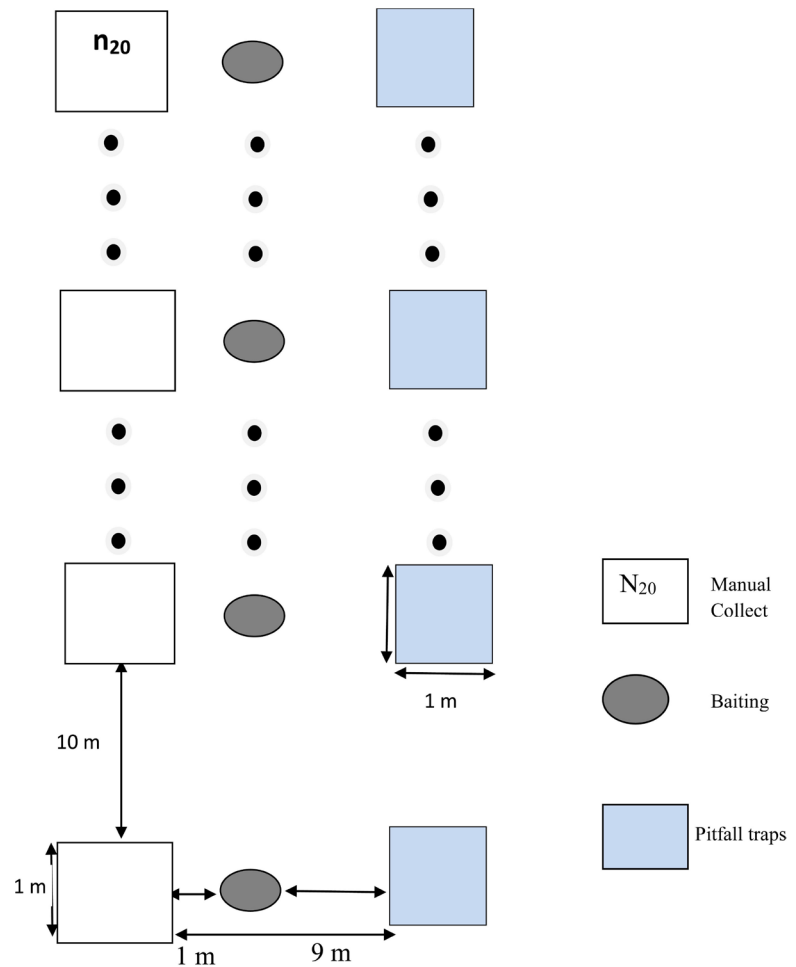
Different methods were used to collect the ants. These are: threshing, pitfall traps and manual collection (**Figure 2**).

## 2.4. Pitfall Traps

This method is a component of the ALL protocol (the Ants of the Leaf Litter). It is used to collect litter ants [18]. For this study, containers of the same capacity commonly called “cups” were used. These cups are placed in the ground so that their borders are at the same level as the surface of the ground. Pitfall traps (**Figure 3(a)**) capture forage ants (Bestelmeyer *et al.*, 2000) [19]. The cups thus placed are filled to a quarter of their volume with a mixture of ethanol and glycerin or ethanol and glycerol [20] or else ethylene and glycol (Abensperg *et al.*, 1996) [21]. Ethanol and ethylene kill the animals collected and their addition



**Figure 1.** Different types of plots studied. (a) Young plot (0 - 5 years); (b) Intermediate plot (6 - 15 years); (c) Old plot (>15 years old); (d) Control plot (botanical garden of University Peleforo Gon Coulibaly).



**Figure 2.** Sampling device for a modified transect Yéo [14].



**Figure 3.** Different methods of catching ants. (a) Pitfall trap; (b) Beating method.

with glycerine, glycerol and glycol respectively, limits their evaporation. In this study, ethanol diluted at 70° and glycerin was used. The traps (**Figure 3(a)**) were covered with leaves to hide them and protect them from possible rain that could degrade the nature of the solution contained in the cup. After 48 hours, the contents of the cup are transferred into a jar and sent to the laboratory, then sort into a petri dish. The ant species obtained during sorting are put in a pill container containing alcohol at 96°, and then identified. Sixty (60) samples per plot were collected.

## 2.5. Beating

Khelil [22] threshing can harvest the wildlife found in the canopy. In this method, a cotton cloth of one square meter is attached to mango trees so as to be placed under the foliage. The branches are vigorously shaken with a stick allowing the insects to fall on the canvas. With the aid of a pincer and a pill container containing alcohol at 96°, the ants fallen on the canvas are quickly collected. (Figure 3(b)). On the site, sixty (60) samples were collected per age of the plots.

## 2.6. Manual Collection

This method makes it possible to search for ants in micro-habitats, namely on dead wood, tree trunks, fallen fruit, litter according to [23]. The ants are collected using forceps and kept in pillboxes containing alcohol and labeled.

## 2.7. Species Identification

Identification of ants requires prior control of the morphology of the ants and the terminology used in species descriptions by taxonomic myrmecologists. The specimens were all identified under a Leica binocular loupe. Some specimens could be identified to the species using identification keys. The contents of each pill box are spilled in a petri dish for observation, then each specimen is mounted. The assembly consists of sticking the specimen on a triangular paper flake of “canson” type, using special wood glue that is water soluble. The straw is then pinned to an entomological tip for observation. This identification was done using identification keys of [24] and West African reference collection of ants of Professor Yeo Kolo (University of Nangui Abrogoua, Côte d’Ivoire).

## 2.8. Data Analysis

Analysis of the data in scope on the calculation of indices of diversity using software R (version 2.8). Species dominance estimation has been demonstrated using Paleontological statistics (PAST) software (version 2.0). The software EstimateS (version 2.8) was used to calculate the harvesting efficiency through the realization of the accumulation curves of the species. Environmental similarity tests were also performed.

## 2.9. Curve of Accumulation of Species

The accumulation curves make it possible to graphically visualize the specific richness and to compare the specific richness of the different media according to the methods used in the mango plots of the Korhogo department and the natural environment of the said region. They make it possible to know the effectiveness of methods used in each medium. The sampling efficiency is calculated according to the following formula:

$$\% \text{Effectiveness of sampling} = S_{obs} / S_{est} \times 100, \quad (1)$$

$S_{obs}$ : represents the observed species richness and  $S_{est}$  represents the estimated species richness.

## 2.10. Specific Richness ( $S$ )

The species richness or total number of species represented is a decisive criterion for community ecological studies as well as for conservation biology. It allows determining the observed species richness ( $S_{obs}$ ) and the estimated species richness ( $S_{est}$ ). A direct count makes it possible to determine the observed specific richness. It takes into account the number of species observed during a sampling and is often used to estimate the total species richness in the studied environment. The estimated species richness ( $S_{est}$ ) expresses the number of species expected by sampling. To determine its value, we used the second-order estimator of Chao 2. The estimated Specific Wealth also allows to calculate the sampling coverage rate, according to the formula:

$$\text{Sampling coverage rate} = (S_{obs}/S_{est}) \times 100; \quad (2)$$

## 2.11. Specific Diversity

Specific diversity can be approximated by a diversity index that reflects both the species richness and the abundance of different species. The Shannon index ( $H'$ ) takes into account the number of taxa encountered on a plot [25]. Shannon index is calculated according to the equation:

$$H' = -\sum p_i \times \log_2 p_i, \quad (3)$$

with  $p_i$  = probability of encounter of species  $i$ ; When  $H'$  tends to 0, the diversity is minimal. It is maximal when  $H'$  tends to  $\log_2(S)$ . Equitability ( $E$ ), also called regularity, measures the equitable distribution of species. It makes it possible to compare stands with different numbers of taxa. Its objective is to observe the balance of the present populations. The index of equitability is calculated according to the equation:

$$E = H'/\log_2(S), \quad (4)$$

where  $H'$  = diversity index and  $\log_2(S) = H_{\max}$ , maximum diversity. The Simpson ( $D$ ) index [26] assesses the probability that two individuals, drawn at random from an infinite population of  $N$  individuals, belong to the same species. In this study, the “derivative” index of the Simpson index was used ( $IS$ ). The Simpson index varies between 0 and 1. The diversity is minimal for  $D = 1$  and maximum for  $D = 0$ .

$$IS = 1 - D, \quad (5)$$

## 2.12. Relative Abundance

Absolute abundance expresses the total number of incidences (absence/presence) of species collected during sampling. The presence of a species is represented by the number 1 and the absence by 0.

## 2.13. Dominance of Species Depending on the Environment

It is a question of showing for each medium, the species having the greatest ab-



undance on the one hand, and of comparing these different abundances to bring out the species which has the greatest abundance on all the mediums.

## 2.14. Ascending Hierarchical Classification Analysis

A hierarchical classification analysis was performed to assess the similarity of the environments based on the relative abundance of ant species. Statistica software (version 7.1) was used.

## 3. Results

### 3.1. Inventory of Ants

This study made it possible to collect 66 species of ants in all the plots cultivated and 50 species in the natural environment. For the two (2) habitats (natural and anthropised), 82 species of ants were collected belonging to 5 sub-families (**Table 1**): Dolichodorinae, Dorylinae, Formicinae, Myrmicinae and Ponerinae. They are divided into 33 such as *Tapinoma*, *Technomyrmex*, *Aenictus*, *Dorylus*, *Camponotus*, *Lepisiota*, *Oecophylla*, *Paratrechina*, *Plagiolepis*, *Nylanderia*, *Atopomyrmex*, *Cardiocondyla*, *Carebara*, *Cataulacus*, *Crematogaster*, *Messor*, *Monomorium*, *Myrmecaria*, *Pheidole*, *Tetramorium*, *Leptothorax*, *Trichomyrmex*, *Anochetus*, *Bothroponera*, *Brachyponera*, *Euponera*, *Hypoconera*, *Megaponera*, *Mesoponera*, *Odontomachus*, *Tetraconera*, *Lioponera*, *Paltotyreus*. Twenty two (22) species of ants are common to these environments.

**Table 1.** List of ants collected during this study.

Species	Plots												Total
	Botanical garden			Young			Intermediate			Old			
	P	B	CM	P	B	CM	P	B	CM	P	B	CM	
<i>Aenictus</i> sp.1	2	0	0	0	0	0	0	0	0	0	0	0	2
<i>Anochetus africanus</i>	0	0	0	0	0	0	0	0	0	1	0	0	1
<i>Anochetus</i> sp.2	1	0	0	0	0	0	0	0	0	0	0	0	1
<i>Atopomyrmex mocquersyi</i>	1	0	0	0	0	0	0	0	0	0	0	0	1
<i>Bothroponera soror</i>	0	0	0	6	1	3	0	0	1	1	0	0	12
<i>Brachyponera sennaarensis</i>	0	0	0	5	0	0	9	0	4	3	0	0	21
<i>Camponotus acvapimensis</i>	6	13	16	22	25	11	3	21	8	8	13	13	159
<i>Camponotus compressiscapus</i>	0	0	0	12	5	8	0	2	0	4	3	5	39
<i>Camponotus maculatus</i>	0	0	0	11	0	1	20	0	0	8	0	0	40
<i>Camponotus rufigenis</i>	0	0	0	23	10	26	15	1	7	11	1	6	100
<i>Camponotus sericeus</i>	0	0	2	12	13	17	22	22	25	1	0	5	119
<i>Camponotus schoutedeni</i>	1	0	7	1	0	1	1	3	0	2	2	2	20
<i>Camponotus</i> sp.5	0	0	2	2	0	0	0	0	0	0	0	0	4
<i>Camponotus</i> sp.6	0	0	0	1	0	0	0	0	0	0	0	0	1
<i>Camponotus vividus</i>	1	0	0	0	0	0	0	0	0	0	0	0	1

## Continued

<i>Cardiocondyla emeryi</i>	1	0	1	0	0	0	3	0	0	8	0	0	13
<i>Carebara</i> sp.1	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>Carebara diabolus</i>	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>Carebara distincta</i>	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>Carebara thoracica</i>	0	0	0	0	0	0	0	0	0	1	0	0	1
<i>Cataulacus traegaardhi</i>	1	5	3	0	1	0	0	0	0	0	0	0	10
<i>Crematogaster</i> sp.1	1	4	0	18	6	6	5	3	1	1	3	1	49
<i>Crematogaster</i> sp.4	0	0	0	0	0	0	0	3	0	0	1	0	4
<i>Crematogaster</i> sp.2	0	0	0	7	7	8	7	2	2	0	0	0	33
<i>Crematogaster</i> sp.3	0	1	0	0	1	0	5	4	0	3	5	1	20
<i>Dorylus</i> sp.1	1	0	0	0	0	0	0	0	0	0	0	0	1
<i>Euponera brunoi</i>	1	0	0	2	0	0	1	0	0	1	0	0	5
<i>Hypoponera</i> sp.1	0	0	0	0	0	0	0	0	0	1	0	0	1
<i>Lepisiota egregia</i>	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>Lepisiota</i> sp.2	2	4	2	0	0	0	0	0	0	0	0	0	8
<i>Lepisiota</i> sp.5	1	0	0	0	0	0	0	0	0	0	0	0	1
<i>Lepisiota</i> sp.3	1	3	1	4	1	2	15	0	7	6	5	6	51
<i>Lepisiota</i> sp.1	0	14	30	2	1	2	4	5	1	18	6	14	97
<i>Megaponera analis</i>	0	0	0	4	0	2	0	0	0	0	0	0	6
<i>Mesoponera cafraria</i>	3	0	2	1	0	0	0	0	0	1	0	3	10
<i>Hypoponera</i> sp.1	0	0	0	0	0	0	0	0	0	1	0	0	1
<i>Lepisiota egregia</i>	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>Lepisiota</i> sp.2	2	4	2	0	0	0	0	0	0	0	0	0	8
<i>Lepisiota</i> sp.5	1	0	0	0	0	0	0	0	0	0	0	0	1
<i>Lepisiota</i> sp.3	1	3	1	4	1	2	15	0	7	6	5	6	51
<i>Lepisiota</i> sp.1	0	14	30	2	1	2	4	5	1	18	6	14	97
<i>Megaponera analis</i>	0	0	0	4	0	2	0	0	0	0	0	0	6
<i>Mesoponera cafraria</i>	3	0	2	1	0	0	0	0	0	1	0	3	10
<i>Messor galla</i>	0	4	0	2	0	2	3	0	3	0	0	0	14
<i>Monomorium afrum</i>	0	0	0	6	0	2	1	4	1	2	0	0	16
<i>Monomorium bicolor</i>	0	0	1	21	0	0	24	0	3	4	1	2	56
<i>Monomorium egens</i>	0	0	0	0	0	0	0	0	0	1	0	0	1
<i>Monomorium occidentale</i>	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>Monomorium pharaonis</i>	1	0	0	0	0	0	0	0	0	0	0	0	1
<i>Monomorium</i> sp.1	3	1	0	2	0	0	5	0	0	11	0	0	22
<i>Monomorium</i> sp.2	1	0	0	2	0	0	0	0	0	0	0	0	3
<i>Monomorium</i> sp.4	0	0	0	3	0	0	0	0	0	3	0	0	6

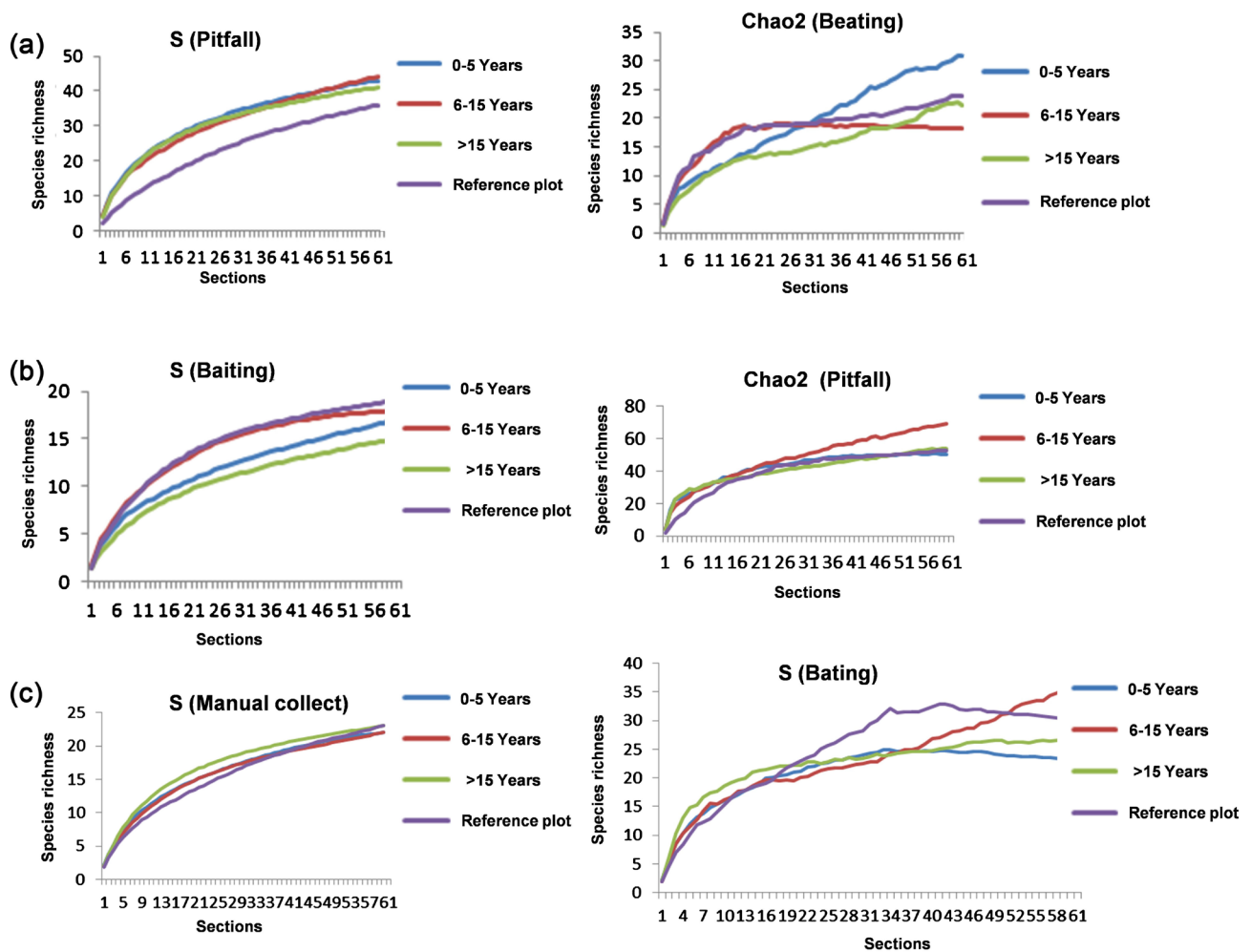


## Continued

<i>Myrmicaria baumi</i>	0	0	0	6	0	1	1	0	1	5	0	8	22
<i>Odontomachus troglodytes</i>	2	0	1	1	0	0	2	2	6	5	0	16	35
<i>Oecophylla longinoda</i>	0	6	1	0	15	18	1	16	6	0	30	15	108
<i>Paltothyreus tarsatus</i>	0	0	0	3	0	0	2	0	0	9	0	0	14
<i>Paratrechina longicornis</i>	2	0	2	4	1	1	13	5	7	4	0	1	40
<i>Pheidole excellens</i>	5	1	6	1	0	0	0	0	0	0	0	0	13
<i>Pheidole megacephala</i>	26	0	15	3	0	0	17	3	6	22	0	2	94
<i>Pheidole</i> sp.8	18	0	0	0	0	0	1	0	0	9	0	0	28
<i>Pheidole</i> sp.1	8	0	1	20	0	1	32	2	21	13	1	4	103
<i>Pheidole</i> sp.7	0	6	0	1	0	0	0	7	0	0	1	0	15
<i>Pheidole</i> sp.2	0	0	0	8	0	0	2	0	0	13	0	0	23
<i>Pheidole</i> sp.20	2	0	0	1	0	0	4	0	1	4	0	4	16
<i>Pheidole</i> sp.3	0	0	0	0	0	0	0	0	0	0	0	1	1
<i>Plagiolepis alluaudi</i>	0	2	1	1	1	0	1	1	0	0	0	3	10
<i>Tapinoma lugubre</i>	0	0	0	1	0	0	1	0	0	7	0	0	9
<i>Tapinoma</i> sp.2	0	1	0	0	1	0	0	0	0	0	0	0	2
<i>Technomyrmex</i> sp.1	3	0	0	0	0	0	0	0	0	0	0	0	3
<i>Tetramorium anxium</i>	4	0	0	2	0	0	1	0	0	2	0	0	9
<i>Tetramorium edouardi</i>	0	0	0	0	0	0	0	0	0	1	0	0	1
<i>Tetramorium eminii</i>	1	0	0	1	0	0	2	0	0	5	0	0	9
<i>Tetramorium minimum</i>	0	0	1	0	0	0	0	0	0	0	0	0	1
<i>Tetramorium sericeiventre</i>	0	0	0	13	0	3	8	0	0	12	0	0	36
<i>Tetramorium simillimum</i>	2	0	1	0	0	0	1	0	1	1	0	0	6
<i>Tetramorium</i> sp.1	1	0	0	0	0	0	0	0	0	0	0	0	1
<i>Tetramorium</i> sp.2	0	0	1	0	0	0	0	0	0	0	0	0	1
<i>Tetramorium zapyrum</i>	1	0	0	0	0	0	1	0	0	0	0	0	2
<i>Tetraoponera mocquerysi</i>	0	4	0	0	0	0	0	0	0	0	0	0	4
<i>Lepisiota</i> sp.4	6	10	0	1	0	0	0	0	1	0	6	0	24
<i>Lioponera</i> sp.1	2	0	0	0	0	0	0	0	0	0	0	0	2
<i>Lioponera</i> sp.4	3	0	0	0	0	0	0	0	0	0	0	0	3
<i>Camponotus puberulus</i>	1	6	8	0	0	0	0	0	0	0	0	0	15
<i>Camponotus cinctellus</i>	0	3	7	15	3	10	8	0	5	14	0	5	70
<i>Leptothorax</i> sp.1	3	1	0	0	0	0	3	0	0	0	1	0	8
<i>Trichomyrmex abyssinicus</i>	0	0	0	2	0	2	2	0	0	1	0	0	7
<i>Trichomyrmex oscaris</i>	0	0	0	8	0	0	1	0	0	2	0	1	12
<i>Camponotus osiris</i>	0	0	0	1	2	2	0	0	0	0	0	0	5
<i>Mesoponera soror</i>	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>Nylanderia boltoni</i>	0	0	0	0	0	0	0	0	0	0	0	1	1
<b>Total</b>	119	89	112	262	94	129	253	106	118	229	79	119	1709

### 3.2. Harvesting Efficiency

The observed species richness obtained with the pitfall method in anthropised media is important compared to that of the control plot (Figure 4(a)). With the method of threshing (Figure 4(b)), the accumulation curve shows that in young and old anthropized media, the observed species richness is lower than that of the natural environment (control). However, only the intermediate plot has a specific richness substantially close to control plot (Figure 4(b)). The specific richness observed in anthropized media is substantially equal to that of the control medium in the case of manual collections (Figure 4(c)). The sampling efficiency of the ants for all the methods used varies from 55.25% to 98.90% in the media studied (Table 2). The pitfall method has an efficiency that varies between 63.69% and 85.64%, an average of 73.39%. That of the method of threshing oscillates between 55.25% and 98.90%, an average of 75.15%. With the manual collection method, the efficiency values are higher and range from 61.50% to 94.71%, an average of 79.52%. However, the harvest efficiency which is defined as



**Figure 4.** Curve of accumulation of ant species in mango orchards. (a) pitfall trap; (b) Beating; (c) manual collect; S: observed specific richness; Chao 2: expected specific wealth; 0 - 5 years: young plot, 6 - 15 years old: intermediate plot; >15 years old plot, control plot (botanical garden).

the arithmetic mean of the efficiency taken on all the methods is 76.02% for the plots studied.

### 3.3. Specific Diversity

The analysis in **Table 3** reveals that the older plot is more diversified ( $H' = 3.37$ ). It is followed by the control plot ( $H' = 3.23$ ) and finally young ( $H' = 3.19$ ) and intermediate ( $H' = 3.18$ ) plots. On all parcels, the values of the equitability ( $E$ ) of the different parcels vary from 0.82 to 0.87. The highest value was obtained in the older plots ( $E = 0.87$ ) and the lowest was obtained in the intermediate and control plots ( $E = 0.82$ ). In the same order, the Simpson indices of the different media are more or less close (0.94 to 0.95).

### 3.4. Dominance of Species Depending on the Environment

The specific composition of the medium shows that the control plot, young, intermediate and aged plots are dominated respectively by the species *Lepisiota* sp.1 (44 individuals), *C. rufigenis* (59 individuals), *C. sericeus* (69 individuals) and *O. longinoda* (45 individuals) The diagram in **Figure 5** shows that on all the plots, the species *C. acvapimensis* is dominant with a population of 159 individuals.

### 3.5. Hierarchical Ascending Classification Analysis

The hierarchical classification ascendant (**Figure 6**) of environments based on the specific composition of each parcel shows two (2) groups at the 85% threshold. The young and intermediate parcels being close constitute the first group. The older and control plots are the second group. The young and intermediate plots are substantially identical under the base of their specific compositions and the aged and control plots are also identical.

**Table 2.** Harvest Efficiency of methods.

Indices	Pitfall				Beating				Manual collecte			
	PJ	PI	PA	PT	PJ	PI	PA	PT	PJ	PI	PA	PT
S (Observed wealth)	43	44	41	36	17	18	15	19	22	22	23	23
Chao 2 (Expected wealth)	50.21	69.08	53.98	52.72	30.77	18.2	22.38	23.92	23.23	35.77	26.69	30.38
Efficiency (%)	85.64	63.69	75.95	68.29	55.25	98.90	67.02	79.43	94.71	61.50	86.17	75.71

PJ: Young plot; PI: Intermediate plot; PA: Old plot; PT: Control plot (botanical garden).

**Table 3.** Diversity of different plots.

plots	Shannon ( $H'$ )	Equitability ( $E$ )	Simpson index (1-D)
0 - 5 years	3.19	0.83	0.94
6 - 15 years	3.18	0.82	0.94
>15 years	3.37	0.87	0.95
control plot	3.23	0.82	0.94

0 - 5 years: young plot; 6 - 15 years: intermediate plot; >15 years: old plot; control plot: botanical garden.

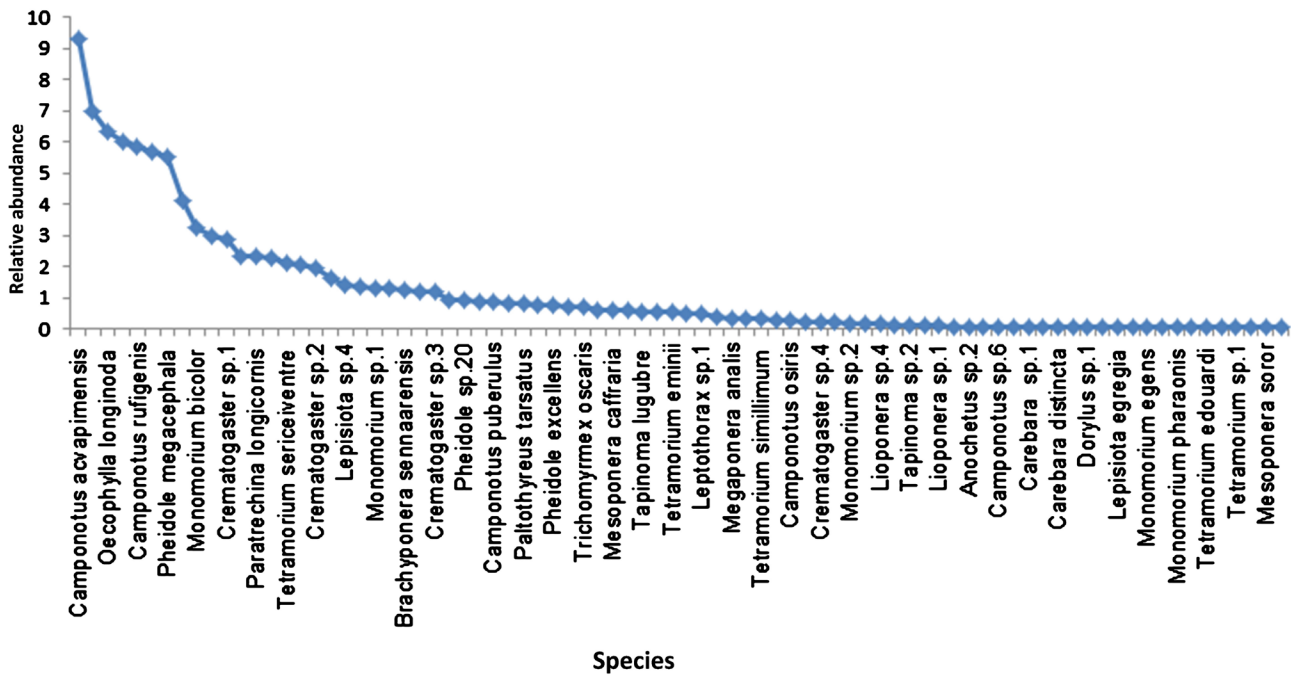


Figure 5. Rank-frequency diagram illustrating the dominance of species.

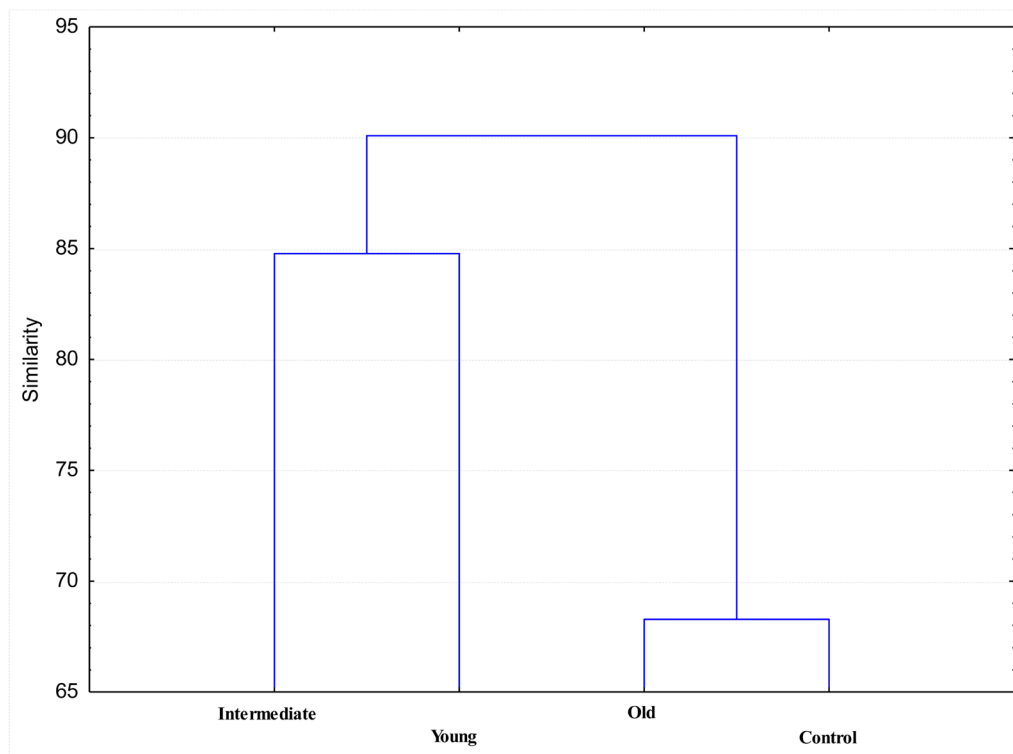


Figure 6. Similarity based on ants specific composition.

#### 4. Discussion

Sampling in mango orchards along an age gradient yielded 76.02% of the expected ant species. Koné [15] also obtained similar results. In all environments,

82 species grouped into 33 genera and belonging to 5 Sub-families were collected. The anthropised environment has high species richness (66 species) against 50 species in the natural environment. This difference could be due to the composition of the medium. Indeed, in the savannah zone, the natural environments have a low floristic density in man-made orchards that are man-made. This low density promotes low relative humidity in these ecosystems [27]. According to this author, the distribution of ant assemblages depends on abiotic (environmental factors) and biotic (inter and intra specific) constraints. According to [28], heterogeneity in colony density and species distribution is a common feature of many tropical ant assemblages. The species richness obtained in this study is lower than that obtained by [15] with 118 species in the pre-forest area of Lamto. Indeed, the pre-forest areas are characterized by a high relative humidity and its canopy. Dejean *et al.* (2007) [28] believe that the canopy is an essential factor in the distribution of species in mosaics. On the other hand [29]; Dieng *et al.* (2016) [23] obtained lower values than this study (15 species). It is estimated that this difference could be due to the sampling methods used. Indeed, this study is based on three (3) techniques to collect the myrmecofauna of litter, canopy and micro-habitats. Thus, the study environment and sampling methods would significantly influence collection results [30].

The anthropized environment has the highest number of individuals per species harvested, unlike the natural environment. In this study the relative abundance of ants decreases with the age of the plot. These results are close to those obtained by [30]. who found that litter ant communities are functionally specific to the type of vegetation formation and habitats. The sampled environments are highly diversified. Shannon's indices range from 3.18 to 3.37. These results are close to those of [30], who states that the forest surrounding the Nouragues (Guyane) research station is home to a highly diversified myrmecofauna. The species *Lepisiota* sp. 1, *C. rufigenis*, *C. sericeus* and *O. longinoda* are clearly abundant in the control plot; young orchards and orchards of intermediate ages. This observation could be related to the high adaptability of these species. On all the plots, *C. acvapimensis* is dominant. According to [15], this species is very abundant in food crops and pineapple plantations. The availability of resources is an asset in the installation of ants [31] and also the quantity and quality of litter Theunis *et al.*, (2005) [32]; Vasconcelos *et al.*, (2008) [33]. These differences would be a niche favorable to the installation of larvae of other insects, insects or sugar that this species needs for its food [15].

## 5. Conclusion

This study on the myrmecological fauna of the Korhogo region was conducted in two different environments (natural or control) and mango orchards (man-made) following an age gradient. A total of 82 species grouped into 33 genera divided into 5 sub-families (Dolichodorinae, Dorylinae, Formicinae, Myrmicinae, and Ponerinae) have been identified. The results obtained show a rela-

tive abundance of ant species lower in the natural environment than in anthropised environments. It has also been found that abundance decreases with the age of the plot. The analysis of the specific composition shows that the control, young, intermediate and aged plots are dominated respectively by the species *Lepisiota* sp. 1, *C. rufigenis*, *C. sericeus* and *O. longinoda*. In all environments, the dominant species is *C. acvapimensis*. This study made it possible to highlight the myrmecofauna of mango orchards. This is the first that will lead to the use of ants in biological pest control of mango fruits.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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